Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4583
Program Title: Exploring planetary nurseries around free-floating planetary mass objects

Principal Investigator: Scholz, Aleks

PI Institution: University of St. Andrews

Deep surveys in star-forming regions have discovered free-floating planetary-mass objects (FFPMOs), with masses comparable to those of giant exoplanets. It is not yet clear whether such objects form like stars, through core collapse, or represent ejected planets assembled initially in circumstellar disks. Neither is it known whether FFPMOs could harbor their own miniature planetary systems. Here we propose a reconnaissance survey of eight of the lowest-mass objects known with robust evidence of infrared excess emission due to a disk, using NIRSPEC-PRISM and MIRI-LRS, to address these questions. In particular, we plan to characterize FFPMO disks by (1) deriving the dust geometry from the 3-12micron SED slope; (2) determining the degree of dust processing from the 10micron silicate feature; and (3) characterising the central sources from the 1-3micron spectrum. Taken together, these three tests will probe the potential for planet formation in disks surrounding the lowest mass free-floating objects hitherto explored, eliciting comparisons to the Jovian system, and also inform the discussion about the formation of FFPMOs themselves.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4586
Program Title: MIRI Spectroscopy of the Brightest Galaxy Spectroscopically-Confirmed at z>11 to Understand the Origin of the Overabundance of Early Luminous Galaxies

Principal Investigator: Harikane, Yuichi

PI Institution: University of Tokyo, Institute of Cosmic Ray Research

The JWST is currently unveiling a significant number of bright galaxies at z>11, both through photometry and spectroscopy. The remarkably high number density of these luminous galaxies, compared to theoretical model predictions, raises questions about potential differences in the physical properties of galaxies at such extreme redshifts and those at lower redshift. However, the exact physical mechanism responsible for this overabundance is still a subject of debate, primarily because the currently available NIRSpec dataset does not cover the rest-optical lines such as Ha and [OIII] at z>11, which are essential for investigating key physical properties. Given that GN-z11 at z=10.60 (being observed in Cycle 2) exhibits atypical features, studying another bright galaxy at z~11 with MIRI is crucial for understanding the physical origins responsible for the overabundance. In this proposal, we aim to conduct MIRI MRS spectroscopy and imaging of CEERS2-588, the most luminous galaxy spectroscopically confirmed at z>11. These observations will yield detections of strong rest-optical lines and allow us to investigate critical physical properties such as stellar mass, star formation rate, metallicity, AGN activity, and burstiness, which are of intense interest in the context of the overabundance of z>11 galaxies. The successful detection will open the door to ambitious follow-up observations targeting more z>11 galaxies to obtain a comprehensive understanding of properties of early galaxies. Conversely, the absence of these emission lines would pose an immediate question about the nature of this galaxy, which appears UV-luminous despite indications of extremely weak emission lines.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 4598
Program Title: Silver Bullet for Dark Matter

Principal Investigator: Bradac, Marusa

PI Institution: University of Ljubljana, Dept. of Physics

The principal objective of this proposal is to study the nature of dark matter by using a merging galaxy cluster. Gravitational lensing provides a unique tool transforming these clusters into dark matter laboratories. The pioneering example, the Bullet Cluster, is an ideal laboratory for detecting dark matter and distinguishing between cold dark matter (CDM) and other scenarios (e.g., self-interacting dark matter). With this proposal, the limits on the dark matter self-interaction cross-section will be improved (by a factor of 4, to <0.2cm^2/g) to the extent that the possibility that dark matter self-interactions might explain the observed non-cuspy mass profiles can be fully excluded. To pin down the position of the dark matter component we require high resolution, absolutely calibrated mass maps that will be compared to simulations. The combination of weak and strong lensing measurements is needed to attain this goal. This can only be achieved with the excellent resolving power and spectroscopic capabilities of JWST. We therefore request NIRCam and NIRSpec observations of the Bullet Cluster. The combination of constraints from multiply lensed images (identified via color information and spectroscopy) and high-resolution weak lensing data will allow us to construct, self-consistently, the mass distribution from the very center to the outskirts. With this proposal we will further improve the selection of cluster members and measure their velocity to unambiguosly separate the baryonic and DM components. The proposal will enable investigations of the nature and properties of dark matter, and how it shapes galaxies and galaxy clusters and their evolution through cosmic time.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4604
Program Title: The source of the gas plumes of Enceladus

Principal Investigator: Brown, Michael

PI Institution: California Institute of Technology

Ever since the discovery of salt particles in the plumes of Enceladus, these plumes have been widely thought to be directly connected to the subsurface ocean. At least one observation is inconsistent with this interpretation, however. Current plume models predict that the water vapor and the particle jets in the plume are intimately connected and should vary in sync. The particle jets have been imaged thousands of times and are known to vary in intensity within a single orbit in an extremely repeatable pattern, with a factor of six or more variation between the pericenter and apocenter of the Enceladus orbit. The vapor component of the plume, in contrast, appears to vary by no more than +/-15% over the entire Cassini mission. Unfortunately, the vapor component has been sparely sampled in both time and space, so its true variability is difficult to assess, and suggestions have been made that the lack of observed variability is just due to coincidences of timing. Resolving this discrepancy is critical. If indeed the vapor component of the plume does not vary with the particle jets, our models of the source mechanism of the plumes, as well as potential connections to the underlying ocean, require serious reevaluation. JWST can resolve this question. We propose to make the first ever observations of the vapor component of the plumes of Enceladus over the course of a single Enceladus orbit. These observations will quickly and definitely determine how much, if any, of the vapor component of the plume varies in sync with the particulate jets, allowing us to determine the true connection between the plumes and subsurface ocean.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4607
Program Title: The Enigma of the Recurrent nova T Coronae Borealis - A ToO

Principal Investigator: Woodward, Chick

PI Institution: University of Minnesota - Twin Cities

One of the most famous and brightest novae, the recurrent nova (RN) T Coronae Borealis, is expected to erupt during the period 2025.5 +/- 1.3. With only two recorded eruptions in 1866 and 1946, it has never been studied in the IR. T CrB declines in visual brightness very quickly after the nova explodes. During this decline towards quiescence, important and profound physical changes occur in the ejecta; e.g., the line profiles show rapid changes and coronal lines appear. Using the MRS IFU, we will observe and analyze the evolutions of: (1) shocks propagating through the ejecta, (2) the changes in velocity profiles of the emission lines, (3) the coronal line emission, deriving elemental abundances from the H, He and coronal lines, (4) dust features in the SED, and (5) ejecta-wind interactions and the possibility of discovering a light echo in the surrounding circumstellar environs. JWST observations will provide unprecedented insight into details of the nova's expanding fireball. They will have an invaluable impact on understanding symbiotic RNe, systems potentially Type 1a SN progenitors as their white dwarfs (WD) seem to exhibit a net accretion of material (i.e., from the Red Giant onto the WD minus that ejected in the RN explosion). This non-disruptive ToO will yield a thorough documentation of all phases (5 visits) of post-eruption evolution. JWST will contribute significantly to and complement a community-wide panchromatic observational campaign to study this extraordinary event. The T Crb event will further our understanding of RNe, yielding insight into Type Ia SN, which are key to determining cosmic large-scale structure.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4611
Program Title: Baselines: Revealing the central extended emision of Circinus with interferometric mode

Principal Investigator: Lopez-Rodriguez, Enrique

PI Institution: Stanford University

The dusty and molecular torus is one of the most elusive structures in active galactic nuclei (AGN), yet its importance is unequivocal for understanding the effects of accretion and feedback during galaxy evolution and provides constraints for theoretical models of galaxy formation. NIR observations are sensitive to the hot dust (1500-500K), which traces the inner edge of the torus, and/or the base of torus walls or dusty winds. Surprisingly, the measured 3-5um excess emission in AGN since first observed in the early ’90s still remains a mystery. This observed NIR excess is thought to arise from hot dusty winds, hot graphite dust within the torus and the broad line region, and/or residual starlight from the host galaxy. Thus, the identification of the physical structure and/or mechanism producing the NIR excess will allow us to connect the accretion disk with the reservoir of gas feeding it. JWST NIRISS Aperture Masking Interferometry (AMI) can provide resolved 3.8-4.8um images of the dusty environments within the central 10 pc in nearby Seyfert galaxies. NIRISS AMI improves the angular resolution by a factor of two (0.07'' vs. 0.14'' at 4.3um), while minimizing the PSF artifacts shown by NIRCAM. The possibility of unveiling the hot (1500-500 K) dusty material within the central 0.1” of AGN relies on making NIRISS AMI a user-friendly and standard observing mode of JWST for the AGN community. This proposal requests 3.8-4.8um NIRISS AMI observations to provide unprecedented 1.8-2.2pc-scale resolved observations of the central 10pc in Circinus. These observations will reveal the location and physical properties of the NIR excess emission measured in Seyfert galaxies.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4627
Program Title: Deuterium in the outer solar system

Principal Investigator: Brown, Michael

PI Institution: California Institute of Technology

The deuterium-to-hydrogen ratio (D/H) of bodies in the solar system holds some of the key tracers of protoplanetary nebular history, including the mixing of protostellar gas and ice and the source of the Earth's water. The inner Solar System, including the Earth's water, is enriched in D/H compared to the initial gaseous nebula and so demands an additional enriched source. Bodies which formed beyond the frost line and accreted unvaporized interstellar ice are expected to have the significantly higher D/H values associated with the ice component of the nebula and thus could be plausible sources of the Earth's water. Measurements of D/H in hydrated asteroids are clearly affected by alteration processes and return ambiguous values, with some higher and some lower than terrestrial. Comets, likewise, show a wide range of values which can clearly be affected by the cometary activity itself. We propose to measure D/H in the solid ice of a small pilot sample of icy TNOs/Centaurs by measuring absorption due to the fundament D-H stretch at 4.13 microns (the analog to the 3 micron O-H stretch). By measuring D/H in the solid phase on bodies which have presumably never had water sublimation, we will be making the first measurement of what should be the pristine D/H ratio in the outer solar nebula. If these pilot observations allow us to successfully measure D/H, they will open in new era in the exploration of the icy bodies of the outer solar system and their formation and evolutionary environments.

Proposal Category: AR (GO-Archival)
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4640
Program Title: SKY in 30D: Stellar Kinematic studY in 30 Doradus

Principal Investigator: Sabbi, Elena

PI Institution: Space Telescope Science Institute

Star formation (SF) is a dynamic process that leaves distinctive marks on the kinematics of young stars. These signatures can be used to discriminate between competing theories for cluster assembly. While Gaia's exploration of young star clusters in our Milky Way (MW) provides valuable insights into the star-forming process in well-established spiral galaxies, it cannot access the intense SF rates seen in starbursts, interacting galaxies, and high-redshift regions. We propose an Archival Legacy Program that exploits the unique JWST/ERO dataset of the Large Magellanic Cloud's (LMC) 30Doradus, the brightest starburst in the Local Group. By comparison to existing Hubble Archival data with a 13-year time baseline, we will chart the evolution of this starburst with a resolution comparable to studies of star-forming regions in the MW. This is inaccessible to Gaia due to the distance and severe crowding. But through JWST and HST's high sensitivity, spatial resolution, and focus stability, we will measure projected motions with 2-4 km/s uncertainty for thousands of stars with mass 0.8-17 Msun. The average motions of stellar sub-clusters will be constrained to 1-2 km/s, allowing us to separate distinct stellar components kinematically. Our program will also enable a wealth of other SF investigations by the astronomical community, as well as new studies in unrelated areas such as binary stellar evolution, dust extinction, and LMC kinematics. We will release catalogs of proper motions, photometry, and stellar parameters as High-Level Science Products to the MAST archive. We will post the Jupyter notebooks used for the analysis of the data on GitHub.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4645
Program Title: Reconstructing the Histories of the Ice Giant Systems through Small Satellite Observations

Principal Investigator: Belyakov, Matthew

PI Institution: California Institute of Technology

Decades of ground-based observations, spacecraft exploration, and now NIRSpec data from JWST have characterized the Jovian and Saturnian satellite systems, leading to ground-breaking discoveries about the gas giants and their satellites. By contrast, observations of the Uranian and Neptunian systems are sparse, with ground-based observations of all but the brightest satellites hindered by their significantly farther distance and no dedicated spacecraft exploration. This lack of data, particularly of the fainter satellites, has made reconstructing the histories and current compositions of the ice giants' systems challenging, leaving vital open questions unanswered. We therefore propose to observe a representative sample of small interior, mid-sized, and irregular satellites of Uranus and Neptune with JWST/NIRSpec, seeking to answer open questions on the composition of the ice giants' subnebulae, to understand the specific compositions of the key satellites Miranda and Proteus, and to trace the individual evolutions of the two systems.
JWST/NIRSpec is uniquely suited to probe the compositions of these faint Uranian and Neptunian satellites. The ices of these objects are expected to have strong absorption features in the 2.5-5.0 micron range, which cannot be studied from the ground due to telluric absorption. In the context of the NASA Planetary Science decadal survey's focus on Uranus and proposed Uranian orbiter mission, obtaining an understanding of the ice giants is now more vital than ever. These proposed observations will provide the single best opportunity to characterize targets of interests for future missions to Uranus and Neptune.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4665
Program Title: Constraining the origin and dynamical evolution of extreme trans-Neptunian objects through NIR spectroscopy

Principal Investigator: Holler, Bryan

PI Institution: Space Telescope Science Institute

We propose to obtain low-resolving power (R~100) near-infrared spectra of 6 extreme trans-Neptunian Objects (ETNOs) using the NIRSpec IFU and the Prism/CLEAR combination to constrain ETNO origins. The ETNOs are a unique and understudied population of trans-Neptunian objects with large perihelia (> 37 au) and semi-major axes (> 150 au) that could not have been placed on their current orbits via Neptune on its current orbit. The majority of the members of this population were only discovered within the past 10 years due to their faintness and no observations of ETNOs were approved in Cycle 1 or 2, representing a large gap in our understanding of the trans-Neptunian region. In this investigation, we will compare the spectra of the 6 ETNO targets to each other to determine if the population is compositionally heterogeneous and therefore formed in different regions of the solar nebula. We will also compare the ETNOs to objects in other TNO sub-populations to constrain their possible origins. The excellent sensitivity of JWST will provide us with an unparalleled opportunity to study these extreme and poorly understood objects as a stepping stone to addressing larger questions about the era of planetary migration, the possible presence of a distant outer planet, and the structure and formation of debris disks around other stars.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4668
Program Title: Arcana of the Ancients: A Spectral Metallicity Survey of the Lowest-Mass Stars and Brown Dwarfs

Principal Investigator: Burgasser, Adam

PI Institution: University of California - San Diego

Metallicity is an essential parameter in the formation, evolution, and atmospheres of the lowest-mass stars and brown dwarfs, also known as ultracool dwarfs (UCDs). The vast majority of known UCDs are solar-metallicity thin disk objects in the Solar Neighborhood, but the exceptional infrared sensitivity of JWST is now reaching distant UCDs in the Milky Way's metal-poor thick disk, halo, and globular cluster populations. These ancient systems provide new opportunities to study the early star formation and chemical evolution history of the Milky Way, and improve our understanding of planet-like atmospheres with non-solar abundances. However, our ability to study and infer the physical properties of metal-poor UCDs is hindered by the lack of empirical data and validated atmosphere models. We propose a 0.6-14 micron spectroscopic survey of 32 L and T dwarfs and subdwarfs, including 11 wide companions to FGK stars, to investigate metallicity's influence on atmosphere chemistry, condensation, and disequilibrium mixing. Our study includes the development of new atmosphere and evolutionary models, and retrieval modeling applied to absolute flux-calibrated spectra sampling a broad range of molecular and continuum features. In addition to advancing our theoretical understanding of low-temperature atmospheres, our spectral survey will provide the necessary empirical guidance for ongoing deep JWST surveys and future Euclid, LSST, and Nancy Grace Roman Space Telescope studies of metal-poor UCDs in multiple Milky Way populations.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4678
Program Title: The chemistry of complex hydrocarbons in ejecta from evolved objects

Principal Investigator: Sloan, Greg

PI Institution: Space Telescope Science Institute

We will obtain infrared spectra of seven evolved objects in the Large and Small Magellanic Clouds that exhibit spectral features from complex hydrocarbons using both the Fixed Slit on NIRSpec and the Medium-Resolution Spectrometer (MRS) on MIRI. These sources have departed from the asymptotic giant branch and are evolving into planetary nebulae. They display a range of carbon-rich spectral characteristics, including the classic spectrum attributed to polycyclic aromatic hydrocarbons seen in many planetary nebulae, mixtures of aromatic and aliphatic hydrocarbons, the still-unidentified 21 um emission feature, and recently discovered but still unidentified emission features apparently associated with hydrocarbons. This project will exploit the unprecedented combination of spectral resolution, wavelength coverage, and sensitivity offered by NIRSpec and the MRS to explore the chemistry of complex hydrocarbons as carbon stars evolve into planetary nebulae. The resulting spectra will sample the gas and dust at different stages of evolution as carbon-rich objects seed their host galaxies with fresh dust.

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Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4687
Program Title: Constraining the Composition and Thermal Histories of Silicate Minerals on Callisto

Principal Investigator: Davis, M. Ryleigh

PI Institution: California Institute of Technology

The heavily cratered surface of Callisto, the outermost of Jupiter's Galilean moons, presents a unique opportunity to study the largest object in the solar system with a primordial surface affected only by cratering and irradiation. Callisto's surface is dominated by crystalline water ice inter-mixed with a dark non-ice component. Yet, despite nearly 50 years of spectroscopic study, the mineral composition of the dark material on Callisto remains unknown and we lack a clear understanding of its source - with possibilities ranging from primordial endogenic silicates to exogenic dust. We propose to observe the leading and trailing hemispheres of Callisto with MIRI MRS in order to confirm the presence of silicates on Callisto, determine ther abundances, trace their thermal histories through the Fe/Mg ratio, and better understand the relationship between the endogenic material and exogenic processes that have shaped Callisto's surface over time.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4691
Program Title: Investigating an Extreme [OIII] Outflow Discovered in a Reionization-era Luminous Quasar

Principal Investigator: Yang, Jinyi

PI Institution: University of Arizona

Observations of z>6 quasars have revealed the existence of billion solar-mass supermassive black holes (SMBHs) and massive host galaxies with intense star formation in the early Universe. A key open question is whether and how the energy output by these first SMBHs regulates the star formation in their host galaxies through quasar feedback. The [OIII] 4959,5007 doublet is regarded as a primary tracer of galactic-scale outflows, but related studies have been largely limited to z<3.5 until the advent of JWST due to limitations in wavelength coverage, resolution, and sensitivity. Quasar J0224-4711 at z=6.5 was observed with JWST NIRCam/WFSS in Cycle 1, and shows signatures of an extreme [OIII] outflow. It is the only case known in high-redshift quasars so far, and one of the most extreme quasar [OIII] outflows known over cosmic time. This system is clearly showcasing one of the most powerful quasar feedback events ever observed. Existing data are limited to shallow slitless spectroscopy. Thus, we propose deep NIRSpec/IFU observations to investigate this strong outflow and the quasar-host galaxy system. The proposed observations will resolve the [OIII] outflow spatially and spectroscopically to map its spatial extent, measure its kinematic properties, and probe the wind-driving mechanism. We will also be able to characterize the host galaxy properties by constraining its spectral energy distribution and mapping narrow emission lines. The observations will reveal the nature of the most powerful AGN feedback known in distant quasars and will be a milestone in our understanding of SMBH-host galaxy interaction, particularly during the early, fast-growing stage of the SMBH.

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Proposal Category: AR
Scientific Category: Galaxies
ID: 4695
Program Title: DARK-SKY: Constrain Zodiacal Light & diffuse Extragalactic Background Light from Archival JWST images

Principal Investigator: Windhorst, Rogier

PI Institution: Arizona State University

Most photons in JWST's near-IR images come from within 5 AU: Zodiacal Light (ZL) as seen from L2. Smaller components come from JWST straylight (SL), Diffuse Galactic Light (DGL), Integrated Galaxy Light (IGL), diffuse Extragalactic Background Light (EBL), and thermal radiation. JWST serves as absolute IR photometer on long timescales, and so can uniquely constrain these components. Archival Legacy Calibration project "DARK-SKY" will analyze the sky-surface brightness (sky-SB) observed between discrete objects detected in public images from ~100 independent sight-lines using 8 broad- and 12 medium-band NIRCam+NIRISS filters. Our calibration and science goals are: 1) Several significant calibration improvements: high-fidelity scene-dependent 1/f-noise and wisp removal, and chip-to-chip zeropoint refinements to <2%, providing a Legacy Calibration dataset to the community. 2) Measure the 0.9-5 micron object-free sky-SB in these filters across the sky within <2-4% including full error propagation, with NIRISS as check on NIRCam systematics. 3) Model the sky-SB for the observing date and the 3D position of JWST in L2 as the sum of: a) ZL using updated models of solar system dust-scattering; b) SL models from the IR sky reflecting off dust on JWST's primary; c) the IGL as a best fit to the galaxy counts; and d) the DGL level derived for each direction. 4) Set competitive limits to, or detect, any remaining Diffuse Light (including diffuse EBL) from the best-fit difference between 2) and 3) across the sky. We expect our 2.7-5.0 micron Diffuse Light values to be better than 4-8 nW/m^2/sr, so DARK-SKY can constrain the SED and source of this mysterious excess Diffuse Light.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4706
Program Title: Fullerenes in Tc 1: a quantitative study of the interaction of large molecules with their radiative environment.

Principal Investigator: Cami, Jan

PI Institution: The University of Western Ontario

We propose to observe the unique fullerene-rich planetary nebula Tc 1 with MIRI (MRS and Imaging) and NIRSpec-IFU to carry out a spatially resolved study of the spectral characteristics of C60 ("buckyballs") and their dependence on the physical conditions. Our goal is to elucidate the excitation, formation and evolution of fullerenes in radiative environments. Tc~1 is the ideal target since it is geometrically simple, resolved (12" diameter), and its spectrum shows little contamination by other species. Our key objective is to measure the spectral characteristics of the main C60 emission bands (at 7.0, 8.5, 17.4 and 18.9 micron) across the main nebula, from the intense radiative environment near the hot central star (Teff=34,000~K) to the Photo-Dissociation Region beyond the ionization front. We will use atomic emission lines to determine the local physical conditions (temperature, density, radiation field). We will thus be able to describe quantitatively how fullerenes respond to changes in their environment. We will also search for and characterize other fullerenes and compounds (e.g. C60+, C70+ and hydrogenated fullerenes). This detailed description will provide key insights into the excitation mechanism of large aromatic species in radiative environments, and offer much needed constraints on the (photo-)chemical pathways to fullerenes in evolved stars. We will use this study to calibrate models for the excitation, ionization and processing of polycyclic aromatic hydrocarbons (PAHs) that are widespread and abundant in the Universe, and play key roles in large-scale astrophysical processes such as star and planet formation and galaxy evolution.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4711
Program Title: Efficient and Detailed Characterization of a Temperate Water World Candidate

Principal Investigator: Hu, Renyu

PI Institution: Jet Propulsion Laboratory

Temperate water worlds, if they exist, provide a new avenue to expand and accelerate the search for potentially habitable exoplanets in the next decade. This is because many more temperate planets in the 1.5 – 2.2 Earth's radius range are suitable for atmospheric studies than the sole TRAPPIST-1 system that hosts temperate and small rocky planets. Among the sub-Neptunes, however, only temperate water worlds, rather than mini Neptunes, can host liquid-water oceans. It is thus crucial to determine whether temperate sub-Neptunes are water worlds. We identify TOI-4336.01, a newly discovered 2.1 Earth's radius temperate planet, as a likely water world and the most favorable target for transmission spectroscopy among the planets with similar sizes, equilibrium temperatures <320 K, and measured masses. The planet can have a liquid-water ocean with reasonable planetary albedo. With only one transit using NIRISS/SOSS and another one using NIRSpec/G395H, the resulting spectra will be sensitive and precise enough to measure the abundances of H2O, CH4, NH3, CO2, and CO, and constrain the cloud pressure. The combination of these gases will determine whether the planet is a water world. This observation will also determine whether the planet has a liquid-water ocean if it is a temperate water world. This highly efficient and yet detailed characterization of the temperate sub-Neptune will constrain the suggested population of water worlds around M dwarfs and have the potential to expand the search space of habitable worlds from Earth-sized planets to larger planets.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4712
Program Title: Looking into the core of a stellar explosion - the case of SNR 0540-69.3

Principal Investigator: Larsson, Josefin

PI Institution: Royal Institute of Technology

JWST observations of supernova remnants (SNRs) offer a unique opportunity to uncover the physics governing stellar explosions, the ejected debris and resulting compact objects. We propose to observe a particular interesting remnant, SNR0540, which stems from a massive star that exploded in the LMC 1100 years ago. The NIRSpec and MRS IFUs will be used to obtain the first spatially resolved infrared spectroscopy of the inner region of the system. This region contains an energetic pulsar surrounded by a pulsar wind nebula (PWN), warm dust, as well as a highly asymmetric distribution of line-emitting ejecta, making it possible to address a wide range of open questions. We will determine the abundances and 3D distribution of the ejecta, the location of the dust, the spatial variations of the synchrotron continuum in the PWN, and also obtain the first mid-infrared spectrum of the pulsar. These results in turn offer key diagnostics of the progenitor, explosion mechanism, dust production and particle acceleration. The proposed observations will thus provide a uniquely detailed view of all the physics operating at the core of a SN.

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Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 4713
Program Title: MASQUERADE: Mapping a Super-luminous Quasar’s Extended Radiative Emission

Principal Investigator: Eilers, Anna-Christina

PI Institution: Massachusetts Institute of Technology

The ultraviolet radiation of luminous high-redshift quasars within the Epoch of Reionization carves out large bubbles of highly ionized intergalactic gas in the quasars’ environments, making the otherwise opaque Lyman-alpha (Lya) forest highly transparent at redshifts near to the systemic redshift of the quasar, which is known as the proximity effect. In this proposal we aim to leverage the unique capabilities of JWST’s NIRSpec/MSA to observe an overdensity of spectroscopically confirmed, bright galaxies in the background of the super-luminous quasar J0100+2802 at a redshift of z=6.33 at close projected distances, in order to tomographically map the quasar’s ionized region for the first time by means of the transverse proximity effect. These observations will uniquely reveal the geometry of the quasar’s ionization cone, and constrain its opening angle and obscuration. Additionally, the extent of the ionized region, also known as the quasar’s light echo, provide a model-independent constraint on the quasar’s age based on the light travel time, which will enable new insights on the puzzle of the early growth of supermassive black holes. Simultaneously, the quasar’s highly ionized region provides a unique laboratory to study the intrinsic ionizing properties of high-redshift galaxies without absorption by the IGM. By measuring the unattenuated line profiles of the Lya emission combined with a first census of high-ionization UV emission lines for ~35 galaxies at 5.7<z<7, our proposed observations will also reveal the elusive protagonists that reionize the universe.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4727
Program Title: Snowline pulsations and UV photo-chemistry in planet-forming regions

Principal Investigator: Banzatti, Andrea

PI Institution: Texas State University

The chemical composition of protoplanetary disks determines the core and atmospheric composition of forming planets. While disk chemical models, for simplicity, typically assume steady-state conditions, the irradiation of the inner planet-forming zone in disks can vary dramatically during the unstable accretion phases that are typical of T Tauri stars at ~1-3 Myr. Stellar accretion variability leads to UV flares that change the heating, excitation, and photo-dissociation conditions in the inner disk. As inner disk chemistry studies are ramping up with JWST-MIRI observations from cycle 1, molecular spectra show broad trends and large scatters that expand those previously seen with Spitzer-IRS and still challenge current static models. This program will take the rare opportunity of a real-time experiment to clarify the role of accretion flares in altering the chemistry of planet-forming regions. A system with periodic flares of up to 10 times the accretion luminosity will be monitored with MIRI-MRS to measure cold water "bursts" from ice sublimation when the snowline recedes during the flare, and UV-driven dissociation and re-formation of C, N, O, H chemistry. The results from this experiment will provide groundbreaking insights on the ice mass reservoir at the snowline and on the formation and survival of water and organic molecules in planet-forming regions. This program will inaugurate studies of time-dependent inner disk chemistry, support fundamental developments in disk and planet formation models, and help clarify the interpretation of broad chemical trends and scatters observed in large disk samples observed with JWST.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4735
Program Title: A Closer Look at the Formation and Evolution of M31's Inner Disk

Principal Investigator: Sandford, Nathan

PI Institution: University of Toronto

We propose to use JWST/NIRSpec's unique capabilities to measure detailed chemical abundance patterns for hundreds of resolved red giant branch (RGB) stars in the inner regions (R < 14 kpc) of M31’s disk. We will target 2 fields at R ~ 3 and 8 kpc, where the chemistry of stars encode information of both M31's in situ star formation and accretion history. Combined with an archival field at ~18 kpc, these observations will provide a combined sample of >300 M31 RGB stars for which [Fe/H], [alpha/Fe], and 8 other individual elements will be measured (Si, C, Mg, O, N, Ni, Mn, and Ti) to <0.1 dex precision. These elements trace a variety of enrichment mechanisms, timescales, and nucleosynthetic pathways enabling science which, to date, has only been possible in the Milky Way. We will use these detailed abundance patterns to pursue a broad array of science including confirming the presence (or absence) of M31's [alpha/Fe]-bimodality, mapping radial abundance trends, and measuring the efficiency of radial orbit migration and disk heating in M31. We will use parallel NIRCam imaging to construct the deepest color-magnitude diagrams to date in M31's inner disk, from which we will measure the age-metallicity relationship back to 4-5 Gyr ago and search for evidence of an intense burst of star formation 2-4 Gyr ago. This program will fundamentally transform our understanding of M31 and other Lstar galaxies while further establishing NIRSpec as a premier facility for extragalactic stellar spectroscopy.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4744
Program Title: SN H0pe: Doubling the Time Delay Precision of a z=1.78 Multiply-imaged Type Ia Supernova

Principal Investigator: Frye, Brenda

PI Institution: University of Arizona

The most distant (z=1.78) lensed supernova (SN) Ia was discovered near peak brightness in JWST/NIRCam imaging in the PLCK G165.7+67.0 (G165) galaxy cluster, named "H0pe." SN H0pe is triply-imaged and provides the first opportunity to measure the Hubble constant (H0) using time delays from a multiply-imaged SN Ia. This H0 constraint is independent of the field SN Ia and CMB approaches, which are currently in ~5sigma tension. However, the lack of imaging without the supernova present makes disentangling the SN light from its bright host galaxy a challenge, particularly at wavelengths >2 micron where most of the leverage for time delays resides. The initial time delay measurements for SN H0pe are limited by photometric uncertainties in the F200W and F277W filters, and the absence of measurements in F356W & F444W, which cannot be extracted without template imaging. 1) Simulations demonstrate that obtaining a reference epoch after SN H0pe has faded introduces 18 new photometric points from the previously missing long wavelength filters, and improves the overall time delay uncertainties using all six filters by a factor of 2. 2) The reduced uncertainty in the time delay taken together with a conservative lens model uncertainty of 10% translates to ~20% reduction in the uncertainty on H0 by this method. Therefore, we propose straightforward imaging of the G165 system with NIRCam in six broad bands, in order to to extract precision photometry of SN H0pe from extant data and provide the definitive time delay and H0 measurement. An investment of 3.5 hours with JWST can directly improve a critical independent cosmological measurement to confront the Hubble tension.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4748
Program Title: The Ancient Star Formation History of the Isolated, Quenched Ultra-faint Dwarf Galaxy Tucana B

Principal Investigator: Sand, David

PI Institution: University of Arizona

We request F090W+F150W NIRCam imaging of Tucana B, a newly discovered, isolated ultra-faint dwarf galaxy beyond the edge of the Local Group (M_V=-6.9; D=1.4 Mpc). Tucana B is a unique ultra-faint, as it has likely never had an encounter with the Milky Way's hot halo or tidal field, yet its ground-based observations only display an old (~13 Gyr), metal poor ([Fe/H]=-2) stellar population, and it lacks any HI gas with which to make new stars -- it is quenched. Reionization is expected to quench many of the smallest galaxies at early times, heating their gas reservoirs and stopping any subsequent star formation. Observations of Tucana B down to the oldest main sequence turnoff will be a definitive test of the role that reionization plays, identifying whether early star formation stopped around the reionization epoch, or continued up until more recent times, as is seen in more massive field dwarfs. Only JWST can perform these observations well outside the Milky Way's virial radius, where ultra-faint dwarf galaxies are unaffected by ram pressure and tidal forces. Tucana B is currently the only target that can test this prediction of modern galaxy formation theory. We have designed our observations with potential, future proper motion measurements in mind, which could further elucidate the origins and history of Tucana B with respect to the Local Group.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4750
Program Title: Unveiling the Primordial Universe: A <1000 Msun Stellar Cluster at z=6.6

Principal Investigator: Nakajima, Kimihiko

PI Institution: National Astronomical Observatory of Japan (NAOJ)

The formation of primordial stars and galaxies in the early universe has been a challenge for observational astronomers until recent advancements with JWST. Notably, Vanzella et al. (2023) used NIRSpec-IFU observations to study a highly magnified (>~100x) Lyman-alpha emitting arc at z=6.6, hinting at the presence of a low-mass (Mstar <1000 Msun), low-metallicity stellar cluster within the arc. This suggests it might host Population III stars formed from pristine gas. This program proposes extensive NIRSpec spectroscopy of the stellar cluster. The main goal is to confirm the existence of primordial gas at z=6.6 and ongoing Population III star formation. To achieve this, deep observations requiring 24 hours of on-source integration will be conducted. These observations aim to identify the HeII 1640 emission line, which will serve as a critical test of the Population III star formation scenario. The objectives also include establishing a more stringent upper limit on gas-phase metallicity by examining the deep spectrum around [OIII] 5007, providing stronger support for the primordial nature within the star forming regions of the stellar cluster. Furthermore, we will combine the entire suite of NIRCam images from GTO observations to obtain a stricter limit on the stellar mass of the stellar cluster, potentially down to 500 Msun. With these updated observational findings, this program will contribute to our understanding of the characteristics of Population III stellar clusters and the persistence of pristine gas conditions in the universe.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 4757
Program Title: Using water to test for variation in the stellar initial mass function

Principal Investigator: van Dokkum, Pieter

PI Institution: Yale University

Despite many years of effort, the question whether the form of the stellar initial mass function (IMF) is universal or varies in different environments is still not settled. Of particular current relevance is the IMF in the central regions of the most massive galaxies: several lines of evidence suggest that it is bottom-heavy, with an excess of low mass stars, and this would have direct implications for the stellar masses that are assigned to JWST-discovered galaxies at the highest redshifts. The strongest and clearest spectral signature of low mass stars in the integrated light of old stellar populations is H2O absorption, with a sharp onset at 1.33 micron. So far H2O has not been used in IMF studies, as the strong absorption in our own atmosphere makes it impossible to observe this feature from the ground. Here we propose to measure the 1.33 micron H2O feature with the NIRSpec IFU to test whether the IMF varies with environment. The sample of seven objects includes several galaxies with a claimed extremely bottom-heavy IMF as well as two metal-rich and old M31 globular clusters as a control to verify the method. A secondary goal is to measure the spatial variation of the 1.33 micron feature on 0.1'' scales, and to determine whether radial gradients seen with other IMF indicators on much larger scales continue all the way into the center.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4758
Program Title: From Day to Season: Constraining the Rotation Period and Obliquity of Beta Pic b with Time-resolved High-contrast Imaging

Principal Investigator: Zhou, Yifan

PI Institution: The University of Virginia

Rotational modulation is common among brown dwarfs and planetary-mass objects. The periodic light curves reveal heterogeneous atmospheric structures and enable precise measurements of rotation period and spin angular momentum. The observed rotational period, when combined with the projected rotational velocity (v sin i), constrains spin axis orientations and planetary obliquity, which offer unique insights into a planet's formation history and dynamical evolution pathway. The light curves of directly imaged exoplanets can only be precisely measured with JWST/NIRCam coronagraphic imaging. The super-Jovian planet Beta Pic b, reciding in a dynamically interactive system, stands out as an ideal target of time-resolved high-contrast photometry. We propose a photometric monioring campaign using the JWST NIRCam dual-band coronagraphic mode to observe the rotational modulation in Beta Pic b. These observations will probe the heterogeneous atmosphere of Beta Pic b, precisely constrain the planet's rotation period, uncover the planet's obliquity, and test the alignment between the planet's spin and orbital axes. Beta Pic b will have its maximum angular separation from its host star during JWST Cycle 3. The same opportunity will not repeat until 2035.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4761
Program Title: A Deep Look into PAHs: Resolved PAH and Fine-Structure Emission in z=1 Main-Sequence Galaxies

Principal Investigator: Faisst, Andreas

PI Institution: California Institute of Technology

Dust is an essential part of galaxy evolution. Dust properties are altered by the radiation field of stars and AGN, shocks, and winds. Thus the study of dust provides important clues on physical processes at work in galaxies. Polycyclic aromatic hydrocarbons (PAHs), aliphatic variations, and fine-structure lines at 3-20um are the most prominent and sensitive probes of neutral and ionized dust and the ionization field in galaxies. These features have been probed on unresolved scales with Spitzer and only recently with MIRI/MRS on resolved scales in local galaxies. Here we exploit the capabilities of MIRI/MRS at full and propose the highest redshift observations of resolved PAHs (3.3, 6.2, 7.7, 11.3um) and Ar/Ne fine-structure lines in 8 carefully selected typical main-sequence galaxies at z=1. With this unique sample (which already has JWST/NIRCam and some MIRI imaging) we will (i) pursue the first comprehensive modeling of the resolved dust grain distribution in the nucleus, disk, and diffuse ISM in z=1 disk galaxies and mergers; (ii) study the correlation between grain properties and stellar ionization field via cross-correlation to NIRCam imaging and assess the use of PAH 3.3um as SFR indicator; and (iii) characterize the fraction of dust-obscured AGN in typical z=1 main-sequence galaxies from a joint modeling of mid-IR continuum and PAH band ratios. These unique observations enable for the first time the detailed understanding of resolved dust production and destruction mechanisms in the highly star forming environments of typical z=1 galaxies. It will also be a valuable comparison sample to local galaxies and studies of bright sub-mm galaxies at higher redshifts.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4762
Program Title: Panchromatic characterizations of the super-Eddington accretion black hole, host, and environment: Epicenter of red dots, mergers, and dusty starbursts at z=7.2

Principal Investigator: Fujimoto, Seiji

PI Institution: University of Texas at Austin

A remarkable outcome from JWST is the high abundance of low-mass BHs, such represented by red point sources, so-called red dots. However, the limited survey volume of JWST is still sensitive to the abundant ``faint'' populations, where most represent less active accretion. Here we propose in-depth JWST observations for the first, best candidate of the rapid growing young quasar embedded in a dusty starburst host (SFR=1,600 Msun/yr) at z=7.2, GNz7q, discovered with moderate UV luminosity as a quasar (Muv= -23) but still >10-100x brighter than those recent red dots. The latest NIRCam grism observations detect the broad Balmer line feature, suggesting a super-Eddington accretion (Eddington ratio~16) taking place in a low-mass black hole (logMBH~6.9 Msun), while the interpretation is still inconclusive with the current S/N. Interestingly, the recent JWST and NOEMA observations also unveil the area around GNz7q highly overdense (delta>=5-100) harboring unique systems such as multiple red dots, a merging galaxy, and dusty starbursts, with possible filamentary structures. We request NIRSpec, MIRI, and NIRCam F410M grism observations to 1) confirm the low MBH and uniquely high accretion, 2) look for signatures of significant outflows and a young quasar age, 3) spectroscopically and spatially separate the quasar and host to get independent measures of SFR and Mstar of the host, 4) quantify their co-evolution stage via MBH/Mstar, and 5) comprehensively map out surrounding objects to examine the overdense/filamentary structure. Our program will achieve the first comprehensive characterizations of the rapid growing system in the early universe from BH, host, to its environment.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4783
Program Title: Anchoring the JWST population II distance ladder to Gaia

Principal Investigator: Savino, Alessandro

PI Institution: University of California - Berkeley

We propose to obtain multi-band imaging of 8 nearby galaxies that have deep HST photometry and secure distances tied to the Gaia geometric standard in order to establish a Gaia-based anchor for the JWST population II distance ladder. Extragalactic distances play a pivotal role in many branches of modern astrophysics, from galaxy property determinations to measuring cosmic expansion. JWST will massively increase the detection range of Pop II distance indicators, such as the tip of the red-giant branch (TRGB) and the horizontal branch (HB). This program will critically anchor the JWST Pop II distance scale to the Gaia standard, while avoiding challenges posed by saturation. The data acquired by this program will also enable a range of complementary science from improving Pop II stellar age estimates to measuring precise stellar parameters when coupled with panchromatic HST imaging.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 4793
Program Title: Unveiling the physics that govern massive star-formation in extragalactic Central Molecular Zones (eCMZs)

Principal Investigator: Schinnerer, Eva

PI Institution: Max Planck Institute for Astronomy

Gas-rich galaxy centers like our own Central Molecular Zone (CMZ) are extreme environments for star formation where many formation promoting or inhibiting forces acting locally or on larger scales compete. CMZs are compact (<1kpc in size) and subject to high extinction, blocking optical light and limiting our understanding of the detailed physical processes at play. Observations that pierce through dust and resolve individual star-forming sites within galaxy centers are scarce. We propose ~10pc (0.2”) resolution NIRCam emission line imaging of a representative, unbiased set of 16 nearby well-studied extragalactic CMZs to provide the first robust statistical assessment of CMZ star formation properties (age, mass, size, location etc.), compare to in progress ALMA ~0.25” mapping of their molecular gas giving cloud properties, and correlate these with global CMZ and galaxy properties to determine whether local processes (i.e. stellar feedback) or large-scale environment control their star formation activity and answer if the unexpected properties of our own CMZ are unusual or common. We will obtain continuum-subtracted maps of five NIR emission lines: Pa alpha, Br alpha, the [FeII] line at 1.64 micron, the H2 line at 2.12 micron, and the 3.3 micron PAH feature which together provide well-understood diagnostics to map the location, amount, and (relative) age of embedded sites of massive star formation. This comprehensive study will provide the urgently needed data to distinguish between theories for CMZ star formation that either argue for a highly time-variable evolution caused by local processes or a more steady-state evolution regulated by the large-scale environment.

Proposal Category: AR (GO-Archival)
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4810
Program Title: Quantitative Study on the Search for Sulfur-bearing Molecular Ice Signatures

Principal Investigator: Qasim, Danna

PI Institution: Southwest Research Institute

JWST programs #1309 and #2151 published new and pioneering findings on the composition and abundance of ices in the Chameleon I interstellar molecular cloud and protostellar environment (Yang et al. 2022; McClure et al. 2023). Notably, JWST observations confirm that the sulfur (S) budget – which S is one of the 6 biogenic elements – is tremendously low in the cloud (1% of the cosmic abundance), with OCS as the only S-bearing molecule securely detected towards the cloud and protostar. With other S-bearing molecules, such as H$_2$S and SO$_2$ detected in the gas-phase in clouds and around protostars, in addition to other justifications, it is suspected that S-bearing ice signatures are hidden, rather than missing, in the archived data. We propose to perform laboratory experiments, supported by computational simulations, of iron sulfide-ice reactions for a resilient search for H$_2$S and SO$_2$ ice signatures in the Chameleon I cloud and protostellar data of #1309, #2151 and #1854. Sulfide minerals are proposed to be significant sources of sulfur in the Chameleon I cloud (McClure et al. 2023). Deliverables include quantitative results, such as column densities and abundances of reactants, intermediates and products to compare to the archived data. This quantitative data will be critical to the interpretation of data from other JWST programs, such as JOYS (#1290), which preliminary spectral studies towards >30 protostars have indicated the necessity for the work proposed here (private communication).

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Proposal Category: AR
Scientific Category: Galaxies
ID: 4814
Program Title: Understanding galaxy formation at cosmic dawn

Principal Investigator: Shen, Xuejian

PI Institution: Massachusetts Institute of Technology

There are many unresolved questions in our understanding of cosmic dawn (z~10-30) and the galaxies illuminating the Universe during this early epoch. This previously unexplored territory has recently been uncovered through early-science observations from JWST, with the discovery of many photometric drop-out galaxy candidates at z>~10. These abundant, UV-bright, galaxies have created tensions with our current understanding of galaxy formation within the standard cosmological paradigm, but many uncertainties remain. While this UV abundance tension can potentially be attributed to observational uncertainties, it currently implies that there are missing ingredients in our galaxy formation and cosmological models. With our extensive experience developing theoretical galaxy formation models, we will use state-of-the-art cosmological simulations to expand our understanding of this critical piece of the puzzle. We will investigate the systematic uncertainties inherent in observational estimations, explore the physical causes of discrepancies between theoretical predictions and observations, and suggest methods to empirically test these hypotheses and predictions within existing and novel observations.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4818
Program Title: A survey to search for silicate vapor atmospheres in the ultra-hot terrestrial planet population

Principal Investigator: Mansfield, Megan

PI Institution: University of Arizona

Theory predicts that terrestrial planets with irradiation temperatures above 1,700 K may be hot enough for silicate vapor atmospheres to form from evaporation of their solid surfaces. However, the exact temperature at which silicate vapor atmospheres appear is unknown because of several uncertainties in modeling the formation of these atmospheres. For example, the rate of cloud formation in silicate atmospheres is unknown, and the magnitude of the silicate greenhouse effect is relatively unconstrained. Additionally, the amount of heat a silicate vapor atmosphere could transport to a planet's nightside is largely unknown. Models of silicate vapor atmospheres require observations to benchmark against in order to move past these large uncertainties. We propose a survey of secondary eclipses of 10 terrestrial planets with irradiation temperatures T>1500 K to further our understanding of the formation and properties of silicate vapor atmospheres. Our survey will allow us to unambiguously identify the presence or absence of a silicate vapor atmosphere using just a single eclipse for each planet, constraining the turn-on temperature for the existence of silicate atmospheres. For those planets with atmospheres, we will be able to compare their temperature to the maximum expected temperature and constrain the amount of heat redistribution occurring. For those planets without atmospheres, we will use measurements of the inferred albedo to investigate to what extent their surfaces are impacted by space weathering. These targets sample a range of irradiation temperatures that is poorly covered by prior Spitzer and planned JWST observations.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4829
Program Title: A spectroscopic exploration of a directly imaged multiplanet system in the mid infrared

Principal Investigator: Boccaletti, Anthony

PI Institution: Observatoire de Paris - Section de Meudon

As the first directly imaged multiplanet system, HR8799 is a prime target for spectral characterization of exoplanet atmospheres. We aim to obtain spatially resolved spectroscopy at high contrast of the HR8799 system with MIRI-MRS to characterize with the very same observing mode, both the planets' atmospheres as well as the inner disk, by providing totally unique information unattainable with other JWST instruments, nor from the ground. MIRI-MRS will detect H2O, CO allowing us to carry out a comprehensive C/O analysis of the four planets at once. It can also possibly detect NH3 which would be unprecedented, and clarify the debate on CH4. Last but not least, MIRI-MRS can identify Silicates clouds for the first time in the atmosphere of young imaged planets.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4857
Program Title: Confirmation of Planetary Companions to White Dwarf Stars

Principal Investigator: Mullally, Fergal

PI Institution: Orbital Insight

We propose single-band MIRI F1500W imagery to confirm two high-quality candidate Jovian-mass planets detected around white dwarf stars. These observations will both confirm common proper motion and potentially measure a change in the relative position of the planet around the star due to orbital motion. JWST Cycle 1 observations of metal-rich white dwarf stars detected two point-source companions with fluxes and colors consistent with planet masses of 1-5 Jupiter masses. Due to their proximity to the white dwarf star, the odds these are background galaxies is less than 2%. However, a second epoch image is required to conclusively demonstrate their true nature. If confirmed, these companions would be among the first true Jupiter analogs discovered around other stars, with masses, orbital separations, and ages consistent with the giant planets in our own solar system. They are bright enough to allow spectroscopic follow up to measure the chemical composition of their atmosphere, testing atmosphere models in a regime quite different to that probed by either young planets, or transit spectroscopy. If the observations demonstrate that the companions are background sources, this null result will cast doubt on the theory that planets are responsible for driving the accretion of metals known to occur in 25--50% of field white dwarf stars. Conversely, confirmation of these planets is strong evidence in favour of the theory, and argues that such white dwarf-planet systems are common in the Galaxy.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4866
Program Title: A Survey for Free-floating Brown Dwarfs and Planets Down to the Mass of Jupiter

Principal Investigator: Luhman, Kevin

PI Institution: The Pennsylvania State University

A Cycle 1 program obtained NIRCam images for a small field (6'x4') in the center of IC 348, which is a nearby star-forming cluster (300 pc, 5 Myr). Those data were used to identify candidates for new free-floating planetary-mass objects (PMOs), which were then observed spectroscopically with NIRSpec (1-5 um) to confirm their cool nature. That program discovered three new PMOs, the faintest of which may be the least massive object that has been directly imaged and spectroscopically confirmed to date (~3-4 Jupiter masses). In addition, two of the three PMOs exhibit several strong absorption features from an unidentified aliphatic hydrocarbon, the presence of which is unexplained by models of brown dwarfs and giant planets. The only atmospheres in which similar hydrocarbons have been previously detected are those of Saturn and Titan. We propose a wider (16'x20') and deeper survey for PMOs in IC 348 that reaches the mass of Jupiter. The objectives are as follows: 1) improve the statistical constraints on the minimum mass of brown dwarfs and the frequency of ejected giant plants, 2) compare the mass functions of PMOs in IC 348 and the Orion Nebula Cluster to test whether the frequency of PMOs varies with stellar density, 3) assess whether the frequency of PMOs in IC 348 varies with distance from the center of the cluster, as might be expected if some of them are ejected planets, and 4) test scenarios for the origin of the unidentified hydrocarbon by determining whether they are found in all PMOs below a certain mass or temperature, or whether their presence is correlated with other factors (e,g., UV flux from the most massive star in the cluster).

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4876
Program Title: Time-resolved protoplanetary disk physics in DQ Tau

Principal Investigator: Kospal, Agnes

PI Institution: Konkoly Observatory

Planet-forming disks are no longer thought of as static structures. The accretion of mass from the disk onto the forming star is highly variable on timescales of hours to days, and the changing X-ray, UV, and optical radiation may have profound effects on the physical and chemical properties of the disk material, right when planetary cores are being assembled or when the planets are accreting their primary atmospheres. Most T Tauri stars vary stochastically, therefore variations in their disks are only discovered serendipitously. The lack of a systematic study on disk variability in the infrared regime, where material forming terrestrial planets mainly emit, severely limits our understanding on how disks react to variable irradiation. DQ Tau, thanks to its periodically changing accretion rate modulated by a central close eccentric binary, provides a unique opportunity for exactly such a study. This system's X-ray, UV, and optical brightness is known to increase during (almost) every periastron due to magnetic interactions and pulsed accretion. Earlier Spitzer/IRS data shows definite changes in the continuum flux and marginal (few percent) variability in molecular emission features in the disk. Consistently with this, our simulations of changing disk temperature also predict similar changes in the spectrum. After evaluating the repeatability of JWST MIRI observations, we demonstrate that our carefully planned 4-epoch monitoring of DQ Tau coupled with detailed modeling has the potential to reveal the physical (temperature, emitting area) and chemical (abundances) changes the disk experiences as a consequence of variable accretion and high-energy irradiation.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4877
Program Title: The Host Galaxy, Environment, and Hot Dust Emission of the First Known Extremely-Luminous Obscured AGN at z>6

Principal Investigator: Endsley, Ryan

PI Institution: University of Texas at Austin

The existence of billion solar mass black holes within the first 750 Myr of cosmic history poses a major challenge for models of early supermassive black hole (SMBH) formation. A major obstacle towards furthering our understanding of early SMBH growth is that all known extremely luminous AGN at z>6 fall in the category of type 1 quasars. Several recent studies have hinted that early SMBHs frequently grew as obscured AGN, stressing the importance of identifying and characterizing these objects. Here, we will take steps towards this goal by characterizing the hot dust emission, host galaxy, and environment of a newly discovered obscured AGN at z_spec = 6.853. This AGN is extremely luminous (with L_bol comparable to the brightest z~7 quasars thus implying M_BH ~ 10^9 Msol) and has multiple ALMA line detections proving its high redshift. Remarkably this object was found in a relatively small (1.5 deg^2) field, consistent with a scenario in which obscured z~7 AGN are far more abundant than similarly-luminous quasars. We will 1) deliver the first clear and detailed study of a galaxy hosting a rapidly-growing SMBH at z~7; 2) finely sample the rest near-IR SED to characterize the hot dust emission and deliver the first empirical mid-IR SED template of an obscured z>6 AGN, assisting efforts to identify similar objects with MIRI data; 3) locate the AGN relative to the resolved radio synchrotron, infrared starburst, and unobscured stellar emission to begin characterizing the interplay between the AGN and host; and 4) measure the galaxy environment of this object to better place it in context of type 1 quasars at very similar redshifts for a first glimpse into its halo rarity.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4896
Program Title: AI-Enabled Modeling of Instrument Systematics for Exoplanet Time-Series Observations

Principal Investigator: Mayorga, Laura

PI Institution: The Johns Hopkins University Applied Physics Laboratory

Exoplanet observations require extremely precise measurements to detect atmospheric signals, particularly on terrestrial targets. At these precisions, telescope systematics such as ramps, thermal fluctuations, voltage activations of observatory heaters, etc. are present as additional noise sources in the data. However, telescopes like JWST have hundreds of instrument sensors tracking the temperatures and voltages throughout the observatory systems. This archival proposal seeks to use machine learning tools to characterize the systematics in exoplanet time series data for the most commonly used JWST Exoplanet time series modes. MIRI/LRS has the greatest number of integrations, while NIRSpec/G395H has the greatest number of individual programs. We will first use a random forest to conduct feature engineering tests and determine the basis mnenomics that drive the red noise. These will then be used to train the random forest to predict the systematics signal present in reduced white light curves. We will provide the model and a description of its implementation for the community to use. We will also incorporate new software into the appropriate reduction stage of the Eureka! pipeline. This proposal is pioneering work and expected to have a high impact on all exoplanet time series analyses by improving the precision of dozens of exoplanet programs.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4901
Program Title: Zooming in on the Dust in the R Aqr Symbiotic System: Effects of the Powerful Outburst and Jet resulting from the Recent WD Periastron Passage

Principal Investigator: Karovska, Margarita

PI Institution: Smithsonian Institution Astrophysical Observatory

We propose JWST/MIRI coronagraphic imaging of the complex circumbinary dust environment of R Aqr, a nearby wind accreting and jet producing symbiotic binary system (WD + Mira-type star). The unprecedented sensitivity of the MIRI coronagraph imaging will provide a unique opportunity to map directly the R Aqr circumbinary dust, including in the vicinity of the binary -- as close as about 100 AU (~0.5"), and in the extended (outer jet) region, reaching up to a distance of over 3000 AU (15"). Our goal is to determine - for the first time - the spatial/spectral distribution and characteristics of the faint silicate dust emission in this extremely active interacting system, and including along the jet and in the orbital plane. Our aim is to carry out a timely high-angular resolution (0.4") study of the distribution and characteristics of the dust and especially of the effects of the new outburst and jet (observed since 2019 in X-ray, UV-optical, radio and near-IR) - resulting from the enhanced accretion during the recent WD periastron passage. These phenomena are observable in R Aqr only about twice a century, with the next periastron expected in about 40 years. We will use the 4QPM masks to block the bright central source, in order to detect fainter emission as close as ~0.5" to the binary. We will observe an unresolved reference source to obtain a good empirical PSF. By zooming in on the close circumbinary region, where the jet/ejecta plow through (and interact with) the newly formed and pre-existing dust, we will gain unique insights into the R Aqr symbiotic system, and the precursor environments of potential progenitors of PN and of a fraction of SN Ia.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 4903
Program Title: Early Quiescent Galaxies Under the Magnifying Glass

Principal Investigator: Newman, Andrew

PI Institution: Carnegie Institution of Washington

Star formation had shut down in a significant fraction of massive galaxies by z ~ 2. We still lack a firm understanding of the processes that ended star formation and prevent future activity, as well as their relationship to morphological change and black hole growth. A significant advance requires detailed, spatially resolved information that can be gleaned only through IFU spectroscopy. Yet this is a challenge, even with JWST, due to these galaxies’ compact sizes. We propose to overcome this limitation via deep NIRSpec IFU spectroscopy and brief NIRCam imaging of 4 gravitationally lensed and exceptionally bright quiescent galaxies at z=2.1-2.6, all seen within ~1 Gyr after quenching. We will (1) spatially resolve detailed star formation histories and multi-element stellar abundances, testing proposed quenching models by constraining when, where, and how quickly quenching proceeded; (2) resolve the stellar kinematics of recently quenched galaxies to determine how much morphological transformation into ellipticals accompanied quenching; (3) test the exciting suggestion that early quiescent galaxies, like local "relic" galaxies proposed to be their analogs, host overmassive black holes by searching for their dynamical signature; and (4) map the ubiquitous ionized gas that appears to be shock heated, along with any neutral ISM or outflows, thereby shedding light on the suppression of star formation at high redshifts. These rich and detailed insights into early quiescent galaxies' formation history, chemistry, structure, kinematics, ISM, outflows, and black holes are possible only by coupling lensing with the resolution, sensitivity, and wavelength coverage of JWST.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4912
Program Title: Mapping the multi-phase outflows in z~6 luminous quasars

Principal Investigator: Carniani, Stefano

PI Institution: Scuola Normale Superiore, Pisa

Old, passive, and massive galaxies observed at z~4-5 must have undergone through quenching at z~6. Massive galactic outflows were considered to be the most efficient mechanism for rapid quenching in the early Universe. However, current observations of molecular and neutral atomic gas at z~6 have suggested that they may not be powerful enough to sweep gas out of massive galaxies. Since recent works have highlighted that ionized gas may account for a significant part of the total outflowing gas in such massive high-z galaxies, we propose JWST/NIRSpec observations to map the warm ionized gas in five z~6 quasars showing evidence of massive cool (molecular/neutral) outflows, which all have a mass loading factor less than or of the order of one when only the cool gas phase is considered. By mapping the broad components of the optical nebular lines (e.g. [OIII]5007, Halpha) with NIRSpec IFU observations, we will be able to reveal ionized outflowing gas on kpc scales and estimate its key physical properties such as size, velocity, and mass. The properties of the ionized gas combined with those of the cool phase will establish how efficient galactic outflows are in regulating star formation in the early Universe. We will also investigate if the gas kinematics and morphology are affected by outflows or not.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4924
Program Title: A Novel Wavelength Calibration of NIRCam WFSS with a Nearby Star-Forming Galaxy

Principal Investigator: Sun, Fengwu

PI Institution: University of Arizona

As one of the most powerful observing modes of JWST, NIRCam WFSS can efficiently obtain spectroscopic redshifts of a huge sample of distant galaxies through the detections of strong emission lines. However, ironically, all the wavelength calibrations of NIRCam WFSS rely on very limited data taken so far: one post-AGB star with a dozen of emission lines at a few dithering positions. This hampers the accurate redshift determinations for thousands of galaxies, which have been discovered with hundreds of hours of precious JWST time. We propose a novel and efficient wavelength calibration of NIRCam WFSS, specifically for its field-dependence (i.e., distortion / curvature) with all the four module x grism combinations. This will be achieved by observing the Brackett alpha (BrA, 4.05 um) emission from the HII regions of a nearby face-on spiral galaxy. The galaxy NGC 2835 has been observed with HST, JWST NIRCam, MIRI, VLT/MUSE and ALMA through the PHANGS survey, and therefore the astrometry and velocity field are highly accurate. We will model the offset between BrA emission detected with narrow-band imaging and grism spectroscopy, and thus provide the most accurate wavelength calibration model to the broader JWST user community. Scientifically, this program can also search for highly dust-obscured star-forming clusters through BrA and Paschen-alpha line imaging, providing the last missing piece for a comprehensive study of star clusters, gas clouds and HII regions in a paradigmatic nearby galactic ecosystem.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4927
Program Title: Testing The Polar Vortex Hypothesis: JWST Predictions for Spatially Distinct Circulation Modes and Composite Spectrum in the Polar Regions of Giant Exoplanets and Brown Dwarfs

Principal Investigator: Apai, Daniel

PI Institution: University of Arizona

The atmospheres of directly imaged exoplanets and brown dwarfs display a significant diversity: Even for the same temperature, their colors and spectra can differ substantially. Multiple processes have been invoked to explain these variations -- all within the framework of one-dimensional models. However, recently, four lines of evidence emerged that suggests an additional -- and perhaps dominant -- process. We introduce here the Polar Vortex Hypothesis and propose a JWST Theory/Archival Program to assess which JWST observations (existing or future) can be used to test this hypothesis. Polar Vortex Hypothesis: Giant exoplanets and brown dwarfs - just like Jupiter and Saturn - have composite atmospheres that consist of jet-dominated (belts-and-zones) equatorial regions and vortex-dominated polar regions. These regions have distinct colors and spectra, resulting in inclination-dependent variations in the colors and spectra of brown dwarfs. Time-resolved multi-scale spectrophotometry has the potential of disentangling the equatorial and polar components: Equatorial/mid-latitude features will rotate in-and-out of the visible hemisphere, i.e., modulated on the rotational timescale. In contrast, the always-visible polar regions (in inclined brown dwarfs) will evolve over much longer timescales. We will connect existing atmospheric models (1D radiative transfer and 3D general circulation models) to simulate JWST observations to assess if and how these can disentangle equatorial and polar features and spectral components. Our project will add a fundamental dimension to the understanding of brown dwarf atmospheres and the interpretation of existing and future JWST data.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4929
Program Title: Exploring the Birth and Early Evolution of Massive Star Clusters with JWST

Principal Investigator: Turner, Jean

PI Institution: University of California - Los Angeles

We propose to use JWST to map out the evolution of massive star clusters from birth to adulthood. The targets are the youngest clusters in the local dwarf galaxy NGC1569, with ages ranging from 0.5-25 Myr. Using MIRI/MRS IFU on JWST, we will image the full mid-infrared spectrum in these young embedded and partially embedded clusters; we expect to detect nebular forbidden lines, HI recombination lines, PAH features, H2 lines, and dust continuum. The JWST data will be combined with existing submillimeter images with similar spatial resolution of excited lines of CO, HCN, and HCO+ and each cluster individually modeled with Cloudy. With this dataset we can observe how cluster emission properties vary with evolutionary stage and arrive at self-consistent models for forming clusters. The goal is to determine how the star-forming gas within giant clusters evolves in a changing stellar environment over time, and through modeling, measure the evolution of their stellar contents.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4931
Program Title: Constraining the atmosphere of the terrestrial exoplanet TOI-4481b

Principal Investigator: Mansfield, Megan

PI Institution: University of Arizona

JWST will provide the first opportunity to search for signs of habitability on terrestrial planets orbiting M dwarf stars. However, it is currently unknown whether planets around M dwarfs can retain atmospheres given the relatively violent history of extreme UV irradiation from their host stars. The first step to understanding the habitability of rocky planets is therefore to establish whether M dwarf terrestrial planets can retain significant atmospheres. Furthermore, terrestrial exoplanets well inside the inner edge of the habitable zone offer a chance to test theories of atmospheric evolution in a previously unexplored regime. We propose to use MIRI/LRS secondary eclipse observations to search for the presence of an atmosphere on the terrestrial M dwarf planet TOI-4481b and to constrain its composition. TOI-4481b is the highest signal-to-noise terrestrial planet for these observations other than LHS 3844b, which has been previously observed with Spitzer and found to not possess an atmosphere. We find that with three secondary eclipse observations of TOI-4481b we can determine whether or not it has an atmosphere with a surface pressure of P>=1 bar at the 5-sigma significance level. The observed spectrum will also constrain the composition of its atmosphere (if one is observed) at the >=2-sigma significance level. If no atmosphere is detected, we will study the impact of space weathering on TOI-4481b by constraining its dayside albedo to within 0.05. These observations will provide valuable data for constraining the impact of M dwarf irradiation on terrestrial planet atmospheres.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4938
Program Title: A Tale of Two Warm Giants: Characterizing the Atmospheres of TOI-2525 b & c

Principal Investigator: Fortney, Jonathan

PI Institution: University of California - Santa Cruz

Warm giant planets with equilibrium temperatures between 300 and 600 K are unique objects where carriers of C, N, and O all exhibit visible signatures in the atmospheric absorption spectra. As a result, warm giants are sensitive probes to planet formation models as both C/O and N/O ratios can be constrained observationally. We propose to observe the transmission spectra of the warm giant pair, TOI-2525 b and c, which has the highest Transmission Spectroscopic Metric among all appropriate systems hosting multiple transiting warm giants. Having two co-natal warm giant planets provides distinctive leverages in constraining the co-growth and interactions of the pair in the protoplanetary disk, including scenarios where the outer planet may block the inward drifting pebbles and alter the composition of the inner planet. In addition, the atmospheres of warm giants are scarcely observed compared with hot Jupiters or even cold Jupiters in our own Solar System, which have multiple in-depth and in-situ probes. Therefore, theories predicting disequilibrium chemistry and cloud formation in the 300-600K temperature range are rarely tested. This pair of warm giants will serve as an important benchmark in both intra-system and inter-system comparative studies differential to our Solar System, and it will also provide more context for other warm and temperature giants and T/Y transition brown dwarfs that will be observed with JWST spectroscopy or direct imaging.

Proposal Category: AR
Scientific Category: Galaxies
ID: 4948
Program Title: Flux-calibrating NIRSpec MSA data, finally

Principal Investigator: Maseda, Michael

PI Institution: University of Wisconsin - Madison

NIRSpec has promised to revolutionize our ability to understand the growth and evolution of galaxies across cosmic time with sensitive spectroscopic observations far surpassing the capabilities of other instruments on other facilities. The design of its microshutter array (MSA), while allowing for simultaneous spectroscopy of more than 150 galaxies, means that flux calibration for resolved sources is extremely challenging due to the regular aperture size but spatially and spectrally varying point spread function. For a typical z~2 galaxy, the STScI pipeline can incorrectly calibrate the absolute flux of the spectrum by a factor of 5 or more, depending on the wavelength and the centering of the source inside the aperture. In order to permit science that requires accurate flux information (star formation rates, metallicities, dust attenuation, stellar population information; i.e. most of the extragalactic science one would want to perform with NIRSpec), we will develop open-source software designed to calibrate the spectra taken with the MSA. We outline two methods which use morphological and/or photometric information for a galaxy combined with detailed models of the NIRSpec instrument in order to accurately determine the intrinsic flux level of a spectrum. With the newest calibration data taken in Cycles 1 and 2 as well as non-MSA spectroscopy, we will validate our methods across the full population of high-z galaxies. We will calibrate all Treasury and ERO MSA data and release the spectra to the community. Calibrating the flux level for NIRSpec MSA spectroscopy is crucial for the success of the mission and cannot be done correctly for most galaxies by the STScI pipeline.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4967
Program Title: Dwarfs of Fire and Ice: Mapping the Irradiated Atmospheres of White Dwarf-Brown Dwarf Binaries with NIRSpec PRISM Phase Curves

Principal Investigator: Zhou, Yifan

PI Institution: The University of Virginia

Spectral phase curves are the most powerful tool for probing the processes that shape the three-dimensional structures in tidally-locked and highly irradiated atmospheres. White dwarf-brown dwarf (WD-BD) binary systems, characterized by high phase-curve amplitudes and short orbital periods, are particularly advantageous for such observations. Phase-resolved spectroscopy of these irradiated brown dwarfs offers the most rigorous validation for planetary atmospheric and circulation models. We propose NIRSpec PRISM BOT observations of five WD-BD binaries. Our targets straddle the temperature ranges of hot and ultra-hot Jupiters. The extremely high signal-to-noise spectral phase curves allow us to map the thermal profiles, clouds, and molecular features in the five irradiated brown dwarfs. These maps constrain four key processes --- circulation, vertical mixing, condensate clouds, and photochemistry --- and their impact on the spectral appearance of planetary atmospheres. The high-precision phase curves will challenge planetary atmospheric models and thereby catalyzing breakthroughs in the atmospheric characterization of exoplanets. NIRSpec PRISM's unparalleled time-series capibilities and wavelength coverage are indispensable for achieving our scientific objectives.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4972
Program Title: Hunting the Kinetic Mode Feedback of AGNs via PAH Features

Principal Investigator: Zhang, Lulu

PI Institution: University of Texas at San Antonio

The "kinetic mode" feedback given its significance has been widely embraced in recent cosmological simulations of galaxy evolution. Inspired by some studies of Polycyclic Aromatic Hydrocarbons (PAHs) for different types of AGNs, we propose to explore and then utilize the capability of PAH features in diagnosing jet/shock processes that are highly correlated with the kinetic mode feedback. This goal will be achieved through empirical calibrations between PAH features and other infrared diagnostics, along with PAH emission and shcok models for explanations. PAH features are widely distributed from ~3 to 20 micron and the kinetic mode feedback is more prevalent in low lumnosity AGNs (LLAGNs), especially in the low-ionization nuclear emission-line regions (LINERs). Therefore, we propose to obtain the NIRSpec/IFU and MIRI/MRS 2.9-28.5 micron spectroscopy for the central ~300-600 pc regions, where AGN activities are dominant, of 3 well studied nearby LINERs. We will constrain the spatial distributions of intrinsic and relative strengths of different PAH features in these LINERs. The distributions of infrared ionic emission lines and particularly H2 emission lines are also valuable. These lines provide a necessary probe of the underlying physical conditions to explain the PAH characteristics and associate the PAH characteristics with jet/shock processes. Secondly, through comparison with the archived JWST Cycle 1 and 2 spectroscopy of luminous nearby Seyfert galaxies, we will quantify the differences in PAH characteristics in regions dominated by a kinetic feedback versus the “quasar mode” feedback. The latter is more prevalent in luminous, highly accreting Seyfert galaxies.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4979
Program Title: Uncovering the cold donors of AM CVn binaries

Principal Investigator: El-Badry, Kareem

PI Institution: California Institute of Technology

We propose high-cadence NIRSpec observations of three eclipsing, long-period AM CVn binaries using the G235M and G395M gratings. These observations will result in the first-ever detection of AM CVn donors, which are cold (T_eff ~ 1000 K) and only observable in the IR. The main goals of our program are to measure the chemical composition of the donors — which are expected to consist of a mix of helium and metals produced during nuclear burning of their progenitor stars — and to measure their radial velocities, leading to precise constraints on their masses and radii. These observations will uncover a never-before-observed class of astrophysical object — metal-rich worlds resembling giant planets but consisting mostly of helium — and constrain models for the formation of AM CVn binaries, overcoming a major bottleneck to our understanding of several classes of compact binaries.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4982
Program Title: First image and spectrum of a true Jupiter-Saturn Analog

Principal Investigator: Ruffio, Jean-Baptiste

PI Institution: University of California - San Diego

We propose to take the first image and spectrum of a true Solar System gas giant analog, the emblematic eps Eridani b, with the NIRSpec integral field unit (IFU). Eps Eri b is a known radial velocity planet orbiting a nearby Sun-like star (K2V) at ~3.5 au (7.3 yr period) with a dynamical mass between that of Saturn and Jupiter (0.57-0.78 MJup), which means that it can be directly compared to the Solar System gas giants. This adolescent (400-800 Myr) sub-Jupiter is unique because it lies halfway between the transiting and directly imaged exoplanets in terms of semi-major axis, mass, and age. This region of the parameter space has been inaccessible for spectroscopic characterization until now. Additionally, Cycle 3 is the optimal time to observe the planet because it is at its furthest projected separation, which only happens every 4 years. We will obtain a R~2,700 spectrum in 3-5 um targeting the peak flux of this cool sub-Jupiter (~140-215 K) and enable the first measurements of its brightness, effective temperature, and composition (C/H, O/H, N/S). The direct detection of eps Eri b possible is possible thanks to the demonstration from Cycle 1 data that the NIRSpec IFU can reach a contrast (1e-6 at 1" in 35 min) superior to JWST's coronagraphs.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5014
Program Title: Anatomy of a Low-Metallicity Starburst

Principal Investigator: Hunt, Leslie

PI Institution: INAF - Osservatorio Astrofisico di Arcetri

Dwarf galaxies, systems with low baryonic masses, are the most abundant population at any redshift. Dwarf systems likely played a major role during the Epoch of Reionization (EoR) because their shallow potential wells make them vulnerable to stellar feedback processes that can enhance the porosity of the interstellar medium (ISM). Reionization and the escape fraction of ionizing (Lyman Continuum, LyC) photons ultimately depend on the ISM porosity. While fesc has been constrained on galactic scales in some high-redshift dwarf galaxies, it cannot be mapped at the critical few parsec scales around the young massive star clusters that drive feedback. Leveraging the parallels between high-z dwarfs and star-forming dwarf galaxies (SFDs) in the Local Universe, we propose a pilot study of the nearby iconic metal-poor SFD, NGC 5253, using NIRCam imaging, NIRSPec/IFU spectroscopy, MIRI imaging, and MRS/IFU spectroscopy. JWST will provide a detailed assessment of feedback on the surrounding ISM, with 2-7 pc resolution, through maps of ionized and warm molecular gas, Polycyclic Aromatic Hydrocarbons, and warm dust. JWST will also quantify dust production in the evolved stellar population, through a census of Asymptotic Giant Branch stars and the past star-formation history. These combined observations will yield a resolved measurement of fesc. This ambitious pilot program exploits JWST's superb infrared sensitivity and spatial resolution for a detailed spatially-resolved analysis that will revolutionize our understanding of stellar feedback, ISM porosity, and stellar dust production in a low-metallicity starburst environment, with potential similarities to conditions at the EoR.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5015
Program Title: Unveiling the nature and impact of the first population of black holes: an extensive NIRSpec-IFU survey in the first billion years

Principal Investigator: Uebler, Hannah

PI Institution: University of Cambridge

One of the most exciting results of JWST has been the discovery of a large population of active galactic nuclei (AGN) at high redshift. Their large number density is not the only unexpected finding, they share several other intriguing properties, such as a black hole-to-stellar mass ratio much higher than local galaxie,s and a large fraction of dual/binary black holes. These results are being interpreted in the context of different scenarios, especially in terms of early black hole seeding, however major uncertainties are preventing further progress in understanding their nature. We propose a fresh approach by obtaining NIRSpec-IFU spectra of all JWST-discovered broad-line AGN at z>5. While the data will be available for the community to pursue a plethora of science cases, some of the primary goals of the program are: constrain with unprecedented accuracy the stellar and dynamical masses of the host galaxies, hence exploring whether early black holes are truly over-massive or their stellar populations are under-massive; identify binary AGN, tracing merging black holes, and provide predictions for gravitational waves observatories; trace AGN-driven outflows and their feedback on the host galaxies; find SNe at z>5, which may mimic AGN; constrain the AGN contribution to reionization; map the metallicity and chemical enrichment of the host galaxies; search for Population III stars forming in pockets of pristine gas in the haloes, as predicted by recent models.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5017
Program Title: AGN and their outflows: probing fragmentation and survival of polycyclic aromatic hydrocarbons

Principal Investigator: Garcia Bernete, Ismael

PI Institution: University of Oxford

It is widely accepted that the short-lived phase of active galactic nuclei (AGN) and their winds can have a drastic impact on the interstellar medium of most galaxies. Large amounts of dust and gas are located at the central regions of AGN, where optical wavelengths are heavily affected by extinction making the mid-infrared (MIR) the ideal spectral range to investigate these inner regions. Polycyclic Aromatic Hydrocarbons (PAHs) are carbon-based molecules, which are responsible for strong MIR emission features. PAH emission is potentially one of the best tools to trace star-forming (SF) activity in the heavily dust-extinguished and hostile environments of AGN. However, our limited knowledge of the effect of the radiation field, outflows and shocks on them is a shortcoming of this approach. AGN and their winds offer unique environments to investigate not only the fragmentation/survival of PAHs but also the mechanism for transporting them in their winds. Our proposal builds on targets with existing/scheduled MRS observations and for which we request 3-5 micron NIRSpec observations. NIRSpec+MRS data are essential for reaching our goals. The first goal is to fully characterize the properties of PAHs in AGN and their winds. For this, the 3.3+3.4 micron PAH proposed observations are crucial to put strong constraints on the fragmentation and survival of PAHs. The second goal is to understand AGN feedback mechanisms. To do so, once the PAH propesties are fully characterize, we will establish which PAHs are best to trace SFR activity in active galaxies. The proposed study is fundamental since PAH bands are routinely used to measure SF activity in near and far SF galaxies and AGN.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5018
Program Title: Feeding the Black-Holes : From cooling filaments to H2 accretion disks

Principal Investigator: Salome, Philippe

PI Institution: Observatoire de Paris

Brightest Cluster Galaxies (BCGs) are unique direct evidence of AGN-feedback caught in the act. The large cavities inflated by the AGN-radio lobes have pushed the hot intra-cluster medium and made gigantic bubbles raising buoyantly in the ICM. BCGs lying at the center of cool core clusters (short cooling time) are also surrounded by a huge network of kpc-scale filaments, visible in the optical and detected in warm H2 and cold CO. Those cold filaments are likely formed via thermal instabilities in the low-entropy cluster core. There is strong evidence that AGN-jets themselves play an important role in the local compression and cooling of this gas. BCGs are thus the best objects to study this key piece of the feedback. Once cooled the gas can settle down in the galaxy and feed the central Black Hole, powering the feedback engine. To understand the detailed circulation of the cold gas is of prime importance. The spatial resolution and sensitivity of JWST with MRS and MIRI can (i) map the H2 lines tracing the bulk of the mass in the filaments and seek warm dust at large scales; it can also help (ii) determine the main excitation processes in the filaments (and confirm the important role of shocks) via mid-IR line diagnostics and (iii) map the expected central molecular disks, a yet unobserved element of the feedback cycle.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5019
Program Title: The prevalence of TP-AGB stars in the near-IR rest-frame spectra of high redshift quenched galaxies: implications for spectral synthesis models and galaxy evolution

Principal Investigator: LU, Shiying

PI Institution: CEA/IRFU, Saclay

A two decade-long debate has not yet settled on the impact of TP-AGB stars in the near-IR rest-frame spectra of quiescent galaxies in the distant Universe. Wildly varying model-treatment of this uncertain but hyper-luminous stellar phase results in major discrepancies in their inferred stellar masses, ages, and star-formation histories, preventing a solid description of the evolution of this crucial class of galaxies and the overall understanding of the quenching process. JWST has the unique power to finally settle the debate, revealing (or not) the distinct spectral features that betray TP-AGB stars in galaxies' near-IR rest-frame spectra. A single massive (2x10^10Msun) quiescent galaxy from the archive at z=1.086, serendipitously observed with NIRSpec+PRISM, has surprisingly revealed a pletora of strong TP-AGB features, including those of C- and O-type stars. The features observed in this galaxy's spectrum are incompatible with AGB-poor models, but even current AGB-strong models (from Maraston et al.) are incapable of returning acceptable fits and reproducing all features. We propose to dedicate one NIRSpec pointing of 2.5h (4.6h with overheads) to observe as primary targets >10 similarly bright quiescent galaxies, spanning a larger range of masses (10^10--10^11.5), redshifts (1<z<2.5), stellar ages and metallicities. Fainter quiescent galaxies and luminous non quiescent galaxies at the same redshifts will be used as fillers. These observations will deliver a unique database to start grasping the phenomenology of TP-AGB stars in distant galaxies, and tune future generations of models to finally have accurate predictive power on key stellar population parameters.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5022
Program Title: Probing the internal structure of WASP-103b

Principal Investigator: Barros, Susana

PI Institution: Universidade do Porto

We request 35.44 hours of JWST time to observe a phase curve of the ultra-hot Jupiter WASP-103b in order to constrain its internal structure and atmosphere. WASP-103b is a 2.0 Rjup planet in a 22 hour orbit. The close proximity to its host star leads to strong tidal forces which deform the planet. By observing both the transit and phase curve deformation signatures of WASP-103b with JWST, we can directly measure its deformation with a precision 5.7 times higher than current measurements. The higher precision will be crucial to constrain, the planetary internal structure differentiation, in particular, the planet's core mass fraction and the envelope's metallicity. This would be the first time that an unambiguous measurement of the core mass fraction of a giant exoplanet is made. WASP-103b is one of the rare exoplanets for which we can obtain this detailed information, up to now only available for solar system planets. Constraining the internal structure will provide valuable insight into accretion processes that form planets. The same observations will also allow us to probe the atmospheric chemistry of WASP-103b as a function of orbital phase. We will be able to detect the spectral lines of important carbon, oxygen, and nitrogen compounds and to quantify the degree of cloudiness on the cooler nightside. This will provide carbon-to-oxygen (C/O) ratios and the identification of chemical equilibrium/disequilibrium as a function of orbital phase. We will not only obtain comprehensive understanding of the planet's atmospheric properties across different wavelengths and orbital phases but also establish WASP-103b as a valuable benchmark object for exo-atmospheric studies.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5037
Program Title: Confirmation of the closest directly detected exoplanet: a super-Jupiter orbiting Eps Ind A

Principal Investigator: Matthews, Elisabeth

PI Institution: Max Planck Institute for Astronomy

We will confirm that a candidate companion to Eps Ind A is indeed a massive planet, and detect (or place stringent constraints on) a second massive planet in the system. Eps Ind A is the ideal location to search for solar-age exoplanets: the system is nearby, hosts a known RV planet, and is co-moving with a benchmark brown dwarf binary. Even super-Jupiters orbiting the ~4Gyr Eps Ind A could be as cold as ~200K, far older and colder than any imaged planet to date. Only JWST, with its excellent mid-IR sensitivity, can detect such companions - and these companions would be exquisite targets for detailed atmospheric characterization in future cycles. Radial velocity and astrometric measurements suggest a planet with mass ~3Mjup and semi-major axis ~8-11au - readily resolvable and detectable with JWST/MIRI. JWST Cycle 1 images of Eps Ind A reveal a candidate companion that is consistent in color and magnitude with a massive (~10Mjup) planet. However, the position angle and mass of the candidate is different than expected from RV/astrometric models of the companion orbit - perhaps suggesting there are two giant planets in this system, with only one of these detected in the MIRI images. No counterpart is seen at the background location in archival Spitzer 8um and 24um images, and the object is challenging to explain as a chance-aligned background. A second epoch of observations will allow us to test for common proper motion to confirm that the source is a planet and not a chance-aligned background, carry out preliminary orbit fitting efforts to constrain a planet mass and test planet evolution models, and place further constraints on a proposed second candidate in the system.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5057
Program Title: Late Time Spectroscopy of Type Ia Supernovae: Determining the Explosion Mechanism and Elemental Production

Principal Investigator: Ashall, Chris

PI Institution: Virginia Polytechnic Institute and State University

Type Ia Supernovae (SNe Ia) are the thermonuclear explosions of white dwarf stars, which originate from binary star systems and synthesize roughly half of the iron-group elements in the universe. The nature of the progenitors and the explosion mechanism is an open question. Understanding SNe Ia is foundational for: the late stages of stellar evolution, the origins of the elements, and controlling systematic errors related to the use of SNe Ia as cosmological rulers. Observational estimates of the nuclear burning products in SNe Ia probe the progenitor and explosion. JWST provides an entirely new window of opportunity as there are spectral lines with unique information in the MIR. We request 20.8 hours of time to obtain 3 Medium resolution MIRI spectra 100-500d past maximum light for the nearest SN Ia discovered in Cycle 3. The progenitor and explosion mechanism will be constrained using spectra acquired in three physical regimes: 1) 100-200d which measures radioactive Co and the intermediate mass elements, 2) 250-350d where hard gamma-rays, non-local effects, and the appearance of forbidden lines of neutron rich elements probe the progenitor density, 3) 400-500d where positrons deposit energy locally revealing the radioactive cobalt distribution. One of goals of JWST is to reveal the origin of heavy elements and how they feedback into the universe. The sensitivity and resolution of MIRI will produce resolved line profiles, probing the element distribution. MIRI spectra will also show many isolated forbidden lines of isotopes with known wavelengths. The atomic physics learned will provide insight into many transients to come.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5058
Program Title: Early stars -- Properties of lensed stars at z~7

Principal Investigator: Furtak, Lukas

PI Institution: Ben-Gurion University of the Negev

Recent years have seen the advent of a new method to directly observe individual stars at cosmological distances through the micro-lensing effect that occurs when a star in a distant lensed galaxy crosses the caustic of a foreground lens. Its unprecedented sensitivity and spatial resolution make JWST the perfect observatory to detect and study these ultra-faint sources and indeed, every JWST observation of a lensing cluster to date has yielded at least one lensed star candidate. We propose here a small pioneering JWST/NIRCam imaging program specifically designed to monitor the highest-redshift caustic-crossing arc known to date in order to detect extremely magnified stars. The target is the spectroscopically confirmed z=6.7 arc in the cluster MS 0451.6-0305. Several characteristics of this arc make it especially well suited for detecting lensed stars: its configuration that makes it cross the caustic not once but twice and therefore yields a very large causic-crossing area in which micro-lensed stars can become observable, and its high-redshift nature which enhances the attainable magnifications. The lensing magnification pushes single stars to observed magnitudes brighter than 29 AB, depths easily achievable with JWST. Our program will not only crown the new highest-redshfit stars observed to date, but also for the first time directly constrain the radii of individual stars on such cosmological distances.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5064
Program Title: Constraining Cosmic Rays with H2 Ro-Vibrational Excitation in Dense Clouds

Principal Investigator: Bialy, Shmuel

PI Institution: Technion-Israel Institute of Technology

Low energy (E < 1 GeV) cosmic rays (CRs) play a key role in regulating the chemical and thermal state of molecular clouds. These CRs penetrate into the clouds' interior, ionizing H2 molecules, (i) generating gas heating, (ii) initiating chemical reactions leading to a rich array of molecules, and (iii) providing coupling of the gas to the Galactic magnetic fields. Yet, to date, the value of the CR ionization rate (CRIR), remains highly uncertain. Recently, it has been shown that the CRIR may be derived by observing H2 rovibrational emission lines in cold, dense molecular clouds. The idea is that the same CRs that provide ionization also excite the vibrational modes of H2 resulting in line emission in the near-IR with an intensity proportional to the CRIR. We propose to observe the H2 line emission spectrum in the dark cloud Barnard 68, and obtain the CRIR. Due to the atmospheric background, ground-based observations are not capable of detecting these faint lines. In contrast, NIRSpec/JWST can effectively detect these key H2 transitions with a high SNR. This would be the first detection of H2 vibrational emission lines in a molecular cloud and a first-time application of the H2 method for determining the CRIR. The constrained CRIR value will have direct implications on the poorly-known spectrum of low-energy proton CRs, and CR propagation theories. Furthermore, this observation will open a window for future determinations of the CRIR in the ISM in the Milky Way and beyond, shedding new light on the origin and propagation modes of Galactic CRs.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5069
Program Title: Weighting the odd: dynamics, assembly history and quenching of the oldest galaxy in the young Universe

Principal Investigator: D'Eugenio, Francesco

PI Institution: University of Cambridge, Kavli Institute for Cosmology

ZF-UDS-7329 is one of the most remarkable objects to have been discovered by JWST in its first year of operations (Glazebrook et al., 2023). This galaxy stands out as by far the oldest high-redshift galaxy, with a formation redshift of z = 11 and a stellar mass M*>10^11 MSun. At the time of formation, the volume density of this type of galaxy is much higher than that of dark-matter haloes sufficiently massive to host it; its stellar mass and age would have required a baryon-to-dark-matter fraction higher than the cosmic value, which is impossible. In addition, the old age and lack of star formation in ZF-UDS-7329 require quenching to have happened extremely quickly. Existing JWST data may support this scenario, with spectral features hinting at non-solar chemical abundances and neutral gas outflows. Unfortunately, our understanding of this unique object is currently severely limited by the low resolution of the existing prism spectrum. However, this is easy to fix: we propose to observe ZF-UDS-7329 in high spectral resolution with the NIRSpec IFU, to measure its dynamical mass, chemical abundances, gas properties, and spatially resolved star-formation history. Its dynamical mass will provide the true mass of this galaxy, and and a test of IMF assumptions. Its chemical abundance pattern will allow us to see if this galaxy really did form extremely quickly at z>10. This analysis will be able to confirm or rule out the tension between previous observations and theory. Its impact extends to many fields: stellar kinematics and galaxy assembly, initial mass functions, chemical abundances, SMBH feedback and quenching, and, possibly, even the theory itself of galaxy formation.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 5073
Program Title: What drives the aurora of Uranus?

Principal Investigator: Melin, Henrik

PI Institution: University of Leicester

Very little is known about the aurora of Uranus. The conduit of the auroral currents is the magnetic field, which at Uranus is full of strange complexity. It is tiled 60 degrees from the rotational axis, which means that it rotates a full 360 degrees during one Uranian day (17.24 hours), switching polarity relative to the interplanetary magnetic field (IMF). This produces a very complex and poorly understood interaction between the field and the solar wind. Auroral emissions are the electromagnetic manifestation of this interaction. The first JWST NIRSpec IFU observations of Uranus were obtained in January 2023 (GTO-1248), showing strong auroral emissions present, and forms the proof of concept for this programme. Here, we expand on these, proposing to observe Uranus for a full rotation with the NIRSpec IFU, observing the evolution and morphology of the aurora as it moves in local-time, connected to field lines in the tail, to the magnetopause and back again. The magnetospheric mapping of these emissions yields their source mechanisms: are they produced via the interaction with the solar wind (like the Earth), or are there internal sources within the system (like Jupiter), or somewhere in-between (like Saturn)? In turn, the spectral analysis of these emissions provides the atmospheric viewpoint: how does the injection of auroral energy alter the physical state of the upper atmosphere, and how significant a heat source is it for the global energy budget? Lastly, since the longitude system of Uranus has been long lost, because of the substantial uncertainties of the Voyager 2 period, tracking the morphology of the auroral provides the means to establish a new system.

Proposal Category: AR
Scientific Category: Large Scale Structure of the Universe
ID: 5075
Program Title: Unveiling the Morphological Evolution of Galaxies in Protoclusters: Insights from JWST Imaging

Principal Investigator: Shen, Lu

PI Institution: Texas A & M University

Galaxy clusters at z < 1.5 are found to facilitate more rapid galaxy evolution with evidence of more massive, elliptical, and quenched galaxies compared to field galaxies at similar redshift ("coeval"). It is natural to study whether such an effect is already in place in high-redshift clusters or "protoclusters". Thus, we propose to investigate the morphology of galaxies in six well-studied protoclusters at 2.5 < z < 4.5 from the C3VO survey that are covered by JWST NIRCam imaging from COSMOS-Web, PRIMER, JADES, and FRESCO surveys. Galaxy morphology reveals important formation processes that only structural analyses can provide, such as galaxy sizes, surface brightness profiles, merging activities, and clumpiness. This morphological study is only possible with JWST as it provides high-resolution rest-frame optical/NIR imaging for galaxies at z > 2, where the contribution from old stellar populations is more significant and less affected by dust. Leveraging a large number of spectra from the C3VO survey and other spectroscopy surveys, we robustly identified protoclusters/sub-structures and have spectroscopically confirmed 355 protocluster members in the selected protocluster sample. This large statistical sample of protocluster members over a large, critical redshift range allows us to (1) constrain the size evolution of protocluster members to determine how the environment affects the evolutionary track of galaxies, (2) classify morphology and characterize the evolution of the morphology-density relation, and (3) investigate the morphology of star-forming galaxies and AGN to constrain the physical processes that trigger the starbursts and AGN activities in protoclusters.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5086
Program Title: Confirming Population III or a Direct Collapse Black Hole in the halo of GN-z11 at z=10.6

Principal Investigator: Maiolino, Roberto

PI Institution: University of Cambridge

Previous observations have revealed HeII emission in the halo of the lumionous galaxy GN-z11 at z=10.6, which could be tracing either Population III stars (formed in a pocket of pristine gas, as expected by some models) or an accreting Direct Collapse Black Hole (DCBH), in the earliest (pristine) phases of its formation. However, the detection is still tenative (5 sigma). We propose to obtain a deep NIRSpec-IFS observation (40 hours on-source), with the high resolution grating, with the primary goal of confirming the HeII detection in the halo of GN-z11 and discriminate between the PopIII and DCBH scenarios. The confirmation of the detection of either of these long-sought objects would be a groundbreaking discovery. In addition, the observation will tackle a wealth of additional science cases, such as: trace the ionization cone and outflow in GN-z11, which is key for understanding the onset of AGN feedback in early galaxies; determine the C/O abundance in the host galaxy of GN-z11 and in its circumgalacting medium, possibly confirming signatures of PopIII enrichment; accurately measure the black hole mass of GN-z11; disentangle the nitrogen emission from the Broad Line Region in GN-z11 from the emission coming from of the host galaxy, hence constraining the N/O abundance in the nuclear region of GN-z11 and its host galaxy; confirm the presence of WR stars and their spatial distribution, hence providing tight constraints on the age of the stellar population in GN-z11.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 5094
Program Title: Composition of an Interstellar Object - Unique Insights into Protoplanetary Disk Midplane Chemistry

Principal Investigator: Cordiner, Martin

PI Institution: Catholic University of America

We propose spectroscopy and imaging with NIRSpec, NIRCam and MIRI to investigate the physical and chemical properties of a target-of-opportunity interstellar object (ISO), to help elucidate the nature and origin of this fundamentally new class of astronomical body. We will perform a deep search for outgassing using the NIRSpec prism over three epochs. If a coma is clearly visible, higher-resolution grating observations will be used to measure the production rates of multiple coma gases (including H2O, CO2, CH4, CH3OH, CO, HCN, H2CO and C2H6), to determine the ice content of the nucleus. MIRI-LRS spectroscopy will reveal the coma dust composition, while NIRCam and MIRI imaging will measure the nucleus size. In the absence of significant outgassing, our near-to-mid-IR observations have been designed to directly measure the ISO's surface composition and spectral shape, for comparison with Solar System asteroids. We will target an ISO similar to (or brighter than) 1I/'Oumuamua and 2I/Borisov, with V <~25 mag. Only JWST has the sensitivity to perform the required gas, dust and nucleus measurements in the event of a faint apparition. The proposed observations will provide new insights into the diversity of protoplanetary disk midplane chemistry in our Galaxy, and in a sufficiently bright and gas-rich object (V<~19), will yield a comprehensive inventory of the volatiles available for pre-biotic chemistry in a planetary system other than our own.

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Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 5105
Program Title: NEXUS: the North ecliptic pole EXtragalactic Unified Survey

Principal Investigator: Shen, Yue

PI Institution: University of Illinois at Urbana - Champaign

NEXUS is a proposed multi-cycle treasury spectroscopic survey around the North Ecliptic Pole with exquisite optical through MIR photometry and temporal sampling. It contains two overlapping tiers. The Wide tier (~400 arcmin^2) performs NRCam/WFSS 2.4-5micron grism spectroscopy with three epochs over 3 cycles. The Deep tier (~50 arcmin^2) performs high-multiplexing NIRSpec 0.6-5.3micron MOS/PRISM spectroscopy for up to ~10,000 targets, over 18 epochs with a 2-month cadence. All epochs have simultaneous deep NIRCam and MIRI imaging. The field is within the continuous viewing zone of JWST, and is fully covered in the Euclid Deep Field North, with a wealth of deep multi-wavelength data to maximize synergy across wavelengths and science areas. NEXUS has three science pillars. First, with its massive spectroscopic sample and deep photometry, it will perform efficient classification and physical characterization of galaxies and AGNs from z~1 to Cosmic Dawn. With the large contiguous area coverage, it will measure the spatial clustering and demography of the first galaxies and SMBHs at z>6. Second, multi-epoch observations enable systematic time-domain investigations, focusing on z>3 supernova searches and low-mass AGN reverberation mapping. Third, the comprehensive data set from three JWST instruments will enable knowledge transfer to other legacy fields, create data challenges, and initiate benchmark work for future space missions. With rapid public releases of processed data and an open invitation for participation, NEXUS aims for broad and swift community engagement, to become a powerhouse to drive transformative advancements in multiple key science areas of astronomy.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5110
Program Title: omega Centauri: the coolest pieces of its population puzzle

Principal Investigator: Bedin, Luigi

PI Institution: INAF - Osservatorio Astronomico di Padova

As the largest and oldest coeval stellar populations, globular clusters (GCs) trace the origin of chemical abundances in the Galaxy and offer unique insight into the properties of ancient metal-poor stars. The long-held notion of chemical homogeneity among cluster members has been firmly ruled out by two decades of space-based photometry that revealed complex color-magnitude diagrams (CMDs), displaying multiple populations (mPOPs) of stars with distinct compositions. The enrichment mechanism responsible for this phenomenon remains uncertain, in part, because most GC studies have been restricted to bright main sequence or giant stars. We propose to use JWST in direct-imaging mode with NIRCam and NIRISS to obtain high-precision photometry and astrometry of the faintest objects in omega Centauri (NGC 5139) – the most massive GC that may host as many as 15 sub-populations. We intend to explore the transition in the CMD between stars fusing Hydrogen and non-fusing brown dwarfs (BDs). Observations of BDs will provide precise ages and compositions for individual sub-populations as well as probe the hypothetical dependence of abundances on the stellar mass, allowing direct tests of various mPOPs formation theories. The new data will be also used for calibrating metal-poor models of BDs, thus serving as a 'Rosetta-stone' between the poorly understood physics of low-temperature atmospheres and reliable measurements of chemical abundances in higher-mass stars. In addition, the proposed program will be sensitive to the entire white dwarf (WD) cooling sequence, allowing the search for IR excess in WD colors as a signature of ancient planetary systems.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5114
Program Title: Tracing the evolution of circumstellar and protoplanetary disks at low metallicity

Principal Investigator: Sabbi, Elena

PI Institution: Space Telescope Science Institute

The interaction between pre-supernova FUV feedback from massive OB stars and radiation from the host stars plays a crucial, albeit not yet fully characterized, role in the evolution of the interstellar medium and circumstellar disks, as well as in the ability of low-mass stars to retain planetary systems. The synergy between NIRCam and MIRI observations finally offers us the opportunity to advance the study of the rapid (< 3 Myr) evolution of young stellar objects and pre-main sequence stars' disks in extragalactic star-forming regions. Our neighboring low-metallicity galaxy, the Large Magellanic Cloud, hosts the well-studied giant HII complex N159, which comprises three giant molecular clouds at various evolutionary stages. This system serves as a particularly rare example of the transition from an embedded region at the onset of high-mass star formation to a region where pre-supernova feedback has already begun to clear the natal molecular cloud, revealing massive star clusters. N159 provides a unique window for witnessing the full evolution of a giant molecular cloud under the influence of emerging star formation in conditions significantly different from those observed in the Milky Way. We have, therefore. the opportunity to document how the progressively increasing stellar feedback affects the evolution of protoplanetary disks and the properties of the ISM at low metallicity, as the FUV radiation from O and B stars clears the surrounding natal material.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5118
Program Title: Fundamental Properties and Formation Pathways of an Extremely Cold Companion

Principal Investigator: Schneider, Adam

PI Institution: United States Naval Observatory Flagstaff Station

Cold substellar companions to nearby stars are rare but extremely valuable benchmarks for testing formation, evolutionary, and interior models. These objects also give us the opportunity to gain key insights into the chemistry of low-temperature atmospheres akin to those of cold, extrasolar giant planets. A wide-separation (~10') substellar companion to the nearby (~17.5 pc) M dwarf Ross 19 has been identified. This system represents a compelling laboratory for investigating how age, metallicity, and formation mechanism affect the emergent features of substellar atmospheres at extremely cold temperatures. Different formation models for planetary and brown dwarf companions suggest that the atmospheric elemental abundances should be different depending on the mechanism. We propose a combination of NIRSpec and MIRI spectroscopy and photometry to 1) measure the fundamental properties (e.g., bolometric luminosity and effective temperature) to the highest precisions possible for an extremely cold brown dwarf, and 2) constrain this benchmark companion's origin by probing the atmospheric chemistry unique to different formation pathways.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5119
Program Title: Resolving galaxy building blocks at high-z: the comprehensive picture of internal physical properties in an ultra-low-mass major merger system at z=5.2

Principal Investigator: Asada, Yoshihisa

PI Institution: St. Mary's University

In the hierarchical picture of structure formation, galaxies are expected to grow through successive mergers. Hierarchical galaxy growth has been well studied in the low-z universe, and it is now possible to study this assembly process in its early stages at high-z with JWST. We propose a NIRSpec/IFU observation of a gravitationally lensed, galaxy merger system of two ultra-low-mass galaxies at z=5.2. Although the two galaxies are only Log(M/Msun)~6.9 and intrinsically small, thanks to the high lensing magnification (~x20), this merging system is spatially resolved and can be investigated in detail with JWST. We will obtain all the key rest-optical emission lines of Hbeta, Hgamma, [OIII]4959/5007, [OIII]4363, [NeIII]3867, and [OII]3727, aiming at mapping the spatially resolved interstellar medium properties down to ~40 pc scale and revealing the velocity field in this merging system. Combined with previous observations, this observation will enable us to derive the comprehensive picture of the internal structure within an ultra-low-mass galaxy merger system at high-z for the first time. This will include spatial maps of young stars, old stars and ionized gas, metallicity, and dust, and will let us unambiguously reveal how galaxy mergers govern low-mass galaxy evolution in the early stages of galaxy assembly.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5137
Program Title: Weighing the Intermediate Mass Black Hole in Omega Centauri

Principal Investigator: Seth, Anil

PI Institution: University of Utah

We propose for deep NIRSpec IFU observations to follow up the detection of an intermediate mass black hole (IMBH) based on proper motion measurements of 7 fast-moving stars in the central 3" of Omega Centauri. These stars place a firm lower limit of 8000 solar masses on the black hole. This unique black hole is simultaneously (1) the most robust detection of any IMBH, (2) the nearest massive black hole, and (3) only the second with a resolved system of orbiting stars. Only with JWST NIRSpec IFU can we simultaneously measure the line-of-sight velocities of the stars and make the deepest available search for the expected accretion emission from the black hole. We will obtain line-of-sight velocities for ~70 stars, including the first measurements for all four fast moving stars within the central 1". In addition we will identify 3.1+/-1.7 additional fast moving stars. These measurements will provide 3D velocity information crucial for the precise measurement of the IMBH mass based on the orbits of the stars. The proposed observations will also be sensitive to black hole accretion ~100x fainter than the upper limits placed by deep X-ray observations. Detection of any accretion source would identify the exact location of the black hole and reveal a black hole accreting orders of magnitude more faintly than any known.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5141
Program Title: The Fornax Planetary Nebula - an LRS Pilot Study

Principal Investigator: Kraemer, Kathleen

PI Institution: Boston College

Our goal is to characterize the Fornax planetary nebula (PN). This PN is the only one known within the Fornax Dwarf Galaxy and was the most distant PN observed with the Infrared Spectrometer (IRS) on Spitzer. The rarity of PNe known in Local Group dwarf galaxies means we have few options to characterize the stellar ejecta with which these objects are enriching their hosts. This makes it essential to study the few that are know in order to understand their stellar populations and better inform the models of distant, unresolvable galaxies. The PN is so faint, though, that while hints of spectral features can be seen in the IRS spectrum, it was too noisy to analyze. The high sensitivity of the Low Resolution Spectrometer (LRS) on JWST's MIRI makes it the ideal instrument for this study, requiring less than 3 hours to complete.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5145
Program Title: Resolving the Global Stellar Populations and Star Formation History of the Starburst Galaxy M82

Principal Investigator: Smercina, Adam

PI Institution: University of Washington

We propose a NIRCam imaging survey of the nearby starburst galaxy, M82. As the prototypical massive starburst, which is also engaged in the nearest major galaxy interaction in the universe, M82 is a galaxy evolutionary laboratory. Imaging M82's disk out to R~8 kpc, we will for the first time break through its horrific line-of-sight dust extinction to reveal the bulk of its luminous stellar population, which are uniquely accessible with JWST. We will resolve at least 10 million individual stars across M82's disk, generating a stellar catalog that will have a lasting legacy value to the astrophysical community for decades. The key science goals of this proposal are to: measure M82's globally resolved star formation history over at least the past 6 Gyr, including the evolution of its recent starburst; map the metallicity of its stellar populations; and constrain dynamical models of its interaction history in the M81 Group. These will inform our understanding of starbursts and their winds, major mergers as drivers of galaxy evolution, and stellar evolution in high-metallicity, starbursting environments. The multiple filters, combined with rich archival data and parallel NIRISS imaging, will allow abundant future breakthrough science, including on star cluster populations, dusty evolved stars, high-resolution mapping of dust in and above the disk, stellar spectroscopy, and M82's stellar halo. The exposure times of 6356s in F115W/F356W and 4638s in F150W/F444W will reach the Red Clump feature at all spatial positions and for all extinction values in the disk, except for the crowded central 1 kpc. The scientific impact of this 65 hour investment by JWST will be felt for years.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5168
Program Title: First Direct Measurements of Interstellar Silicate Dust in the Magellanic Clouds

Principal Investigator: Gordon, Karl

PI Institution: Space Telescope Science Institute

We propose to measure the 10 micron silicate extinction feature for a sample of 11 sightlines in the Large and Small Magellanic Clouds that show large variations in dust composition as probed by their ultraviolet extinction properties. These measurements will be the first direct measurements of the properties of interstellar silicates in the diffuse ISM at metallicities below solar. We will investigate the variation in the strength, central wavelength, width, and asymmetry of the feature and compare to variations seen in the Milky Way. Combined with existing ultraviolet observations we will probe the silicate-to-carbonaceous dust ratio and test the importance of Asymptopic Giant Branch stars for dust formation as a function of metallicity. In addition, comparisons to silicate grain models will constrain shapes, Mg-to-Fe content, and oxidization of the grains. Combining this work with existing UV extinction measurements for the same sightlines will provide empirical average extinction curves at two different metallicities from the ultraviolet through the mid-infrared enabling all to account for the effects of dust on observations of lower than solar metallicity targets.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5177
Program Title: Detailed Atmospheric Characterization of a Unique Low-Temperature Exo-Saturn

Principal Investigator: Hu, Renyu

PI Institution: Jet Propulsion Laboratory

Astronomers have learned a great deal about the atmospheres of hot extrasolar Jupiters and Saturns using ground-based, HST, Spitzer, and JWST observations. These planets are however in very different atmospheric circulation and chemistry regimes than their solar-system counterparts, and so far, there lacks an extrasolar analog of Jupiter or Saturn where we could test the basic theories of giant planet atmospheres. Here we identify TOI-199 b, a 350-K, Saturn-sized planet orbiting a G star, as a highly favorable target for detailed atmospheric characterization via transmission spectroscopy. We propose to observe one transit of the planet using NIRSpec/G395M. With a TSM of >100 and a long transit duration of nearly 8 hours, the observation will result in exquisite photometric precision and precisely constrain the abundances of $H_2O$, $CH_4$, $NH_3$, HCN, $CO_2$, and CO in the planet’s atmosphere. This unprecedented information will not only determine the atmospheric metallicity and C/O ratio, but also assess whether the vertical mixing in the planet’s atmosphere is closer to the Jupiter regime or the hot Jupiter regime, and if the planet has a Jupiter-like vertical mixing, constrain the photochemical production mechanisms of HCN. The constraints on the metallicity and vertical mixing will also determine the fraction of nitrogen as $NH_3$ (or indirectly as HCN), leading to a comprehensive picture of the planet’s C, N, and O inventories. This program pushes the frontier of exoplanet characterization to low-temperature planets and advances the understanding of atmospheric physics and chemistry in unique planetary environments.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5191
Program Title: Bare rocks are not supposed to do that

Principal Investigator: Ducrot, Elsa

PI Institution: CEA/DSM/DAPNIA/Service d'Astrophysique

We propose to elucidate the origin of several puzzling observations relative to the thermal fluxes of TRAPPIST-1 b and c in the mid-infrared. Recent observations of five secondary eclipses of TRAPPIST-1 b and a partial eclipse of c in the F1280W band have revealed two puzzling findings: - During one visit, JWST recorded a partial eclipse of TRAPPIST-1 c with an unexpectedly large occultation depth, contradicting previous 15microns measurements and equilibrium temperature predictions. - Brightness variations between visits during the five TRAPPIST-1 b eclipses, not seen at 15 microns, suggest intriguing potential origin such as star-planet interactions through photochemistry or outgassing. To solve both these mysteries at once and save telescope time, we propose to observe four eclipses of TRAPPIST-1 b and c one after the other during the same visits, requiring a total of 23.3 hours. This proposal is key to unraveling the TRAPPIST-1 innermost planets' internal heating and atmospheric characteristics, and will have major implications for the system’s outer, potentially habitable planets

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5192
Program Title: The first multi-scale and multi-phase characterization of black hole feedback at z>6

Principal Investigator: Bischetti, Manuela

PI Institution: Universita degli Studi di Trieste

Bright quasars at z > 6 are powered by rapidly accreting supermassive black holes that lie above the local black hole (BH)-galaxy mass correlation. Simulations predict that these BHs at redshifts around 6-7 release strong radiation and power energetic winds, regulating both BH and galaxy evolution. Recent near-infrared surveys reveal that up to 50% of quasars at z>6 show evidence for BH-driven winds through broad absorption lines (BAL) in rest-frame UV spectra, indicating the importance of winds in regulating both black hole and host-galaxy growth in the early universe. Here we propose to target with JWST/NIRSpec IFU a z~6.6 quasar with multi-phase detection of a BH-driven outflow and a robust measurement of the outflow energetics, both on 10-100 pc and on ~2 kpc scale. Strong AlIII and MgII absorption lines provided excellent constraints on the energetics of the nuclear wind, consistent with >10% of the quasa luminosity. ALMA observationsalso discovered the presence of a powerful, galaxy scale cold gas outflow. The excellent sensitivity and spatial resolution of the JWST/NIRSpec will allow us to map the galaxy-scale ionized outflow, the distribution of dust, and the unobscured star-formation in the quasar host using the rest-optical emission line diagnostics (e.g., [OIII], Ha, [NII], Hb). We will also probe the ionized counterpart of the 10 kpc, cold gas halo detected by ALMA. The outcome of this proposal will provide the first multi-phase, multi-scale characterization of a BH-driven outflow at z>6 and its impact on galaxy and circumgalactic scales.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5204
Program Title: Probing the Dynamical History and the Mid-IR SED of WD 1856b

Principal Investigator: Limbach, Mary Anne

PI Institution: University of Michigan

The WD 1856 system hosts the only known transiting exoplanet around a white dwarf, WD 1856 b, a gas giant with an orbital separation of 0.02 AU. Recent NIRSpec observations of WD 1856 b have presented a perplexing and unexpected outcome. The observations provide further evidence that the exoplanet candidate is likely in the planetary mass regime, while conversely finding it has a temperature far above what is expected for the estimated age and mass of this planet. This mystery can most readily be solved by obtaining a better understanding of the exoplanet's dynamical history. There are currently two possible explanations for WD 1856 b's arrival at its current location, either common-envelope evolution or high eccentricity migration. If the latter is responsible for the planet's migration to its current location, then there is likely a higher mass planet in the WD 1856 system that kicked it in. We propose an efficient MIRI direct imaging + common proper motion program to search for additional exoplanets in this system to constrain the migration mechanism of WD 1856 b. Additionally, WD 1856 b outshines its host star in the mid-IR, and the proposed observations will provide the first flux measurement of this exoplanet in the mid-IR from 5-25 microns via IR excess in the blended white dwarf + planet SED, allowing for improved characterization of the planet's spectrum and physical parameters. In particular, the observations will probe the emission temperature, atmospheric C/H ratio and disequilibrium chemistry of the exoplanet.

Proposal Category: AR (GO-Archival)
Scientific Category: Galaxies
ID: 5213
Program Title: SCUBADive: A JWST Archival Analysis of the Most Dust-Obscured Galaxies Across Cosmic Time

Principal Investigator: McKinney, Jed

PI Institution: University of Texas at Austin

What are the optical and near-infrared counterparts to sub-millimeter galaxies (SMGs) and what is their redshift distribution? Are they overwhelmingly disturbed by galaxy-galaxy interactions, or can the high star-formation rates commonly found in SMGs reside within smooth disks? Historically, the answers to these questions have been limited to lower redshift (z<1-2) sub-mm sources where ground- and space-based telescopes can still detect the rest-optical light from stars. Now, JWST is sensitive enough to detect the optical/near-IR counterparts to SMGs up to much higher redshifts (z>2-4) - enabling a new perspective on a pivotal category of galaxies which dominates the star-formation rate budget for most of cosmic time. In this program we propose an Archival analysis of SMGs to uncover their JWST counterparts, leveraging JWST's ability to detect stellar light through extreme optical attenuation and in distant galaxies. We will use the combined optical/near-IR (JWST) through far-infrared/sub-mm (ALMA, SCUBA2) data to (1) measure the full redshift distribution of SMGs down to fainter sub-mm fluxes than ever expolored before, (2) measure the volume density of the elusive population of z>4 SMGs, and (3) spatially resolve the stellar properties of SMGs to distinguish principle quenching pathways. To answer these questions we will identify the JWST counterparts to the 706 SMGs that fall within the NIRCam footprint of COSMOS-Web (Cycle 1). This archival program will produce the largest volume-limited SMG sample with multi-wavelength SEDs that include JWST data, and also pave the way for a similar analysis over other JWST+ALMA fields.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 5221
Program Title: Mapping Cosmic Structure Evolution: Characterizing Two Massive Galaxy Protoclusters Anchored by z>7.5 Luminous Quasars

Principal Investigator: Pudoka, Maria

PI Institution: University of Arizona

Structure formation models predict that the earliest billion-M_sun supermassive black holes must form in the most massive dark matter halos and can therefore be anchors of protoclusters in the Epoch of Reionization. We propose to study the environments of the two most high-redshift quasars (z>7.5) using a mosaic of NIRCam/WFSS to search for [OIII] emitters at the quasar redshifts. Both quasars show strong evidence of residing in large-scale overdense environments based on photometric selection of Lyman break galaxies using JWST NIRCam multiband imaging. However, the existing data is limited by: (1) a single pointing of NIRCam that cannot cover the full extent of protoclusters, and (2) broad-band photometric selections that do not probe the 3-D structure of the protoclusters. We will carry out NIRCam/WFSS mosaic observations that will cover 2.5 times the area of existing data, and measure precise redshifts that map the large-scale structure and kinematics of the protocluster member galaxies. We expect to confirm the spectroscopic redshifts of ~150 galaxies at z~7-9 and characterize the kinematics of ~50 galaxies in the close environments of these quasars in order to verify and characterize the properties of two of the most extreme high-z protoclusters anchored by quasars. These observations will allow us to calculate spatial clustering around z~7.5 to constrain dark matter halo mass, probe AGN activity in protocluster environments, and study galaxy formation and evolution in the most dense and active regions in the early universe.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5224
Program Title: Mirage or Miracle? Spectroscopic Confirmation of Remarkably Luminous Galaxies at z>10

Principal Investigator: Oesch, Pascal

PI Institution: University of Geneva, Department of Astronomy

The first year of JWST has finally pushed our observational frontier beyond z~11, into the last unknown epoch of our cosmic timeline. Dozens of galaxy candidates have been reported at record-breaking redshifts, and some even spectroscopically confirmed. While this is exactly what JWST was built for, the large number of luminous Muv<-20 candidates barely a few hundred Myrs after the Big Bang continues to be one of the biggest surprises from early JWST data. These galaxies have excited the community -- *if* they are at z>10, they imply new ingredients are required in our galaxy formation models, and perhaps even cosmology. Despite the intense interest and large numbers of candidates, spectroscopic follow-up and confirmation is severely lagging behind. Only a handful of sources at Muv<-20 have so far been confirmed at z>~10. Here we propose the first systematic spectroscopic survey of luminous z>~10 galaxies that will definitively settle the number density and nature of this population. We will target a carefully selected sample of 15 sources that are found to have a ~10x higher number density than theoretical models predicted. Our observations will test whether these sources genuinely are at z>~10 or if they are new classes of interlopers that may be corrupting JWST's searches. At the same time, these spectra will provide detailed insights into the physics of luminous z>~10 galaxies through continuum slopes and rest-frame UV emission lines, which can constrain the presence of Pop-III stars, AGN, or globular cluster formation in action. These observations have immediate implications for the success of JWST to securely expand our horizon to cosmic dawn.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5226
Program Title: The Weather Forecast in a Cloudy (or not) Cool Planetary-Mass Brown Dwarf

Principal Investigator: Manjavacas, Elena

PI Institution: Space Telescope Science Institute - ESA - JWST

Ross 458 c is a ~9 Jupiter mass, T8 spectral type brown dwarf that has similar mass and temperature to some cold directly-imaged exoplanets, like 51 Eri b, GJ 504 b, and GJ 758 b. Due to the high separation between Ross 458 c and its host stars, and to the proximity of the system, it is possible to obtain high signal-to-noise spectra for this exoplanet couterpart using JWST/NIRSpec. We propose to perform prism spectroscopy during two full rotational period (6.75±1.58 hr) to measure its spectral variability across the 0.6-5.3 micron wavelength range, which is key to understand if this variability is due to clouds or to temperature differences and circulation in the atmosphere of Ross 458c. In addition, we will use an exoplanet mapping software to reveal the 2D maps at different pressure levels of the object, producing a 3D weather map of such a low-mass and cold object for the first time. The results obtained for this planetary-mass brown dwarf might serve as a guidance to further understand the atmospheric dynamics and composition of directly-imaged exoplanets of similar effective temperatures to Ross 458c, for which due to instrumental limitations we are unable to obtain similar high signal-to-noise spectra to this date.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5229
Program Title: Super-Jupiters in our backyard: MIRI coronagraphic imaging of a massive planet/brown dwarf orbiting an M dwarf at 12pc

Principal Investigator: Matthews, Elisabeth

PI Institution: Max Planck Institute for Astronomy

We will directly detect a massive planet (>2MJ), or low-mass brown dwarf (<20MJ), orbiting the solar-age M dwarf GJ179. We will derive a luminosity and a dynamical mass, and perform a rare but important observational test of evolutionary models at old age and low mass. The detection will pave the way for detailed atmospheric characterization of a cold atmosphere, and JWST coronagraphic imaging is the only facility capable of detecting this object. We will differentiate chemical equilibrium and non-equilibrium models of the target by combining NIRCam F444W and MIRI F1550C images, and differentiate true companions from backgrounds stars and galaxies with a high level of statistical certainty. The constraints on separation and apparent flux will also be crucial to design future spectroscopic campaigns using NIRSpec and the MIRI MRS. This will allow detailed atmospheric characterization campaigns - providing a rare opportunity to study the rich molecular chemistry of a cold atmosphere, and probe its formation and evolution. GJ179 is an ideal target for this work. The system shows strong evidence of an outer planet, from a long-term RV trend and an astrometric acceleration. The host star is nearby (12pc), allowing for very deep absolute magnitudes to be reached; it is late-type (M3.5V), reducing the contrast between the star and a massive companion; it has a well-constrained age (5.0Gyr). Archival imaging with Keck/NIRC2 rules out companions >20MJ and hotter than 450K, but the RV trend confirms that the companion must be massive and widely separated, and detectable with JWST - paving the way to detailed atmospheric characterization of a cool, solar-age planet/brown dwarf.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5232
Program Title: Getting Late Early: Mid-Infrared Spectroscopy of White Dwarf Supernovae

Principal Investigator: Kwok, Lindsey

PI Institution: Rutgers the State University of New Jersey

Type Ia supernovae (SN Ia) have enormous importance to cosmology and astrophysics, but we still lack a detailed understanding of their progenitor systems and explosion mechanisms. As a supernova expands over time, it enters the nebular phase where the ejecta become optically thin, allowing us to see interior layers and directly probe its composition, density, temperature, and kinematic structure. JWST observations have shown that nebular phase observations in MIR provide powerful constraints on models, including the density-dependent nucleosynthesis of intermediate mass elements, radioactive iron-group elements, and stable iron-group elements. In the MIR, supernovae transition to the nebular phase far earlier than they do in the optical, and their evolution during this early, rapid transition is expected to reveal unique MIR signatures that will differentiate between models. Here we propose to build a legacy, reference sample of JWST MIR spectra of white dwarf supernovae at early times, as they transition to the nebular phase, with non-disruptive target-of-opportunity observations. In addition to normal SN Ia, we will also observe the diversity of thermonuclear supernovae, including extreme and peculiar objects. Our data will open a new, unexplored window on the early MIR evolution of thermonuclear explosions, uniquely probing wavelengths where the ejecta quickly become optically thin, and strongly testing progenitor and explosion models. All data obtained will bemade public immediately, with no exclusive access period.

Proposal Category: AR
Scientific Category: Large Scale Structure of the Universe
ID: 5238
Program Title: Constraining the Epoch of Reionization via Cross Correlation of JWST Pencil-Beam Galaxy Surveys and Line-Intensity Maps

Principal Investigator: Visbal, Eli

PI Institution: University of Toledo

Line-intensity mapping is an emerging technique to characterize cosmological large-scale structure through spatial fluctuations in line emission from galaxies and/or the intergalactic medium (e.g., in 21cm or Lyman-alpha). Intensity mapping has the potential to constrain cosmic reionization and the early stages of galaxy evolution by probing numerous faint sources that will be challenging to directly detect, even with JWST. A key challenge in intensity mapping observations is eliminating contamination from astrophysical foregrounds, such as galactic synchrotron emission in 21cm observations, which is orders of magnitude brighter than the cosmological signal. A reliable method of mitigating these contaminants is to cross correlate the intensity mapping signal with a galaxy redshift survey at the same redshift. Recent analytical work has shown that a JWST galaxy survey consisting of a number of pencil beams which sparsely fill the intensity mapping volume can yield a high signal-to-noise when cross correlated with intensity maps such as a Lyman-alpha map from SPHEREx. However, a number of rough assumptions were made in these estimates (e.g., the detection criteria for JWST galaxies and only linear clustering). We propose to address these shortcomings by creating detailed numerical simulations of intensity maps and JWST pencil-beam galaxy surveys within the same volumes. We will survey a wide variety of JWST survey configurations and intensity mapping lines/experiments (e.g., 21cm with SKA and Lyman-alpha with SPHEREx) to determine optimal observing strategies and forecast associated constraints on astrophysical quantities of interest (e.g., timing/topology of reionization).

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5255
Program Title: Defining the Dwarf Galaxy Reionization Transition Zone

Principal Investigator: Skillman, Evan

PI Institution: University of Minnesota - Twin Cities

The impact of reionization on galaxies is relatively well understood in a dichotomous sense: massive galaxies are not impacted by reionization and low-mass galaxies have their star formation terminally extinguished. Nonetheless, there is an intermediate regime where the star formation in relatively low-mass galaxies is impacted by heating during reionization but can recover and continue at a later date. We know of this "transition zone" from recovered star formation histories of three nearby isolated currently star-forming galaxies. With JWST we can add a fourth galaxy to this sample (SagDIG) which has only shallow HST photometry primarily due to high foreground extinction. Post-reionization re-ignited star formation in dwarf galaxies has implications for cosmological simulations. Specifically, if delayed star formation is typical for lower galaxy masses, this would significantly impact the interpretation that low-mass galaxies are engines of reionization and, thus, our expectations of the high-redshift galaxy UV luminosity function. JWST observations of SagDIG will help us to better understand this important galaxy mass regime with regard to the effects of reionization.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5261
Program Title: Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Principal Investigator: Jiang, Haochang

PI Institution: European Southern Observatory - Germany

We propose to confirm an accreting protoplanet candidate in MWC 480 disk. This candidate has been recently detected with Subaru SCExAO/VAMPIRES H-alpha imaging observations. Situated within a prominent dust continuum gap ~0.4" from the host, this candidate spatially coincides with a group of carbon-rich molecular line-emission rings observed by ALMA. These configurations are consistent with the chemical footprint of a hot accreting planet, which triggers the release of C-rich ice into the gas phase inside the dust gap. To independently confirm this candidate, we propose to observe the Pa-alpha emission line from the accreting planet / circumplanetary disk with the F187N filter and M210R mask on NIRCam. This is a unique target for this scientific case, and JWST is the only facility capable of measuring the Pa-alpha emission which ground-based facilities cannot due to the opaque atmosphere. Successful confirmation of the planet will mark a unique detection of a gap-opening protoplanet still undergoing the so-called runaway gas accretion. This is different from the previously detected 'low' accreting super Jupiter protoplanets in the large cavity of PDS 70, which will put the candidate robustly as the youngest planet that can be directly detected. It would present as a Rosetta stone to guide observational studies and vastly improve our theoretical understanding of giant planet formation and planet-disk interactions.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5263
Program Title: Observing the Atmosphere of a Pulsar Planet

Principal Investigator: Zhang, Michael

PI Institution: University of Chicago

Pulsar planets were the first exoplanets ever discovered, but little is known about their atmospheres or formation processes. We propose to observe a NIRSpec/PRISM spectroscopic phase curve and a 2 h NIRSpec/G295H dayside snapshot of a pulsar planet with mass and temperature typical of hot Jupiters. The millisecond pulsar host to the planet is invisible at infrared wavelengths, allowing us to obtain brown dwarf quality spectra (SNR $\sim$ 200) for an externally irradiated hot Jupiter--a feat impossible for any other known object in the universe. These exquisite spectra will allow us to measure the radius, composition, heat circulation, and possibly outflow of this exotic planet, heated by an ultra-hard pulsar spectrum and a pulsar wind. The composition will constrain the planet's formation mechanism: did it form in a supernova fallback disk, or in an accretion disc born from the tidal disruption of a star? These observations would also help address long-standing questions in high-energy astrophysics. By measuring the radius of the planet, we will know whether it is currently overflowing its Roche lobe, shedding light on whether this companion could have spun up its millisecond pulsar host. By measuring the inclination and orbital velocity of the planet, we will measure the mass of the pulsar, which for other millisecond pulsars has sometimes been large enough to constrain the neutron star equation of state.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5266
Program Title: A sharp view on the small-scale star formation in a remarkable redshift 2.58 spiral galaxy

Principal Investigator: Adamo, Angela

PI Institution: Stockholm University

During cosmic noon, galaxies experience intense star formation phases that double the galaxy stellar mass over short time scales. Their morphologies are dominated by compact stellar clumps which are trust to be a major mode of star formation and mass growth during this period. In contrast to HST based studies, JWST observations have revealed that spiral galaxies are already in place at redshift higher than 1.5, with higher than expected incidence of bulges and even bars structures. To capture this rapid evolution phase, we propose NIRSpec/IFU observations of the optical rest-frame of Sp-a2744, a remarkable face-on spiral at z=2.58, detected in the UNCOVER data of the lensing cluster Abell 2744. Homogenous 2D magnification preserves the morphological appearance of this target that shows ~40 clumps, an asymmetric disk, a potential bar and proto-bulge in the making. This galaxy represents a unique laboratory to study the rapid morphological evolution and the star formation cycle close to the peak of star formation history. Recently, ALMA has mapped the giant molecular clouds (GMCs) at resolution comparable to the here requested NIRSPEC/IFU observations. The combination of ALMA, NIRCam, and NIRSpec/IFU will enable us to derive key physical properties (age, SFR, dynamical mass, extinction, electron density, gas pressure, metallicity, ionisation parameters) down to 10s of parsec scales. We will evaluate the effect of stellar feedback on the disruption of their parent GMCs, in setting the integrated star formation efficiency, power the ionised ISM, as well as probe bulge formation in a representative MS galaxy at cosmic noon.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5268
Program Title: Around the world in less than two days: observing the spectral phase curve of an ultra-hot Jupiter with JWST/NIRSpec

Principal Investigator: Wardenier, Joost

PI Institution: Universite de Montreal

We propose to observe the full phase curve of the ultra-hot Jupiter (UHJ) WASP-76b with NIRSpec/G395H. WASP-76b is one of the best-characterized exoplanets to date, having been observed with at least 8 different ground-based instruments. To date, 22 different atoms and molecules have been detected in its atmosphere, while 13 optical species (i.e., refractories and alkalis) have measured abundances. This poses an exceptional opportunity: if we combine these data with infrared JWST measurements of the planet's volatile content (C, O, H, etc.), we can compute robust volatile-to-refractory ratios and trace back the formation history of WASP-76b with unprecedented detail. One aspect that complicates the spectral analysis of UHJs is their inherent 3D structure. The permanent dayside and nightside show extreme differences in temperature and chemical composition. Hence, interpreting observations of UHJs with 1D atmospheric models can lead to biased inferences of chemical abundances. To bypass this issue, we need to measure the full 3D temperature structure and cloud cover of the planet, which can then serve as a prior for a multi-dimensional retrieval framework. This will also allow us to re-interpret previous abundance measurements based on ground-based observations. Observing the full phase curve of WASP-76b with sufficient spectral resolution is the only way to obtain a complete picture of the 3D temperature structure and chemistry of its atmosphere. With NIRSpec/G395H on JWST, we will measure the spectroscopic phase curve of WASP-76b at hundreds of wavelength points across a wavelength range that contains the absorption bands of all prominent volatile-bearing molecules.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5269
Program Title: A Multi-wavelength Survey of Irradiated Disks Around a B-star

Principal Investigator: Munoz-Romero, Carlos Eduardo

PI Institution: Harvard University

Most stars form in clustered environments, with protoplanetary disks exposed to different levels of external irradiation. This means that most planets form in irradiated disks. With this proposal, we aim to carry out a comprehensive, multi-wavelength survey with JWST MIRI MRS and ALMA Band 6 to unveil irradiated disk chemistry—typical disk chemistry—in a holistic manner. We target seven proplyds in NGC 1977, the only ones known to exist around a B star, 42 Ori. These proplyds are assailed by an external UV field 1e4-1e6 times the ISM average, and thus lie in the range where we expect the most significant chemical effects, while planet formation is still possible. Our goals are to explore how the chemical and physical structure of the inner (< 10 au) and outer disk are affected by the level of FUV/EUV external irradiation. Since volatiles are transported both via gas advection and pebble drift, the outer and inner disk chemistry and structure are intimately linked. Hence, the inner disk chemistry revealed by JWST can only be fully understood in the light of outer disk observations with ALMA. We aim to obtain a complete MIRI MRS spectrum with SNR > 300 to perform a deep search for inner disk ionization (CH3+), photochemistry (H2O/OH, carbon chains, organics), icy pebble drift (hot and cold water vapor), and gas-phase C/O ratio (H2O, CO2, carbon chains) tracers. With ALMA, we propose to observe in 3 settings to obtain high SNR disk-integrated spectra for similar chemical tracers: HCO+ (ionization), HCN/CN ratios (photochemistry), carbon chains and CS/SO (C/O ratios), 13CO and C18O as optically-thin gas tracers, and dust emission to inform pebble drift models.

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Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5275
Program Title: From Dawn to Dusk: Diagnosing Asymmetric Limbs in Exoplanet Transmission Spectra

Principal Investigator: Kempton, Eliza

PI Institution: University of Maryland

We propose an archival study to analyze the publicly available exoplanet transmission spectroscopy data for signatures in the time and spectroscopic domain that indicate the presence of limb asymmetries. Such asymmetries can arise from inhomogeneous temperatures, compositions, and/or aerosol properties across the terminator and are predicted by 3-D models of exoplanet atmospheres. JWST is the first facility to provide the precision and wavelength coverage needed to unambiguously detect these inhomogeneities for a broad range of planets. Hints of limb asymmetries are already apparent in Cycle 1 data, indicating a wealth of further such discoveries to be made as additional exoplanet data sets become public. Our innovative data analysis technique involves extracting time-resolved transmission spectra (e.g. separate ingress and egress spectra) and applying novel signal recovery techniques (e.g. catwoman) to obtain a complete picture of the terminator region. This will be accompanied by a forward modeling effort designed to tie our observational results to fundamental predictions for how limb asymmetries manifest as a function of key system parameters such as planetary irradiation. By measuring limb asymmetries in a total of 19 individual exoplanet atmospheres, we will effectively "spatially resolve" these otherwise unresolved targets. The measurements will provide powerful 3-D diagnostics of aerosols, atmospheric dynamics, and energy budgets that can otherwise be difficult to disentangle in classical transmission spectroscopy. Our analyses will further demonstrate how best to extract information on limb asymmetries from future JWST data sets.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5279
Program Title: PAHSPECS: An Unbiased Study of PAHs at Cosmic Noon

Principal Investigator: Shivaei, Irene

PI Institution: Centro de Astrobiologia (CAB), CSIC/INTA, Spain

The physical conditions of the interstellar medium (ISM), out of which stars form in galaxies, are thought to differ greatly in high-redshift environments compared to those in the local universe. As the majority of stars seen in today’s universe were formed at redshifts z~1-2, it is crucial to fully characterize the prevalent ISM conditions at those redshifts (‘cosmic noon’). Recently, ALMA has made significant progress by providing a first unbiased census of the cold molecular gas and dust continuum emission in galaxies in the Hubble Ultra-Deep Field. These galaxies have the deepest observations available from the X-ray (traced by Chandra) through the rest-frame UV (traced by HST) and near- and mid-IR (traced by JWST), to the millimter regime (traced by ALMA). Currently unexplored are the PAHs in these galaxies, a crucial component and key diagnostic of the ISM, in particular regarding its thermal and chemical balance. Using the unparalleled capabilities of JWST, we propose to quantify this missing component (i.e., the PAH features at 3.3, 7.7 and 11.3 micron) with the MIRI MRS in an ALMA-selected galaxy sample at z~1 to measure how the PAH band ratios and mass fractions differ from those found in the local universe. Complementing tremendous JWST GTO efforts in the HUDF (that do not include MIRI MRS observations), the proposed data will provide a legacy dataset of star-forming galaxies at the peak of cosmic star formation.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5290
Program Title: Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Principal Investigator: Ashall, Chris

PI Institution: Virginia Polytechnic Institute and State University

Core collapse supernovae (SNe) with hydrogen-rich envelopes, aka Type II SNe (SNe II), are the most common stellar explosions in the Universe. They are the main producers of heavy elements, and produce significant amounts of dust. Thus, the study of these cosmic explosions probes the chemical evolution of the universe, sheds light on the composition of dust in our solar system, and ultimately the genesis of life. Despite the prevalence of SNe II, their exact role as dust producers is poorly understood. Molecules (e.g. CO and SiO) have been observed in the in the ejecta that form dust. These molecules determine which elements are present in interstellar gas and which are tied up in cosmic dust. To make progress in understanding the role of SNe II in dust formation, we must observe nearby SN from days to years after explosion. Here, we request 20.0 hours of time to observe the closest SN II in JWSTs lifetime, SN 2023ixf. Data will be obtained at four epochs from 500-1500 d past explosion. Allowing us to determine, i) How molecule formation leads to dust formation? and ii) When, what kind, and how much dust is produced in the ejecta? With a spectroscopic time series of data, ??for the first time, we can use molecules to trace the physical conditions throughout the epochs of dust formation, along with the composition of the dust. JWST spectra will reveal the pathway from molecules to dust in a way which was not previously possible. Finally, the data presented here will contribute an important part of the SN 2023ixf legacy dataset which will be used for decades to come.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5293
Program Title: Galactic Winds in the Early Universe: observing outflows in emission and absorption in a typical z~6 galaxy

Principal Investigator: Xu, Xinfeng

PI Institution: Northwestern University

Galactic winds have long been identified to provide various feedback effects that impact the galaxy evolution. While galactic winds have been intensely studied in the low-z universe given abundant spectroscopic data, their properties at the highest redshifts (z >~ 6) are largely unknown. This is because the predominant diagnostics of outflows - blueshifted UV absorption lines - are not feasible for high spectral resolution observations due to the faint UV continuum. One solution is to search for highly magnified galaxies, where strong gravitational lensing can uncover early galaxies that are bright enough for detailed UV+optical spectroscopic analyses. Toward this goal, we propose to observe the strongly lensed galaxy MACS0308-zD1. Given an AB magnitude of 23.4, a confirmed spectroscopic redshift of 6.2 from ALMA, and a magnification of 20 times, MACS0308-zD1 serves as the brightest known lensed galaxy at z > 6. Additionally, the delensed UV luminosity of MACS0308-zD1 is around Lstar, indicating that it is a typical galaxy for its redshift. We propose for NIRSpec/IFU spectra to map its rest-UV to -optical range and aim to get the most robust outflow analyses so far for any z > 6 galaxy. This includes spatially resolved measurements of outflow kinematics, column and number density, sizes, and outflow rates. This will be aided with short NIRCam observations to characterize the stellar populations that power the outflows. This investigation will serve as an essential pathfinder for future JWST followup of strongly lensed high-z galaxies discovered by Euclid and the Roman Space Telescope.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5298
Program Title: Catching a cat by the tail: Tracing Dust Dynamics in the Beta Pictoris Debris Disk in the Aftermath of Giant Collisions

Principal Investigator: Perrin, Marshall

PI Institution: Space Telescope Science Institute

JWST cycle 1 MIRI observations of the Beta Pictoris system yielded several complete surprises, in particular the discovery of a curved "tail" of material apparently arcing sharply away from the disk, and complex surrounding mid-IR nebulosity. These features may arise from streamers of debris from recent collisions. Along with dramatic changes in the inner disk's mid-IR spectrum over the last 19 years, these discoveries reinforce a picture of the Beta Pic system as the site of dust-producing massive collisions among large planetesimals, perhaps more frequently than expected. The most promising physical model to explain the cat's tail and related nebulosity requires these features to be composed of porous refractory organic-rich dust, to be sorted in size such that the smallest particles (being blown out most rapidly) are at the tip of the tail, and for the tail to be moving outwards at high speed. MIRI observations, in particular MRS spectroscopy of the tail region, can directly test all of these predictions, and thereby confirm or refute the proposed models. The newly-discovered and totally unexpected "tail" appears to offer a new window for understanding dust production and outflow within debris disks. MIRI is the only instrument capable of determining what the dust there is made of, whether it is indeed being blown out of the system, and testing the proposed models for the physical processes that formed it.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5299
Program Title: The JWST View of Icy Volatiles In Disks

Principal Investigator: Bergner, Jennifer

PI Institution: University of California - Berkeley

Planets form within disks of dust, gas, and ice around young stars. While our view of protoplanetary disk dust and gas has improved tremendously in recent years, we still have only a rudimentary understanding of the ice reservoirs in disks. The diversity of exoplanets and exocomets that may form around other stars depends crucially on whether disk ice compositions are similar or different in different systems. This can only be answered definitively with a deep near/mid-IR survey of edge-on protoplanetary disks, which is the aim of this proposal. We will assess the diversity in ice compositions across different planet-forming systems by observing an unprecedented sample of 6 edge-on disks around low-mass stars. Spectral coverage from 1.7-28um with NIRSpec IFU and MIRI MRS will provide comprehensive ice inventories and simultaneous access to inner-disk gas compositions. We will obtain the deepest 3-5 micron spectra of edge-on disks to date, enabling detailed modeling of the ice band profiles. This is critical to accurately retrieving the disk ice abundances and compositions. Ultimately, this program will provide much-needed constraints on disk volatile budgets, ice-phase C/O ratios, and the compositions of icy planet-forming solids, with broad relevance to the planet formation, exoplanet, and solar system communities.

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Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 5308
Program Title: Hunting for the source of Saturn's atmospherically driven aurora

Principal Investigator: Moore, Luke

PI Institution: Boston University

Recent ground-based observations of Saturn’s auroral dynamics have discovered aurorae produced by neutral winds in the planet’s atmosphere, a process that overturns decades of orthodoxy describing aurorae as the product of currents following into the planet, caused by drivers within the surrounding space environment. Instead, roughly half of Saturn’s auroral power results from currents created within the atmosphere itself. However, while these observations provide powerful evidence of an atmospheric driver, there is currently no understanding of how Saturn’s atmosphere produces these neutral winds. Indeed, there is almost no understanding of how the ionosphere and thermosphere exchange energy in the upper atmosphere of Saturn. Here, we propose to observe Saturn’s northern auroral region through an entire Saturnian day, 10.6 hours in length, allowing us to observe the changing temperature of this region as the planet rotates. In addition to a wealth of complementary science returns, in revealing the atmospheric auroral energies for the first time we can hunt for a source of Saturn’s atmospherically driven aurora, and thus contextualize this new process more widely, allowing us to understand whether the process is important at Earth, other planets in the solar system, and within astrophysical objects across the universe. JWST-NIRSpec is the only means of producing the needed maps of Saturn’s upper atmospheric temperatures, and these maps will additionally serve as crucial constraints on global atmospheric dynamics.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5311
Program Title: Continuing the Legacy of AU Mic: Simultaneous FUV and NIR Observations of AU Mic b

Principal Investigator: Feinstein, Adina

PI Institution: University of Colorado at Boulder

The 23 Myr M star AU Mic and its transiting planets are an ideal laboratory for understanding the impact of stellar activity on young exoplanet atmospheres. Young planetary systems offer a unique advantage in that their spectral signatures are representative of primordial formation conditions. This is significantly advantageous when compared with more evolved planets which have experienced significant stellar irradiation, processing and pollution. The formation mechanism and subsequent evolution of massive, short-period planets is not currently well understood. For example, these planets may have formed at large distances and migrated inwards or alternatively formed in situ. Here, we propose to obtain spectra during 4 transits of AU Mic b, the innermost Neptune-sized planet in the system (Teq = 820K), with NIRCam F322W2/F444W (2.4 - 5 micron). Our primary objective is to measure atmospheric C/O and metallicity to constrain the formation location of the planet. We propose for simultaneous JWST + HST observations. The chemistry in the atmosphere of AU Mic b will be dictated by the environmental ultraviolet flux. Because AU Mic is both young and a flare-active star, we require FUV observations to (i) identify and remove stellar flares from our transmission spectrum and (ii) characterize the FUV environment, which will be crucial for interpreting our planet spectrum. These observations will also provide unique FUV - NIR measurements of flare events, furthering our understanding of stellar magnetism. These spectra will provide an important legacy for understanding young stars, planetary atmospheres, and combining NIR + FUV to mitigate stellar contamination.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 5324
Program Title: Do Pass z=2, Do Collect Type Ia Supernovae: Breaking Out of Redshift Jail with JWST

Principal Investigator: Pierel, Justin

PI Institution: Space Telescope Science Institute

Type Ia supernovae (SNe Ia) have been one of our most valuable cosmological probes for over 20 years, and are expected to make landmark dark energy measurements this decade. These next-generation SN Ia dark energy measurements, coming primarily from the Rubin Observatory and Roman Space Telescope, will rely upon SN Ia luminosities remaining constant with redshift to remain unbiased. Any evolution in luminosity distances would indicate variable dark energy, unless SN Ia intrinsic luminosities also vary with redshift. Beyond z~2.5, any such behavior strongly indicates intrinsic SN Ia luminosity evolution, breaking the degeneracy with dark energy and giving high-z SNe Ia unique leverage on evolving systematics. Here we propose to efficiently build a sample of the first 10 spectroscopically-confirmed SNe Ia at z > 2.5 (with sensitivity to z~5) using target of opportunity (ToO) observations. The program identifies any intrinsic SN Ia evolution at the >10% level, puts limits on any monotonic evolution at lower-z, and makes the first z > 2.5 SN Ia rate measurement, which is critical to understanding SN Ia progenitor systems. While Roman is soon expected to observe thousands of SNe Ia, JWST will still be the only telescope capable of detecting SNe Ia beyond z~3-4. This program therefore probes a region of parameter space beyond the capabilities of Roman, opening a brand new discovery space for one of our most mature and important cosmological probes. Only JWST can push this critical frontier for SN Ia cosmology.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5328
Program Title: Measuring the Form of the IMF in Passive Galaxies at z=1.2

Principal Investigator: Gonzalez, Anthony

PI Institution: University of Florida

We propose a direct measurement of the low mass slope of the initial mass function (IMF) close to cosmic noon. We will use gravity-sensitive absorption features in the spectra of massive, passively evolving galaxies at z=1.2 to determine whether the IMF is bottom-heavy in these galaxies, and to quantify the dependence of the IMF on velocity dispersion for these elliptical galaxies. Derived galaxy properties such as stellar mass, age, and star formation history fundamentally depend on the IMF, with most studies assuming a single, universal form. However, evidence for massive ellipticals in the local Universe indicates velocity dispersion-dependent variation in the shape of the IMF with the most massive galaxies having the most bottom-heavy IMF. Our observations will yield the first statistical measurements of the low mass slope of the IMF in the distant Universe, and also its dependence on galaxy mass. At the same time, these IMF measurements provide a new means of directly connecting passive galaxies with their progenitor populations across cosmic time.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5342
Program Title: Spectroscopic characterization of the lowest-mass imaged Jupiter analog

Principal Investigator: Xuan, Jerry

PI Institution: California Institute of Technology

We propose to collect NIRSpec high-resolution spectroscopy (R~2700, 2.9-5.3 micron) for AF Lep b, the lowest-mass directly imaged planet with a dynamical mass (3 Jupiter masses). Orbiting its late-F host star with a semi-major axis of 8 AU, AF Lep b is one of the closest analogs to Jupiter amenable to spectral characterization with JWST. Our program will measure the abundances of at least five different molecules (CH4, H2O, H2S, CO2, CO) to provide a comprehensive picture of AF Lep b’s atmosphere. Specifically, our simultaneous constraints on C/H, O/H, and S/H would break degeneracies in the planet’s formation location relative to various snowlines by constraining the solid-to-gas accretion rate. In addition, we will measure the vertical mixing coefficient to high precision from carbon disequilibrium chemistry, which has important implications for cloud formation and the spectral appearance of cool planets. Finally, our program will enable a comparative atmospheric study with another Jupiter analog in the same beta Pic moving group, 51 Eri b, to be observed by GO 3552 with NIRSpec. 51 Eri b has similar model-inferred mass and semi-major axis as AF Lep b, but is a factor of about 3 fainter than AF Lep b at 2 and 4 microns. Do the two planets have similar elemental abundances, indicating similar formation pathways? Or could differences in their abundances shed light on different formation timescales, even different formation mechanisms? Our program would inform planet formation in a region of parameter space where giant planets are most common (~1-10 AU).

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5354
Program Title: Mapping a Black Hole Accretion Flow with JWST/NIRSpec

Principal Investigator: Hlavacek-Larrondo, Julie

PI Institution: Universite de Montreal

We propose leveraging the unique capabilities of JWST’s NIRSpec IFU to resolve the gas kinematics within the sphere of influence of the black hole in NGC 4696, the central dominant galaxy of the Centaurus cluster of galaxies. Due to its proximity, recent deep high-spatial-resolution HST images of NGC 4696 have, for the first time, revealed an intriguing swirl in the ionized gas that appears to lead directly to the black hole—providing a unique opportunity to understand black hole accretion processes and their relationship with galaxy scale. Our objectives include mapping the velocity structure of the swirl, comparing it with state-of-the-art MHD simulations, measuring the black hole's mass, examining Bondi accretion, probing radio jet interactions, and searching for hidden cooling flows. Overall, these observations will contribute significantly to our understanding of fundamental processes in galaxy evolution, notably supermassive black hole fueling and its connection to the host galaxy.

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Proposal Category: AR
Scientific Category: Galaxies
ID: 5355
Program Title: Adapting the Constrained Matrix Factorization Deblender Scarlet to Separate Overlapping Sources in JWST IFU Data

Principal Investigator: Bustamante Rosell, Maria

PI Institution: University of California - Santa Cruz

JWST's incredible sensitivity is producing exceptionally deep images of the sky. At these depths, the surface density of sources is so high that a large fraction of extended sources overlap with other sources. Separating the light from each source (``deblending'') is critical to every science case done with these deep images. This work is challenging with broad-band imagining, but with integral field unit (IFU) data, which is effectively many narrow-band images, we can use spatial and spectral correlations to properly separate all photons into their originating source. In this context, scarlet, a constrained matrix factorization algorithm originally designed for the Legacy Survey of Space and Time (LSST) pipeline, is an invaluable resource. It excels in disentangling multi-band observations using chromatic and spatial information, surpassing the capabilities of current tools that predominantly rely on single-band deblending. We propose to adapt and rigorously test scarlet to effectively process spectral data cubes generated by JWST's IFUs, specifically the NIRSpec IFU and MIRI MRS. This adaptation empowers the extraction of individually decomposed spectra from overlapping sources without the necessity of prior templates, thereby advancing the work initiated by the JWST-funded q3dfit project. While tailored to JWST's IFUs, this program will adapt scarlet for generic IFU usage, thus extending the deblending capacities of the astronomic community at large. We will develop all tools using NASA's suggested open-source guidelines, providing code to the community as we develop it.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5357
Program Title: Sailing with the winds of HL Tau towards the origin of rings and gaps in protoplanetary disks

Principal Investigator: Bacciotti, Francesca

PI Institution: INAF - Osservatorio Astrofisico di Arcetri

We propose to map with the MIRI-MRS and NIRSpec IFUs the atomic jet and the warm (T = 400-3000 K) molecular H2 winds from the young star HL Tau (a prototypical jet/outflow/disk system at 140 pc). The observations will target the first 6-10 arcseconds squared of the south-western red-shifted lobe, in a position coincident with the opening of a well defined conical wind imaged by ALMA at 0."25 resolution in the 1.3 mm CO line. The comparison between the JWST and ALMA datasets, of similar angular resolution, will provide critical constraints on the nature of the flows and on their feedback on the protoplanetary disk. In particular we will check if the arc-shaped and bubble features observed in the ALMA channel maps are replicated with continuity in the inner warm H2 wind. Such evidence would support a scenario in which the various components of the molecular outflow at different excitation are arranged in nested, detached flow surfaces within a global extended layered disk wind. The interest in such a picture is that it would support recent models of magnetized inhomogeneous disk winds that see the formation, at the same time, of detached flow surfaces and of a ring-gap substructure in the disk. These models therefore introduce a justification of the ringed disk structure alternative to the action of the yet elusive protoplanets. The program also sees the study of the jet in mid-IR atomic lines, with the purpose of testing alternative models of internal bow-shocks as the origin of the arc-shaped features in the outer molecular layers. The high sensitivity and angular resolution offered by JWST in the mid-IR domain are crucial for this investigation.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5365
Program Title: Identifying, counting, and mapping YSOs in Sgr B2: our Galaxy's most massive molecular cloud

Principal Investigator: Ginsburg, Adam

PI Institution: University of Florida

In the central few hundred parsecs of our Galaxy is the gas-rich, extremely dense Central Molecular Zone (CMZ), which exhibits physical conditions unique with in the Local Group that are analogous to galactic environments at Cosmic Noon. Star formation in the CMZ is suppressed by more than an order of magnitude compared to predictions based on Galactic disk star formation laws. Within the CMZ, there is one region that stands out above the rest and accounts for more than half of the total star formation, Sgr B2. We propose to observe the forming young stellar population in Sgr B2 using a range of filters on NIRCam and MIRI that sample YSO tracers, such as accretion, presence of ices, or dust excess. We will map out where YSOs are forming to assess whether star formation occurs above different thresholds in the CMZ, to measure the overall star formation rate, and to determine whether the stellar initial mass function (IMF) is consistent with standard models. There is some evidence from ALMA observations that both the thresholds and the IMF are different in the CMZ, however measurements of the low-mass YSO population, only available with JWST, are needed to test this. The proposed observations enable a robust test of how star formation varies within the extreme environment of our Galactic Center, and will serve as a crucial template for interpreting extragalactic observations.

Proposal Category: AR
Scientific Category: Galaxies
ID: 5366
Program Title: Maximizing the value of extragalactic JWST surveys using realistic, highly-resolved simulations

Principal Investigator: Cochrane, Rachel

PI Institution: Flatiron Institute

Some of the earliest results from JWST challenge our existing picture of galaxy evolution. These include a claimed overabundance of UV-luminous galaxies at z>10, as well as early-forming massive galaxies and black holes (at z>5), though controversies abound. Robust interpretation of the new data requires a better understanding of the many assumptions that underpin our inference methods and proper modelling of observational biases. Our proposed program leverages hundreds of highly-resolved simulations already run with FIRE physics, as well as state-of-the-art radiative transfer-based forward-modelling techniques developed by our team, to generate a comprehensive suite of synthetic observations, modelled using different assumptions, such as different stellar initial mass functions, stellar population synthesis models, dust modelling, and emission from active galactic nuclei. By training on forward-modelled data in association with the 'ground truth' known from the simulations, we will test and refine fitting tools commonly applied to observations of high-redshift galaxies. We will focus on extracting reliable redshifts, stellar masses and star formation rates from photometry and spectra. The crucial insights on parameter inference, model degeneracies, and uncertainty estimation resulting from this project will enable us to maximize constraints on models of galaxy formation and the value of JWST. The systematic variation of forward-modeling parameters over the largest set of highly-resolved galaxies available will also provide a publicly-available legacy dataset of synthetic SEDs with immense community value.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5368
Program Title: A comprehensive proper motion survey of the Milky Way Nuclear Star Cluster to reveal its formation and evolution

Principal Investigator: Do, Tuan

PI Institution: University of California - Los Angeles

We propose a new survey to measure the physical properties and kinematic structures of the Milky Way Nuclear Star Cluster (MW NSC) to constrain its formation and evolution. This survey will measure proper motions for over 300,000 stars and resulting the most comprehensive study of the MW NSC so far. We propose to map the kinematics of the MW NSC out beyond its half-light radius (> 5pc) with NIRCam with full azimuthal coverage. The survey has the following scientific objectives: (1) Accurately measure essential physical properties such as mass and shape of the MW NSC. (2) Characterize the rotation of the MW NSC and search for kinematic substructures to test theories for its formation. (3) Investigate the interplay between the supermassive black hole, the NSC, and the larger-scale nuclear stellar disk. These measurements are necessary to constrain formation theories of how NSCs form in this extreme environment and provide us the context for comparing our Galactic nucleus with other galaxies.

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Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5369
Program Title: A Database of Interstellar Ice Absorption Spectra

Principal Investigator: Tolls, Volker

PI Institution: Smithsonian Institution Astrophysical Observatory

Throughout star formation ices play a very important role. They grow to be a major reservoir for the volatile elements H, O, C, N, P, and S (CHNOPS). The chemical composition and its evolution from molecular clouds to protoplanetary disks (PPD) eventually determines the atomic and molecular composition of forming planets, which coagulated from dust and pebbles in the PPD. Many chemical reactions take place on dust grains in the coldest parts (T<30K) of molecular clouds, cloud cores, and the midplane of PPDs where they are shielded from the destructive UV radiation of (proto)stars. These chemical reactions produce not only molecules like H2O, but also more complex molecules like CH3OH, hydrocarbons, alcohols, and aldehydes. To quantify the chemical reaction efficiencies and how they affect the chemical composition, inherited or reprocessed, we must determine the bulk composition from molecular clouds to PPDs. This archival research proposal aims at providing the first step to quantify the ice composition during the various steps of star formation by accumulating all ice absorption spectra from JWST observations, currently >140 spectra. We will use the database to categorize the observations, to investigate the correlations between ice species and types of observed absorbing media, and to look for evolutionary trends, extending previous efforts (Öberg et al. 2011) based on only a limited number of ISO, AKARI, and ground-based ice observations. The new database of ice observations is just the first step, and over time, JWST will observe many more astronomical objects and the database will grow. Finally, the database will be made publicly available through the MAST archive.

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Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5370
Program Title: Eyes on the Stars: A JWST Population Survey of Exoplanet Host Star Heterogeneities and Spectral Contributions to Transits

Principal Investigator: Rackham, Benjamin

PI Institution: Massachusetts Institute of Technology

Early JWST results have shown both the observatory's promise for revealing the properties of exoplanet atmospheres and the challenge that stellar spots and faculae pose to precise transmission spectroscopy. Without a reliable method to account for this stellar spectral contamination, stellar photospheric heterogeneity may limit JWST's scientific legacy in unveiling the atmospheres of the most exciting exoplanets. Fortunately, the same JWST datasets provide exquisite out-of-transit stellar spectra that can be leveraged to mitigate this effect, though most observations have yet to be fully exploited. Here we propose to thoroughly tap this priceless database via a large, uniform analysis of 36 NIRISS/SOSS and NIRSpec/PRISM time-series observations of 21 exoplanet hosts. Our analysis will reveal the photospheric properties of important hosts, provide insights into limitations of stellar models across spectral types, and constrain stellar variability and spectral contamination in JWST transits. As Legacy Data Products, we will produce a JWST Legacy Library of time-dependent exoplanet host star spectra, constraints on their photospheric spectral components and coverages, and transmission spectra with fully quantified uncertainties accounting for stellar spectral contributions. Our Legacy Data Products will also include open-source Python libraries we develop for the data reduction, stellar heterogeneity analysis, and transmission spectra corrections. The results of this program will pave the way for robust constraints on stellar photospheres from JWST, unlocking the observatory's full potential for characterizing transiting worlds.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5381
Program Title: Unveiling the compact object and stellar populations of globular clusters Terzan 5 and Liller 1

Principal Investigator: Burdge, Kevin

PI Institution: Massachusetts Institute of Technology

Among the Milky Way's globular clusters, Terzan 5 and Liller 1 are exceptional. Terzan 5 boasts more known pulsars than any other globular cluster, while Liller 1 exhibits unprecedented gamma-ray emission, hinting at a vast pulsar population. Both clusters are not only massive and dense but are also believed to experience the highest stellar collision rates in the Galaxy. This makes them prime sites for the formation of compact binary systems through dynamical interactions. Additionally, these clusters share the rare characteristic of multiple stellar populations, a trait only otherwise seen in Omega Centauri, suggesting they experienced several star formation episodes. However, our understanding of the compact objects and sellar populations within these clusters has been limited due to their high levels of obscuration. We propose employing NIRCAM to capture time-series photometry of these unique environments, aiming to unveil the ultracompact binary systems and variable stars therein. This effort will provide insights into the role of dynamical processes in the formation of compact binaries—a topic now at the forefront of gravitational wave astronomy. Our program will maximize NIRCAM's potential, relying on its unmatched sensitivity, field of view, angular resolution, and wavelength capabilities. The resulting dataset promises wide-ranging applications, catering to the optical, IR, radio, X-ray, and gravitational wave communities. We anticipate that our findings and this dataset will significantly enrich the scientific legacy of JWST.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5390
Program Title: HD 131488: A Unique Laboratory to Probe Volatile Transportation Mechanism in the Epoch of Terrestrial Planet Formation

Principal Investigator: Lu, Cicero

PI Institution: NOIRLab - Gemini North (HI)

Studies of the Solar system suggest that comets can deliver volatile and refractory elements from the outer solar system to Earth during the epoch of terrestrial planet formation. Even as a mature planetary system, solar system comets outgassing CO gas and H2O vapor were caught in the act. JWST Cycle 1 observations have discovered CO fundamental emission in a young, and exocomet-active planetary system, HD 131488. This is the first time that CO ro-vibrational emission at near-infrared wavelengths has been discovered in a debris disk. We propose a follow-up observation to map the CO distribution and the hot dust emission in HD 131488, with NIRSpec IFU G395H/F290lP disperser and filter combination. We will test several hypotheses for the cometary delivery models by mapping and comparing the spatial distribution of 12CO and 13CO transitions that probe various gas populations and search for dust disk asymmetry due to exocometary delivery. The detailed characterization of HD 131488 will benchmark our understanding of volatiles in an exoplanetary system.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5394
Program Title: Untangling the Nature of the Kennicutt Relation at the Low End: the Iconic Case of the Giant Low Surface Brightness Galaxy Malin 1

Principal Investigator: Berg, Michelle

PI Institution: University of Texas at Austin

Star formation is the basis for galaxy evolution, but how this process occurs in extremely low gas density environments is not understood. The Kennicutt relation correlates the star formation rate surface density to the gas surface density in galaxies. On the low end of the relation, there is a break in the profile and a steepening of the slope where HI efficiently converts to H2. What is unclear is the physical process or ISM conditions that cause the steepness in the relation. Either galaxies have an HI-dominated disk with low H2 filling factor or there is low star formation efficiency within the H2 in this regime. At the extreme low end of the Kennicutt relation sits low surface brightness galaxies (LSBGs), which can be used to distinguish between these two scenarios. Recent work has placed a stringent upper limit on the H2 gas surface density within the giant LSBG Malin 1, seeming to point towards a low H2 filling factor. However, the true answer cannot be determined without quantifying the amount of H2 gas within the disk. Here we propose to observe Malin 1 with MIRI in the F770W dust emission filter and F1280W dust continuum filter to map out the gaseous disk (HI and H2) using dust as a tracer. These observations will enable us to determine the spatially-resolved gas surface density of Malin 1 to the disk edge. By comparing the total gas surface density to the previously measured HI gas surface density, we will identify the cause of the steepening in the Kennicutt relation through the difference of the two values. This work will deepen our understanding of the star formation process in the most extreme gas conditions.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5398
Program Title: POPPIES: The Public Observation Pure Parallel Infrared Emission-Line Survey

Principal Investigator: Kartaltepe, Jeyhan

PI Institution: Rochester Institute of Technology

We propose POPPIES, the Public Observation Pure Parallel Infrared Emission-Line Survey, a 1455 arcmin^2 NIRCam wide-field slitless spectroscopy (WFSS) program. POPPIES will obtain WFSS in 1-3 filters (F444W, then F322W2/F277W+F356W when possible) and direct imaging in 3-8 filters over 150 fields, providing a blind emission line survey that is minimally impacted by cosmic variance. POPPIES covers an area 1.6 times larger than all Cycle 1 and 2 NIRCam WFSS programs combined, and 10 times larger than all those taken with the F444W filter. POPPIES will detect an estimated 40,000 galaxies from z=0-12, enabling us to: 1) Identify galaxies at z>7, quantify the evolution of the [OIII] luminosity function, identify potential overdensities, and characterize their physical properties. 2) Quantify the evolution of the Broad Line AGN fraction through broadened recombination lines and investigate the evolution of the M_BH - M* scaling relation 3) Investigate the evolution of the mass-metallicity relation and fundamental metallicity relation and study the dust attenuation in low mass galaxies 4) Measure the star formation rates (SFR) of galaxies across cosmic history, quantify the evolution of the SFR-M* relation at low masses, and constrain stochastic star formation histories in the early universe. 5) Identify 15-20 late-M, L, and T dwarfs in the Milky Way and investigate variations in their molecular chemistry as a function of temperature, surface gravity, and metallicity. The unique opportunity to conduct NIRCam WFSS in pure parallel mode makes POPPIES an efficient way to conduct a wide area spectroscopic survey with enormous legacy value using minimal telescope resources.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5405
Program Title: Accretion Irradiation as an Agent of Protoplanetary Disk Evolution: JWST IFU Observations of a Protostellar Pulsed Accretor

Principal Investigator: Muzerolle Page, James

PI Institution: Space Telescope Science Institute

Accretion-driven UV irradiation of protoplanetary disks is an important factor in setting disk structure and chemical pathways across a wide range of evolutionary states, from deeply embedded protostars to the dispersal of protoplanetary disks. However, other mechanisms such as viscous dissipation and shocks are also operating, and the typically stochastic nature of accretion variability hinders our ability to disentangle these competing effects. To help address this issue, we propose MIRI MRS and multi-epoch NIRSpec IFU observations of a rare periodically-varying protostar. The pulse-like variability in this low-mass object exhibits a tenfold-increase in accretion luminosity every 25 days, which subjects the surrounding disk and infalling envelope to repeated blasts of UV radiation. The predictability of this source provides a unique opportunity to quantify the importance of UV irradiation on molecular gas in disks and outflows at a very early evolutionary stage, during which direct measures of UV light are impossible because of high dust extinction from protostellar envelopes. Spectral imaging will provide characterization of molecular emission from several key constituents of the circumstellar material; comparison with pulse phase and simultaneous accretion diagnostics will illuminate the connection to UV irradiation. The results will in turn provide key constraints needed to fully test theories of planet formation in protoplanetary disks, and will set the stage for future multi-epoch studies with JWST.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5407
Program Title: MEOW: The MIRI Early Obscured-AGN Wide Survey

Principal Investigator: Leung, Gene

PI Institution: University of Texas at Austin

Obscured AGN at high redshift likely mark the location where the first SMBHs underwent most of their growth, and could play a significant role in the cosmic BH accretion history. This crucial population of objects remains largely undetected at z>~4. We propose 74 hrs of wide MIRI imaging observations to conduct a census of obscured AGN at z=3-8 over 95 square-arcmin in the GOODS-N and GOODS-S fields. We will observe in F1000W and F2100W, reaching 5-sigma depths of 1 micro Jy and 4 micro Jy, respectively. Our survey area is fully covered by existing NIRCam WFSS spectroscopy and deep NIRCam imaging, allowing robust spectroscopic and photometric redshift measurements. We will identify AGN candidates using SED modeling and color selection techniques. We expect to detect 600-900 AGN candidates, including a first statistical sample of ~15 obscured AGN at z>6. We will characterize the physical properties of these objects, measure the number density and fraction of obscured AGN at previously unexplored redshifts, and determine the contribution of obscured AGN to the cosmic BH accretion history.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5408
Program Title: Diving Deeper: uncovering the full spectrum of accretion and outflow in the heart of the Carina Nebula

Principal Investigator: Reiter, Megan

PI Institution: Rice University

We propose a targeted survey of the vigorously star-forming Carina Nebula that will produce the first comprehensive census of accretion and outflow activity across a wide range of protostar masses. Extrapolating from published results using JWST imaging of the neighboring region NGC3324, we expect this survey of Carina to discover ~400 new jets, producing the largest sample of outflows in any single region. At 2.3 kpc, Carina is the nearest high-mass star-forming region that fully samples the initial mass function (IMF), and where the impact of massive star feedback is on full display. We request NIRCam images of 12 regions in the F164N and F470N filters to detect [Fe II] and H2 from protostellar outflows. We also request two complementary broadband filters (F150W2, F444W, respectively) to remove continuum emission. Carina represents the optimal combination of sensitivity, source density, and image quality to detect and characterize a statistical sample of outflows and, in the future, measure their proper motions. Obtaining first epoch images in Cycle 3 is essential to build on the legacy of HST which has been following the temporal evolution of this region for ~20 years (including a 3rd epoch of scheduled Cycle 31 observations). This will yield the largest sample of protostellar outflows in a single star forming region, providing a homogeneous sample of jets and outflows to: measure dynamical ages and duty cycles thereby placing important constraints on the episodic mass-loss and accretion history of a wide range of protostars; identify driving sources; and estimate mass-loss rates and therefore momentum injection into the local cloud.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5409
Program Title: A Fundamental Study of Star and Planet Formation: Spectroscopic Confirmation of Free-floating Jupiter Mass Objects in NGC 2024

Principal Investigator: De Furio, Matthew

PI Institution: University of Texas at Austin

Theoretical star formation models have estimated the fundamental limit of turbulent fragmentation of molecular cloud cores to be ~ 1-10Mjup, overlapping masses that can result from planet formation within the disk of a star. At the same time, observational studies identify a decreasing initial mass function (IMF) approaching the limit of formation, yet are incomplete below ~ 20 Mjup. Recent JWST/NIRCam observations in NGC 2024, a moderate density embedded cluster with an age < 1 Myr, have identified dozens of candidate planetary mass objects with estimated masses down to 0.7 Mj based on their photometric color. We propose to obtain 1-5 micron spectra of 75 candidate planetary mass objects and brown dwarfs with estimated masses < 40 Mjup (45 of which are < 10 Mjup) in NGC 2024 with the NIRSpec/MSA in prism mode. With these spectra, we will use both atmospheric models and previously observed planetary mass object spectra in order to estimate masses and determine membership of our sample. Additionally, we will utilize the spectral retrieval technique to estimate elemental abundances and search for signatures of formation within a circumstellar disk, e.g. reduced C/O ratio due to formation beyond the H2O ice line. Our program requires only 10.7 total hours in order to: 1) probe the low mass limit of turbulent fragmentation (i.e. brown dwarf formation), 2) define the shape of the IMF down to Jupiter mass scales, and 3) identify Jupiter-mass ejected planets from their enhanced elemental abundances relative to other cluster members.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5427
Program Title: Feedback and quenching: separating neutral gas in outflows and galaxies at z~2

Principal Investigator: Davies, Rebecca

PI Institution: Swinburne University of Technology

AGN activity is considered a key driver of quenching in massive galaxies, but it remains unclear whether this quenching is caused by powerful outflows (ejective feedback), or preventative feedback, or both. This proposal addresses two key questions: Do AGN-driven cool (neutral) outflows remove gas rapidly enough to quench star-formation? And do quenched galaxies truly lack cool gas? It was previously very difficult to detect cool gas in quenching galaxies at z~2, but JWST has driven a major breakthrough, revealing that NaD absorption tracing dusty neutral gas is widespread in massive galaxies at this epoch. Many quenching galaxies show powerful AGN-driven neutral outflows that appear to eject gas much faster than it is converted into stars, and these outflows may be a key mechanism for fast quenching at z~2. However, the R~1000 discovery spectra do not have sufficient resolution to separate neutral gas in the interstellar medium from that in outflows. This program will add R~2700 observations to the existing R~1000 data for a mass-selected sample of 141 galaxies at 1.7<z<3.5, using the G235H grating to spectrally resolve the gas kinematics in both the NaD and Halpha lines. We will investigate how neutral gas reservoirs vary with time since quenching, enabling us to differentiate between potential quenching scenarios. We will also perform the first direct comparison of neutral (NaD) and ionized (Halpha) outflow properties for a statistical sample of galaxies at z~2, providing crucial insights into multiphase outflow mass budgets. This program will significantly improve our understanding of outflows and the mechanisms driving galaxy quenching at cosmic noon.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5437
Program Title: A Census to the Bottom of the IMF in W3: Atmospheres, Disks, Accretion, and Demographics

Principal Investigator: Best, William

PI Institution: University of Texas at Austin

Young brown dwarfs (BDs) and planetary-mass objects (PMOs) offer powerful tests of the universality of the IMF, the frequency and timescale of planet formation, and the typical atmospheric properties (and range of their variations) for analogs of directly-imaged and transiting planets, all at an extreme (protostellar mass and luminosity, disk mass, young age) where models are most strained. Most known PMOs are in nearby sparse populations, but these regions are small (with few PMOs) and spread out (limiting multiplexing). Given JWST's superb sensitivity, the highest value is in source density rather than closeness or brightness. Distant, massive star-forming clusters offer more and denser targets, and HST has revealed them just in time for carefully optimized JWST follow-up. We propose a highly multiplexed NIRSpec+NIRCam program for young BDs and PMOs, targeting 3 pointings in the young (0-8 Myr), massive (~10,000 members), and dense (R~12 arcmin) W3 cluster. We propose NIRSpec/MOS spectra of candidate young members from HST photometry (prism for 231 faint BDs and PMOs, grism and prism for 112 brighter BDs) to measure Teff, gravity, accretion from emission lines, and disks from IR excess. We propose parallel NIRCam imaging in 12 filters (for SEDs, water bands indicating low Teff, emission lines, and outflows) to seek the very bottom of the IMF (~2 MJup) and measure Teff, accretion, and disks. Our program will deliver a large and robust census of the lowest-mass objects accross varied environments, providing a new view of the IMF, disks, planet formation, and the atmospheres of analogs to the directly-imaged and transiting planets that drive much of JWST's key science.

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Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 5441
Program Title: A JWST Sample of Extragalactic Red Supergiants

Principal Investigator: Kilpatrick, Charles

PI Institution: Northwestern University

NIRCam and MIRI imaging from JWST early release and Cycles 1 and 2 programs provides a vast trove of resolved red supergiant populations in nearby galaxies, increasing by more than a factor of 2 the number of these stars that can be studied in detail from the optical to mid-infrared. This large population of red supergiants can be used to look for rare forms of extreme mass loss predicted for highly-evolved stars, measure the complete bolometric luminosity of red supergiants out to 10 microns, and analyze the dependence of red supergiant properties on metallicity and local environment, especially the uncertain maximum luminosity of red supergiants (the Humphreys-Davidson limit). We propose an archival research program to analyze NIRCam and MIRI imaging covering 11 galaxies within 25 Mpc and totaling 155 unique data sets, identify an estimated 20,000 red supergiants in these data, compare their wide- and medium-band photometry to model red supergiant spectral energy distributions, and analyze the distribution of red supergiant luminosities, spectral types, and mass-loss rates. The final product of this analysis will be the largest population to date of photometrically-identified red supergiants as well as their photometry and basic physical properties. Our program will provide lasting legacy value for JWST and a framework for future studies of resolved massive star populations in NIRCam and MIRI data.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5451
Program Title: Resolving the Dynamic ISM with IR Echoes around Cas A

Principal Investigator: Jencson, Jacob

PI Institution: The Johns Hopkins University

The content and structure of the interstellar medium (ISM) plays an influential role in the overall evolution of galaxies and the formation of stars within them. Importantly, the ISM is also shaped by the massive stars formed out of its gas and dust and the energetic supernovae (SNe) they produce. JWST opens new pathways to investigate the detailed structure and composition of ISM clouds and to witness the effects of SN explosions on their surroundings. This proposal outlines a carefully designed program of time-series NIRCam imaging and MIRI/IFU spectroscopy to observe bright infrared (IR) echoes around the young SN remnant Cassiopeia A. This provides a unique window to view the effects of the high-energy burst of SN radiation as it interacts with the surrounding ISM dust clouds in real time. The requested observations exploit JWST's unique ability to 1) provide 3D maps at milli-pc scales of the structure of the echoing clouds, 2) determine the precise compositions of dust grains and molecules, and 3) measure the changes in, e.g., the sizes, shapes, and ionization states, of the same, in situ populations of dust grains and large molecules induced by the passage of the SN radiation field. These findings will have broad implications in unraveling the connections of ISM clouds and filaments to their role as the seeds of star formation, and how cloud properties are then set by the stars and SNe they produce.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5460
Program Title: A Panchromatic View of Protoplanetary Disk Dispersal

Principal Investigator: Ballering, Nicholas

PI Institution: The University of Virginia

The majority of stars, including our Sun, form in clusters in the presence of massive stars. This UV-rich environment leads to the rapid destruction of the stars' protoplanetary disks. While Hubble, ALMA, and JWST images have glimpsed the photoevaporating "proplyds" in Orion, there is still much we do not understand about the driving forces that lead to these disks' dispersal and its effect on planet formation. We propose to use the JWST NIRSpec IFU to conduct a detailed spatial/spectral analysis of the ionization front, outflow, and disk of three Orion proplyds. The targets exhibit the prototypical proplyd morphology on which models of disk photoevaporation are based. We will map the key molecular dissociation fronts in the outflows and derive their density and temperature to accurately calculate the disk mass loss rates. Measuring the PAH abundance will reveal the microphysics that drives external photoevaporation, putting the leading models of this process to the test. Finally, molecular emission and ice absorption features from the disks will tell us how the cluster environment impacts the chemistry of planet formation.

Proposal Category: AR
Scientific Category: Galaxies
ID: 5464
Program Title: Uncorrelated Noise and Optimal Extraction of JWST/NIRSpec Sources using PypeIt

Principal Investigator: Pelliccia, Debora

PI Institution: University of California - Santa Cruz

Combining spectral images by first resampling dithered observations into a regular grid (which is the standard JWST calwebb_spec3 reduction procedure) introduces correlation between pixels that smooths the data and complicates their noise properties. Particularly for observations that push JWST's sensitivity limits, this approach can affect the detection of key spectral features, such as the Lyman break in spectra of galaxies at extreme redshift, or even lead to false detections. Many studies have used custom codes and applied empirical corrections to deal with the correlated noise, affecting the reproducibility of the results. In this archival research proposal, we request support to add JWST NIRSpec to the pool of spectrographs supported by the spectroscopic data reduction pipeline PypeIt. PypeIt is an open-source Python package that performs end-to-end data reduction for more than 50 ground-based spectrographs, and provides routines that yield coadded spectral images without correlated pixels by instead using an irregular wavelength grid. PypeIt is largely used in the astronomy community (with > 500 users and ~150 publications, so far); therefore, enabling it to reduce JWST data will provide a familiar output datamodel for current PypeIt users, and facilitate the synergy between JWST and ground-based observations. The JWST-specific script will be distributed and documented with the main PypeIt repository and, like for all the supported spectrographs, the following products will be provided: 2D spectral images with uncorrelated noise, robust 1D boxcar and optimal extractions, and detailed QA plots that allow users to quickly assess the results.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5474
Program Title: Revealing New Chemistry in Dusty Extrasolar Atmospheres

Principal Investigator: Suarez, Genaro

PI Institution: American Museum of Natural History

Clouds and hazes are crucial components of planetary atmospheres. We will obtain MIRI MRS 5–18 micron R~2000-3700 spectra of nine young and old cloudy extrasolar atmospheres to i) investigate how dust cloud mineralogy, particle size, and crystallinity depend on surface gravity, and ii) prove the existence of iron-rich silicate clouds in young giant planet analogs. This will shed light on crucial atmospheric processes that are currently lacking in our models to successfully reproduce current and future JWST observations of cloudy atmospheres. JWST MIRI is the only facility able to provide the necessary observations. The low-SNR of most Spitzer IRS mid-infrared spectra of substellar atmospheres prevents the proposed study.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5485
Program Title: How big can you make a planet? Spectroscopic characterization of HD 206893B

Principal Investigator: Baburaj, Aneesh

PI Institution: University of California - San Diego

We propose moderate resolution spectroscopic characterization of HD 206893B, a ~28Mjup directly imaged (DI) companion with strong evidence of formation via a circumstellar disk. Measuring the detailed abundances of this closely separated companion will provide a window into the utility of formation diagnostic tools at the extreme upper end of the planet formation process. We propose observations with an R~2,700 fixed-slit NIRSpec spectra between 3-5um. New analysis of NIRSpec capabilities suggests that detection is easily achievable despite the high contrast and tight separation of the companion (~0.2"). We will measure molecular lines from species such as CO, CO2, H2S, CH4, and H2O. These detections will be used to derive the metallicity, carbon-to-oxygen ratio, volatile-to-sulfur ratio, and cloud properties of HD 206893B. The different abundance ratios we propose to measure on this planet could give detailed insights into its formation pathways. Furthermore, due to its extremely red color and dusty atmosphere, HD 206893B offers an opportunity to investigate the impact of extreme clouds on the spectra in this wavelength regime.

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Proposal Category: AR
Scientific Category: Galaxies
ID: 5486
Program Title: How do galaxies move their metals? Unraveling z > 2 disks with controlled numerical experiments tailored to JWST

Principal Investigator: Acharyya, Ayan

PI Institution: Space Telescope Science Institute

Metals are Nature’s tracer fluids, mapping gas flows in to, out of, and within galaxies as they grow over time. Imaging spectroscopy, such as JWST ’s unique NIR IFUs, can measure resolved metallicities inside galaxies during the first formation of disks at z > 2. Surprisingly, a large fraction of high-z metallicity gradients are positive, indicating that galaxy disks are more metal-rich in their outskirts relative to the center, in strong tension with theoretical expectations. We propose new cosmological zoom simulations optimized for understanding the rapid evolution of metallicity gradients in z > 2 disks. Our new simulations will make three advances over existing work. We will: (1) use high spatial resolution (< 100 pc) and time resolution (~2 Myr) to track metals as they migrate within the disk into the CGM and back, (2) implement experimental controls over the relevant physics to isolate the key physical influences on metallicity gradients, and (3) release public data products to support current and future JWST datasets, including novel non-parametric metallicity maps and metallicity-velocity maps that can be compared to JWST ’s unique IFU spectroscopy.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5491
Program Title: Mining for DIAMONDS (Dust, Ice, And MOlecules iN Distant galaxieS) over the Past ~7 Billion Years

Principal Investigator: Kulkarni, Varsha

PI Institution: University of South Carolina

Interstellar dust grains vitally affect the cooling and heating of the ISM and molecule formation. Understanding grain composition and structure in distant galaxies is therefore crucial for understanding the cosmic star formation history. A robust understanding of dust in distant galaxies is also needed to accurately correct for dust extinction effects on background objects. Unfortunately, grain properties in distant galaxies are poorly constrained. We propose to measure grain composition and structure in dense molecular clouds in galaxies at z<1 with MIRI MRS spectroscopy of background quasars (including several gravitationally lensed quasars) whose UV/radio/sub-mm spectra show strong molecular absorption and strong reddening, indicating large amounts of dust. The proposed MRS spectra will target redshifted features of silicates (10, 18 micron), hydrocarbons (3.4 micron), PAHs (3.3-11.3 micron), and ices (e.g., CO, CO2, CH3OH). Our main science goals are to investigate: (1) the silicate mineralogy and grain structure; (2) how materials in grain cores (carbonaceous/silicate) and mantles (ices) correlate in dense ISM in these distant galaxies; (3) how dust and ice are spatially distributed within and around the galaxies, and (4) how dust properties are related to other galaxy properties. Additionally, our observations will cover gas-phase CO rovibrational features and provide constraints on the 12C/13C and 16O/18O isotopic ratios. Only JWST MIRI has the powerful combination of the wavelength coverage, high sensitivity, and high spectral resolution crucial for measuring the mid-IR features of interest in the distant galaxies.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5497
Program Title: Resolving the Radio Riddle: Unveiling the Origins of Radio Emission in a Red Dwarf and its Wide-Orbit Companion

Principal Investigator: Stefansson, Gudmundur

PI Institution: Princeton University

Detection of radio emission due to the electron cyclotron maser instability (ECMI) is likely the only viable way to measure exoplanets' magnetic fields. Because ECMI from exoplanets has not yet been detected we have no empirical knowledge of their magnetic fields. Radio observations of GJ 1151, a 5 Gyr M5 star at 8 parsec, revealed an unexpected ECMI signature. In the absence of known massive planets around GJ 1151 capable of emitting this signature, the emission was originally attributed to star-planet interaction with a short-period planet. Subsequent radial velocity (RV) measurements excluded this hypothesis, but revealed an RV trend suggestive of a distant gas giant or brown dwarf companion. Is this the coveted radio-emitting exoplanet? To answer this question, we propose the 'Resolving the Radio Riddle' program to obtain 3 hours of JWST/NIRCam coronagraphy observations of GJ 1151 with the F200W and F444W filters, which would be sensitive to companions down to 3 Mjup from 3-25 AU. The companion is expected to be cool (200K-350 K depending on its mass), making JWST the only instrument capable to detect the companion down to planetary mass regimes. Through combining the proposed NIRCam observations with the available RVs, we will be able to measure the dynamical mass of the companion, and inform evolutionary models that lack observational constraints at these ages. We will for the first time confirm radio emission of a planetary mass companion, provide the first empirical test of dynamo scaling laws that predict exoplanetary magnetic fields, and open up the emerging field of radio astronomy to characterize exoplanets and substellar companions.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5502
Program Title: Probing the existence of dark matter halos at parsec scale with JWST

Principal Investigator: Ferraro, Francesco

PI Institution: Universita di Bologna

Terzan5 is a stellar system in the Galactic bulge that, despite its globular cluster appearance, harbors sub-populations with huge differences in age (7.5 Gyr) and in iron content (1 dex). Its chemical abundance pattern is strikingly similar to that of the bulge, strongly suggesting that Terzan5 could be the relic of a primordial structure, possibly embedded in a dark matter (DM) halo that contributed to form the bulge. Its velocity dispersion remains constant out to more than 20 core radii, at odds with the luminosity that rapidly decreases with radius. This suggests either an anomalously large amount (~8 times larger than expected) of very low-mass stars in its outer regions, or the presence of a DM halo.We propose ultra-deep NIRCam observations in F115W and F200W to probe the stellar mass function of Terzan5 down to 0.2 Msol and distinguish between the two possibilities. If no excess of low-mass stars is found, the velocity dispersion profile of Terzan5 would be the first evidence of a DM halo at sub-galactic scale (~5 pc). For decontamination purposes we plan an offset NIRCam pointing properly sampling the bulge population, thus also providing the community with the deepest color-magnitude diagram of the Galactic bulge ever obtained. This program can be done only with JWST and NIRCam offers the unique opportunity to sample the core and the periphery of this extincted object in just one pointing, with the needed angular resolution and at near-IR wavelengths. With a modest investment of observing time, this program promises a huge scientific pay-back: proving the existence of DM halos at parsec scales would represent a revolution in the field of observational cosmology.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5507
Program Title: Deep Spectroscopy of Galaxies at z=4-14: Uncovering Drivers of Early Galaxy Formation and Black Hole Growth

Principal Investigator: Hutchison, Taylor

PI Institution: NASA Goddard Space Flight Center

The first year of JWST observations has led to many exciting discoveries, with key results challenging previous expectations of the formation and evolution of the early Universe. Such fascinating discoveries include a much higher than anticipated abundance of z > 9 galaxies, the presence of small accreting supermassive black holes in otherwise "ordinary" galaxies, and unpredicted massive galaxies at early times. JWST's spectroscopic capabilities can provide immediate insight into the physical cause behind these surprising results. We propose deep (~8 hr integrations over two pointings) NIRSpec G395M spectroscopy (to restframe EW ~ 10 angstroms) to i) probe high ionization features indicative of top-heavy initial mass functions or accreting supermassive black holes at z > 9; ii) search for accreting supermassive black holes in typical galaxies at z ~ 4-9 detectable via broad Balmer line emission, and iii) probe the stellar-mass growth histories of massive galaxies via absorption line measurements. We can achieve all three goals via this single grating with a 23.3 hr total program, obtaining spectra for a sample of at least 135 galaxies discovered in the CEERS survey.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5545
Program Title: Dead or alive? Unveiling the nature of massive galaxies in the early Universe

Principal Investigator: Barrufet, Laia

PI Institution: University of Edinburgh, Institute for Astronomy

JWST's NIRCam images have unveiled an enigmatic new population of massive red galaxies in the first 1-2 Gyr. Their nature is not clear: are they dusty, quiescent or even AGN? They differ in physical properties but share the common trait of large stellar masses. Given the current challenges posed by early massive galaxies, it is crucial to gain insights from a large unbiased sample. They are red enough and disparate enough that they cannot be well-characterized just from imaging surveys. We use a novel approach to selecting galaxies for a NIRSpec study at z>3 based on their stellar mass from the PRIMER NIRCam survey of the COSMOS field, providing a more complete, unbiased sample of high-mass galaxies. We propose a high-return, very efficient low-resolution NIRSpec study to unveil the nature of red massive galaxies through spectral analysis and redshifts for ~100 massive galaxies, including three robust quiescent candidates at z>4.5. If confirmed, the identification of these quiescent candidates could mark a significant breakthrough in the detection of passive galaxies, potentially setting a new record for the highest redshift quiescent galaxy. The NIRSpec spectra of these massive red galaxies will yield redshifts using emission lines for dusty star-forming galaxies and continuum features for quiescent ones, enabling an exploration of the dusty/quiescent/AGN breakdown, the mass-metallicity relationship, mass-size relation, obscured star formation, obscured star-formation rate density and shed light on the high-mass end of the stellar mass function. Our program provides unique and sorely needed insights into the nature of massive red galaxies at very early times.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5547
Program Title: Spectral catalogue of externally ionized protoplanetary disks in the Orion Nebular Cluster

Principal Investigator: Rogers, Ciaran

PI Institution: Universiteit Leiden

Proplyds are young pre-main sequence stars surrounded by a disk of dust and gas, enshrouded in a larger cocoon of material that has been shaped into a characteristic "teardrop" due to the ionizing UV radiation of nearby massive stars. As such, proplyds are ideal targets to investigate the initial conditions of star and planet formation. The objective of this proposal is to provide an unprecedented near infrared spectroscopic survey of about 50 proplyds in the Orion Nebula Cluster (ONC) using the Micro-shutter Assembly of NIRSpec, and to determine in a self consistent way the mass loss rates associated with accretion and photoevaporation. By combining spectra with the available spatially resolved images of each proplyd from the PDRs4ALL ERS program, we will also place tight constraints on parameters related to the morphology, inclination, and distance to the massive stars in the Trapezium cluster. With spectra of proplyds at various distances from Ori Theta 1C, we will be able to investigate in detail how the photoevaporation mass-loss rate scales with distance, and what this implies for survival timescales of protoplanetary disks and planet formation around these stars. This spectroscopic survey will also establish the chemical inventory of the proplyds, since numerous simple species can be observed in the 1-5 micron range covered by NIRSpec, including CO, OH, H2O, CH+, C2H2, CH3+, etc.. The ONC is the best environment to probe the effect of massive stars on star/planet formation and JWST/NIRSpec is currently the only instrument capable of deciphering how this works.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 5551
Program Title: Characterization of Water Outgassing in Main-Belt Comets 133P/Elst-Pizarro and 457P/Lemmon-PANSTARRS

Principal Investigator: Hsieh, Henry

PI Institution: Planetary Science Institute

Current small solar system body research suggests that comets and asteroids occupy a continuum, and that inner solar system objects (with orbits inside the orbit of Jupiter) may contain substantial extant ice. This work has profound implications for models of the origin and evolution of water, volatiles, and organics in our solar system. We request JWST GO time to characterize the volatile content of two main-belt comets (MBCs), which are small bodies that orbit in the main asteroid belt yet exhibit comet-like activity (implying the presence of ice), with NIRCam and NIRSpec. With NIRSpec observations proposed here, we will be able to detect water gas production rates from MBCs 133P/Elst-Pizarro and 457P/Lemmon-PANSTARRS as low as ~10^23 molecules/s (5-sigma), exceeding pre-JWST upper limits by three orders of magnitude. NIRCam imaging will allow us to characterize the spatial distributions of our targets' gas and dust comae, providing insights into ejection mechanisms and active area distributions. Together with completed or upcoming Cycle 1 and 2 observations of MBCs, our proposed Cycle 3 observations will address scientific questions about how physical or dynamical properties or orbital circumstances affect outgassing properties, and also facilitate the leveraging of JWST results to the large body of available ground-based MBC data by improving our understanding of the relationship of JWST-derived water production rates to visible dust production rates.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5552
Program Title: Mapping the distribution of ices in the host environments of protostellar hot corinos

Principal Investigator: Jorgensen, Jes

PI Institution: University of Copenhagen, Niels Bohr Institute

To date, there exists no systematic view examining the chemistry of protostellar systems in the gas- and condensed-phases at all size and temperature scales from the cold dark cloud to the embedded protostar and its emerging protoplanetary disks. As a result we are missing critical information about the emergence of complex organic molecules in the interstellar medium, a fundamental puzzle of astrochemistry. Here, we propose a program to link the large-scale, cold chemistry of protostellar envelopes to the small-scale, warm gas toward emerging protostars and their protoplanetary disks. This will be done through NIRSpec MOS observations of a sample of eight protostars known to harbor hot corinos with abundant complex organic molecules present on small scales. The JWST observations will provide the large scale view of the distribution of fundamental ices in the parental cloud of these sources. These observations, combined with complementary ALMA Large Programs will provide the most comprehensive and systematic view of the chemical evolution of gas and ice around protostars in different environments so-far. The resulting insights will fundamentally alter our understanding of the complex chemistry arising around young protostars and will allow us to address the fundamental question: what role do natal molecular cloud conditions play in setting the organic inventories that eventually may be inherited by emerging planetary systems?

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5553
Program Title: The first changing-multiplicity lensed quasar: a subparsec-scale probe of a quasar at Cosmic Noon

Principal Investigator: Lemon, Cameron

PI Institution: Ecole Polytechnique Federale de Lausanne

A standard scheme for quasar structure has been built up over the last 60 years, comprising a supermassive black hole, accretion disk, torus, and broad and narrow line regions. However, constraining these regions' kinematics and geometry remains difficult, particularly at high redshift, where all studies are unresolved. A recent discovery of a quadruply imaged lensed quasar has opened up an unprecedented and exciting probe of the subparsec-scale geometry of a quasar at z=2.7. The system shows four point sources in the optical (to 0.93 microns), yet only two point sources in recent JWST-MIRI imaging (5.6 microns), and follow-up ERIS-NIX Ks imaging (2.1 microns). This is entirely unexpected since lensing is achromatic, but could be explained by the source lying within a parsec of the region that splits the four- and two-image regions. However, there are still several unanswered questions. How is the rest-frame UV of the accretion disk imaged four times, yet its optical emission is not? How can parts of the broad line region be imaged four times, yet the torus, thought to be larger in extent, is not. A full UV to optical rest-frame spectrum is needed to map the various components to the source plane. We therefore propose JWST NIRSpec IFU observations to cover this range. The complete UV-optical spectrum of each quasar image will show when and how the images disappear, provide the first high-resolution image of the rest-frame UV, and probe key emission lines including MgII, H-beta, OIII, and H-alpha. Through detailed lens modelling, we will physically map the accretion disk, broad line region components, and torus, constraining their sizes, locations, and even shapes.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5554
Program Title: Ionization and Obscuration in LyC Emitters: A MIR Look at Lyman Continuum Escape

Principal Investigator: Flury, Sophia

PI Institution: University of Massachusetts - Amherst

At z>6, galaxies transformed the universe by releasing ionizing, Lyman continuum (LyC) photons and reionizing the intergalactic medium (IGM). However, which galaxies dominated reionization and how their LyC photons escaped remains unknown. Because of the high IGM opacity during the epoch of reionization, we can only study the physics of LyC escape at lower redshift. We propose the first analysis of the MIR spectral properties of LyC-emitting galaxies. Using full-coverage MIRI MRS spectra of 4 of the strongest LyC emitters at z=0.3 and a matched control sample of 4 non-emitters, we will investigate the role of the ionizing spectrum and dust content in LyC escape. The full MIRI spectra will capture a suite of nebular lines from different ionization states, which span the energies of the predicted ionizing spectra. These lines will constrain the shape of the ionizing spectrum and show whether LyC-emitting galaxies are characterized by a harder radiation field or particular ionizing sources. Emission from the MIR dust continuum, PAH features, and H2 lines will demonstrate whether LyC emitters have weaker global dust absorption, a different grain size distribution, or a deficiency in neutral material. By connecting ionizing photon production, dust absorption, and LyC escape, these observations will provide new insights into the physics of LyC escape and reionization.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5557
Program Title: Deep imaging for the ring-shaping planet in orbit around Fomalhaut

Principal Investigator: Janson, Markus

PI Institution: Stockholm University

Fomalhaut hosts a well studied circumstellar disk, consisting of several rings that are thought to be separated and shaped by a system of planets in orbit around the central star. The widest of the rings is most intensively studied, and its sharp edges and eccentric shape are considered as particularly strong indicators of being sculpted by a planet. A visible-light point source (Fomalhaut b) detected with HST was originally thought to correspond to this planet, but follow-up studies concluded that this point source was on a ring-crossing orbit, and therefore could not correspond to the ring-shaping planet. The planet therefore remains undetected, but it has a predictable brightness and location, based on its impact on its surroundings. JWST images have recently been acquired of Fomalhaut, but are not deep enough to detect the predicted brightness of the planet. Here, we propose an imaging campaign of Fomalhaut designed specifically for reaching the necessary sensitivity to detect the planet. A detection would provide the first direct images of a sub-Saturn-mass planet, and the presence or absence of such a planet would in either case shed light on the nature of the mysterious Fomalhaut b visible-light source. The observations would also serve as an instrument- and strategy demonstrator for high-contrast imaging deep into the PSF wings of a bright star, which has never been probed before to any comparable depth, and which is necessary to detect the coldest and smallest planets that are within the sensitivity range of JWST.

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Proposal Category: AR
Scientific Category: Galaxies
ID: 5558
Program Title: A Census of Optical Diagnostics of Ionizing Sources Across Cosmic Time

Principal Investigator: Cleri, Nikko

PI Institution: Texas A & M University

We propose a systematic improvement to the selection of active galactic nuclei (AGN) throughout cosmic time via rest-frame optical emission-line ratio diagnostics. We will (1) perform photoionization modeling to describe the evolution of the BPT, VO87, and OHNO diagrams using physically motivated scenarios, including alpha- or CNO-enhanced chemical abundances of stellar populations and AGN, (2) leverage publicly available spectroscopy of ~14,000, $0 < z < 10$ galaxies from the JWST archive to test their evolution of BPT, VO87, and OHNO as a function of observable characteristics, and (3) combine these methodologies to formulate a comprehensive physics and chemistry informed redshift evolution of BPT, VO87, and OHNO. This work will provide a critical result to the community which is immediately applicable to all studies of high-redshift emission-line galaxies.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5564
Program Title: Measuring the Hubble constant with the next multiple-imaged lensed supernova

Principal Investigator: Goobar, Ariel

PI Institution: Stockholm University

Spectroscopic time-delay measurements of multiply-imaged supernovae offer a very efficient way to measure the expansion rate of the universe. NIRCam and NIRSpec follow-up observations with JWST upon the next lensed supernova (SN) discovered by the Zwicky Transient Facility (ZTF) or the La Silla Schmidt Southern Survey (LS4) could pave the way for a novel technique to measure the Hubble constant and adress the "Hubble tension". Unlike any other time-delay measurement, spectroscopic dating of multiple SN images can be done without repeated observations. We propose to select a suitable lensed supernova for ToO observations and anticipate a 5% (or better) measurement of H0, with only 3.5 hours of JWST time.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5572
Program Title: Red Monsters: Kinematics of Two ‘Universe Breaking’, Ultra-Massive Galaxies in the First Gyr

Principal Investigator: Xiao, Mengyuan

PI Institution: University of Geneva, Department of Astronomy

A surprising result of early JWST observations was the discovery of several extremely massive galaxies up to z~8 challenging the standard LCDM model. However, the lack of spectroscopic redshifts and/or inherent uncertainties of SED fitting sparked a debate about a possible overestimation of stellar masses. The only way to resolve this tension is dynamical masses. Here, we propose to do exactly this for two even more extreme galaxies (S1 & S3) at z_spec=5-6 discovered in deep JWST images and spectra. They are extremely red and massive - almost Milky Way mass only at ~1Gyr after the Big Bang - and have a very extended dust distribution (ALMA 1.1mm size ~6 kpc of S1). These two monsters were hiding in plain sight in the GOODS-S&N field. Despite 30 years of observations, they were only now revealed thanks to JWST. We propose NIRSpec IFU/G395H high-resolution grating observations on these two Universe breaker candidates, the only way to achieve our two scientific goals: 1) to confirm their ultra-massive nature in an independent way -- by obtaining their dynamical mass and 2) to understand the build-up of these massive beasts -- by studying their star formation, ionized gas, and dust properties in 2D distributions at high spatial resolution. This timely program will directly address the puzzle of surprisingly early massive galaxy assembly, and pave the way for understanding the formation of such extremely massive galaxies in the first 1Gyr of the Universe.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5578
Program Title: The MIRI deep imaging survey of the lensing clusters Abell2744 and MACS0416

Principal Investigator: Iani, Edoardo

PI Institution: Kapteyn Astronomical Institute

JWST has marked a turning point in astronomy by offering an unprecedented view of the universe at near- and mid-IR wavelengths, enabling statistical studies of galaxies at redshifts z > 6, and the identification of candidates up to z ~ 16. Spectral energy distribution fitting techniques are crucial to confirm and explore the physical properties (e.g. z, stellar age, mass, dust extinction) of such statistical sample of galaxies. To obtain solid results, however, deep imaging surveys with long wavelength baselines and coverage of critical galaxy spectral features are needed. With its unique capabilities, JWST/MIRI allows for the detection and characterization of the rest-frame near-IR and optical emission of galaxies at z > 4, a key wavelenght regime to probe for robustly constraining galaxy physical properties, while also eliminating contamination from intermediate-z dusty star-forming galaxies and AGNs. We are requesting a 75-hour MIRI imaging at 7.7 and 10 um to survey two of the most well-known Hubble Frontier Fields galaxy clusters: Abell 2744 and MACS J0416.1-2403. The proposed observations will cover a total area of about 8.8 arcmin^2, double the wavelength coverage so far available in these fields and achieve unprecedented depths than any previous extragalactic survey at similar wavelengths and recent MIRI lensing cluster studies in the same filters. Thanks to lensing magnification, this data will also probe fainter galaxies than the deepest MIRI blank field observations. These observations will have a crucial legacy value since they will also allow the access to the rest-frame near-/mid-IR emission of low-z galaxies in both the cluster and the fore-/back.

Proposal Category: SNAP
Scientific Category: Large Scale Structure of the Universe
ID: 5594
Program Title: JWST Cluster SLICE - Strong LensIng and Cluster Evolution

Principal Investigator: Mahler, Guillaume

PI Institution: Universite de Liege

We propose Survey mode NIRCam imaging of 182 massive galaxy clusters selected to track 8 Gyrs of cluster formation history, picked from more than 6500 candidates in Sunyaev-Zel'dovich (SPT, ACT & Planck) and X-ray (BCS, eBCS, REFLEX, MACS, eMACS) cluster catalogs. Our carefully-selected clusters sample slice the average mass-z evolution from z~0.2 to z=1.9, exploring two key fundamental properties of their evolution: (A) How infalling cluster galaxies build-up the stellar content of 1) the bright central galaxy, 2) the intra-cluster light and 3) the large population of globular clusters. (B) How dark matter distributes over the cluster, and gets tidally stripped from sub-halos to feed the main cluster's potential. Our observing strategy uses the broadest NIRCam filters (F150W2+F322W2), to effectively turn the observatory into a giant light bucket, achieving maximal depth and redshift range with minimal time. This approach provides information on a wide range of galaxies, from cluster members to gravitationally-lensed star-forming and dusty galaxies at cosmic dawn. Even with an estimated completion rate of 20%, the requested data will more than double the total number of JWST observed strong lensing sightlines in just a year, enabling a variety of galaxy evolution studies with lensed systems. JWST’s unique sensitivity, wavelength coverage and spatial resolution will bring breakthrough science in these areas. Furthermore, this sample is complemented by a wide range of ancillary ground- and space-based data, from X-rays to radio wavelengths, and will have substantial legacy value for extra-galactic science.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5627
Program Title: Dust and Molecular Gas in Galactic Winds and Fountains: A JWST Survey of Nearby Highly Inclined Starburst and Active Disk Galaxies

Principal Investigator: Veilleux, Sylvain

PI Institution: University of Maryland

The amount of dust outside of galaxies, inferred from reddened background sources, is comparable to that within galaxies. The recent discoveries of dusty winds driven by stellar and SMBH processes that extend on 100-kpc scales suggest that winds are one source, and possibly the main source, of the enriched circumgalactic medium (CGM), although the processes by which the dust is launched, entrained, and possibly altered in these winds remain uncertain. This is due to the fact that the angular resolution (2") of present-day observations is insufficient to extract the dust signal at the base of the wind against the bright galaxy, and allow to pinpoint where the dust lies relative to the cool, warm, and hot gas phases of the winds. We propose to map, for the first time on sub-arcsec scale (<10-100 pc), the warm dust and H_2 in 10 nearby highly inclined disk galaxies with well-known galactic winds or fountains, spanning a range in stellar masses (metallicity), energy sources (stellar or AGN), and dust erosion processes (shocks, stellar or AGN photoionization). The PAH 3.3, 7.7, 11.3, H_2 17.03, and adjacent continuum emission will be compared with existing sub-arcsec maps and velocity fields of the ionized gas to determine the mechanisms by which the dust is launched and carried into the halos of these galaxies, and whether dust grains and warm H_2 molecules evolve as the wind carries them to form the CGM. The <10-100 pc resolution is critical since the processes that can alter the dust and clouds in which it resides operate on such scales. The results will inform future modeling and HST/UV observations. The proprietary period is shortened given the legacy value of the data.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5629
Program Title: Extremely deep spectroscopy of quiescent galaxies at z~0.7: A direct measurement of the stellar initial mass function beyond the low-redshift universe

Principal Investigator: Kriek, Mariska

PI Institution: Leiden Observatory

The stellar initial mass function (IMF), which describes the distribution of the birth masses of stars, is of paramount importance to galaxy evolution. Exploiting the universality of the IMF shape, we infer fundamental parameters, such as stellar mass and star formation rate, and accordingly unravel how galaxies build up over time. However, in the centers of very massive elliptical galaxies, the IMF is distinctly different from what is observed in the Milky Way. With its excess of low-mass stars, this IMF would increase the inferred stellar masses by a factor of 2-3. The cores of massive elliptical galaxies are thought to have formed at early times and thus we expect distant massive galaxies to also have a bottom-heavy IMF. However, this bottom-heavy IMF yields inferred stellar masses that exceed the dynamical masses. To solve this puzzle and derive more precise stellar masses and star formation rate of distant massive galaxies, we propose to directly measure the IMF in nine z~0.7 galaxies using ultra-deep spectroscopy with the NIRSpec-MSA. These observations will also yield stellar mass profiles, resolved stellar kinematics, and thus robust dynamical masses. Our program will (i) reveal whether the IMF was already bottom heavy in z~0.7 quiescent galaxies, (ii) yield the most robust baryonic-to-dark matter mass ratios in z~0.7 quiescent galaxies to date, (iii) provide new insights into the build up of the cores of massive elliptical galaxies, and (iv) assess other explanations for the "unphysical" stellar-to-dynamical mass ratios of distant quiescent galaxies. We will also observe 8 quiescent galaxies at 1<z<2 and 15 star-forming galaxies at similar and higher redshifts.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5634
Program Title: Clear as day: Constraining the thermal structure and photochemistry on WASP-39 b's day side

Principal Investigator: Baeyens, Robin

PI Institution: Universiteit van Amsterdam

WASP-39 b has rapidly evolved into a benchmark planet for observational and theoretical studies of hot exoplanet atmospheres. The reasons are clear. This planet has yielded the most precisely measured transmission spectrum to date, leading to a spectral detection of CO2 at an unprecedented significance of 26 sigma, and the first evidence of photochemistry occurring on an exoplanet through the detection of SO2. Such a rich dataset demands an equally rich context in order to provide a suitable interpretation of the physical and photochemical phenomena occurring in its atmosphere. Currently, such context is still lacking, given that the thermal structure of WASP-39 b is unconstrained. We propose to observe an emission spectrum of WASP-39 b using JWST/NIRSpec G395H in order to constrain the vertical temperature-pressure profile, and to measure the abundances of SO2 and CO2 at the planetary day side. With this observation, we will be able to determine the day-side temperature, energy redistribution, and vertical thermal gradient of WASP-39 b, thereby confirming or ruling out the formation of a stratosphere through heating by sulfuric species. In tandem with the measured SO2 and CO2 abundances, we will leverage this thermodynamic context to provide a precise estimate of the metallicity, and investigate the production and transport of photochemical species in exoplanet atmospheres in further detail.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5637
Program Title: High-resolution mapping of the very cold superwind in ESO484-036

Principal Investigator: Mazzilli Ciraulo, Barbara

PI Institution: Swinburne University of Technology

Galactic-scale winds play a key role in regulating star formation by removing gas from the disk, and are a top-tier component to all models of galaxy evolution. Despite this fact, there is no theoretical consensus for how, and how effectively, galactic winds actually remove the gas. Moreover, observations of winds are quite rare, and typically focus on the nearest outflows, which have similar properties. What theory does to describe the energetics of this important process is constrained by a small number of galaxies. We need more observations of the full range of outflows in order to properly include them in galaxy evolution models, especially those at describing the z>1 Universe when star formation was much more extreme. We propose to use JWST for an in-depth analysis of ESO484-036, a nearby starburst that hosts a galactic-scale wind with neutral Na D emission extending over multiple kiloparsecs. This is a rare feature, implying the wind is much colder and more dust rich than other outflows. Theory argues that cooling is a key physical mechanism setting outflow kinematics, which makes this target specifically interesting. We will use MIRI and NIRCam imaging to resolve the small-scale structure of the wind, and to identify dust heating and destruction in the wind using PAH line ratios. Existing VLT/MUSE and in progress ALMA observations make this project the first multiphase study of a Na I D emission outflow. ESO484-036 is expected to have a much colder wind, comparison to Cycle 1 observations of outflow galaxies M82 and NGC253 will suggest trends in cloud scale properties of outflows with the total cold gas mass.

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Proposal Category: SNAP
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5645
Program Title: A 3D view of the first QSOs: A JWST/NIRSpec survey program

Principal Investigator: Farina, Emanuele

PI Institution: NOIRLab - Gemini North (HI)

We propose to leverage the unprecedented power of JWST/NIRSpec in IFU mode to take a decisive leap towards an unbiased census of QSO activity during the Epoch of Reionization. This survey program draws from all the 343 QSOs known at 5.7<z<7.0, without any additional selection bias. The data will deliver simultaneous spectral coverage of the key emission lines [NII], HAlpha, [OIII] and HBeta arising from the central QSO and its close (<15pkpc) environment. Assuming a completion rate of 5-10%, this sample will double to triple the number of high-z QSOs observed with the NIRSPec IFU. This survey will provide a statistical sample of high-z QSOs enabling a variety of investigations into early black hole and host galaxy evolution. Key science goals include: (i) measurement of precise black hole masses and accretion rates from Balmer lines; (ii) determination of the incidence of [OIII] outflows; (iii) measurement of masses and physical properties of the QSO host galaxies and any close companions; (iv) derivation of physical constraints on the cool gas reservoirs in the circumgalactic medium. This dataset will open the exciting prospect of providing a statistical view of the complex link between hierarchical structure formation, the stellar mass growth in galaxies, and the QSO activity at the dawn of the Universe, when current models of massive galaxy formation can be better constrained.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5650
Program Title: A multi-wavelength view of warm dust in the eta Crucis planetary system: inward transport or inner belts?

Principal Investigator: Matra, Luca

PI Institution: University of Dublin, Trinity College

Determining the origin of warm dust interior to outer exocometary belts in planetary systems is our only chance to test whether inward transport of icy material to the terrestrial planet region is taking place in nearby planetary systems, and determine the physical mechanism driving it. We propose a JWST/MIRI F2550W resolved imaging program to investigate the structure of warm dust interior to an outer belt in the nearby eta Crucis system. This system has a rare ALMA mm-wave resolved detection of warm dust as well as its outer belt, enabling the first JWST+ALMA joint resolved analysis of warm dust in a planetary system. Our main goal with JWST/MIRI imaging (0.8" resolution) is to determine the origin of the warm dust, by resolving either (1) an inner belt or belts, with planet-induced gap(s), or (2) a continuous inner disk of emission, which would prove that inward transport of icy material from the outer belt is ongoing. In the latter case, joint modelling of the new JWST/MIRI image and the existing ALMA image will deliver an independent measurement of the size distribution for the warm dust and the cold belt - distinguishing whether transport is induced by Poynting-Robertson (P-R) drag, or inward scattering. Overall, this pilot study on eta Crucis will uniquely leverage the high resolution capabilities of both JWST and ALMA, and demonstrate that multiwavelength resolved imaging is the key to understand the link, if any, between warm and cold dust in planetary systems.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5664
Program Title: Dissecting Little Red Dots: the connection between early SMBH growth and cosmic reionization

Principal Investigator: Matthee, Jorryt

PI Institution: Institute of Science and Technology Austria

The presence of supermassive black holes (SMBHs) in galaxies out to the highest redshifts is one of the key puzzles of observational astrophysics. Among the most surprising results of JWST so far has been the discovery of a population of relatively faint, optically red AGN at high-redshifts identified through broad Halpha emission in virtually every extra-galactic field. Their SMBH masses and UV luminosities are up to 100 times lower than high-redshift AGN found with wide-field ground-based surveys. While the AGN are red in the rest-frame optical, suggesting obscured early SMBH growth, a significant fraction of them has surprisingly blue UV colors. What is the origin of the UV emission? Does it originate from young stars in the host galaxy, or is it scattered light that can escape the AGN disks through holes in the dust? How common are galactic scale outflows, and is there a link between the UV emission, the properties of outflows and the AGNs? Here we aim to address these questions by performing deep NIRSpec IFU prism and high resolution grating spectroscopy of a carefully selected sample of faint AGN at z~5.3. We will a) address the fraction of UV light due to scattered AGN light versus star formation of their host galaxy, and b) characterise the properties of outflows, and correlate these with the SMBH mass and the origin of the UV light. This allows us to address whether outflows from AGN activity may have driven openings in the dust that surrounds early SMBH growth, through which we can detect scattered UV light and through which AGN could have contributed to the end stages of the reionization of the Universe.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5687
Program Title: Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Principal Investigator: Valentine, Daniel

PI Institution: University of Bristol

Eclipse mapping is currently the only method capable of measuring 2D (latitude-longitude) profiles of exoplanet atmospheres. The method has been used to accurately map the longitudinal profiles of a handful of exoplanets, allowing us to characterise their atmospheric dynamics using key tracers such as the longitudinal offset of the hotspot (the hottest point on the planet) due to supersonic jets. However, no exoplanet has yet been adequately mapped in latitude because there is a limited parameter space in which we are capable of observing such signals. Latitudinal hotspot offsets can be induced by a marginal misalignment between the magnetic field of an exoplanet and its spin axis, with the scale of the offset related to the field strength and angle of misalignment. Characterising this offset would thus allow us to probe these parameters for planetary-mass objects for the first time, which is only possible via eclipse mapping because it is the only method capable of mapping these objects in latitude as well as longitude. KELT-8b's 1675 K equilibrium temperature make it ideally susceptible to a magnetically-induced latitudinal hotspot offset, and its 0.741 impact parameter and 45 minute ingress/egress duration make this offset optimally observable. We will use MIRI/LRS to observe two eclipses of KELT-8b, using a unique observing strategy designed to give the best constraints on both its longitudinal and latitudinal profile. This will allow us to construct the most informative eclipse map of an exoplanet to date, from which we will be able to extract a wealth of information, including the atmospheric dynamics, heat redistribution, wind speeds, and magnetic field geometry.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5709
Program Title: What causes warm dust interior to planetesimal belts?

Principal Investigator: Han, Yinuo

PI Institution: University of Cambridge

One of the most notable findings of JWST in exoplanetary systems so far has been the discovery of a continuous distribution of warm dust permeating the space interior to the planetesimal belt in Fomalhaut. An intermediate dust ring was also discovered within this dust distribution that pointed to the presence of perturbing planets, highlighting the unique capability of JWST to probe this intermediate region of planetary systems. Such a discovery has prompted a re-evaluation of our understanding of debris disk structures more generally, while opening up a new method to search for planets by looking at planetary perturbations within continuous inner warm dust distributions. In this proposal, we aim to test whether there exists a common mechanism for causing this inner warm dust, which may be ubiquitous in debris disks. We target the Gamma Oph system, which is the best target to image with MIRI to probe this inner dust distribution alongside Fomalhaut and Vega which have been observed as part of GTO programs. We will be able to test whether these systems host inner warm dust commonly explained by Poynting-Robertson drag, as has been modelled in Fomalhaut, or whether a more diverse range of mechanisms are at play, such as comet delivery or a two-belt configuration analogous to the Solar System. In all possible scenarios, we will be able to constrain the planetary architecture in Gamma Oph to compare with Fomalhaut and Vega, leading to a more complete understanding of debris disk structures in this new region enabled by JWST and the architecture of otherwise invisible planets.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5716
Program Title: Precision Tests of Black Hole Mass Measurements in Massive Elliptical Galaxies

Principal Investigator: Walsh, Jonelle

PI Institution: Texas A & M University

About 100 supermassive black hole (BH) masses have been dynamically measured in nearby galaxies. The local BH census, however, is highly incomplete, and questions about the slope, scatter, and even the shape of the BH-host galaxy relations remain, especially at the high-mass end. Moreover, only a handful of studies have made direct comparisons of BH masses using different dynamical tracers or under different modeling assumptions. Recently, ALMA has enabled the mapping of molecular gas (CO) within the BH's gravitational sphere of influence (r_soi). CO is a far superior tracer of the potential compared to the traditionally used ionized gas, and there has been a large uptick in the number of ALMA BH masses. Concurrently, substantial advancements have been made to stellar-dynamical models, including new/updated triaxial codes and modern search strategies to simultaneously determine mass and intrinsic shape parameters for each galaxy. With the new CO BH masses and the exciting improvements to stellar-dynamical models, the time is right for a systematic study of BH masses from CO emission versus stars. We will use the NIRSpec IFU to acquire the best high angular resolution spectra to date at the center of three massive elliptical galaxies that have superb ALMA observations and some of the most precise CO BH masses. We will extract reliable stellar kinematics deep within r_soi, matching the resolution of ALMA, and apply state-of-the-art models to obtain robust stellar-dynamical BH masses. The three galaxies are the best targets for such analysis and will allow us to assess the consistency of these two main methods and the subsequent effects on the upper end of the BH relations.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5718
Program Title: A Spectroscopic Census of Faint, Broad-Line AGN at z > 5

Principal Investigator: Kocevski, Dale

PI Institution: Colby College

One of the more surprising results from Cycle 1 was the discovery of broad-line AGN at z>5 with luminosities and black hole (BH) masses that are 2-3 dex below those of bright quasars found from the ground. These faint quasars are more representative of the underlying BH population and are the key to constraining models of BH seeding, the contribution of AGN to reionization, and the early coevolution of galaxies and BHs. What we currently know about these sources is based on a limited sample (~20 broad-line AGN with R>1000 spectroscopy) that is likely biased toward the most massive and active BHs due to non-uniform target selection in Cycle 1 that favored observing brighter sources. We request 20.5 hours of NIRSpec observations to carry out a systematic census of both unobscured and obscured low-luminosity quasars at z>5 via the detection of their broad-line emission. We have compiled a target sample of 55 unobscured AGN candidates and 77 dust-reddened AGN candidates (sources known as “little red dots”). We will observe 55 of these sources in 6 MSA pointings, which will quadruple the current sample of faint quasars with R>1000 spectroscopy. Our requested 2 hour exposures will be sensitive to BH masses down to 1.7x10^6 Msol. We will use our resulting sample to: (1) make the most robust estimate yet of the BH mass function at the low-mass end, which constrains models of BH seeding and their growth history, (2) constrain the evolution of the local M_BH-M* relationship at the lowest BH masses yet probed, and (3) determine the fraction of little red dots that host broad-line AGN with the most sensitive spectroscopic follow-up of these enigmatic sources yet carried out.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 5734
Program Title: Placing a z=7.27 AGN in context with cosmic structure formation

Principal Investigator: Schindler, Jan-Torge

PI Institution: Universitat Hamburg, Hamburger Sternwarte

Deep spectroscopic JWST observations have unveiled an emerging population of faint z>5 active galactic nuclei (AGN). First estimates of their number densities exceed the expectations from extrapolating the quasar luminosity function by factors of 1000, possibly constituting as much as 10% of the total galaxy population. With supermassive black hole (SMBH) estimates of 10^6-10^8 M_sun, their high number densities challenge theories of SMBH formation and it is unclear how they fit into the context of cosmic structure formation as a whole. The serendipitous discovery of a faint z=7.27 AGN within an overdensity of 8 associated galaxies provides the first opportunity to place this population in the cosmological context via AGN-galaxy clustering analysis. However, the low resolution NIRSpec/PRISM discovery spectrum is inadequate to determine the SMBH mass, bolometric luminosity and Eddington ratio for two reasons: i) estimates imply high levels of dust attenuation, which remain largely unconstrained (A_v=1 to 5), but are critical to correct for and ii) the low resolution does not resolve narrow line components, strongly biasing the SMBH mass estimate based on the decomposed broad Hb line. We propose for a small 12h program to obtain R=1000 NIRSpec G395/F290LP fixed-slit spectroscopy (8.4h), resolving the narrow line emission and MIRI/LRS spectroscopy (3.5h) to determine the Ha flux for an accurate measurement of the dust attenuation with the Ha/Hb Balmer decrement. During the NIRSPEc/fixed-slit observations, MSA shutters will be opened on galaxy candidates to additionally identify more associated sources for an improved clustering measurement.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 5743
Program Title: Spotlighting the ionised Universe by uncovering the faintest ever host galaxy of a Fast Radio Burst

Principal Investigator: Deller, Adam

PI Institution: Swinburne University of Technology

Fast Radio Bursts (FRBs) are millisecond duration radio transients that originate at cosmological distances. Because the ionised intergalactic medium (along with the circumgalactic and interstellar media in both the host galaxies and the Milky Way) leads to a frequency dependent delay in their arrival time on the order of seconds, the electron column along an FRB line of sight can be measured to 0.1% or better, meaning they can be used as precision probes of the ionised Universe - including the elusive diffuse components. The current record holder is a recently-identified FRB from redshift 1, but other bursts exhibit frequency dependent delays consistent with an origin at even higher redshift. Of these, just one - FRB 20210912A - has been localised sufficiently precisely for follow-up, and yet no host has been seen in deep ground-based imaging at this location - to a limit 3 magnitudes fainter than any of the dozens of other known FRB host galaxies! Modeling indicates that the host of FRB 20210912A is likely a faint galaxy at z~1.3, and will be infeasible to detect with ground-based facilities. With a modest JWST imaging and spectroscopy program, we can detect the host of this FRB, confirm its record-breaking redshift, and use it to 1) support (or refute) the neutron-star magnetosphere model for FRB progenitors, and 2) extend the relationship between FRB dispersion and redshift, refining the prospects for using FRBs to determine both cosmological parameters such as the Hubble constant and the impact of galaxy feedback on the distribution of ionised baryons.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5749
Program Title: The Red Rectangle: a space laboratory for the formation and evolution of interstellar carbon material

Principal Investigator: Candian, Alessandra

PI Institution: University of Amsterdam

Astrophysical dust grains and molecules are fundamental components of the Universe. Their interactions with gases, photons, sub-atomic particles, and cosmic rays drive the evolution of the interstellar medium from the first generations of stars to star/planet formation. Large carbon molecules and dust particles exhibit numerous and omnipresent spectral signatures imprinted on astronomical spectra from the UV to the IR: 1) the very strong 2175 angstrom absorption band in the interstellar extinction curve; 2) the blue luminescence - optical emission peaking at 380 nm; 3) the diffuse interstellar bands - hundreds of unassigned optical and near-IR diffuse Galactic and extragalactic interstellar absorption bands; 4) the extended red emission - broad optical emission between 500-1000 nm widespread through the Galaxy; 5) the aromatic infrared band emission dominating the IR spectra of star-forming regions, ISM, and galaxies. A key difficulty in figuring out how these phenomena and their carriers are related is that it has not been possible to study these phenomena at the same time in the same object - until now. We propose to use the incredible spatial and spectral resolution of JWST to obtain MIRI-MRS spectra across the Red Rectangle, a unique nebula surrounding an evolved star, that exhibits all these signatures of carbonaceous dust at the same time. These spectra will, for the first time, connect these important interstellar carbonaceous materials in a well characterised environment, reveal their IR spectroscopic fingerprints, bring us closer to deciphering dust formation and photo-processing and to identifying new species of the interstellar carbon inventory.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5761
Program Title: Ionized Gas Kinematics of a z > 4 Main Sequence Disk Galaxy

Principal Investigator: Neeleman, Marcel

PI Institution: Associated Universities, Inc.

Fundamental to any theory of galaxy formation is a description of the spin-up of galactic disks across cosmic time. Current conventional wisdom asserts that the process is driven by mergers and gas accretion, both to fuel star formation and to impart angular momentum. However, the onset of disk formation is set by hard-to-model physical processes. ALMA [CII] observations have revealed the first disk galaxies at z>4, suggestive that disks are already commonplace at these high redshifts. Using JWST, we now have the exciting opportunity to explore the ionized gas kinematics and morphology of these galaxies. In this proposal we aim to do exactly this for the archetypal early disk galaxy, the Wolfe disk, which is the best studied main sequence [CII]-emitting disk galaxy at z>4. Using NIRSpec IFU Halpha observations, we will constrain the kinematics of the ionized gas, and compare it to the kinematics of the cold ISM as traced by [CII] and CO in order to test the prediction that ionized gas is dynamically hotter than the cold ISM. We will also constrain the morphology of the ionized gas to explore the distribution of star formation within the disk and compare this to the distribution of the cold ISM. The proposed NIRSPEC/IFU observations will extend the kinematic analysis of main-sequence disk galaxies at z ~ 2 to one of the earliest known main-sequence disk galaxies. This will enable a fair comparison between these two populations without the intrinsic uncertainty of using different tracers to characterize their kinematics and open up a new window for exploring main sequence disk galaxies in the early universe.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5765
Program Title: Two for the price of one: complete spectroscopy from 0.7 to 23 micron of the benchmark brown dwarfs Eps Ind BA and BB

Principal Investigator: Matthews, Elisabeth

PI Institution: Max Planck Institute for Astronomy

The binary brown dwarf Eps Ind BA/BB is a key benchmark system with well measured mass, age and metallicity, and serves as a unique laboratory for comparative studies of brown dwarf atmospheres. We will use spectroscopic observations of Eps Ind BA/BB to carry out several crucial tests of brown dwarf formation, evolution and atmospheric chemistry, such as the following: a stringent comparison of mass, bolometric luminosity, and age against models; measurement of the 15N/14N ratio as a tracer of formation; testing the ability of retrievals to infer accurate C/O ratios; a comparison of brown dwarf cloud properties, in a region where silicate clouds in the atmosphere are expected to disperse. This work will underpin broader efforts to understand brown dwarf and exoplanet atmospheres, and the tail end of the IMF. Eps Ind BA/BB are the 2nd and 3rd closest T dwarfs to earch, allowing excellent signal-to noise spectroscopic measurements. The pair has a well-constrained orbit giving extremely precise mass measurements (<0.5% accuracy), and a favorable semi-major axis allowing the pair to be spatially resolved with JWST. They are co-moving with a main-sequence star, providing an independent measure of the system age and metallicity. That star itself hosts a wide-orbit super-Jupiter planet - potentially allowing for the comparative studies of three substellar companions with the same age, metallicity and formation environment. We will collect a complete spectrum of the brown dwarf binary from 0.7um to ~23um with NIRSpec and MIRI, spatially resolved to ~12um. These observations will provide a rich legacy JWST dataset.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5766
Program Title: Probing the bar slowing down across cosmic time

Principal Investigator: Cuomo, Virginia

PI Institution: Universidad de Atacama - INCT

Bars are stellar structures common in the majority of galaxies in the nearby Universe. The secular evolution of barred galaxies is governed by the angular frequency of the bar rotation around the galaxy centre, i.e. the bar pattern speed. This parameter is strongly linked to the dark matter content in the galaxy inner regions, due to dark matter halos slowing down bars through dynamical friction. Observational studies of barred galaxies find that bars rotate fast, while simulations of galaxy evolution in the cold dark matter framework suggest that bars slow down excessively. This means a tension between fast bars and the standard cosmological paradigm. Several explanations have been proposed for the paucity of slow bars in the local Universe, but the lack of direct measurements of bar pattern speed for galaxies at $z > 0.1$ makes it impossible to test the efficiency of dynamical friction and the bar slowing down across cosmic time. We propose to use the new capabilities of JWST to measure directly for the first time the bar pattern speed of two recently discovered barred galaxies at $z > 1$, some of the furthest bars known up to date. The proposed observations based on near-infrared integral-field spectroscopy will allow us to compare directly values of bar pattern speed at the dawn of bar formation with analog results in the local Universe. This will put stringent constraints on the evolution of the bar pattern speed across cosmic time, therefore limiting the nature (or even existence) of dark matter in galaxies.

Proposal Category: AR
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 5779
Program Title: A User's Guide to Lyman-alpha Damping Wings in Reionization-Epoch Galaxies

Principal Investigator: Finlator, Kristian

PI Institution: New Mexico State University - Dona Ana

JWST has recently discovered a trio of reionization-epoch galaxies whose stellar continua show clear evidence of Lyman-alpha damping wing absorption. Surprisingly, the absorption cannot originate in the intergalactic medium (IGM). Instead, it points to a substantially-neutral circumgalactic medium (CGM). This is a novel probe of both the timing and the topology of hydrogen reionization, and we will write its "User's Guide." CGM damping wings complement metal-ion tests including the MgII and OI forests because interpreting them does not depend on the unknown metallicity distribution. They complement Lyman-alpha emitter statistics because they do not reflect complicated resonant scattering, and they are sensitive primarily to the CGM rather than the IGM. Their discovery raises many questions: How do the reionization histories of the CGM and IGM relate? To what extent are CGM damping wings a barometer of the metagalactic ionizing background that drove reionization? To what extent are they sensitive to small-scale processes such as inefficient inflows or feedback from star formation? We propose a two-year study to address these and related questions. We will anchor our work in comparisons between JWST observations and detailed analysis of cosmological radiation hydrodynamic simulations. The simulations are known to match a variety of galaxy and reionization observables. Encouragingly, they also readily predict that the absorbing HI column varies strongly with halo mass and redshift as observed by JWST. We will publish our predictions in a way that encourages further observational tests, and our methods in a way that encourages complementary modeling efforts.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5782
Program Title: Abell 1689: Opening a Unique Window on Lensed Galaxies at Cosmic Noon

Principal Investigator: Claeyssens, Adelaide

PI Institution: Stockholm University

Galaxies at cosmic noon (CN, z~2) are characterized by irregular morphologies dominated by compact and bright stellar clumps. The role of these clumps in galaxy morphological evolution and their contribution to the total galaxy mass buildup are so far poorly understood and widely debated. The combination of JWST/NIRCam high sensitivity and resolution with the strong gravitational lensing effect produced by galaxy clusters has opened a new window on the internal physical processes at play in distant galaxies. We propose deep NIRCam images of the massive lensing cluster Abell1689 to probe the physical properties of star-forming clumps and galaxies at CN, a key time for galaxy evolution. A1689 is far superior to the Hubble FF clusters to study CN galaxies at it is known to produce extremely high magnifications over a large volume of Universe at 1<z<4.5. These observations will enable us to study >1000 galaxies over a wide range of masses and resolve their clump and star cluster populations across CN down to 1 pc scale and 10^5 solar mass. By extending the wavelength coverage to the IR and combining broad-band and medium-band filters, we will be able to derive robust clump/cluster physical properties (size, age, mass, boundness). Clumps trace star-formation and play a major role in the stellar feedback at a galactic scale. We will answer questions related to diverse formation mechanisms and survival time scales of clumps as a function of galaxy mass. We expect to detect young and intermediate age proto-globular clusters in the many giant arcs produced by A1689, enabling us to constrain their redshift formation.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5791
Program Title: The Crucible of Planet Formation - Protoplanetary Disks in the Extreme Environment of Trumpler 14

Principal Investigator: Kuhn, Michael

PI Institution: University of Hertfordshire

The evolution of disks around young stellar objects governs the character of the planetary systems that form. In massive star-forming regions, UV irradiation drives mass loss from disks, which could affect the resulting planets. Although a significant fraction of planetary systems (including our Solar System) are thought to have arisen in extreme environments, the nearest (best studied) star-forming regions lack significant UV radiation fields, meaning that we must study more distant regions accessible for spectroscopic study only with a sensitive facility like JWST. We propose NIRSPEC/MSA observations of the Trumpler 14 cluster, a uniquely rich starburst cluster in the Solar neighborhood with a UV radiation field a thousand times higher than in the Orion Nebula. The MOS observations of the cluster will produce a sample of ~340 cluster-member spectra (down to M=0.08 Msun). The near-infrared spectra will provide a statistical sample to determine 1) How does the disk fraction vary with local FUV strength and stellar mass? And 2) How do disk properties (e.g., CO temperatures, accretion rates, and mass-loss rates) vary with the environment? High signal-to-noise near-infrared spectroscopy allows the spectral classification of the stars and a characterization of accretion and disk irradiation via atomic and molecular emission. The spacing of cluster members in Tr14 makes efficient use of the MOS shutters. NIRCam pre-imaging, together with existing VLT/HAWK-I and SPHERE images, will be used to better characterize the total stellar population of Tr 14. This unique dataset will be the first of its kind and will serve as a benchmark for disks in extreme conditions.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5799
Program Title: TOI-3884: A JWST Rosetta Stone for the study of M-dwarf stellar contamination

Principal Investigator: Garcia, Lionel

PI Institution: Flatiron Institute

Transiting exoplanets around late-M dwarfs are of prime importance for the field of exoplanetary science, as the relative size of their host star leads to high signal-to-noise transit signals. By using transmission spectroscopy one can access the composition of the planet's atmosphere, and make links to its formation and evolution history. But interpreting such measurements presents a major challenge: the effect of stellar contamination. Indeed, transmission spectra contain the signatures of stellar surface heterogeneities, such as starspots, able to mimic or hide planetary signals. In this respect, the opportunity offered by late-M dwarfs is balanced by their low effective temperatures, and their large convective nature known to further enhance this issue. As groundbreaking JWST transmission spectroscopy of exoplanets transiting these cool objects are being conducted, stellar contamination remains an unsolved issue, for which strategies and data have yet to be obtained. In this study, we propose to observe the M4-type star TOI-3884 with the NIRISS and NIRSpec-G395H instruments, as its giant polar spot is being occulted by the large-Neptune companion TOI-3884 b. Beyond enabling the detailed atmospheric characterization of this unique planet free of stellar contamination, these observations will provide the community with the first mid-resolution spectra of a spot on an M dwarf, and the first benchmark of the different strategies widely used to account for their presence in transmission spectra. Overall, these observations will further unlock the immense value of M dwarfs for both the field of stellar physics and exoplanetary science.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5804
Program Title: HEFE: High Angular Resolution observations of Stellar Emergence in Filamentary Environments

Principal Investigator: Megeath, Tom

PI Institution: University of Toledo

We propose NIRCAM, NIRSpec and MIRI-MRS observations of the integral shaped filament (ISF): a 6000 Msun, 8 pc long, massive filament at 390 pc containing the Orion Nebula. We focus on the OMC2/3 region north of the nebula. Illuminated by UV radiation from the nearby OB stars, OMC2/3 is the most active region of low mass star formation in the ISF with 46 protostars. IFU 2.9-29 mu observations of the 13 Class 0 protostars will trace the mass flows in jets and wide-angle winds in shock heated atomic, ionic and molecular species that will trace how jets and winds interact with the infalling gas and shape the IMF. These observations will be extended by NIRCam from 1000 au to parsec scales, including all 46 protostars, to examine how outflows from all stages of protostellar evolution inject momentum and energy into their enironment and regulate star formation. IFU and prism spectra will show the compositions of ices in the envelopes of Class 0 protostars, elucidating the formation of organic molecules in clouds near OB stars, and illuminating the role of external UV photons on the initial chemistry of planet formation. Finally, the data will be used to examine accretion onto protostars using multiple tracers: HI lines, OH lines, and ices thermally processed by accretion driven outbursts. These data will determine typical rates of mass accretion during the primary accretion (Class 0) phase , establish the fraction of gas launched in outflows, and assess the importance of outbursts in mass assembly. Building on an extensive, existing observations, JWST will provide crucial observations of this essential region that cannot be obtained by any facility in the forseeable future.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5814
Program Title: Auroral chemistry in the atmospheres of T dwarfs

Principal Investigator: Fitzgerald, Michael

PI Institution: University of California - Los Angeles

We propose to obtain high-resolution, L and M band spectroscopy of five T dwarfs with JWST /NIRSpec. These T dwarfs possess strong evidence of auroral activity in the form of polarized radio emission from an electron-cyclotron maser process. Through a cross-correlation and subsequent atmospheric retrieval analysis, we will place constraints on auroral chemistry, primarily the production of $H_3^+$ , and the compositions of these dwarfs. Successful detection of $H_3^+$ will enable characterization of the otherwise invisible upper atmospheres of these objects. Our proposal will help to understand the conditions in the upper atmospheres of objects at the transition between stellar and planetary masses, and the effect that powerful magnetosphere processes can have on them. At the most fundamental level, our proposal will explore why some BDs appear to have extremely powerful aurora, what consequence those processes have on their atmospheres, and what similar processes may be occurring in giant exoplanets

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5816
Program Title: Lifting the Veil: A Direct Measure of Dust Properties and Extinction in a Planet Opened Gap

Principal Investigator: Cugno, Gabriele

PI Institution: University of Michigan

In the complex realm of protoplanetary disks, our understanding of dust properties and their evolution during planet formation stages remains highly uncertain, primarily due to the lack of empirical constraints. To enhance our ability to observe and characterize the dust properties in protoplanetary disks, we propose a pioneering study employing the cutting-edge capabilities of the JWST/NIRCam instrument. This program leverages the unique opportunity arisen from the serendipitous detection of a background star aligned with the outer gap of the AS209 disk traced by ALMA CO and IR scattered light observations, where at least one protoplanet is suspected to be forming. The proposed multi-band observations will provide the photometric SED of the extincted star over a wide wavelength range. This unique setting will enable us to accomplish two critical objectives. Firstly, we will empirically determine the properties of dust grains in a protoplanetary disk gap, shedding light on their characteristics and composition. These information will provide valuable constraints to understand dust evolution processes. Secondly, we aim to measure the extinction within the planet-forming gap for the first time, a crucial information to interpret direct imaging searches of embedded protoplanets.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5835
Program Title: Into The Spotlight: Unveiling Wide-Separation Sub-Jupiters for Future JWST Characterization

Principal Investigator: Carter, Aarynn

PI Institution: University of California - Santa Cruz

We propose to perform JWST NIRCam coronagraphic imaging observations of a selection of stars within the Beta Pictoris Moving Group. This survey will be sensitive to an unexplored population of sub-Jupiter and sub-Saturn mass exoplanets at separations beyond 10 au. At present, and for the foreseeable future, only JWST has the capabilities in wavelength coverage and infrared sensitivity required to access this region of parameter space. The sub-Jupiter demographic constraints provided by this survey will be the most precise to date for separations >10 au, and are crucial step towards understanding the overall architectures of planetary systems. Furthermore, by constraining the occurrence of these objects we will also improve our understanding on a range of ongoing questions relating to: planetary scattering, the population of free-floating planets, and the structures of debris disks. Crucially, the wide-separation sub-Jupiters discovered through this survey will be the only sample amenable to follow-up JWST characterisation observations across future cycles. Our sensitivity stretches to 0.1 Jupiter masses or lower, corresponding to objects as cool as ~250K. Future JWST imaging or spectroscopic observations of these objects will provide a unique opportunity for comparison to other objects across the transiting, directly imaged, brown dwarf, and free-floating populations, and are an essential step towards understanding the overall diversity of sub-stellar atmospheres.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5842
Program Title: What lies beyond the inner spiral of Apep?

Principal Investigator: Han, Yinuo

PI Institution: University of Cambridge

Wolf-Rayet binaries have been found to drive spiral dust shell that encode and amplify the internal workings of these evolved stellar systems. While ground based imaging has so far been unable to detect their higher order outer dust shells, JWST has demonstrated in recent ERS observations that ~20 concentric dust shells could be detected in WR140. We propose to leverage this unique capability to study the analogous system, Apep, which has presented the field with enduring and fundamental questions since its discovery. Apep’s spectroscopically determined wind speed of 3500 km/s appeared to be four times faster than the expansion speed of its inner dust plume resolved with ground-based imaging, which is striking given the overwhelming momentum embodied by the WR wind. It has been suggested that the central WR binary is capable of launching spatially anisotropic wind speeds caused by rapid rotation of the stars, a scenario which would make Apep the best candidate for a long-duration gamma ray burst progenitor in the Galaxy if this theory is confirmed. However, alternative explanations for the wind and dust speed discrepancy are possible, and each of which predicts a different geometry for the outer spiral plumes of Apep which the central star launched further back in time. This proposal aims to resolve the outer dust shells of Apep to discern between potential scenarios explaining this wind speed puzzle. The possible scenarios of Apep have far-reaching implications for stellar-wind physics and the role played by massive stars in the enrichment of the ISM and dust budgets, and for settling Apep's standing as a local candidate long-duration gamma ray burst progenitor.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5844
Program Title: Starspots, Hazes, and Disequilibrium Chemistry: A Deep Dive into the Atmosphere of HAT-P-18b

Principal Investigator: Radica, Michael

PI Institution: Universite de Montreal

The atmospheres of warm Jupiters are hotbeds for disequilibrium processes. Chemical quenching from 3D mixing is predicted to significantly alter the atmosphere composition away from equilibrium expectations. In tandem, photochemistry can alter the landscape of the upper atmosphere; opening chemical pathways for the production of new molecules and even hazes. HAT-P-18b, an inflated warm-Jupiter orbits an active K-type star. Multiple analyses of the JWST NIRISS transit observations of this target have differed on the extent to which the host star's inhomogeneous photosphere affects the slope in the transmission spectrum, resulting in inferences of the planet's atmosphere composition which differ by orders of magnitude. We propose to observe two transits of HAT-P-18b, one each with NIRSpec/G395M and MIRI/LRS, in order to construct a complete 0.6-12µm transmission spectrum of this intriguing target. By leveraging the full capabilities of JWST, we will robustly differentiate between atmospheres sculpted by hazes vs. by stellar heterogeneities, via searching for the 5.8µm C-O haze scattering feature; a detection of which would be a first in an exoplanet atmosphere. This measurement will have wide-reaching implications for the interpretation of transmission spectra of other planets from which the presence of scattering hazes have been inferred on the basis of detecting a blue-wavelength slope. We will moreover, complete the chemical inventory of HAT-P-18b's atmosphere and probe the partitioning of Carbon and Sulfur; thereby gaining a deeper understanding of its formation history as well as the disequilibrium processes governing its evolution.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 5846
Program Title: The enigma of Ultra-Luminous X-ray sources and its Achilles Heel in the Foot Nebula

Principal Investigator: Oskinova, Lidia

PI Institution: Potsdam University

We request 15.2 hr science time for the NIRspec IFU and MIRI MRS observations of the template low-metallicity ultra-luminous X-ray source (ULX) Holmberg II X-1 and the high-excitation HeIII nebula it powers. Believed to be comprised of a black hole accreting matter from its massive-star donor, Holmebrg II X-1 is the closest and the best example of the enigmatic population of accreting black hole binaries in low-metallcity galaxies. It is hypothesised that strong hard ionizing radiation and energetic outflows of the accreting black holes is the key feedback agent regulating the state of the interstellar medium in low-metallicity galaxies but lack of conclusive observations precludes definite conclusions. The unique capabilities of JWST allow us to spectroscopically map the nebulae around ULXs. Using both, NIRspec and MIRI, we will chart the ionization fronts within the Holmberg II X-1 nebula, establish whether the dust is present, and finally settle the type of its donor star. Complemented by archival X-ray, UV and optical spectra, the new JWST data will be analyzed using photoionization and dust models to uncover the physical conditions within the nebula and shed much needed light on the nature of ULXs.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5857
Program Title: Constraining the volatile budget in the birthplace of TRAPPIST-1-like systems

Principal Investigator: Nazari, Pooneh

PI Institution: European Southern Observatory - Germany

JWST observations demonstrate that rocky planets around M dwarfs, such as those of TRAPPIST-1 system, have little or no atmosphere. The reason for this could be that they either have experienced significant atmospheric loss or that their initial volatile inventory was smaller. We propose to break this degeneracy by studying the volatile budget in the birthplaces of TRAPPIST-1-like systems. While many GO and GTO programs target the ice budget of solar-type protostars, the inventories of icy volatiles around very low luminosity protostellar systems, potential TRAPPIST-1 precursors, are vastly unexplored. Through the study of ices in 9 very low-luminosity protostellar systems across different star forming regions, we will examine whether there are any systematic differences in the initial volatile inventory between the very low luminosity systems and their higher luminosity counterparts.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5863
Program Title: Shining a Spot-light on the Atmosphere of a Giant Planet around a Cool Star

Principal Investigator: Murray, Catriona

PI Institution: University of Colorado at Boulder

We propose to observe two transits each with NIRSpec/G395M and NIRISS/SOSS of TOI 3884 b with two aims. (1) To characterize the atmosphere of the only known super-Neptune planet around a fully convective M dwarf. These transmission spectra will offer glimpses in the atmospheric metallicity and C/O ratio of M-dwarf giant planets to better understand their unlikely formation, and into the potential clouds and hazes that form on planets around a young, active star. This wide 0.6—5.1$\mu$m spectral range will be highly sensitive ($>$6$\sigma$) to the large predicted absorption features from \ch{CH4} and \ch{H2O}, and to species indicative of disequilibrium chemistry or photochemical processes: \ch{CO2}, \ch{NH3}, \ch{HCN}, or \ch{SO2}. (2) For the first time, take multiple precise measurements of the spectra of starspots on a cool M dwarf. Stellar inhomogeneities are a ubiquitous problem for planets around low-mass stars, and severely limit our inferences from high precision transmission spectra. TOI 3884 b eclipses a persistent complex of polar spots every transit. Therefore, we will tightly constrain the temperature, coverage, and spectral impact of occulted and unocculted star spots on a cool dwarf, directly comparing two gold-standard methods of constraining spot properties. We will observe TOI 3884's stellar contamination at work, empirically deriving the spectra of TOI 3884 and its spots, making this proposal directly synergistic to all M-dwarf planet observations made by JWST.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5866
Program Title: Oceans of Uncertainty: A Veritable Waterworld or a Desolate Wasteland?

Principal Investigator: MacDonald, Ryan

PI Institution: University of Michigan

Recent JWST transmission spectra observations of the M-dwarf rocky planet GJ 486b have detected a spectral signature attributed to water vapor at 3-sigma confidence. However, given the available wavelength coverage (NIRSpec G395H: 3-5 microns), the water signal could either originate from the planet's atmosphere or unocculted starspots. If an atmosphere is confirmed, this would be the first definitive detection of a secondary atmosphere from a rocky exoplanet and have major implications for JWST's search for atmospheres on potentially habitable planets. If the 700K super-Earth GJ 486b is proven to have a water-rich atmosphere, it would suggest that cooler, habitable-zone planets can also retain or replenish their water reservoirs in the face of significant stellar activity. Water is a crucial ingredient for life to have evolved on Earth and is expected to play a similar role for life on other worlds. We request three transit observations of GJ 486b using the NIRISS/SOSS instrument mode to definitively resolve the atmosphere-starspot degeneracy for GJ 486b. With only 15.7 hours of charged time, these data could yield the first definitive detection of a water-rich secondary atmosphere. If, however, starspots turn out to be the preferred explanation, we will obtain unprecedented constraints on stellar inhomogeneities for an M-dwarf star. This alternate science outcome would represent a major advance in our knowledge of the physics of M-dwarfs and their surface features. The requested observations would therefore prove transformative for planetary science and/or stellar astrophysics.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5882
Program Title: Composition, Origin, and Fate of the Four Newborn Planets in the V1298 Tau System

Principal Investigator: Dai, Fei

PI Institution: California Institute of Technology

NASA's Kepler mission revealed that small planets between the size of Earth and Neptune are ubiquitous. Moreover, such planets are often found in tightly-packed multi-planet systems. The present-day patterns in the sizes and orbits of 'compact multis' are relics of the planet formation process. While the patterns are unambiguous, the physical processes that produce them remain mysterious. Fundamental questions about the formation of small planets remain unanswered. A key obstacle is the shortage of young planets with well-characterized bulk and atmospheric properties. The best way to make progress is to characterize the progenitors of Kepler multis at young ages, at different stages in their formation. The planetary system around the 20–30 Myr star V1298Tau is such a progenitor. We propose to construct a homogenous library of NIR transmission spectra of all four planets in the V1298Tau system using NIRSpec/G395H. These spectra will reveal atmospheric carbon-to-oxygen ratio (C/O), mean metallicity [Fe/H], envelope entropy, and cloud/haze properties. These measurements, in turn, will enable insights into where the planets formed in their disks, whether they experienced significant migration, the rate of cooling and the extent of envelope loss by 20–30 Myr. The homogeneous nature of this dataset enables planet-to-planet comparisons in the same system, which removes uncertainties from the modeling and interpretation and leads to a deeper understanding of the system.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5883
Program Title: The most distant Cosmos-Web strong gravitational lens: mass content in the foreground lens and dissecting the background source

Principal Investigator: Gavazzi, Raphael

PI Institution: Laboratoire d'Astrophysique de Marseille

We propose to spectroscopically confirm the redshift of a possibly record breaking gravitational lens at z~2, discovered recently in the COSMOS-Web survey. If confirmed, this source will represent an exceptional laboratory to study the rise of the massive elliptical galaxies. Our proposed NIRSpec IFU observations are designed to achieve a kinematic study of the deflector, to be joined with the lensing analysis. By lifting degeneracy between the baryons and the Dark Matter (DM) to establish the mass profile, we could reveal the assembly channels (wet/dry merger) of this massive elliptical galaxy. Combined with stellar population synthesis models, we will test the need for a bottom-heavy IMF for massive elliptical galaxies. Furthermore, we will easily confirm the spectroscopic redshift of the lensed source, possibly between z=3 and 5.5. As a result, the uncertainty on the total halo mass of the deflector will improve from 100% to 5%. This accuracy is sufficient to clarify if radical changes in our understanding of massive high-z source is needed. As a side product, we will take advantage of this gravitational telescope to resolve spatially the lensed galaxy over a scale of 400 pc or better, unveiling the complex nature of the source at z>5. While such lensing system is unique, some of its extreme properties (if confirmed) could revolutionize our understanding of massive galaxies. Furthermore, it represents a precursor of what could be done applying JWST on the high-z lenses potentially discovered with Euclid.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5890
Program Title: JUMPS: The JWST Ultimate Medium-band Photometric Survey

Principal Investigator: Withers, Cassandra

PI Institution: York University

The characterization of high redshift galaxies and the sources responsible for reionization are major science goals of JWST. One of JWST's key science results is showing that ultra-low mass, ultra-faint galaxies are likely the primary driver of Hydrogen reionization. However, an in-depth accounting of these objects is challenging, which has prevented a full understanding of the drivers of reionization. One way to select ultra-faint galaxies in the epoch of reionization is by using medium-band imaging which selects galaxies on line flux instead of continuum emission. To this end, we propose the JWST Ultimate Medium-band Photometric Survey (JUMPS), which will observe three massive galaxy clusters (Abell 370, MACS0416, and MACS1149) using four LW medium bands (F360M, F430M, F460M, and F480M) with one SW broad band (F150W). In combination with existing F410M observations, JUMPS will select ultra-faint galaxies over $5.2 < z < 9.4$ by searching for “JUMPS” in medium band colors driven by powerful emission lines. This technique is distinct from the more commonly used selections since it does not require galaxies to have strong continuum emission and can select “emission line only” sources which have little to no continuum emission. Samples selected in this way will provide a more complete picutre of galaxies at $5.2 < z < 9.4$, and can be used to put robust constraints on the ultra-faint end of the UV luminosity function. Additionally, JUMPS will incorporate deep F150W imaging, which will allow us to put constraints on the UV properties of medium-band selected galaxies as well as allow us to select z = 13 – 16 Lyman break galaxies.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 5893
Program Title: COSMOS-3D: A Legacy Spectroscopic/Imaging Survey of the Early Universe

Principal Investigator: Kakiichi, Koki

PI Institution: Cosmic Dawn Center, Niels Bohr Institute

We propose to perform a slitless spectroscopic survey with NIRCam/WFSS targeting the COSMOS-Web field together with deep parallel MIRI imaging, to establish a treasury dataset covering the largest ever field (0.33 deg2, including 500 arcmin^2 with MIRI) in the infrared, and secure redshifts of ~20000 galaxies and 5000 AGN over a survey volume of 3x10^7 Mpc^3, including >4000 galaxies and up to 500 AGN at z>5, into the epoch of reionization (EoR), providing a true 3-D panoramic view of the early Universe and addressing the following key scientific questions: (1) How did the early massive galaxies emerge? Do they pose a challenge to modern cosmology? We will measure unbiased 3-d galaxy correlation function at EoR to map the growth of early dark matter halos and unveil the earliest galaxy protoclusters. (2) How did the early supermassive black holes (SMBHs) emerge? What is the nature of the puzzling ‘Little Red Dots’ unveiled by JWST? The survey will provide a complete AGN census in the early universe to probe the modes of early SMBH accretion and growth. (3) How did ‘Cosmic Web’ of the Universe emerge? What’s the sources of reionization? How did galaxies and SMBHs evolve in that context? The survey will produce the first IGM tomographic map at EoR and trace IGM/galaxy connections from cosmic noon to reionization. This treasury dataset will enable a wide-range of extragalactic science, including the measurements of high-z galaxy luminosity function, census of dusty galaxies across cosmic time, supernovae and AGN detections through variability. The team will provide fully reduced spectra and valued added spectroscopic and photometric catalogs to the community.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5894
Program Title: Comparative Atmospheric Planetology With the Three Large, Close-in Planets of TOI-4010

Principal Investigator: Kunimoto, Michelle

PI Institution: Massachusetts Institute of Technology

Comparing the atmospheres of multiple planets within a single system offers unique insights into their formation and evolution. As one of the only systems for which we can characterize the atmospheres of three planets, TOI-4010 offers an incredible opportunity for comparative planetology. We propose to use JWST/NIRSpec-Prism to observe single transits of TOI-4010 b, c, and d. By measuring planetary C/O ratios we will test predictions from multiple planet formation models, and by measuring atmospheric metallicity we will test predictions from photoevaporation theory. Atmospheric characterization of TOI-4010 with JWST will help answer where and how a rare hot Neptune desert-dweller and multiple close-in large planets could have formed around the same star, for the first time.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5896
Program Title: 47Tuc: A Second Epoch to Extend the Mass-Rotation Relation to the Brown Dwarf Regime

Principal Investigator: Scalco, Michele

PI Institution: INAF - Osservatorio Astronomico di Padova

A recent investigation of the internal kinematics of a few globular clusters has provided the first observational evidence of a correlation between the rotational velocity of the stars around the cluster's center and the stars' masses. That more massive stars rotate more rapidly around the clusters' center than low-mass stars, was predicted theoretically. The first observational detection marks a significant advancement in our exploration of the dynamic and kinematic evolution of globular clusters, but it is thus far based on a narrow stellar mass range and limited to masses larger than 0.65Mo. The full study of this trend and its exploitation to gather new fundamental insights into the manifestations of the relaxation-driven dynamics in star clusters requires exploring this relation over a broader mass range. Here we propose JWST observations to extend the investigation of this relationship into the lower mass range, reaching the mass domain of brown dwarfs. We plan to observe an outer region of the globular cluster 47Tuc, previously studied by JWST, which revealed a dozen strong brown dwarf candidates. The new JWST observations will serve two additional main objectives. First, we will increase the number of brown dwarf candidates within 47 Tuc, and second, we will validate their cluster membership by precisely measuring their proper motions. Furthermore, we will explore the multiple population phenomenon on the lower main sequence of 47Tuc and investigate the behaviour of white dwarf cooling sequences in the infrared spectrum.

Proposal Category: AR (GO-Archival)
Scientific Category: Galaxies
ID: 5907
Program Title: Characterizing the z>1 satellite population with public deep-field JWST surveys

Principal Investigator: Suess, Katherine

PI Institution: University of Colorado at Boulder

The abundances and radial distributions of satellite galaxies can be used to constrain both our dark matter models and the galaxy--halo connection. While existing observations of the satellite population at z<0.2 have proven a rich dataset against which to test our models, to date it has been difficult or impossible to observationally measure the satellite population at cosmological distances. The advent of JWST has opened the door to measurements of faint satellites (<1/10 the mass of their host) at z>1 for the first time, showing that these tiny galaxies are easily resolved in deep-field JWST imaging. Here, we propose to use existing public data to perform a complete selection of satellites around a set of both star-forming and quiescent hosts at 1<z<3 and make the first measurements of the number density, radial distribution, and galactic conformity of low-mass satellites at z>1. We will pair these first-of-their-kind observations with equally novel theoretical predictions for the high-redshift satellite population which take advantage of recently developed halo finder tools and novel star-tagging methods that can track simulated subhalos down to small radii through intense tidal disruption. We will predict the observed satellite number counts, radial distribution, and conformity of satellites in our observed mass and redshift range and assess whether model predictions agree with the data.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 5911
Program Title: Emergence of the Baryon Cycle in the First Billion Years

Principal Investigator: Simcoe, Robert

PI Institution: Massachusetts Institute of Technology

We propose a dual-band blind search for [OIII]-emitting galaxies with the NIRCam slitless grism in the field of a z=7.5 quasar, to search for companions of the earliest known metal absorption systems at 5.3 < z < 7.5 -- deep in the Epoch of Reionization (EoR). Existing high quality ground-based IR spectra and archival JWST observations of the central quasar allow detailed analysis of the chemical compositions for nine foreground heavy-element absorption systems. These include one that exhibits a CII* fine structure cooling line, and another with MgII in the immediate foreground of this quasar whose HI damping wing has been interpreted as a constraint on the neutral fraction of intergalactic gas at z=7.5. JWST is the first observatory with the sensitivity to identify absorption line hosts in the EoR, via [OIII] emission. With deep grism observations and contemporaneous six-band photometry, we will be able to measure redshifts and impact parameters of foreground galaxies without pre-selection, and estimate their stellar masses, star formation rates, and ages from stellar population modeling. The same observations will also be used to measure the galaxy density and the projected galaxy-quasar cross correlation in the neighborhood of the background quasar, helping to constrain the host halo mass. These observations will add one of the most famous and important quasar sightlines discovered in the last 20 years to the growing body of legacy fields surveyed with the NIRCam slitless grism, complimenting existing NIRSpec IFU spectra already in the archive that cover the QSO over a very small field in great depth.

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Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5916
Program Title: TUNES: The Unintentional NIRISS Escape Survey

Principal Investigator: Vissapragada, Shreyas

PI Institution: Harvard University

JWST is currently -- and completely unintentionally -- conducting the largest survey of exoplanet atmospheric escape ever performed. NIRISS/SOSS is sensitive to the metastable helium 10380 Angstrom triplet (He*), a powerful probe of atmospheric outflows. By the start of Cycle 3, 21 planets will have publicly-available NIRISS/SOSS transit and/or eclipse coverage on this feature, already the largest homogeneous escape survey ever conducted by a factor of two. We propose an archival program to realize the myriad scientific gains enabled by this new sample, including a uniform analysis of planetary mass-loss rates and searches for helium emission, tails, and chromospheric spot-crossing events. Our primary community-facing scientific product will be an online repository of all He* lightcurves obtained with NIRISS/SOSS analyzed with multiple pipelines to ensure robustness. This program, which we call TUNES (The Unintentional NIRISS Escape Survey), will cement JWST's unanticipated legacy as an atmospheric escape machine without requiring any additional observing time.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5917
Program Title: Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

Principal Investigator: Vanzella, Eros

PI Institution: INAF-Osservatorio di Astrofisica e Scienza dello Spazio

JWST has discovered many distant galaxies, yet most of them will remain unresolved, with their stellar populations only inferred and never observed directly. To understand early galaxies and their contribution to reionization, we must study the sources producing ionising radiation within. Highly lensed early galaxies are the only chance to directly study the engines that reionized the Universe. We propose a detailed spectroscopic study of a galaxy at z ~ 10, observed just 500 Myr after the Big Bang, well before reionization was complete. SPT0615-JD is the brightest z ~ 10 galaxy known, magnified to AB mag 25 and stretched to an arc 5" long. Recent JWST NIRCam imaging has revealed gravitationally-bound star clusters as small as r ~ 1 pc, the first detection of such features at this epoch. We propose NIRSpec IFU prism and MIRI MRS spectroscopy in spatially resolved segments along the arc. We will clearly detect the UV continuum of the star clusters, enabling us to map their stellar ages, masses, extinctions, and UV slopes independently and more accurately than SED photometric analyses. Additionally, the HeII 1640 line will be clearly detected (EW > 30 A) if these are low-metallicity or PopIII star clusters (Z = 2-5% Z_sun from NIRCam SED fits). In the MIRI MRS observations, we will detect H-alpha emission, providing spatially-resolved maps of the star formation rates and, when combined with the NIRSpec FUV spectroscopy, the ionizing photon production efficiency. The latter is a key parameter typically used to evaluate the contribution of galaxies to cosmic reionization, but for the first time here, derived from star clusters in a young galaxy 500 Myr after the Big Bang.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5924
Program Title: JWST's Exoplanet Grand Tour Spectroscopic Survey

Principal Investigator: Sing, David

PI Institution: The Johns Hopkins University

During their Grand Tour, the Voyager spacecraft revolutionized our view of the solar system, making more fundamental discoveries about different planetary environments than any mission before or since. Thousands of exoplanets are now known, and with the transformative capabilities of JWST, a Grand Tour of the exoplanets can now begin. How exoplanets form and their overall composition and chemical makeup remain major outstanding issues, and we seek to make progress on the underlying physical processes of these topics by unlocking the rich spectra of exoplanetary atmospheres, synergizing JWST's capabilities with HST. Here, we propose a first-generation JWST-HST exoplanet statistical survey covering giant planets from Neptune to Jupiter sizes. With a wide comprehensive survey across the major giant planet types and temperatures, our Grand Tour will establish a legacy dataset of high-quality exoplanet spectra early in JWST's lifetime. Without this frame of reference, the multitude of single-planet JWST studies will be hard to place in the context of the wider perspective, and rich areas of discovery can be easily overlooked. This program synthesizes the discordant Cycle 1 & 2 observations by carefully selecting 142 hours of complimentary key targets and wavelengths, leveraging the entire set into a 1st generation 350-hour Treasury-level 25 planet survey, a true exoplanet Grand Tour. A statistically significant number of planets will be available in JWST's first few cycles, enabling comparison studies which will provide immediate progress in answering several longstanding key questions relevant to all exoplanet types regarding their atmospheric chemistry and formation.

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Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 5940
Program Title: The missing link in the Kuiper belt: Reconnaissance spectroscopy of blue binary cold classical KBOs

Principal Investigator: Wong, Ian

PI Institution: NASA Goddard Space Flight Center

Dynamical models of Neptune's early outward migration into the primordial transneptunian planetesimal disk have largely succeeded in reproducing the Kuiper belt's complex orbital architecture within the Kuiper belt. Meanwhile, volatile sublimation models have been developed to explain the color bimodality among the KBOs, with red and very-red objects forming in the inner and outer regions of the disk, respectively. The cold classical KBOs are distinguished by their low inclinations and high binary fraction. These findings have led many to posit that the cold classicals formed in situ in the outermost reaches of the protoplanetary disk. Most compositional models of the Kuiper belt predict that the cold classicals should all be very-red. However, recent observations have uncovered a significant population of bluer objects within the cold classical region that is dominated by binary systems. The presence of these blue binaries has challenged current theories of Kuiper belt formation and evolution. A fuller understanding of their composition in the context of other KBO subpopulations has the potential to fundamentally reshape our understanding of the outer Solar System. A diverse sampling of KBOs have been observed in previous JWST cycles. Notably missing from these observations are the blue binaries, which constitute the only KBO subpopulation that has not been studied with JWST. In this proposal, we seek to fill in this gap by obtaining near-infrared spectra of three blue binaries in the cold classical population. When combined with the results of the previous programs, these spectra will complete the first comprehensive picture of Kuiper belt composition.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5943
Program Title: What really are the Physical Properties of Galaxies in the Epoch of Reionization?

Principal Investigator: Papovich, Casey

PI Institution: Texas A & M University

In its first year, JWST has identified and characterized galaxies into the epoch of reionization. These observations have shown that galaxies appear extreme, with high nebular ionization powered by young, metal-poor stellar populations and possibly accretion onto lower-mass supermassive black holes. These observations challenge our models because they push to the limits of our parameter-space. To make progress requires we detect weaker metal lines in the rest-UV and optical to understand the physical details of these galaxies. Here we propose deep, spectroscopic observations of galaxies at high redshift using two pointings of NIRSpec with 9.1 hrs in G395M and 11.5 hrs in G140M. We target 11 galaxies at $6.9 < z < 8.9$ with known spectroscopic redshifts, combined with 48 candidate galaxies at $5.8 < z < 9$ and 7 more at $z > 9$ with photometric redshifts. We will use these observations to measure accurate fluxes, equivalent widths, and flux ratios of weaker lines: OIII] 1661,1666 and [CIII] 1907 + CIII] 1909 lines in the rest-UV (G140M) and probe for other high-ionization lines such as He II 1640; the [OIII] 4363 auroral line, [OII] 3726, 3729 and other lines in G395M. We will then use these lines, combined with strong nebular emission lines to measure the galaxies' (i) ionization states, (2) gas temperatures and 12 + log O/H abundances, (3) ages and SFRs, (4) C/O abundances, (5) gas densities, (6) dust attenuation and the dust law, and (7) search for indications of AGN. This will be a major legacy dataset for JWST, providing data to understand the detailed physical conditions in the earliest galaxies.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 5952
Program Title: Zooming-in on the sub-grid physics of PAHs at 20% solar metallicity

Principal Investigator: Roman-Duval, Julia

PI Institution: Space Telescope Science Institute

The MIR SED of high metallicity galaxies is dominated by spectral features resulting from the fluorescence of polycyclic aromatic hydrocarbon (PAH) molecules illuminated by FUV photons. In low metallicity systems (<20% solar), Spitzer observations have revealed a deficit in PAH emission, which so far have been explained by either the insufficient carbon content of the ISM of low metallicity galaxies to form PAHs; or by the destruction of PAHs by the hard radiation field percolating through the poorly shielded ISM of these systems. We suggest a third scenario: that the filling factor of PAH clumps decreases at low metallicity owing to the pervasive ionizing radiation field, resulting in diluted, faint emission even at the 2" resolution of Spitzer/IRAC. We propose to test this hypothesis by obtaining NIRCam and MIRI imaging of the 3.3, 7.7, 11.3, and 12.7 micron PAH features in the SMC SW Bar 3 region at the highest spatial resolution achievable in the nearby low metallicity universe (0.03 pc). We will determine the typical length-scales of PAH clumps in a quiescent star-forming environment. By comparing the observations to similar JWST images of the NGC 346 young massive star cluster (also in the SMC), we will investigate the influence of the radiation field on the spatial distribution of PAHs and their properties (size, ionization), traced by the relative strengths of the different features. The results of this investigation will inform the mechanisms responsible for the formation and destruction of PAHs. Since PAHs dominate the heating of gas in galaxies, this program will provide some important clues at a fundamental driver of galaxy evolution.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5959
Program Title: KRONOS: Keys to Revealing the Origin and Nature Of sub-neptune Systems

Principal Investigator: Feinstein, Adina

PI Institution: University of Colorado at Boulder

Mature sub-Neptune-sized exoplanets with H/He atmospheres (from 2.5-4 REarth) are common but remain enigmatic due to predominantly cloudy, featureless NIR spectra. We propose to investigate young sub-Neptunes (< 200 Myr), which so far have shown preferentially clear atmospheres favorable for transmission spectroscopy. Within this large program we will (1) Determine if sub-Neptune atmospheric metallicity is primordial. Sub-Neptunes could form with high atmospheric metallicities or they may evolve to be metal-rich through photoevaporation, photochemistry, and planetary bombardment. (2) Determine whether sub-Neptunes are water enriched or depleted. Depending on their formation location, they could either be "gas dwarfs" with water-depleted atmospheres and rocky cores or "water worlds" with water-enriched atmospheres and ice/rock cores. (3) Analyze the homogeneity of multi-sub-Neptune systems. Depending on formation histories, planets in the same system may all be water worlds, gas dwarfs, or some combination of both. To achieve our science goals, we will observe a sample of seven sub-Neptunes in three systems to fully characterize all known 3+ multi-sub-Neptune systems orbiting young young stars. Our sample will successfully answer questions about intra- and extra-system diversity, which has not been achieved in any other JWST program. We will observe all 7 planets with both NIRISS/SOSS and NIRSpec/G395H (1-5 micron) to obtain high signal-to-noise broad near-infrared spectra of our planets to measure abundances of C-, O-, S- and possibly N-bearing species. We request a total of 77.7 science hours (130 charged hours) to achieve our objectives.

Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 5965
Program Title: An Archival Study of Cosmic Transients in Existing JWST Observations

Principal Investigator: Hu, Lei

PI Institution: Carnegie Mellon University

The James Webb Space Telescope (JWST) is a prolific transient factory. It enables time-domain astronomy to magnitudes and wavelengths beyond the reach of any other current and future transient survey programs. We propose to conduct a comprehensive analysis of a set of archival NIRCam observations with multi-epoch coverage and the development of a transient detection pipeline customized for the NIRCam data. The entire dataset consists of 49 fields covering ~248 square arcminutes with a depth fainter than the 28th mag. These archival observations hold abundant uncovered transients with diverse physical characteristics, including lensed stars, high redshift supernovae, and Active Galactic Nuclei (AGNs) with photometric variability. These transients are a unique asset for the JWST, which can be used to study the formation and evolution of stars in the early universe, and set constraints on cosmological parameters. Through this project, we will develop a data processing pipeline designed to discover and classify transients with NIRCam data. The JWST has a complicated PSF and different detector orientations at different epochs. We will apply three commonly used image differencing packages, HOTPANTS, ZOGY, and SFFT, and compare their performances. We will use the NIRCam data to retrain our neural network-based candidate screening software for automatic spurious source rejection and light curve classification. Our pipeline and the transient catalog will be publicly accessible to the JWST community. Our team has a special interest in using these transients to derive the supernova rates and use them to constrain the initial mass function and star formation rates at high redshifts.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 5967
Program Title: Exploring the desert: Thermal characterization of an exposed planetary core

Principal Investigator: Roy, Pierre-Alexis

PI Institution: Universite de Montreal

The recent discovery of a handful of ultra-dense and hot sub-Neptunes, found right in the middle of the hot-Neptune desert, offer us the unprecedented opportunity to perform direct spectroscopic characterization of primordial planetary cores. Indeed, these sub-Neptunes with large masses and extreme bulk densities are thought to be remnant and exposed version of the cores found at the center of giant planets like Jupiter, but they have never been observed in spectroscopy. We propose to characterize the thermal structure and composition of the highest-ESM ultra-dense sub-Neptune for JWST: TOI-849b. We will observe three secondary eclipses of the exoplanet with NIRSpec/G395H, which will enable us to precisely measure the dayside temperature, and heat redistribution efficiency, as well as infer the metallicity, and the C/O of the planet's envelope. This will be achieved by obtaining an emission spectrum of the exoplanet, which will be precise enough to measure the water and carbon dioxyde contributions. Such measurements will allow us to spectroscopically confirm the metal-enriched, exposed core nature of the sub-Neptune, as well as to trace its formation history, as the C/O measured for this planet will directly be that of the exposed core, in contrast to standard C/O measurements which only access the upper layers of H-rich atmospheres. This program will thus represent a major step forward in the study of the diversity of sub-Neptunes, but also in the study of planet formation, as it will provide us with a direct view at a primordial planetary core.

Proposal Category: GO
Scientific Category: Galaxies
ID: 5974
Program Title: ORCHIDS: ORigin of the [C II] Halos In Distant Systems

Principal Investigator: Aravena, Manuel

PI Institution: Diego Portales University

One of the most interesting findings of recent [CII]158um galaxy surveys has been the clear presence of extended [CII] line emission among massive star-forming galaxies at z=4-6, beyond the rest-frame UV and dust continuum emission and extending out to ~10-kpc. Despite being key to understanding the interplay between star formation activity and feedback processes in the circumgalactic medium (CGM), the origin of such [CII] ``halos'' remains enigmatic. In this proposal, we present a comprehensive program, titled “Origin of the [CII] Halos in Distant Systems” (ORCHIDS), aiming to unravel the nature of these extended [CII] features. Leveraging the capabilities of JWST/NIRSpec and Keck/KCRM IFU observations, we will scrutinize a carefully selected sample of eight massive star-forming galaxies at redshifts z~5-6. These targets have been recently confirmed to exhibit [CII] halos through high-resolution ALMA imaging. Our observations are designed to rigorously test the most plausible scenarios predicting the nature of [CII] halos. These observations will yield a full characterization of the baryonic cycle in these systems, yielding a unique probe of (i) the kinematics and distribution of the star formation and ionized gas, enabling us to discern outflows, multiple component systems and extended dense atomic and ionized gas in the CGM as the origin for [CII] halos (JWST/NIRSpec + Keck/KCRM); (ii) test associations with Lyman-alpha halos/blobs; (iii) the galaxies' gas excitation and shocks (JWST/NIRSpec); and (iv) provide resolved measurements of various star-forming tracers.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 5989
Program Title: The JWST SBF Coma Cluster Survey: Building an Alternative Precision Distance Ladder for Cosmology

Principal Investigator: Jensen, Joseph

PI Institution: Utah Valley University

The Coma cluster is the nearest rich cluster in the universe and a key touchstone for the extragalactic distance scale. Precise extragalactic distances are at the heart of the “Hubble tension” controversy, the most important problem in cosmology today. To address this problem, we will image more than 100 fields centered on 39 of the largest elliptical galaxies in the Coma cluster. We will measure surface brightness fluctuations (SBF) for more than 40 galaxies (depending somewhat on the field orientations), calibrate the color dependence of SBF magnitudes, and study the galaxy and globular cluster population properties in Coma. The SBF distance scale zero point will be set by scheduled JWST observations of the tip of the red giant branch in local elliptical galaxies. The Coma cluster observations are required to establish the SBF calibration as a function of galaxy age and metallicity in rich clusters, where future JWST observations will yield distances out to several hundred Mpc. The resulting calibration will enable an independent, high-precision determination of the cosmological distance scale in the local universe using a technique with precision comparable to that of Type Ia supernovae, but requiring only a single observation per measurement. The ability to measure precision distances efficiently will be an important step towards the ultimate goal of measuring H0 to 1% and resolving the Hubble constant controversy.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 5997
Program Title: OASIS: Observing All phases of StochastIc Star formation - A census of galaxies at z = 5–8 over the entire SFR–M? plane

Principal Investigator: Looser, Tobias

PI Institution: University of Cambridge

Within the first year of operation, JWST collected overwhelming evidence for stochastic (“bursty”) star-formation histories (SFH) at early cosmic epochs (z > 5). However, understanding and quantifying the physical mechanisms responsible for this increased burstiness requires an unbiased view of galaxies throughout all phases of their SFHs, i.e., including during faint ‘off-burst’ phases found below the star-forming main sequence. This proposal advocates for the first unbiased investigation of stochastic SFHs at high redshift, using a mass- and SFR-limited sample reaching down to M? = 10^8 M? and SFR = 0.15 M? yr^-1. We will use two 28-hour NIRSpec/MSA pointings with the prism to observe a representative sample of 223 galaxies at 5 < z < 8, including up to six quenched galaxies and twenty low-sSFR “lulling” galaxies. This sample will help us to answer these questions: I) what is the duty cycle of star formation? II) what is the fraction of (temporarily- or mini-)quenched galaxies? and III) how fast do galaxies quench? The proposed sample will provide the first statistical benchmark for testing the efficiency of feedback models in numerical simulations at 5 < z < 8. The impact of our findings will extend to the theory of star formation regulation, to our understanding of stellar and supernovae feedback, and of SMBH growth.

Proposal Category: SNAP
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6005
Program Title: Imaging Young Sub-Jupiter Planets down to Solar-System Scales

Principal Investigator: Biller, Beth

PI Institution: University of Edinburgh, Institute for Astronomy

The extreme IR sensitivity of JWST enables imaging of sub-Jupiter exoplanets for the first time, yielding sensitivity even to young analogues of Saturn. JWST survey mode observations are an excellent way to survey nearby young stars for highly scientifically valuable sub-Jupiter exoplanets, in a manner that minimizes risk. We propose here for survey mode observations of a carefully selected sample of 114 young FGK stars (all <500 Myr, but predominantly <150 Myr) within 50 pc -- the first survey to systematically search for wide sub-Jupiter exoplanets around solar analogues. Our survey targets are drawn from nearby young moving groups (MG) with well-established ages, specifically the Beta Pic, Columba, Tuc-Hor, AB Dor, Carina-Near and Ursa Majoris associations. All of our survey targets reach sensitivities sufficient to image sub-Jupiter exoplanets, with more than half of our sample reach sensitivity sufficient to image to 0.5 MJup planets and 1/3 of our sample will yield sensitivity down to young Saturn analogues, thus this survey has the potential to discover the coldest and lowest mass exoplanet directly imaged to date. Our survey targets are also uniformly distributed on the sky, allowing for robust scheduling opportunities. Fulton et al. 2021 find an enhanced frequency of radial velocity sub-Jupiters relative to higher mass planets, suggesting the presence of an enhanced population of wide sub-Jupiters at semi-major axes beyond 10 AU. Observations of even a small subset of our survey stars will yield a useful statistical result and confirm or refute the existence of an enhanced sub-Jupiter population, whether or not a new exoplanet is detected.

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Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 6010
Program Title: Spin doctor: unwinding stellar contamination from TRAPPIST-1

Principal Investigator: Morris, Brett

PI Institution: Space Telescope Science Institute

In Cycles 1 and 2, a total of 265 hours were allocated for spectroscopy of a single target: TRAPPIST-1. This M8V star hosts seven transiting Earth-sized planets in a resonant chain, and its planets may be the first rocky exoplanets to have their atmospheres characterized. Transmission spectra collected with JWST can measure atmospheric compositions for the planets if and only if contamination from stellar atmospheres is absent or well-understood, but neither condition is met for TRAPPIST-1. Cycle 1 observations confirm sufficient time-variable stellar magnetic activity to prevent the detection of atmospheres for the outer planets. We will use archival JWST observations of TRAPPIST-1 to measure the properties of active regions, and the stellar contamination they produce, with two complementary approaches: (1) chromatic rotational modulation in the out-of-occultation spectra; and (2) transits of planets without thick atmospheres. We will determine which planetary spectral features are least affected by stellar contamination, and which climates or compositions can be detected/falsified with JWST observations given the ubiquitous stellar contamination.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6012
Program Title: Finding the great sculptors: A Renaissance in Planet Disk Dynamics

Principal Investigator: Millar-Blanchaer, Maxwell

PI Institution: University of California - Santa Barbara

Understanding the origins and evolution of planetary systems is one of the major goals of modern exoplanetary science. In the outer regions of planetary systems, disks of planetesimals have long been thought to retain evidence of the evolution of giant planet imprinted in their morphologies though secular resonances. This is well observed in the solar system, with Neptune shepherding the bodies in the Kuiper belt, and with the planet's resonances defining the belt inner and outer edges. Such intricate interactions are however much less obvious in extrasolar systems. While both giant long-period planets and debris disks are common around other stars, very few have been observed together, leaving the role of exoplanets in sculpting outer these disks. Despite ample observational evidence of debris disks being carved by inner planets (SED, ALMA and coronagraphic images), and despite multiple dynamical models explaining their morphologies by planet stirring, we are still missing a conclusive demographic study for such sculptor planets. A recent comprehensive dynamical study of 178 debris disks found that the large majority of sculpting planets should be less massive than Jupiter. This is well below the detection limits of ground-based high-contrast imagers, explaining the low number of exoplanets detected in disk systems to date. JWST's sensitivity at 4microns will for the first time enable us to carry out a systematic survey to measure the occurence of disk-sculpting planets. We have identified the 13 systems with predicted mass and semi-major axis detectable with NIRCam, and we propose to measure the real occurence of disk-sculpting planets from this well-defined sample.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6023
Program Title: The Full Picture: Determining the Ultra-Late Time MIR Flux Redistribution in SN 2021aefx

Principal Investigator: DerKacy, James

PI Institution: Virginia Polytechnic Institute and State University

Type Ia supernovae (SNe Ia) are the explosive, thermonuclear deaths of white dwarf stars in multi-star systems. Despite decades of intensive study, the true nature of their progenitors and the physical mechanism by which they explode are highly debated. SNe Ia provide crucial insights into other areas of astronomy, including: understanding sources of systematic errors in the use of SNe Ia as cosmological probes, the final phases of stellar evolution, and the origin and distribution of heavy elements. Enabled by the sensitivity of JWST, ultra-late MIR imaging with MIRI is key to addressing longstanding questions about flux redistribution to the MIR (estimated to be up to 80% of the total flux) and the bolometric luminosities of SN Ia at ultra-late times. We request 14.01 hours of MIRI imaging of SN 2021aefx at 1000 and 1150 days after maximum light to complete a legacy data-set which includes approved contemporaneous HST imaging and JWST NIRSpec and MIRI/LRS spectroscopy. The combined observations will obtain the first ever ultra-late time SED of a SN Ia from 0.4-28 um, enabling full use of accurate bolometric light curves. These data will: (1) reveal the amount of flux redistributed to the IR at late-times in SNe Ia and its time-dependence; (2) determine the masses and isotopic ratios of radioactive electron capture elements including 57Co and 55Fe; and (3) constrain the strength and evolution of the magnetic field in the SN. This ground-breaking data will provide the foundation upon which future studies of late-time SN Ia light curves are built. It will enormously enhance our understanding of heavy element production and the reliability of SNe Ia as distance indicators.

Proposal Category: GO
Scientific Category: Galaxies
ID: 6035
Program Title: Hidden Clusters No More! Completing a Full Cluster Catalog from NUV to MIR in *The Extreme* Star-Forming and Dusty Galaxy NGC 1614

Principal Investigator: Caputo, Miranda

PI Institution: University of Toledo

NGC 1614 is a highly star-forming and luminous infrared galaxy with a range of environments from a dust-free UV-bright arm to a highly dust-enshrouded nuclear region that is home to a large number of optically-obscured clusters. The Hubble Space Telescope has been used extensively to find and determine the ages and masses of optically visible clusters. These HST data have been used to quantify the shape and normalization of the cluster mass function and the fraction of stars that form in clusters. These quantities are predicted to increase with increasing star formation rate density. However, these works are almost certainly missing many clusters that are younger than 10 Myr old due to the large amounts of dust, potentially leading to grave underestimates for both quantities. JWST will enable the detection, along with age and mass estimates of all the deeply embedded (Av = 15 or more), young (<10 Myr), and massive (>10,000 Msun) clusters in the extremely star forming and dusty central region of NGC 1614. This IR-based catalog, combined with the optical HST-based cluster catalog, will span from the NUV to MIR and reveal the the shape of the initial cluster mass function and the fraction of stars formed in clusters. The use of NIRCAM to observe hydrogen emission lines and broadband colors in NGC 1614 will enable the calculation of both the extinction and age of clusters with ages from 1Myr to 1Gyr, that are completely invisible to optical observations.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 6036
Program Title: JWST+ALMA reveals the earliest-known thin disk galaxy

Principal Investigator: Hodge, Jacqueline

PI Institution: Universiteit Leiden

According to prevailing galaxy evolution models, galaxies at high redshifts should be increasingly dominated by chaotic and turbulent motion. Remarkably, a highly rotation dominated disk galaxy has recently been discovered at z=7.3, with exquisitely resolved (700pc) high-fidelity ALMA [CII] observations revealing a v/sigma = 10 — an order of magnitude higher than predicted. Here we propose NIRCam WFSS+imaging observations of this extraordinary target. We will utilize a novel method to measure the ionized gas dynamics directly from NIRCam grism data via the bright [OIII] 5007A nebular emission line (which falls in the NIRSpec chip gap between z=6.95-7.4). These observations are critical for constraining the ionized gas kinematics, testing whether the discrepancy with theory is due to the gas tracer used. Importantly, this proposal will also reveal the underlying stellar populations on the same (sub-)kpc scales as the high-fidelity ALMA [CII]+dust imaging, crucial for unveiling the highly dust-obscured stellar morphology, deriving an accurate stellar mass to test early disk formation models/decompose the rotation curve, and constraining early dust production mechanisms. As an added bonus, we will use NIRCam's large field of view to detect ~20 neighbor galaxies via [OIII] emission, piloting this method for larger samples. Combined with the unrivaled ALMA imaging of an exceptionally bright target, the proposed program is a rare opportunity for a joint ALMA+JWST study of the formation of the Universe's first disk galaxies.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6045
Program Title: Detecting ongoing gas-to-solid nucleation on the ultra-hot planet WASP-76 b

Principal Investigator: Baeyens, Robin

PI Institution: Universiteit van Amsterdam

Nucleation, the process of single molecules clustering together to form a macroscopic particle, is an ill-understood but crucial process to a range of astrophysical environments. Nucleation is a necessary condition for cloud formation in hot, fully gaseous media, such as exoplanet and brown dwarf atmospheres. Additionally, nucleation and subsequently circumstellar dust formation is the driving factor of stellar outflows. We propose to measure the mid-infrared transmission spectrum of the ultra-hot gas giant WASP-76 b using MIRI/LRS, with the aim of observing ongoing nucleation for the first time on an exoplanet. We target the smallest and most refractory clusters (Al2O3)N and (TiO2)N, which represent the first steps in the high-temperature transition from gaseous to solid material. New quantum-chemistry studies demonstrate that these clusters have detectable spectroscopic features in the MIRI wavelength range, and observations of WASP-76 b have shown evidence for ongoing condensation. Confirming the presence of these species on WASP-76 b would provide an explanation for the anomalous titanium and aluminium depletions that have been inferred on this planet, and constraining their abundances will be crucial for our understanding of how astrophysical solids grow and evolve.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6049
Program Title: Populating the Gap in Dust-Formation History of Type IIP Supernovae

Principal Investigator: Szalai, Tamas

PI Institution: University of Szeged

Core-collapse supernovae, especially Type IIP SNe, have long been considered to significantly contribute to the cosmic dust budget. Models of expanding ejecta predict 0.1-1 solar masses of dust in SNe IIP. New dust cools quickly and is therefore detectable at longer (mid-IR) wavelengths. However, only a handful of nearby SNe IIP have shown direct observational evidence for dust condensation (based primarily on Spitzer data), and dust masses (generally limited to early epochs, and to >500 K temperatures) have been 2-3 orders of magnitude smaller than theoretical predictions. At the same time, more recent observations of Galactic SN remnants (SNRs) and the very nearby (~50 kpc) SN 1987A have revealed that massive cooler dust reservoirs may form over years or decades in SNe. However, no other SNe II(P) have significant amounts of newly-formed ejecta dust measured < ~5 yrs after explosion up till now. As demonstrated by recent results on two nearby SNe IIP, JWST finally allows hidden cool (~100--200 K) dust reservoirs in a larger sample of extragalactic SNe to be revealed and to help fill the gap currently existing in the dust-formation history for SNe. Here we propose 7-filter JWST MIRI Imaging of 4 of the most dusty, nearby SNe IIP that will be age > 5 yr by the time of expected Cycle 3 observations. Via modeling their expected mid-IR spectral energy distributions, we will estimate or place stringent constraints on the dust mass for each SN. The deeper understanding of dust mass evolution would also would reveal how dust opacity evolves with time and would provide a more appropriate characterization of the composition of dust grains.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 6053
Program Title: UNCOVERing the Drivers of Reionization with JWST's F410M Medium Bandpass Filter; Rest-Frame Optical Spectroscopic Properties

Principal Investigator: Wold, Isak

PI Institution: The Catholic University of America (NASA GSFC)

Low-mass, star-forming galaxies have emerged as one of the most likely drivers of reionization, and their identification and study is a main goal of JWST, but the current reionization epoch JWST spectroscopic campaigns primarily focus on broadband or slitless WFSS-selected sources. An exciting alternative is to investigate JWST F410M Medium bandpass excess objects, where extreme [OIII] emitters at z~7 significantly perturb the medium band relative to the encompassing F444W broadband filter. Strong emission from doubly ionized oxygen is a beacon for some of the most intensely star-forming galaxies and for some of the highest known LyC leakage. Furthermore, the F410M bandpass selects emitters at an important redshift range z=6.72-7.59 which is thought to be a transition regime where the intergalactic medium is substantially neutral, yet there are also significant islands of ionization. We use F410M-excess selection to identify high-EWs (>500A) OIII emitters at z~7 within the UNCOVER strong lensing field, giving amplification to study intrinsically fainter galaxies. We find that only 60% of our objects are detected in extremely deep (5sigma depth of ~30 AB) JWST broadband-selected survey. Additionally, our objects are an order of magnitude fainter than found in JWST slitless WFSS surveys, allowing us to isolate numerous – allowing for efficient MSA use – low-mass galaxies postulated to contribute significantly to reionization. In this proposal, we aim to measure the ionized gas properties including metallicity, ionization production, and AGN contribution of these z~7 low-mass, extreme emission line galaxies with NIRSpec G395M/F290LP follow-up.

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Proposal Category: AR (GO-Archival)
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6061
Program Title: A Systematic Study of the 3.3 - 3.5 micron PAH Features at z~0 with Archival NIRSpec Observations

Principal Investigator: Sandstrom, Karin

PI Institution: University of California - San Diego

We propose an archival study of all publicly available NIRSpec IFU observations that cover the 3.3-3.5 micron PAH features in z~0 extragalactic and Milky Way observations of the ISM. Uniformly analyzing this growing compilation is an efficient way to build a comprehensive sample of 3.3-3.5 micron PAH measurements, spanning a wide enough range of ISM and galactic environment to unlock the diagnostic potential of these emission features. As the PAH features detectable out to the highest redshifts and the focus of wide-field NIRCam medium band mapping capabilities at z=0, the 3.3-3.5 micron PAHs are some of the most valuable tracers we have of the ISM in galaxies, but they are also the most poorly characterized, since they were outside the spectroscopic range of Spitzer. Using our archival compilation, we will investigate how the PAH populations change with environment and establish the z=0 baseline for comparison with high redshift galaxies.

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Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 6064
Program Title: Constraining the dynamical evolution of the outer solar system with trans-Neptunian binaries

Principal Investigator: de Souza Feliciano, Ana Carolina

PI Institution: Florida Space Institute, UCF

Trans-Neptunian objects (TNOs) are icy remnants of the planetary formation that orbit the Sun in the region beyond Neptune. We propose to resolve a sample of 10 trans-Neptunian binaries (TNBs) of similar and different sizes with tight and wide separations using three sets of NIRCAM filters. The combination of the physical and the compositional properties of the binary systems in our sample could constrain the formation scenario cases due to impact, or streaming instabilit in the early trans-Neptunain region. One portion of our sample is not explained by the current binary formation models since they have similar size (that could be compatible with the streaming instability) but tight separation (as the satellites of the larger TNOs, that could have been formed by impacts). The characterization of the surface composition of both components is crucial to address that matter. Due to their spatial separation, NIRSpec is not suitable for this task. Through the combination of the short and long filters of NIRCAM with the compositional map of the trans-Neptunian region done in the first cycle of JWST, this proposal has potential to constrain proposed formation models and provide an initial input for the expansion of dynamic and evolution theories for some TNBs.

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Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6067
Program Title: Dynamics of high-redshift proto-globular clusters

Principal Investigator: Vesperini, Enrico

PI Institution: Indiana University System

The first JWST observations have already led to the detection of a large number of possible globular cluster (GC) progenitors at high redshifts. These observations are significantly enriching the observational study of GCs by providing key information on the fundamental properties of these systems and their external environment at the epoch of their formation. The proposed investigation is aimed at building a comprehensive theoretical framework to determine the possible evolutionary links between the high-redshift proto-GCs observed by JWST and old GCs in the local universe. We will combine high-resolution cosmological simulations with realistic N-body and Monte Carlo simulations to carry out an extensive investigation of the dynamical evolution of GCs. In the first part we will run a large survey of simulations aimed at studying the early dynamics of GCs and explore when the strong external tidal field (as constrained by cosmological simulations) in the high-redshift environment where they form (and its time variation) may lead to the clusters' rapid dissolution. For surviving clusters, we will study how the high-redshift external tidal field affects the clusters' structural and kinematic properties emerging at the end of these early evolutionary phases. Our investigation will then continue with simulations following of the long-term evolution of the surviving clusters and provide all the elements necessary to determine the possible evolutionary paths linking the GC progenitors observed by JWST at high-redshifts and local old GCs.

Proposal Category: GO
Scientific Category: Galaxies
ID: 6073
Program Title: JWST as a time machine: weighting the carbon produced exclusively by massive stars

Principal Investigator: Citro, Annalisa

PI Institution: University of Minnesota - Twin Cities

Carbon is one of the most abundant elements in the Universe and can be produced both by low/intermediate mass stars (1 < Msun < 8) and massive stars (>8 Msun). The relative contribution of the two channels, however, is still undefined. The interpretation of observations of individual stars and galaxies is complicated by the fact that it is impossible to separate the two contributors, as any stellar population older than 500 Myr can release carbon into the ISM through both channels. With JWST we now have the unprecedented opportunity to “travel back in time” and observe stellar populations in which only massive stars could have contributed to the release of carbon. This is because low/intermediate mass stars can significantly contribute to the C budget only at times older than ~ 500 Myrs. We propose to study the C/O abundance in four spectroscopically confirmed galaxies at 9.1 < z < 9.5, when the Universe is only 500 Myr old, and only MS contribute to the release of C. We will obtain 28.3 hrs (including overheads) of NIRSpec+G235M spectroscopy on 2 targets, and use archival data for the remaining two. All galaxies have rest-frame optical emission lines, but lack the UV C III]1909 and O III]1666 lines required for measurement of C and O abundances. The proposed observations will constrain the carbon and oxygen yields at early times, shedding light on the nature of the first stars responsible for the pre-enrichment of the ISM.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 6074
Program Title: The First Measurement of AGN Feedback in Action in the First Billion Years

Principal Investigator: Lambrides, Erini

PI Institution: NASA Goddard Space Flight Center

Early results from JWST have raised more questions than answers on the prevalence, growth, and impact of growing SMBHs (referred to as AGN) during Cosmic Dawn. With most JWST studies finding extreme over-abundances of AGN relative to predictions, the impact of these high-z powerfully accreting sources on the formation history of their nascent host-galaxies is unknown. We propose for NIRSpec IFU G395M/F290LP (Total Science Exposure Time ~6 hours) to observe the only known z> 7 heavily obscured radio-loud AGN candidate (COSW-106725, z~7.7). As highlighted in the proposal, heavily obscured RL AGN are the ideal candidates for efficiently testing AGN feedback paradigms during the Epoch of Reionization. These proposed observations will provide the first robust constraints on the effect of AGN activity on nascent early galaxy evolution without significant contamination from the central engine. We will constrain, for the first time, the level of ionized AGN contribution on the clumpy, dense, un-settled ISM of an early massive galaxy via [OIII], Hbeta, and optical continuum measurements on 500pc scales. From hunting for fast-moving outflowing ionized gas to mapping the different sources of ionization across the galaxy’s extent, these measurements will allow for unprecedented constraints on the true extent of AGN impact on a young, massive galaxy. This proposal will pave the way forward for future observations of larger sample sizes, and will enable for the first time, greater understanding on the consequence of early Universe growing SMBHs on the evolution of massive galaxies.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6078
Program Title: Confirmation of a Jovian Planet Analog Orbiting a White Dwarf, Rare Low-mass Neutron Star or Black Hole

Principal Investigator: Blackman, Joshua

PI Institution: University of Bern

Blackman et al. (2021) have discovered the first Jovian-analog planet orbiting a white dwarf, MOA-2010-BLG-477b. This is the first example of an exoplanet that resembles the predicted fate of Jupiter in our own Solar System. Discovered by gravitational microlensing, constraints on the microlensing parallax signal due to the orbital motion of the Earth rule out host stars more massive than the Sun as well as brown dwarf hosts. Meanwhile, Keck adaptive optics observations set an upper limit on the lens brightness that excludes main sequence host stars, leaving a white dwarf or very low-mass neutron star or black hole host as the only remaining possibilities. Confirming its nature will provide the first observed example of the end stage of a planetary system like our own and is a unique opportunity to constrain the pollution and long-term dynamical evolution of planets in wide orbits. In the unlikely case the host is not a white dwarf, the outstanding discovery of a planet around a low-mass Neutron star or black hole would nonetheless be significant.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 6083
Program Title: Probing the ionzing sources of Pox 186: the best local analogue of reionization era galaxies

Principal Investigator: Kumari, Nimisha

PI Institution: Space Telescope Science Institute - ESA - JWST

One of the frontier goals of observational cosmology is to understand the epoch of reionization and its connection to the early star-forming galaxies, which show several high-ionization lines (e.g., CIV). While these distant sources are too faint to put tight constraints on stellar population models, local metal-poor dwarf galaxies are also found to have similar spectral features in the UV and IR as the high-z galaxies and can be used as reliable analogues. A local (z ~0.0040705), metal-poor (12 + log(O/H) = 7.87) blue compact dwarf galaxy, Pox 186, exhibits the brightest CIII] 1908 A emission (equivalent width, EW ~36 A) observed in the local Universe, along with an extreme [OIII] 88 micron/[CII] 158 micron (~ 10) and a bright optical [OIII]+Hbeta emission (EW~1800A). Such extreme EWs and line ratios are comparable to those observed in galaxies at redshifts of z ~ 6-7, when the reionization process is thought to be completed. We request JWST Cycle 3 time to obtain mid-infrared (MIR) spectroscopy for this galaxy using MIRI/MRS, to obtain high S/N constraints on the high ionization MIR emission lines, as it will allow us map out the shape of the ionizing spectrum. Uninhibited by dust attenuation, fine-structure lines such as [OIV] will tightly constrain the ionizing spectrum up to and beyond the Helium limit, where the contribution from interacting binaries starts to dominate. We will confront the most recent stellar population models with the myriad of line diagnostics that MIRI will provide and derive the ionizing photon production efficiency of a unique reionization era analogue.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6084
Program Title: Is CWISE 1055+5443 the first young Y-type brown dwarf?

Principal Investigator: Meisner, Aaron

PI Institution: NOIRLab - (AZ)

Y-type brown dwarfs (Teff <= 500 K) overlap in mass and temperature with giant exoplanets, providing unique laboratories for studying cold atmospheres, free from contaminating glare of a host star. However, substellar objects cool gradually over billions of years and thus suffer from a fundamental degeneracy between age, temperature, and mass which is not readily disentangled via the observable spectral energy distribution. At present, no Y dwarf is known to be young, and none has any age constraint more accurate than +/- 20-30+%. This lack of Y dwarf ages critically limits our ability to test brown dwarf (and exoplanet) evolutionary and atmospheric models. At a very nearby distance of just 6-8 parsecs, CWISE 1055+5443 (Teff ~ 500 +/- 150 K) is the first strong candidate for a young Y dwarf. Its nearly complete kinematics yield a > 98% probability of membership in the Crius 197 moving group (only 180 +/- 9 Myr old), and its peculiar 1-2.4 um spectrum favors very low gravities log(g) ~ 3-3.5, also consistent with youth. We will use NIRSpec/G395H to measure an accurate (uncertainty ~ 1-2 km/s) radial velocity for CWISE 1055+5443, completing its kinematic profile and conclusively testing its young moving group membership. We will further combine JWST NIRSpec and MIRI from ~1-21 um to accurately measure a bolometric luminosity and hence temperature for CWISE 1055+5443, providing a unique anchor for brown dwarf evolutionary models. JWST is the only facility capable of accurately measuring the radial velocity or bolometric luminosity of CWISE 1055+5443.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6086
Program Title: A First Detailed Exploration of Circumplanetary Disk Gas and Dust with NIRSpec and MIRI/MRS Spectroscopy

Principal Investigator: Ward-Duong, Kimberly

PI Institution: Smith College

The nature of the Galilean moons of Jupiter and the recent discoveries of accreting protoplanets indicate that circumplanetary disks (CPD) form during the formation of gas giant planets and their satellites. However, these reservoirs of gas and dust have proven more challenging to detect than the disks surrounding brown dwarfs and stars. The dearth of CPD detections in deep submillimeter surveys suggests that they are compact and depleted in large grains suggesting that they are better suited for study in the near- and mid-infrared. Thus, JWST provides excellent capabilities with which to explore these systems in detail. We propose the first in-depth spectral characterization of the gas and dust properties of a CPD by obtaining ~1-27μm spectra of SR 12 c using both NIRSpec and MIRI/MRS. The target is a wide-orbit 11 Jupiter mass companion with the hallmarks of a massive and actively accreting CPD: 1) significant infrared excess, 2) multiwavelength accretion signatures, and 3) a sub-millimeter disk detection, all making it an ideal candidate for this study. The high signal-to-noise observations of SR 12 c will provide a benchmark NIR-MIR spectrum of a CPD, which will allow for a novel study of dust grain processing through measurements of crystalline vs. amorphous silicates, and provide insights into gas composition and disk chemistry by constraining the nature and abundance of volatiles within the CPD.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6095
Program Title: Where is the Antimatter? Identifying the Galactic Positron Engines

Principal Investigator: Darling, Jeremy

PI Institution: University of Colorado at Boulder

The existence of antimatter in the form of positrons has been observed in the Galaxy via 511 keV annihilation photons for half a century, but the astrophysical engines producing the positrons have yet to be identified. Numerous plausible sources of positrons have been proposed, some of which are distributed and some of which are pointlike such as Sgr A*, stellar-mass black holes, and compact X-ray binaries. If the Galactic matter-antimatter annihilation is dominated by point sources, then JWST is the only facility that can detect them. Studies of the annihilation gamma-ray spectrum show that nearly all annihilation events are preceded by the formation of an electron-positron bound state called Positronium (Ps), a hydrogen-like "atom" where the proton is replaced by the positron. Positronium has quantum transitions with half the energy of hydrogen: its Lyman alpha line has a wavelength 243 nm, H-alpha is 1.31 microns, and Paschen alpha is 3.75 microns. There will therefore be Ps "recombination" emission lines that precede annihilation. These are faint but within the reach of JWST, and ground-based observations have thus far been unable to adequately remove terrestrial atmospheric spectral features, despite custom-built spectrometers. We propose to address the mystery of the sources of Galactic antimatter by observing two likely Ps engines in the Pa-alpha transition: Sgr A* and the Great Annihilator. Both detection and lack of detection will provide important insight into positron production mechanisms and the general physics of high-energy phenomena. Theory alone has so far been unable to identify the dominant mechanism for antimatter production.

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Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 6116
Program Title: Testing Natal Heritage Among Comet Dynamical Families: A JWST Study of Parent Volatiles in Halley-Type Comets.

Principal Investigator: Saki, Mohammad

PI Institution: University of Missouri - Saint Louis

We propose to use the James Webb Space Telescope's (JWST) NIRSpec instrument to study the parent volatiles of six Halley-type comets (HTCs). Despite their importance in understanding the relationship between Oort cloud comets (OCCs) and Jupiter-family comets (JFCs), HTCs have been understudied due to their relatively long orbital periods. Our study will use NIRSpec IFU (G395H/F290LP) to examine the composition and spatial distribution of multiple parent volatiles in cometary coma, including H2O, CO, CO2, CH3OH, C2H6, CH4, and HCN. Our proposed observations aim to understand the heritage and evolutionary processing of volatiles incorporated into HTCs by analyzing the "hypervolatiles" CO, CH4, and CO2 along with other volatiles chemistry. We will compare our results with other comets from different dynamical classes. Our measurements will provide unprecedented details on the coma chemistry and volatile content of a suite of HTCs and will help to answer fundamental questions about evolutionary processes on the primordial properties of comets from different source regions as well as inform chemical models of the protosolar disk.

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Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6118
Program Title: An Empirical Constraint on the Evolution of An Isolated Low-Mass Galaxy: The Star Formation History of the Dwarf Galaxy Sextans A

Principal Investigator: Newman, Max

PI Institution: Rutgers the State University of New Jersey

In the nearby Universe low-mass galaxies are some of the best probes of galaxy formation and evolution, and are often used as benchmarks for theory and cosmological simulations. However, low-mass satellites near a massive host evolve in complex environments and undergo environmental processing that can dominate the shape of their SFHs, making their secular evolution difficult to constrain. In contrast, isolated low-mass galaxies evolve in simpler environments and are less influenced by environmental processing, thereby providing a clearer picture on secular galaxy growth. Yet, to date, we have measured robust SFHs for only four isolated dwarf galaxies across the stellar mass range from 10^5 - 10^8 Msun. We propose to derive the SFH of the isolated, low-mass, well-studied galaxy Sextans A. We will use archival NIRCam imaging of the resolved stars in Sextans A that are incredibly deep and well-suited for SFH work. The resulting constraints will allow us to shed new light on the evolution of a low-mass galaxy outside the influence of a massive host, investigate tentative evidence that there was an early dynamical interactions between Sextans A and the Milky Way (MW), and explore the interplay of low-mass galaxies and reionization.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6122
Program Title: Cool kids on the block: The direct detection of cold ice giants and gas giants orbiting young low-mass neighbors

Principal Investigator: Bowens-Rubin, Rachel

PI Institution: University of California - Santa Cruz

Cold ice giant and gas giant exoplanets (<200K, 0.03 - 10 Mjup) in systems orbiting low-mass stars (0.08 - 0.45 Msun) could prove to be one of the most common types of exoplanets in the galaxy, yet we currently know of none that we can characterize through direct measurements. This survey presents an efficient pathway to utilize JWST's unique capabilities to accomplish a major objective in the exoplanet observing community: directly imaging a benchmark set of sub-Jupiter mass exoplanets. We propose a survey that has excellent coverage for detecting the under-studied population of ice-giant exoplanets (0.05 Mjup), which is out of reach for all but the most tailored JWST direct imaging observations. We will observe six of the nearest (< 6 pc), young (< 1 Gyr) M-dwarfs to directly image exoplanets down to temperatures of 75K and as small as Neptune. We select nearby targets to optimize our coverage to the orbits where we expect giant planets to be the most prevalent (1 - 15 AU). We propose to use F444W NIRCam Coronagraphic Imaging in conjunction with F2100W MIRI Imaging to ensure the detection of clear and cloudy exoplanets. Based on our survey sensitivity and previously measured occurrence rates of giant planets, we predict a discovery yield of 4.6 (+2.9 -1.9) planets, and nondetections would challenge the existing occurrence rates to 2.5-sigma. Exoplanets identified through this survey will be ideal candidates for JWST spectroscopic follow-up characterization to further understand the formation differences between gas giant and ice giant exoplanets and enable comparative planetology to the giant planets in our own solar system.

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Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 6123
Program Title: MIRI IMAGING OF A CANDIDATE DIRECT COLLAPSE BLACK HOLE AT z=10

Principal Investigator: Gallo, Elena

PI Institution: University of Michigan

The recent discovery of UHZ-1, a candidate X-ray bright AGN at z=10.1, has been hailed as the smoking gun for the direct collapse black hole model. UHZ1 is thought to host a highly obscured, accreting black hole whose mass is between 5 and 100% that of its host galaxy. This program aims to acquire deep mid-IR imaging of UHZ1 (rest-frame 0.4-2.2 micron), with the goal (1) to confirm (or disprove) the presence of an AGN; (2) if the AGN is confirmed, provide an independent lower limit (or estimate) to the black hole mass, so as to test the viability of the direct collapse scenario.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6130
Program Title: The most typical planet formation in the most typical environments

Principal Investigator: Boyden, Ryan

PI Institution: The University of Virginia

The inner (<10 AU) regions of protoplanetary disks are where most planets form locally, therefore understanding the structure, composition, and evolution of the inner disk is crucial to interpreting the demographics of exoplanets. We propose joint JWST MIRI-MRS and ALMA 0.87 mm observations of 11 protoplanetary disks in the Orion NGC 1977 region. NGC 1977 is a young stellar cluster with a UV radiation field that is weaker than those found at the centers of O-star-hosting clusters, but stronger than those found in low-mass star-forming regions (SFRs). These “intermediate” UV fields are the most common external UV radiation field strengths found in Galactic SFRs, yet disk properties in intermediately irradiated SFRs remain poorly constrained. Theoretical work suggests that intermediate external UV fields may dramatically affect the chemical evolution of the inner regions of protoplanetary disks through enhanced irradiation of the outer disk and subsequent mixing of the outer and inner disk. Our program will test this hypothesis by measuring the inner disk chemical inventories and outer disk mm dust reservoirs over a representative sample of intermediately irradiated disks. With these measurements, we will be able to 1) determine whether intermediately irradiated disks have different inner disk compositions than disks in low-mass (i.e., weakly irradiated) SFRs, and 2) identify the dominant physical mechanisms driving the observed chemical differences (or lack thereof). This program will constrain the initial conditions of planet formation in the most common environments of star formation, and it will complement ongoing Cycle 1/2 MIRI-MRS surveys of other disk populations.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6133
Program Title: Identifying the progenitors of a complete sample of long gamma-ray bursts

Principal Investigator: Gompertz, Benjamin

PI Institution: University of Birmingham

The discovery of kilonovae alongside gamma-ray bursts (GRBs) lasting tens of seconds or more has sparked a paradigm shift in our understanding of the diversity of jets launched by merging neutron stars. The prototypes of this new class are two of the brightest GRBs ever detected, strongly suggesting a hidden population that are systematically misclassified as collapsing massive stars - the canonical model for GRBs that last for more than two seconds. Long-lived mergers have palpable implications for binary neutron star merger rates, heavy element nucleosynthesis, the physics of relativistic jet launch, and multi-messenger follow-up strategies to gravitational wave events. We propose NIRSpec observations over the next three JWST cycles to systematically target and classify 15 emergent GRBs at $z < 1$ as either mergers or collapsars based on spectroscopic identification or exclusion of supernovae. We will build the first 'clean' observational samples of collapsars and mergers to investigate their respective rates and observable properties. For mergers up to $z = 0.5$, we expect to make spectral detections of kilonovae, potentially resulting in the largest spectroscopic sample of this rare class of transient to date. We will also extend the redshift range of detected type Ic broad-lined supernovae, which accompany long GRBs, out to $z = 1$. This will allow us to uniquely probe their evolution at redshift $0.5 < z < 1$ for the first time, providing insights into how the composition of massive stars and their host galaxies change in this cosmic epoch.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 6138
Program Title: MIRACLE: Mid-IR Activity of Circumnuclear Line Emission

Principal Investigator: Marconcini, Cosimo

PI Institution: University of Florence

Galaxy evolution is tightly connected to the central Active Galactic Nuclei (AGN) through the interplay between the accretion of gas onto the central super massive black hole (SMBH), the circumnuclear star-formation (SF) activity, and AGN feedback mechanisms. Recent results from ALMA and MUSE show that these mechanisms can be investigated by looking at inner regions of the AGN with high spatial (<100 pc) and spectral resolutions. JWST is already transforming our comprehension of galactic evolution, providing an unique insight on gas physics, morphology and kinematics at unprecedented spatial resolution. Employing MIRI we will have access to a plethora of low-to-high ionisation atomic emission lines and rotational transitions of H2. With modern suites of photionisation and kinematic models, we will map the gas ionisation source, kinematics and morphology at 20-150pc resolution, for each gas phase. Finally, we will quantify the interplay between different gas flow phases at similar sptial resolution, constraining the gas flow energetics and impact on the ambient gas. Our sample of nearby Seyfert galaxies is selected to have confirmed molecular and ionised outflows, traced by CO and [OIII] emission. We will target the circumnuclear gas with MIRI IFU to cover the full spectral range from 5-29 microns With the proposed observations we will provide the community with a long-lasting legacy value sample for all the future studies of local galaxies and the interactions between AGN and their hosts. Moreover, we will set the stage for more extensive studies of multi-phase and multi-scale gas physics, morphology, and kinematics.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6139
Program Title: Angular Momentum Architectecture of the HR 8799 Planetary System

Principal Investigator: Bowler, Brendan

PI Institution: University of Texas at Austin

HR 8799 is a system of four directly imaged giant planets orbiting at 15-70 AU. Asteroseismology of the host star, patient orbit monitoring of the planets, and resolved sub-mm observations of the outer cold disk all point to overall alignment of the system's angular momentum vectors. The only missing components are the planetary obliquities, which are expected to have been aligned at formation but can be tilted through post-formation processes including orbital migration, resonances with other planets, or interactions with moons. We propose NIRCam coronagraphic monitoring of all four HR 8799 planets in F200W and F444W to determine the angular momentum architecture of this unique system and test whether post-formation dynamical interactions have impacted the orientation of their spin axes. Rotation periods will be coupled with radius estimates and recently measured projected rotational velocities of the planets to determine their inclinations, offering the first glimpse of the spin states of giant planets locked in mean motion resonance outside of the Solar System. Furthermore, this rich dataset will be used to study cloud layers via wavelength-dependent variability, compare the atmospheric dynamics of "sibling" planets, and conduct the deepest search for an outer "planet f" with sensitivity down to sub-Saturn masses.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6151
Program Title: The determination of the upper initial mass function in the nearest massive star-forming region, W51A

Principal Investigator: Yoo, Taehwa

PI Institution: University of Florida

The universality of the initial mass function (IMF) is still an open question. The compilation of observation has been reported that the slope of the IMF has non-negligble scatter and moderate deviation from the canonical IMF models, possibly due to the observational uncertainties and/or environmental effects. The acquisition of the IMF in very young (t<1Myr) star-forming region is expected to eliminate the great uncertainty in estimating the initial mass from tracing back the evolution of evolved stars. Therefore, we propose to observe (proto)stars in W51A, the nearest young and massive star-forming region with NIRcam and MIRI. In particular, we are focusing on the upper IMF as W51A is the best target to observe the birth of massive stars given its age (t<1Myr) and mass (M>10^4 Msun). The another advantage of observing this region is that we can exploit the catalog of dust core and YSOs provided by ALMA observation. Especially, the comparison of the core mass function and the IMF will provide an unique oppertunity of directly observing an evolution process from core to star in the same region. As a byproduct of NIRcam and MIRI observation, a rich information of YSOs will be provided. With this data, the evolution of YSOs can be explored by classifying YSOs with spectral slope. Finally, we expect to verify the star formation model by measuring the mean protostellar luminosity and by examining the possible primordial mass segregation.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 6154
Program Title: Enabling accurate velocities for science with the NIRSpec MSA: simultaneous wavelength and LSF calibration

Principal Investigator: de Graaff, Anna

PI Institution: Max Planck Institute for Astronomy

Multi-object spectroscopy with the NIRSpec microshutter array (MSA) has proven to be one of the most popular modes on JWST for extragalactic science. By the end of Cycle 2, 15,000 MSA spectra will have been obtained across 0<z<13. Moving beyond initial studies that focused primarily on redshift confirmation and the detection of individual emission lines, recent studies have started to exploit the full sensitivity and resolving power of NIRSpec. This science pushes the limits of the instrument capabilities and calls for precise calibrations. Currently, differences in line wavelengths between gratings exceed nominal calibration uncertainties by a factor 5, and prevent simultaneous modeling of multiple observations. The instrument line spread function has also been reported to differ from expectations by up to a factor 2. Calibration programs thus far have focused on single stars or planetary nebulae, which suffer from the severe undersampling of the PSF by the large detector pixels. We propose to exploit the multiplexing power of the MSA by observing 20-25 red giant stars within a crowded region on the sky with all medium- and high-resolution gratings. The large number of narrow absorption features will mitigate undersampling issues that affect individual line centroid and width measurements, providing wavelength and LSF calibration with the high precision needed to enable velocity measurements of high-redshift galaxies (black hole masses, kinematics, outflows, and halo masses) with the MSA. These data will also provide first insight into distortion of the PSF across the MSA and its effect on flux calibration.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6161
Program Title: Following the water throughout star formation via its deuteration ratio in ices

Principal Investigator: Slavicinska, Katerina

PI Institution: Universiteit Leiden

The question of how water forms and evolves throughout star and planet formation is not only crucial for understanding how life was able to evolve on Earth, but also whether life can evolve in other solar systems. Due to the sensitivity of deuteration processes to physicochemical conditions, the deuterium abundance of water provides a window into the environment in which it formed and existed. Recent JWST data show that the unprecedented sensitivity of the NIRSpec IFU at 4.1 um enables robust measurement of the HDO/H2O ratio of interstellar ices for the first time, providing a clear path to characterizing the link between prestellar water ice and the water found in solar system bodies such as our Earth, comets, moons, and water-rich asteroids. We propose to search for HDO ice with NIRSpec IFU in three prestellar cores and three low-mass protostars. In these objects, we will constrain the column densities and morphologies of H2O ice via the O-H stretching band at 3 um and HDO ice via the O-D stretching band at 4.1 um, which can only be observed via G395M when observing with NIRSpec IFU. We will also constrain the CH3OH ice column density via the 3.53 um band to ensure that any observed absorptions at 4.1 um cannot be attributed instead to CH3OH. The use of the IFU will enable correlation of ice morphologies in extended sources. In two of the low-mass protostars, the ratios in measured in the ices will be compared to their gas-phase HDO/H2O ratios obtained by ALMA. The proposed observations will probe more deeply than before the physicochemical history of water and evaluate if prestellar water ice is inherited by protoplanetary disks and bodies that form within them.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6193
Program Title: A Search for Exoplanet Satellites that are the Same Size as the Earth's Moon

Principal Investigator: Pass, Emily

PI Institution: Harvard University

With its proven ability to achieve an RMS precision of 5 ppm in white-light transit curves, JWST with NIRISS/SOSS provides a novel opportunity to find Moon-analog (0.27REarth) exomoons around the terrestrial planets of M dwarfs. While no conclusive detections of exomoons have been reported to date, planet formation theories predict that such satellites should be a common outcome of the collisional dynamics in early exosolar systems. Exomoons have the potential to open the door to a multitude of new avenues to learn about exoplanet systems, speaking to topics of habitability, tidal heating, planet formation, late-stage growth, planetary compositions, and more. The standout best system to conduct a first search for rocky moons is TOI-700, which contains two habitable-zone terrestrial planets that present a large dynamically allowed region in which moons could exist. The next best system is TRAPPIST-1, which has already been observed: We present an analysis of the TRAPPIST-1 h data that shows we can rule out moons down to 40% the size of the Earth's Moon. Although there exist several other known exoplanet systems where JWST could search for such moons, we emphasize that the TOI-700 planets alone account for nearly half of all dynamically allowed phase space when summing over all systems, owing to their long orbital periods. The discovery of a habitable-zone Earth-Moon analog would be a transformative discovery; likewise, a non-detection would allow us to rule out an occurrence rate in excess of 12%.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6199
Program Title: Moving forward, get to the point: a forward model approach to the point cloud for accurate spectral extraction with JWST's IFUs

Principal Investigator: Ruffio, Jean-Baptiste

PI Institution: University of California - San Diego

The goal of this proposal is to provide the JWST community with improved spectral extraction, PSF subtraction, and data modeling tools for the NIRSpec integral field units (IFU) and MIRI Medium Resolution Spectroscopy (MRS; also an IFU). This program is motivated by the severe spatial undersampling of the JWST IFU modes, which is causing systematics in individual spatial pixels (spaxels) of the reconstructed spectral cubes (as high as 50% in single exposures) from the JWST calibration pipeline. It was recently demonstrated that these systematics can be mitigated by fitting the data directly in detector images, also called the point cloud. Building on recent literature work, we propose to develop tools for spectral extraction, PSF subtraction, and general forward modeling of the data in detector space. Existing spectral extraction routines, based on interpolated spectral cubes and aperture photometry, only accurately work on isolated sources. Aperture extraction is not adequate for more complex astrophysical scenes with overlapping signals because of the flux cross-contamination between neighboring sources. PSF fitting, or optimal extraction, is the preferred approach in these cases, but fitting data in the spectral cubes is hindered by the spaxel-to-spaxel systematics. Future IFU data analysis effort for JWST will benefit greatly from working directly in the point cloud, which is the goal of this program. This work will be especially relevant for any science case with IFU observations of blended sources, crowded fields, or high-contrast imaging, which include direct imaging of exoplanets, galactic center observations, gravitational lenses, to solar system objects.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 6207
Program Title: Testing CDM: The Dark Matter Mass Function Below 10^9 Solar Masses

Principal Investigator: Lagattuta, David

PI Institution: Durham Univ.

Cosmological simulations of cold dark matter robustly predict a hierarchy of low mass (<10^9Msun) substructures. These do not form stars, so the prediction has never been tested. Moreover, the substructures are smoothed away in simulations of any other form of warm/interacting/fuzzy dark matter. We propose imaging of galaxy cluster RXJ0437+00 (z=0.285). Uniquely, this hosts 'Hyperbolic-Umbilic' strong gravitational lensing of three galaxies at z=2, 3 and 6. This exotic lens configuration is rare (two years ago, only one was known, but MUSE has now found ~12). Unlike normal gravitational lensing, multiple images of background galaxies are magnified isotropically and away from contamination by foreground lens light. This system is sensitive to >10^7.5Msun substructures along the lines of sight to any image, which would appear additionally distorted. HST observations have proved feasibility of this technique, but are sensitive to only 10^9Msun substructures. We expect to detect ~2 dark matter perturbers if the universe contains CDM (the first confirmation of this prediction), but none if the universe contains WDM. For free, star forming regions in the high redshift galaxies will be magnified by ~200x for an isotropic resolution of ~100pc.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6213
Program Title: Unraveling cosmic dust origins: JWST revelations from legacy observations of SN 2023dbc

Principal Investigator: Shahbandeh, Melissa

PI Institution: Space Telescope Science Institute

During JWST Cycle 1, a "once-in-a-decade" event transpired -- SN 2023dbc, a Type Ic supernova, exploded in M108 at only ~10 Mpc. The proximity of this SN offers a unique opportunity to study the details of dust formation in the early Universe and to probe its total "dust budget." While asymptotic giant branch (AGB) stars have been considered to be the primary producers of dust in the local Universe, at high redshifts they are not expected to significantly contribute to the dust budget of the Universe. Stripped-envelope supernovae (SESNe) come from the death of the most massive, shorter-lived stars, and are therefore one of the earliest possible sources of cosmic dust in the Universe. No SESN has occurred close enough to monitor dust formation from early to late times, until now. Remarkably, JWST Cycle 1 observations of SN 2023dbc have revealed both the fundamental and first vibrational bands of CO and SiO (dust precursors), and scheduled Cycle 2 observations will trace their early evolution. Yet, to fully understand how dust is formed in SESNe, a longer time series of data is required. By analyzing the evolution of molecular bands at later epochs, as well as capturing the early formation of dust features, the exact conditions in the ejecta during the dust formation can be determined. Here we request 23.9 hr of JWST time to follow SN 2023dbc at three epochs from 600-1200 d past maximum. With these data, the molecular emissions will be used to measure the exact conditions for dust formation in the ejecta. The observations will also create a legacy data set that can be used to model dust formation and investigate the poorly-constrained ejecta composition of SESNe.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6219
Program Title: MIRI LRS Slit for transiting exoplanet observations

Principal Investigator: Dyrek, Achrene

PI Institution: Commissariat a l'Energie Atomique (CEA)

In this calibration proposal we offer to explore the feasibility of using the MIRI LRS in fixed-slit mode for the atmospheric characterisation of transiting exoplanets, observed when the planet passes in front of its host star. We aim to explore the possibility of expanding the range of accessible targets for TSOs with the MIRI LRS mode; exploiting the superior sensitivity of the LRS fixed-slit mode to probe cooler, lower-mass and fainter stars than are accessible with the LRS slitless mode, and avoiding some of the challenging systematics observed in the SLITLESSPRISM subarray so far. These observations will allow us to (1) compare the performance of the instrument in fixed-slit and slitless configurations for a known target that has been extensively observed with JWST (2) understand the parameter space of exoplanet physical properties in which the LRS in fixed-slit mode is most valuable for time series observations; and (3) produce a calibration recipe for these observations that can be adopted by the JWST calibration pipeline and offered to the community. This calibration proposal has been approved by STScI MIRI team members (please see helpdesk ticket INC0194552).

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Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 6221
Program Title: H-alpha mapping of a giant, prototypical Lyman-alpha blob at z=3

Principal Investigator: Umehata, Hideki

PI Institution: Nagoya University

Lyman-alpha blobs (LABs) are bright and extended Lyman-alpha nebulae in the early universe. LABs are suggested to be bright knots of the cosmic web filaments, where galaxy growth takes place during the active baryon cycle, such as gas fueling, feedback, and recycling. Thanks to the brightness, therefore LABs offer an invaluable opportunity to visualize distributions and kinematics of surrounding HI gas and understand interplay with growing galaxies. However, the resonant Lyman-alpha line alone is insufficient, and on top of Lyman-alpha, a new tracer of the nebulae is required. The detection and measurement of hydrogen H-alpha flux can be a powerful tool for tracing gas originating from recombination. In this proposal, we aim to map H-alpha and other key diagnostics lines in the giant, prototypical LAB, SSA22-LAB1 at z = 3.1, utilizing a four-pointing mosaic of NIRSpec-IFU. In tandem with multi-wavelength data including VLT/MUSE, Keck/KCWI, and ALMA, we will uncover (i) what is the dominant Lyman-alpha powering mechanism, (ii) what is the origin of the heating source, (iii) what is the prevalence and roles of satellite galaxies, and (iv) how metal enrichment proceed during the baryon cycle.

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Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 6241
Program Title: Characterizing Supernova Progenitor Stars in Archival JWST Imaging

Principal Investigator: Kilpatrick, Charles

PI Institution: Northwestern University

Supernova progenitor star research has greatly benefitted from vast NASA archives in which individual massive star systems can be resolved in pre-explosion imaging of nearby (<40 Mpc) galaxies. Inevitably, there will be supernova explosions in available JWST imaging, requiring careful analysis of NIRCam and MIRI data in order to isolate, measure photometry, and characterize the type of star that exploded. This analysis will provide new insight into the heavily reddened progenitor systems of Type II supernovae similar to the recent SN2023ixf in M101, stripped-envelope supernova progenitor stars in highly extinguished and crowded environments, the eruptive and enigmatic progenitor stars of Type IIn supernovae, and new discoveries we have not yet been able to probe due to a lack of deep, high-resolution, mid-infrared data. New discoveries are already occurring, including the pre-explosion counterpart to the Type Ibn SN2023fyq in the dusty, inclined spiral galaxy NGC 4388 at ~20 Mpc, whose analysis this program will directly support. The final products from this program will be photometry and deep upper limits on all new supernova progenitor star discoveries with archival JWST imaging as well as the imaging analysis tools, models, and software necessary to analyze their optical to mid-infrared spectral energy distributions.

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Proposal Category: AR
Scientific Category: Galaxies
ID: 6278
Program Title: BonFIRE: Modeling Galaxy Formation in the Early Universe

Principal Investigator: Samuel, Jenna

PI Institution: University of Texas at Austin

Results from JWST on high-redshift galaxy formation appear to be in tension with theoretical predictions, but current simulations lack the necessary resolution, volume coverage, and detailed physics to accurately model the high-redshift galaxy population. We propose to use a new large-volume hydrodynamic simulation, BonFIRE, to bridge this gap and make robust predictions for early galaxy formation that are ideal for comparison with JWST observations. BonFIRE will simultaneously leverage high resolution and a large volume to make robust predictions for the formation histories of early galaxies and the statistical evolution of the galaxy population at z=8-20. The simulation will allow us to address crucial questions about the onset of galaxy formation, the conditions for early galaxy formation, the number of early galaxies, the role of galaxies in reionizing the Universe, and the emergence of disk morphology. Using BonFIRE, we will make predictions for the ultraviolet luminosity function, the number density of massive galaxies, and the physical mechanisms driving the growth of early galaxies. We plan to re-run the simulation with additional physics models such as AGN feedback and Population III stars to test their effects on the high-redshift galaxy population. We will also generate and publicly release mock observations of the simulated galaxies for direct comparison to observations from JWST. This work will provide insight into the conditions for galaxy formation in the early Universe and set a critical theoretical benchmark for observations of high-redshift galaxies.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6284
Program Title: Searching for Signatures of Surface-Atmosphere Interaction on a Small Planet in its Magma Era

Principal Investigator: Coy, Brandon

PI Institution: University of Chicago

Despite early results from JWST, the nature of sub-Neptune atmospheres remains elusive. Models predict that interaction between a sub-Neptune's hydrogen-rich atmosphere and an underlying global magma ocean will outgas large amounts of water vapor to the observable atmosphere. This process would affect many commonly-retrieved observables, such as the C/O ratio, metallicity, and H2O/CO2/CH4 abundances of the planet's atmosphere. The effects of magma-atmosphere interaction are expected to be most pronounced in young and small sub-Neptunes warm enough to prevent water vapor condensation in the lower atmosphere. The best planet for observing this scenario is the recently discovered warm mini-Neptune HD 207496 b (age 520 Myr, T=743 K, R=2.25 Re). We propose to use the NIRCam long-wavelength grism to measure the 2.41-5.08 micron transmission spectrum of HD 207496 b to search for signatures of magma-atmosphere interaction. If high mixing ratios of H2O and CO2 alongside a highly-depleted C/O ratio are observed, it will provide the first observational evidence for magma-atmosphere interaction and transform our understanding of water sources for small worlds. Our observations will also provide much-needed constraints on the atmospheric properties of the smallest sub-Neptunes.

Proposal Category: AR
Scientific Category: Galaxies
ID: 6319
Program Title: Measuring ionizing photon production efficiency and characterizing the bursty star formation history of dwarf galaxies at 0.5 < z < 2.4

Principal Investigator: Alavi, Anahita

PI Institution: California Institute of Technology

JWST continues to amaze us by gazing at faint galaxies from the epoch of reionization (EoR). Nevertheless, with many hours of observations, the fundamental question that remains is understanding the key sources of ionizing radiation. To address this, our focus must shift to lower redshifts, where ionizing radiation can traverse IGM. Several factors, such as low dust content, and higher ionizing escape fraction, contribute to why dwarf galaxies play a substantial role in ionizing the IGM. These parameters are influenced by the star formation history (SFH). Suggested by various observations and simulations, dwarf galaxies have a bursty SFH, characterized by significant variations in SFRs on short timescales (~ 5-10 Myr), unlike their larger counterparts. Hence, to comprehend their ionizing capabilities, it is imperative to investigate their SFH. We propose for archival funding to incorporate the JWST NIRISS grism data in Abell 2744 galaxy cluster, from GLASS ERS with deep existing HST/WFC3 UV data to investigate (1) how effective are dwarf galaxies in producing ionizing photons at 0.5<z<2.4, (2) their bursty star formation history. We will measure the UV luminosity from HST imaging and H-alpha Luminosities from JWST spectroscopy for a sample of 326 lensed dwarf galaxies covering down to log(M*)=7.5 and Muv=-14 at 0.5<z<2.4 . UV and H-alpha will determine star formation rates on very different timescales, allowing us to measure $\xi_{ion}$ and to quantify the level of burstiness in these galaxies. We select Abell 2744 cluster, because it provides large lensing magnification, which enables the study of faintest galaxies that would otherwise be challenging to detect.

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Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6347
Program Title: A High-Performance Analysis Framework for JWST Exoplanet Observations

Principal Investigator: Nixon, Matthew

PI Institution: University of Maryland

The first JWST data sets are providing unprecedented insight into a range of physical and chemical processes that take place in exoplanet atmospheres. These data mark the beginning of a revolution in our understanding of the phenomena that shape planetary formation and evolution. One of the key algorithms used to infer atmospheric properties from an observed spectrum is atmospheric retrieval, which can obtain constraints on key atmospheric properties such as chemical abundances and temperature profiles. While this approach has been successful in the past, a number of key improvements are urgently required to maximise the scientific output from JWST observations of exoplanets and prevent biased inferences. Atmospheric retrieval is computationally intensive, and requires heavily simplified atmospheric models in order to be feasible. This prevents us from learning about more complex atmospheric processes that are left out of the models, as well as creating the potential for biased inferences due to missing physics. The overall aim of the proposed research is to create a robust, high-performance retrieval framework that surmounts these challenges. This can be broken down into two key objectives: (1) improving the computational efficiency of the retrieval algorithm to enable the use of more complex forward models, and (2) integrating 3D models of exoplanet atmospheres into the retrieval framework, since 1D models are known to introduce biases. These developments will significantly advance our ability to characterise exoplanet atmospheres using JWST observations, setting the stage for a revolution in our understanding of other worlds.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6350
Program Title: Probing the Dust in the Diffuse ISM in Galaxies over the Past ~8 Billion Years with Spectroscopy of Background Quasars

Principal Investigator: Kulkarni, Varsha

PI Institution: University of South Carolina

Interstellar dust grains vitally affect the cooling and heating of the ISM and molecule formation. Understanding grain composition and structure in distant galaxies is therefore crucial for understanding the cosmic star formation history. A robust understanding of dust in distant galaxies is also needed to accurately correct for dust extinction effects on background objects. Unfortunately, grain properties in distant galaxies are poorly constrained. We propose to measure grain composition and structure in the diffuse ISM of galaxies at $0.1<z<1.1$ with MIRI MRS spectroscopy of background quasars whose UV/optical spectra show signs of significant dust in the intervening galaxies: strong 2175 A bumps, reddening, and/or element depletion. The proposed MRS spectra will target redshifted features of silicates (10, 18 micron), hydrocarbons (3.4 micron), and PAHs (3.3-11.3 micron). Our main science goals are to investigate: (1) the silicate mineralogy and grain structure; (2) how Si, Fe depletions in the gas phase relate to silicate dust abundance; (3) whether carriers of various carbonaceous dust features are related; and (4) how dust properties are related to other galaxy properties. Only JWST MIRI has the powerful combination of the wavelength coverage, high sensitivity, and high spectral resolution crucial for measuring the mid-IR features of interest in the distant galaxies.

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Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6353
Program Title: Confirming Secondary Star Formation Conditions in Nitrogen-Enriched Super Star Clusters at Cosmic Noon

Principal Investigator: Pascale, Massimo

PI Institution: University of California - Berkeley

Super star clusters (SSCs) are among the most extreme modes of star formation in the Universe. Studying the formation and early evolution of SSCs is fundamental to our understanding of star formation and feedback, and can shed light on the origin of the multiple stellar populations ubiquitously observed in globular clusters (GCs). While these SSCs are rare in our cosmic backyard, they are more common in the young universe. Gravitational lensing offers an outstanding opportunity for studying individual SSCs at cosmological distances. We propose 9-band MIRI imaging to search for hot dust (>300K) thermal emission from two newborn SSCs in the brightest, most magnified lensed galaxy known at Cosmic Noon (z=2.37). The targets, massive enough to be globular cluster progenitors, exhibit unique nebular properties, which reveal dense, nitrogen-enriched (N-enriched) nebular clouds that have condensed out of massive star ejecta in the deep SSC potentials. MIRI is sensitive to thermal emission from only the hot dust, which can be uniquely localized to clouds in the proximity or interior of the UV-intense SSCs. Hot dust residing in the N-enriched clouds will be strong indication that they have shielded, cool neutral interiors, which may undergo Jeans collapse and host secondary star formation despite intense stellar UV irradiation. If detected, this will be strong empirical evidence supporting an origin of secondary stellar population in GCs from retained massive star ejecta in the first 10 Myr of cluster evolution. This science is uniquely achievable with MIRI.

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Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 6356
Program Title: A Bonanza of Dusty, Old Supernovae in Archival Observations

Principal Investigator: Fox, Ori

PI Institution: Space Telescope Science Institute

While transient astronomy is often associated with young, rapidly evolving sources, there is a subset of dusty, old supernovae (SNe) that are quite valuable to our understanding of SN explosions and their progenitor systems. The near- and mid-IR wavelengths span the peak of the thermal emission from such dust and are best to characterize the dust in these systems. Yet the phase space of existing observations (in terms of dust temperature and SN age) remains relatively unpopulated owing to the combined low sensitivity and/or limited IR wavelength coverage of existing telescopes. JWST offers a unique opportunity to detect a large sample of these SNe at long wavelengths and late times. With literally thousands of SNe having exploded in nearby (<200 Mpc) galaxies over the past 50-100 years, an archival study stands to yield a bonanza of low-hanging fruit. Here we propose an Archival Research (AR) program to search for dusty, surviving targets in JWST observations of locations of over 200 known SNe that were/will be observed serendipitously in Cycles 1 & 2. Although relying on archival data may not always result in a complete spectral energy distribution (SED) for each SN, it is a low-risk, easy, and cheap (time-wise) method for taking advantage of existing data to build an initial sample, which can ultimately be used to enable a variety of new and important types of scientific investigations, and set a foundation for additional follow-up and monitoring in future Cycles.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6361
Program Title: Bridging Accretion Mechanisms from Stars to Planets with NIR Diagnostics

Principal Investigator: Follette, Katherine

PI Institution: Amherst College

We propose to conduct an innovative line ratio based comparison of NIR accretion diagnostics for bound and unbound planetary-mass objects in the ~2Myr Chamaeleon Star Forming Region with NIRSpec fixed-slit spectroscopy. The hydrogen series lines accessible only to JWST (including Paschen alpha and Brackett beta), combined with JWST's unique sensitivity to traditional accretion line diagnostics at very low flux levels (Paschen Beta, Brackett Gamma) will enable discrimination between traditional magnetospheric paradigms of accretion assumed for stars and newly-developed accretion models designed for protoplanets. Critical to our understanding and calibration of accreting protoplanet discoveries, the proposed observations will provide diagnostic line ratios for multiple accretion tracers that will improve relations used to interpret accretion rates for accreting protoplanet candidates such as PDS70bc, Delorme 1 (AB) b, etc. With a uniform sample of planetary-mass objects of the same spectral type and age that includes both bound 'planetary' companions and 'free-floating' isolated objects, we will be able to inform whether the accretion mechanisms governing the formation of these objects differ depending on companionship, illuminating the origins of young giant planets and rogue planetary-mass objects.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6362
Program Title: Breaking the degeneracy: substellar anchors for evolutionary models

Principal Investigator: Rickman, Emily

PI Institution: Space Telescope Science Institute - ESA - JWST

We propose to build the gold standard of calibrators for brown dwarf and exoplanet models with JWST. By definition, brown dwarfs have insufficient masses to sustain hydrogen fusion in their cores, which causes them to cool down over time since they never reach thermodynamical equilibrium. This age-mass-luminosity degeneracy is the principal challenge to the characterization of brown dwarfs and exoplanets alike. Brown dwarf evolutionary and spectral models are routinely used to compare with exoplanet data, which intrinsically suffer from lower SNR due to their proximity to their host star. In order to anchor evolutionary models in measured physical parameters and chemical abundances, we request NIRSpec/IFU spectroscopy on a sample of brown dwarf companions to solar-type stars with measured dynamical masses from previous direct imaging in age-calibrated benchmark systems. This carefully mass- and age-calibrated sample will set the basis for testing, calibrating, and identifying physical processes missing in evolutionary and spectral models.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 6368
Program Title: The CANDELS-Area Prism Epoch of Reionization Survey (CAPERS)

Principal Investigator: Dickinson, Mark

PI Institution: NOIRLab - (AZ)

JWST provides transformational new capabilities for surveying galaxy evolution during the early phases of cosmic history. Multi-band imaging with NIRCam is revealing an unexpectedly bright population of galaxy candidates at $z > 9.5$, more abundant than most theoretical models had predicted. NIRCam also images a richly diverse population of galaxies at $4 < z < 9.5$ at rest-frame optical wavelengths that can be observed by HST only at $z < 3$. Spectroscopy with NIRSpec is the essential next step beyond imaging to confirm the most distant galaxy candidates, to determine accurate redshifts needed to robustly quantify galaxy statistics and map large scale structure, to measure physical conditions of the interstellar medium and detailed stellar population properties, and to diagnose the history of reionization using direct measurements of the Lyman alpha damping wing and its evolution. Our proposed CANDELS-Area Prism Epoch of Reionization Survey (CAPERS) will obtain deep NIRSpec prism observations to confirm or refute more than 100 $z > 9.5$ galaxy candidates identified in three wide-field public NIRCam survey fields from CEERS and PRIMER, while also measuring redshifts for approximately 2000 galaxies selected by NIRCam imaging of optical rest-frame light at $4 < z < 9.5$, and 10000 galaxies at all redshifts. CAPERS will build a spectroscopic legacy data set that will serve as a resource for studying galaxy evolution and as a foundation for further, future detailed spectroscopy with JWST's NIRSpec and MIRI and with millimeter and radio observatories.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6377
Program Title: When worlds collide: formation and evolution of a synestia

Principal Investigator: Kenworthy, Matthew

PI Institution: Leiden Observatory

We propose to confirm and characterise a candidate 'synestia', the self luminous remnant produced by a collision that occurred in 2019 between two ice giant exoplanets orbiting a Sun-like star, ASASSN-21qj. The unique sensitivity of JWST at thermal infrared wavelengths will enable the direct detection and spectral identification of chemical species in this post-impact body. Our science goals are: - Confirm the identification of the phenomena observed in ASASSN-21qj as a post-impact remnant. - Constrain the mass and composition of the synestia by measuring the time evolution of its spectral energy distribution. - Quantify the presence of water vapour, silicates and/or other refractory materials in the synestia's photosphere with medium resolution spectroscopy.

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Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 6379
Program Title: Structure and Dynamics of The Rings and Inner Moons of Uranus

Principal Investigator: El Moutamid, Maryame

PI Institution: Cornell University

Uranus is unlike any other planet in the Solar System, not only because of its high axial tilt of ~98 degrees, which may reflect an early giant impact, but also because of its ring-moon system that features a closely-spaced configuration and generally low albedos, suggesting a non-icy composition, yet to be elucidated. NIRCam data will provide key parameters for a better understanding of the current configuration, history, origin, age, and evolution of its rings and moons. Furthermore, JWST observations of the faint and dusty rings will characterize the zeta ring and other material in the ring plane orbiting near Uranus’s cloud tops. This will also provide time-critical knowledge about potential hazards that will help shape the planning of NASA’s Uranus Orbiter and Probe (UOP) mission.

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Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 6384
Program Title: Low-Albedo and Inclination Asteroid Families as Tracers for Water and Organics in the Inner Solar System

Principal Investigator: Takir, Driss

PI Institution: NASA Johnson Space Center

Collisional impacts between asteroid-sized objects are common in our solar system history and have played a significant role in forming asteroid families [1]. Low-albedo (geometric albedo < 0.07) and low-inclination (i < 15o) asteroid families in the inner main belt (IMB) between the v6 secular resonance at ~2.15 AU and the 3:1 mean-motion resonance with Jupiter at ~2.5 AU are particularly intriguing because they were proposed to be the possible sources of low-albedo and water-rich (hereafter primitive) near-Earth asteroids (NEAs) [2, 3]. Primitive NEAs are the parent bodies of the least-altered meteorites, the carbonaceous chondrites, and harbor valuable historical records of the early solar system [4]. These NEAs are rich in water and carbonaceous materials, critical key elements relevant to the origin of life on Earth. Investigating the origin and source of primitive NEAs in the IMB will help us trace the origin of water and complex organics that may have been delivered to Earth by these NEAs. Here, we propose to use JWST's NIRSpec Integral Field Unit (IFU) to acquire spectra (0.6-5.3 µm) of IMB family members and directly compare them to those of primitive NEAs to test the dynamical theories that postulate that the IMB region is the source of primitive NEAs.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6388
Program Title: Diagnosing Residual Correlated Noise in Small Planet Transmission Observations for Maximum Feature Detection

Principal Investigator: Teske, Johanna

PI Institution: Carnegie Institution of Washington

Do 1-3 Rearth exoplanets have atmospheres, what are they composed of, how similar or different are they from Solar System planets? These questions are driving hundreds of hours of JWST observations, but so far the results have been inconclusive or pose challenges to interpretation. Examining these results suggests that there is likely correlated noise still lurking in the observations that may be limiting the precision and thus atmospheric detection significance in small planets, jeopardizing our ability to answer the questions above. Here we propose an archival program encompassing all Cycle 1 and 2 NIRSpec/G395H transmission observations of 1-3 Rearth planets to investigate the correlated noise properties in these data. We will uniformly reduce all of the observations and measure the correlated noise, apply two different correlated noise models (one parametric and one non-parametric), compare the performance of these models and pinpoint where they are making the most difference, and assess the physical origins of the correlated noise across detectors, visits, and our full sample of 28 small planets orbiting a variety of stellar types and magnitudes. From our lessons learned, we will provide the community with valuable recommendations for future design and analysis of NIRSpec/G395H observations. We will also provide updated spectra of the small planets that have reduced if not mitigated correlated noise, which can be used for higher-significance atmospheric feature detection.

Proposal Category: GO
Scientific Category: Galaxies
ID: 6405
Program Title: Clumpy Relics: The First Spectroscopic Confirmation of Globular Clusters at z~3

Principal Investigator: Cutler, Sam

PI Institution: University of Massachusetts - Amherst

With the discovery of "The Sparkler," JWST has opened up uncharted parameter space in the distant universe: remarkable high resolution views of ancient globular cluster (GC) candidates. There exists another fascinating galaxy in the Abell 2744 lensing cluster at even higher redshift that is littered with compact red and blue star-forming complexes - "The Relic". The Relic is a bright, quenched galaxy at z=2.67, merely a few billion years after the Big Bang. These clusters are potential GC candidates, with the red ones consistent with ancient relics, while the blue ones may be caught early in their formation (before possible disruption). However, these clumps will remain GC candidates until spectroscopically confirmed. We propose a detailed spectroscopic follow-up using 20 hrs of NIRSpec IFU PRISM/CLEAR in order to: 1) confirm if the clusters are associated with the Relic, 2) robustly constrain the age, stellar mass, and other physical properties of the GC candidates 3) analyze clump survival timescales to inform theories of bulge formation that rely on infalling star-forming clumps. Obtaining robust spectra for such faint objects will leverage the groundbreaking sensitivity and resolution of JWST, serving as proof-of-concept for a growing population of distant galaxies containing the first ancient relics of GCs.

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Proposal Category: AR (GO-Archival)
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6406
Program Title: Unlocking High-Angular Resolution Spectroscopy for JWST using Kernel Phase Interferometry and the NIRSpec IFU

Principal Investigator: Chaushev, Alexander

PI Institution: University of California - Irvine

This proposal will develop a kernel phase interferometry (KPI) software pipeline for the NIRSpec IFU mode. KPI is a data analysis technique which effectively doubles the angular resolution at which companions (or other asymmetries) can be resolved in images taken from space or behind ground-based extreme adaptive optics systems. The kernel phase is an interferometric observable constructed by using the phase information in a high-Strehl image, boosting the resolution to double that of the classical diffraction limit. In the context of NIRSpec, KPI can unlock high and moderate resolution spectroscopy at smaller angular separations than what can be achieved with other JWST instruments. This opens up NIRSpec to a wealth of observations of young protoplanets, bright exoplanets and other substellar objects at small orbital periods. This is particularly important as we know that the peak occurrence rate of Jovian mass planets are at ~3 AU and GAIA astrometry, next generation direct imaging missions and the ELTs are set to discover planets at these separations. It is therefore critical to develop a NIRSpec IFU KPI pipeline to bolster spectroscopic follow-up capabilities at small angular separations. This would allow characterisation of these kinds of systems at longer wavelengths which are only accessible from space with the JWST.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6410
Program Title: A Giant Planet Candidate Orbiting a Young, Massive White Dwarf

Principal Investigator: Cheng, Sihao

PI Institution: Institute For Advanced Study

From a sample of nearby, young, massive white dwarfs with archival Spitzer/IRAC photometry, we have identified one source with 4.5 micron flux excesses that are inconsistent with debris disks or background galaxy contamination. This source is best explained by a binary system unresolved in Spitzer's 2" PSF consisting of a white dwarf primary and a hot, young secondary with 5 Jupiter mass. If this planetary interpretation is correct, then we expect the white dwarf primary and planetary secondary in this system to have F444W ~ 18 and angular separation in excess of 0.2". The white dwarf primary would have had M_star ~ 8 M_Sun and been classified as B stars on the main sequence. Observing this or analogous systems from the ground with GPI 2.0 or SPHERE would require currently impossible-to-achieve H-band contrast ratios in excess of 10^10 at 0.2". We propose to spectrally and likely spatially resolve this system with JWST NIRSpec IFU to confirm or reject the planetary explanation for its photometry. If the proposed observation recover point sources with planet-like spectra, then it will be the first unambiguously planet-mass objects found orbiting objects that are or were main sequence B stars. The exquisite resolution and sensitivity of the JWST applied to this spatially and spectrally resolvable system will produce high signal-to-noise ratio near-infrared emission spectra of planet-mass objects with precise system age.

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Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6419
Program Title: Mapping undiscovered country; Cloudy simulations of JWST's unique spectral challenges

Principal Investigator: Ferland, Gary

PI Institution: University of Kentucky

The spectral simulation code Cloudy is widely used across the JWST community, with 123 papers appearing in 2023 citing both Cloudy and JWST. This project aims to continue Cloudy's development in support of the spectroscopic challenges posed by JWST's unique spectral bandpass. Cloudy simulations do the microphysics from first principles and rest on a foundation of basic atomic data; energy levels, radiative transition rates, and collisional rate coefficients. Over 95% of a Cloudy download consists of atomic, molecular, or grain data. The result is a full simulation of a non-equilibrium plasma with essentially no free parameters. The specific aims of this project are to incorporate atomic data sets that have appeared in the time since the last major atomic data revision ten years ago and continue Cloudy's development in support of JWST needs. This project will help Cloudy meet the unique challenges posed by JWST's extraordinary capabilities.

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Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 6428
Program Title: Towards self-consistent dust depletion, nucleosynthesis effects, and cosmic chemical evolution

Principal Investigator: Ferland, Gary

PI Institution: University of Kentucky

Atomic species in the interstellar medium (ISM) transition out of their gas phase mainly by depletion onto dust. Photoionization models are an essential investigation tool for studying cosmic plasmas. To study dusty regions of the ISM, it is necessary to have a self-consistent and complete dust depletion model. Abundance measurements of certain elements had previously found that in less dusty regions these values were greater than their reference abundances, indicating a positive depletion. Recent studies suggest that this results from supernovae enriching the ISM with alpha-elements. This phenomenon is called the nucleosynthesis effect. Here, I propose to improve the existing dust depletion model in the spectral simulation code Cloudy by incorporating the most recently published nucleosynthesis effects. The last update on the Cloudy dust depletions occurred before the recent findings on the effect of nucleosynthesis on dust depletions. To obtain state-of-the-art spectral simulations I will use the nucleosynthetic curves developed in the literature to improve the Cloudy dust depletion calculations so that the simulated spectra better reflect the chemical evolution of the cosmos. These improvements will be part of the 2025 release of Cloudy and will be openly available.

Proposal Category: GO
Scientific Category: Galaxies
ID: 6434
Program Title: SAPPHIRES: Slitless Areal Pure-Parallel High-Redshift Emission Survey

Principal Investigator: Egami, Eiichi

PI Institution: University of Arizona

One great surprise in the early years of the JWST operation was the transformative power of the NIRCam/Grism Wide Field Slitless Spectroscopy (WFSS) mode, producing ~1000 redshifts at z=5-9 in a total area of ~120 arcmin^2 with 2 hour integrations. It is particularly suited for conducting a highly complete unbiased survey of bright line-emitting galaxies. In Cycle 3, the NIRCam/WFSS mode has become available for Pure-Parallel for the first time. To capitalize on this new opportunity, we propose here a wide-field (~1 deg^2) pure-parallel NIRCam/WFSS treasury survey SAPPHIRES (Slitless Areal Pure-Parallel HIgh-Redshift Emission Survey) with a total pure-parallel time request of 600 hours. The primary goal is to conduct a highly complete spectroscopy-based census of the most luminous (M_uv < -21 mag) galaxies at z=4-9 and beyond, thereby making a robust determination of their number density and opening up the possibility for further detailed follow-up studies. The higher-than-expected number density (~10^-5 mag^-1 Mpc^-3) of luminous (M_uv~-21) galaxies at z=10-12 reported by early JWST studies has generated much excitement, but a 1-deg-scale survey is required to achieve a statistically meaningful sampling of such luminous high-redshift galaxies. The obtained data will be rich with information, containing a variety of line detections over a wide redshift range (e.g., ~12000 H-alpha emitters at z=4-7; ~1800 [OIII] emitters at z=5-9), allowing a large number of science programs. We will release all our data products together with the softwares we have developed in a timely manner, enabling the world-wide astronomical community to exploit this exciting data set.

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Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 6451
Program Title: The Onset of Environmental Quenching: Star Formation and Quenching Fractions in a Massive Galaxy Cluster at z=1.75

Principal Investigator: Gonzalez, Anthony

PI Institution: University of Florida

We propose a program targeting the dense environments associated with the galaxy cluster IDCS J1426.5+3508 (z=1.75). This program will quantify the quenching timescales of cluster galaxies as functions of stellar mass and cluster-centric radius. Quenching is normally parameterized as an exponential decline in star formation with a quenching time-scale, which can be used to discriminate between various physical mechanisms that operate on different timescales. Observing a cluster near the transition epoch when cluster cores are in the process of transitioning from sites of active star formation and galaxy assembly to regions devoid of significant star formation activity enables robust constraint of the quenching timescale, as well as the ability to identify mergers and AGN that may be associated with tidal processes. With NIRISS we will be able measure star formation rates down to 5 Msun/yr using H-alpha for all cluster galaxies. In combination with existing HST data we will also be able to determine stellar masses and morphologies for all cluster galaxies, and photometric redshifts for passive cluster members lacking H-alpha detections.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6456
Program Title: Using stellar contamination proxy TRAPPIST-1 b to search for an atmosphere on TRAPPIST-1 e

Principal Investigator: Allen, Natalie

PI Institution: The Johns Hopkins University

The detection of the atmosphere of a terrestrial planet in the habitable zone of its host star is one of the main goals of the exoplanet community. In order to see the small signals from terrestrial atmospheres using transmission spectroscopy, small host stars are necessary, as the transit depth is directly dependent on the relative size of the planet to the star. However, early observations of terrestrial planets around small stars with JWST have shown that these small M dwarfs are dangerous. Heterogeneities on the stellar surface, common for M dwarfs, can contaminate the transmission spectrum and cause variations on a level much larger than any atmospheric signals. However, the TRAPPIST-1 system contains a possible solution to overcome this stellar contamination. Using the multiplicative effect of the stellar contamination signal to our advantage, we propose to observe close (but not overlapping) transits of TRAPPIST-1 b and TRAPPIST-1 e. The ratio of the resulting transmission spectrum will correct for the signal from the stellar contamination, and leave only the ratio of their atmospheric opacities. Assuming little to no atmospheric signal from TRAPPIST-1 b based on the thermal emission observations, we expect this ratio to result in the transmission spectrum of TRAPPIST-1 e normalized by the flat transit depth of TRAPPIST-1 b. Using this method, we can detect an Earthlike atmosphere on TRAPPIST-1 e using 15 close transits of TRAPPIST-1 b and e to 3 sigma significance.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6457
Program Title: Thermal emission of a cool, potentially volcanically active exo-Earth

Principal Investigator: Benneke, Bjorn

PI Institution: Universite de Montreal

Rocky planets are abundant in the Universe; yet our understanding of which and how many of them host atmospheres remains highly limited. Empirical evidence is needed in our quest of understanding the complex interplay between the initial volatile content of rocky planets and the atmospheric loss and replenishment processes that drive the atmospheric evolution. Here, we propose to observe the mid-IR thermal emission of the recently discovered cool exo-Earth LP 791-18d to determine whether an atmosphere is present or not. LP 791-18d orbits a nearby M6 dwarf and is proposed to be volcanically active due to strong tidal heating of its interior, similar to Jupiter's moon Io. The volcanic activity would result in continuous replenishment of LP 791-18d's atmosphere, which our observations will probe for. Our observations are designed to distinguish at 4 sigma confidence between a bare-rock scenario and a CO2-rich atmosphere that efficiently transports heat around the planets, even in the presence of Venus-like clouds. The presence of an atmosphere on LP 791-18d would be a first signal that cool rocky planet around M dwarf can host atmospheres, motivating a larger campaign to probe the prevalence and diversity of secondary atmospheres.

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Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6463
Program Title: Testing a new formation tracer for cold gas giant planets with JWST/MIRI

Principal Investigator: Patapis, Polychronis

PI Institution: Eidgenossische Technische Hochschule Zurich (ETHZ)

COCONUTS 2 b is the nearest and coldest directly imaged exoplanet to date. However, it is also the second most widely separated exoplanet from its host star, raising questions about how this 6 Jupiter mass planet formed. With an equilibrium temperature below 500 K, the atmosphere will be dominated by ammonia in the mid-infrared, allowing for the first time the detection of nitrogen isotopes in an exoplanet atmosphere and the use of the 14N/15N ratio as a tracer of exoplanet formation. This novel isotope ratio has been used in the solar system, finding that rocky and icy bodies are more enriched in 15N, similar to protoplanetary disks, than the gas giants which share a composition with nearby pre-stellar cores. By measuring this ratio in COCONUTS 2 b via MIRI/MRS observation, we can compare the isotope ratio to that of the recently observed brown dwarf WISE-J1828, and robustly determine whether it formed through a star-like or planet-like mechanism. This ratio will likely be relevant for new directly imaged exoplanets around mature, nearby stars.

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Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 6474
Program Title: T-Dwarf auroral physics: atmospheric impact, total power, and energy partition function

Principal Investigator: Pineda, John

PI Institution: University of Colorado at Boulder

Aurorae at radio wavelengths indicate that stable large-scale magnetospheric currents can drive persistent energetic electron beams into brown dwarf atmospheres. On Jupiter, these electrical currents produce UV emissions from molecular hydrogen, infrared thermal emission, and H3+ emission through collisional ionization and subsequent ion chemistry. However, emerging evidence points to multiwavelength auroral behaviors on brown dwarfs that differ from Jupiter. Most of the auroral energy deposited in these cool dwarfs dramatically heat upper atmospheric layers and should emerge as thermal emission. New evidence from JWST demonstrates key evidence for such thermal atmospheric inversions. We propose to characterize this thermal structure for 3 auroral T-dwarfs expected to exhibit similar aurorally impacted surface regions. Through spectrophotometric monitoring with JWST across 3-10 microns and joint radio observations of the targets' radio aurorae, we aim to measure (1) the total auroral power of these systems, (2) the efficiency of radio aurorae, and (3) compare the multi-wavlength atmospheric impact across a range of auroral properties. This study measures significant unknowns in the field of brown dwarf aurorae: the total auroral power and multi-wavelength energy partitions.

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Proposal Category: GO
Scientific Category: Galaxies
ID: 6480
Program Title: Revealing the Lifecycle and Environment of Massive z~7 Galaxies

Principal Investigator: Schouws, Sander

PI Institution: Universiteit Leiden

Recent exciting results suggest that the formation of massive galaxies in the early universe built up faster than expected. To better understand this rapid build-up, we will leverage NIRCam Imaging and WFSS to study the lifecycle and environment of 25 of the most [CII]-luminous, massive star-forming galaxies known at z~7. With WFSS, we will measure the clustering around our targets by detecting ~200 [OIII] emitting neighbor galaxies and determine their halo mass. The halo mass gives invaluable insight into their past and present star formation efficiencies and enables a connection to populations at later epochs. We will test whether these massive LBGs could be the progenitors of the quiescent galaxies found at z~5 and BCGs at z~0. The large number of neighbors also allows us to determine to what extent galaxies are impacted by their environment at z~7 and vice versa. Deep NIRCam imaging of the rest-frame optical will allow us to measure stellar masses and star formation histories with unprecedented accuracy. We will look for the possible presence of evolved stellar populations to find out whether these LBGs could be the descendants of the z>10 star forming galaxies found recently by JWST. The stellar masses are also essential to understand the mechanisms driving the rapid build up of dust observed with ALMA in our targets. Finally we will use the synergy between ALMA and JWST to determine the impact of merger-driven growth versus smooth accretion, through both morphology and kinematics. Our proposed targets are essential to bridge the gap between the more normal, less massive sources found in large area surveys (JADES/CEERS) and rare sources like QSOs.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 6491
Program Title: Revealing the Oblateness and Satellite System of an Extrasolar Jupiter Analog

Principal Investigator: Cassese, Ben

PI Institution: Columbia University in the City of New York

Jupiter and Saturn, our best-studied giant planets, likely formed in a very similar way. Consequently, they share many similar features: both host large satellite(s) that formed from the remains of their circumplanetary disks, and both are slightly oblate due to their inability to shed their primordial angular momentum through tidal interactions with the Sun. Each of these properties is thought to be inevitable byproducts of the giant planet formation process, and thus their existence in more distant solar systems is essentially presupposed in our canonical theories. However, neither small moons nor planetary oblateness have been confidently detected in the transits of any planets, let alone cool giant exoplanets. Such measurements are simply not possible with facilities less precise than JWST. Now, however, we propose an opportunity to measure both with a single transit observation; a NIRSpec time series of the well-characterized cool gas giant Kepler-167 e. Injection-recovery experiments suggest that, should this planet be as flattened as Jupiter or Saturn, JWST could confidently detect the oblateness with a signal-to-noise of $>10$ and $>20$, respectively. Similarly, should Kepler-167 e host one or more Galilean-type moons, these observations would recover the satellites with a completeness rate of $(93\pm4)$\%. Kepler-167 e is the ideal target for detecting both moons and oblateness, and indeed given the sensitivity of the proposed observations, non-detections of either would present a compelling scientific mystery. Given the planet's 1000+ day period and JWST's shifting fields of visibility and finite lifetime, there are limited opportunities for this experiment.

Proposal Category: GO
Scientific Category: Galaxies
ID: 6511
Program Title: Galaxy mass buildup in the early universe - ultra deep imaging of the Hubble Ultra Deep Field to 10 microns

Principal Investigator: Oestlin, Goeran

PI Institution: Stockholm University

Despite JWST has delivered science data for just over a year, it is already changing our view of the high redshift universe, finding more distant galaxies than ever before. Among the instruments on JWST, MIRI is unique in its ability to record images at wavelengths beyond 5 micron. This means that only MIRI can study the red rest frame (>0.7 micron) for galaxies at redshifts z>6, and the near IR rest frame (>1 micron) for z>4, which are vital for determining the star formation histories and stellar masses of galaxies. NIRCam is at high redshifts restricted to the UV/blue spectral region where young massive stars dominate the spectrum. Hence, combined deep NIRCam+MIRI surveys will be powerful for tracing the evolution of the galaxy population with redshift. The Hubble Ultra Deep Field has been the target for deep NIRCAM imaging in many filters, spectroscopic surveys with NIRSPEC, and has been observed in filter F560W as part of the European MIRI GTO program. We here propose to complement the NIRCam and F560W observations with very deep F770W and F1000W imaging. This will greatly improve the ability to decipher the star formation history at z>6 by uniquely sampling the continuum on the red side of H-alpha, find H-alpha emitting galaxies, search for the first quiescent galaxies and separate star forming galaxies from AGN at cosmic noon. Moreover, we will study enigmatic sources that are only seen by MIRI (and not by NIRCam). Given the legacy value of the proposed observations, they would be made imediately publically avialable. We add parallel NIRCam imaging in medium band filters to search for high-z emission line galaxies.