Proposal Category: GO
Scientific Category: Galaxies
ID: 2792
Program Title: NIRSpec Spectroscopy of a Remarkably Luminous Galaxy at z=10.19

Principal Investigator: Harikane, Yuichi

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

We propose NIRSpec and NIRCam observations for an extremely luminous galaxy, XMM3-3085 at z=10.2 with Muv=-23.7 mag, whose high redshift is suggested by recent HST grism spectroscopy. XMM3-3085 is the most luminous galaxy at z>10, and such a luminous system is not expected theoretically, indicating an unusually vigorous period of early star formation with high efficiency, the existence of AGN activity, or stellar populations characterized by a top-heavy initial mass function possibly with Pop-III stars. Thanks to its bright nature, a quick 1 hour NIRSpec/PRISM observation will allow us to confirm the HST-based redshift efficiently, and moreover, detect various emission lines including OIII]1665, CIII]1908, [OII]3727, [NeIII]3869, Hdelta, Hgamma, and [OIII]4363. Combined with NIRCam observations tracing the continuum redder than the Balmer break, we will measure the physical parameters including the [OIII]4363-based matallicity for the first time at z>10, to understand early stellar mass assembly and dust and metal enrichment, and will discuss the physical nature of this remarkably luminous galaxy, whose existence is a challenge for current galaxy formation models.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 2820
Program Title: Deciphering the silicate composition of Centaurs and small TNOs

Principal Investigator: Vernazza, Pierre

PI Institution: CNRS, Laboratoire d'Astrophysique de Marseille

Outer solar system small bodies (Centaurs, Comets, small TNOs) hold the residual ingredients from our young protosolar disk that are still observable today. Thus, by measuring their composition and distribution across the solar system we have the potential to unravel the scenario of our planetary system’s formation and dynamical evolution, providing a benchmark to which other stellar systems can be compared. We propose performing spectroscopic observations with MIRI (over the 5-28 micron range) of 2 Centaurs and 2 small TNOs to constrain their silicate composition. We will observe a “less red” and a “very red” object within each population. Our proposed investigation will first enhance our understanding of the overall compositional diversity among primitive outer solar system small bodies, thereby complementing Cycle 1 observations of these bodies with NIRSpec. Second, we will provide critical information regarding the extent of radial mixing among primordial small bodies which took place during their early reorganization. Specifically, our measurements will allow us to confirm/refute the genetic link between outer (Centaurs, small TNOs) and inner (P/D type asteroids, Jupiter Trojans) solar system small bodies, as advocated by the Nice model. Finally, our proposed observations will provide unique constraints on the primordial heliocentric compositional gradient present in the outer (>10 AU) protosolar disk.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 2826
Program Title: Evolution of Chemical Diversity in Inner Disks: Core Accretion and Pebble Inflow

Principal Investigator: Carr, John

PI Institution: University of Maryland

The inner regions of protoplanetary disks around T Tauri stars display remarkable diversity in their infrared molecular line emission, as discovered in surveys with Spitzer, suggesting that inner disks (inside the water snowline ~ 1 au) have diverse C/O ratios at ~1 Myr of age. Chemical diversity of this kind is expected to result from planet formation and disk evolution. Core accretion is expected to efficiently convert icy solids into planetesimals and protoplanets (a process that dehydrates the inner disk), while pebble inflow (a process that superhydrates the inner disk) is expected to dominate at early times or in disks that fail to convert most of their icy solids into planetesimals. By surveying molecular line emission from inner disks as a function of age, we can infer the roles these processes play (their timescale, prevalence, and extent) in the evolution of disk populations. We therefore propose to study an older population of disks in the IC 348 cluster (~ 3 Myr). With the high sensitivity of MIRI-MRS, it is now possible to study disks beyond the nearest star forming regions (> 140 pc) and probe such populations. Our study will complement earlier Spitzer and current JWST studies of young disks (~1 Myr), provide valuable constraints on theories of disk evolution, and inform our understanding of planet formation in disk populations.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 2869
Program Title: The interiors of Jupiter Trojans as tracers of Solar System evolution

Principal Investigator: Brown, Michael

PI Institution: California Institute of Technology

The Nice models of solar system-wide dynamical instability predict that the Jupiter Trojans should be derived from the same region and thus have the same icy composition as the objects in the Kuiper belt. Spectra have shown no relationship between the surface compositions of these objects (and Cycle 1 spectra have made the differences even more dramatic), but it is plausible that the higher temperatures of the Jupiter Trojans would sufficiently modify Kuiper belt surfaces to make them unrecognizable. We have identified 4 ~20km Jupiter Trojans with albedos elevated above the typical Trojan values. Statistically, this is approximately the number of objects of this size which are expected to have had catastrophic collisions in the past ~100 Myr. These objects are plausibly the largest recent impacts in the Jupiter Trojan population and could retain the spectroscopic signatures of fresh interior materials. We propose a short reconnaissance program designed to measure the surface composition of these objects. Such a program could quickly and definitively establish the connection between the Jupiter Trojans and the Kuiper belt objects, confirming an early dynamical instability in our solar system.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 2875
Program Title: Scrutinizing the Dirtiest Cepheids, a Test of the Hubble Tension

Principal Investigator: Riess, Adam

PI Institution: The Johns Hopkins University

We propose an experiment to investigate the growing tension in measurements of the Hubble constant by measuring the most crowded, or “dirtiest”, extragalactic Cepheids in SNe Ia hosts, and comparing them with the least crowded ones, already observed by two teams in JWST Cycle 1. The unmatched resolution of JWST can largely resolve the local environs of HST Cepheids to separate these crucial standard candles from the photometric “chaff” that surrounds them and reduce the associated noise in their period-luminosity relations by nearly an order of magnitude. These crowded Cepheids provide the best leverage to discover unexpected crowding affecting Cepheid photometry at HST resolution. If JWST observations of the Cepheids in the proposed 6 hosts of 8 SNe Ia match HST, it will prove beyond reproach that HST measurements are reliable over the full range used to measure H_0, while improving the least accurate of them. But if a photometric difference were found between JWST and HST, one which systematically grows with local stellar density, it would provide a clear detection of unexpected backgrounds unseen at the resolution of HST and allow us to calibrate their impact on the Tension. These observations will also advance two independent distance indicators that also calibrate SNe Ia and measure H_0 -the IR Tip of the Red Giant Branch (IR-TRGB) and Oxygen-rich Miras - providing a multi-pronged approach to demonstrate whether the H_0 tension is a robust feature of the Universe thus indicating the likely presence of missing physics in the cosmological model.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 2876
Program Title: Probing Water Ice in Distant Comets: Crystalline or Amorphous?

Principal Investigator: Yang, Bin

PI Institution: Planetary Science Institute

Water ice plays a key role in the early stages of planet formation. Characterizing water ice, especially in comets, can yield important insights into the formation of planetary Systems, the origins of planetary atmospheres, and the source of Earth's oceans. However, studying the properties of cometary water ice has been challenging, and our knowledge of primordial ice remains highly limited. Recent JWST observations of the largest Oort Cloud comet, C/2014 UN271, reveal the unexpected presence of a significant amount of crystalline ice in this distant comet, which should be composed solely of amorphous water ice. The surprising discovery made by JWST challenges our current understanding of comet formation in the outer protoplanetary disk. On the other hand, C/2014 UN271 is a large comet (>100 km) and thus could have experienced internal heating. It also underwent multiple outbursts recently. Therefore, the detected crystalline ice may not be primordial but a result of surface or internal alteration processes. With this new detection, JWST has finally opened the window to study water ice in comets, a key piece needed to understand the formation of the Solar system. To exploit this unprecedented opportunity, we propose NIRSpec observations of three kilometer-sized distant comets which have never shown outbursts and are expected to have retained their primordial state. Our study will provide strong observational evidence to answer the hotly debated questions: What is the water ice content of comets? What were the required conditions for the formation of the protoplanetary disk from the Solar Nebula?

Proposal Category: GO
Scientific Category: Galaxies
ID: 2883
Program Title: MAGNIF: Medium-band Astrophysics with the Grism of NIRCam in Frontier Fields

Principal Investigator: Sun, Fengwu

PI Institution: University of Arizona

Which type of galaxies reionized the Universe? Previous HST observations have measured the rest-frame UV luminosity function (LF) of galaxies at z=2-10, suggesting a steeper faint-end slope of UVLF toward higher redshift. If true, dwarf galaxies should contribute to the majority of ionizing photon budget at z=6-10. However, the spectroscopic completeness of galaxies decreases dramatically towards the faint end and high redshift, and it still remains unclear (1) how many dropout-selected sources are genuine galaxies at the Epoch of Reionization, (2) how many ionizing photons did they emit, and thus (3) whether dwarf galaxies reionized the Universe. We propose a novel cosmological experiment, aiming to resolve the fundamental questions mentioned above with the most efficient strategy among all available JWST observing modes/programs. This will be achieved with a medium-band slitless spectroscopic survey with NIRCam grism at 3.6 and 4.8um in four frontier field clusters, where deep JWST 1-5um imaging and 1-2.2um spectroscopy will be obtained by Cycle 1. By combining medium-filter (low sky-background) and lensing magnification, we will construct unbiased, flux-complete samples of ~440 and ~50 [OIII] emitters at z~6 and 8 down to an unprecedented faint end, 10-100x deeper than any existing survey. We will measure the faint-end slope of [OIII] LF and spectroscopic complete UVLF, study the 100pc-scale star formation, metallicity, dust attenuation, kinematics, production and escape of ionizing photon in dwarf galaxies through multiple emission lines across z=1-9. We waive the proprietary period to encourage community engagement, including public transient search.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 2896
Program Title: Confirming the Formation of a Black Hole

Principal Investigator: Kochanek, Chris

PI Institution: The Ohio State University

LIGO is revolutionizing the discovery of stellar mass black holes, but it will almost certainly never observe a new black hole being formed from a star. It is possible to find forming black holes by searching for failed supernovae, where a black hole forms without a dramatic explosion. At present, there is one excellent candidate for a failed supernova: NGC 6946-BH1. This ~300,000 Lsun star has vanished in the optical and near-IR at the level of a few 1000 Lsun and in warm SST at the level of ~10,000 Lsun. This means that there can be no surviving star hidden by warm/hot dust (Td>400K). It is, however, possible to hide it with colder dust. JWST MIRI observations at 5.6, 10 and 21 microns can test this possibility in a single short visit.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 2905
Program Title: First look at high redshift Type Ia supernova cores: Nebular observations of lensed SN Zwicky

Principal Investigator: Dhawan, Suhail

PI Institution: University of Cambridge

Type Ia supernovae (SNe Ia) are excellent distance indicators in cosmology, playing an influential role in understanding dark energy and origin of the Hubble tension. They are pivotal endpoints of stellar evolution and the nature of their progenitors is an important open question. SNe Ia cosmology, especially at high-redshift, is limited by systematic uncertainties, a key source is the evolution of SNe Ia properties with redshift. This proposal presents an unprecedented route to test for redshift evolution. We request the first nebular phase observation of a high-redshift SN Ia; SN Zwicky with a lookback time of 4 Gyr. SN Zwicky is the first strongly lensed SNIa in six years, presenting a rare opportunity for such observations. The mass ratios from the NIRSpec spectrum, will shed light on whether the SN originated from a Chandrasekhar mass or sub-Chandra progenitor. Comparing this with the sizable literature sample of nebular phase observations of local universe SNe Ia, we can determine whether there are evolution effects in the SN Ia properties with redshift, which will critically impact our ability for precision cosmology in the near future. With a small JWST time investment we can break new ground in understanding high-z SNe Ia.

Proposal Category: GO
Scientific Category: Galaxies
ID: 2913
Program Title: Dissecting the Monsters: Resolved IFU Spectroscopy of the Most Massive Quiescent Galaxies at z>3

Principal Investigator: Forrest, Ben

PI Institution: University of California - Davis

Recent deep and wide near-IR surveys have led to the discovery of massive quiescent galaxies at 3<z<4 at abundances approximately ten times those predicted by simulations. Understanding the mechanisms behind their quenching is key to reproducing their number densities in models. We propose deep NIRSpec/IFU G235M/F170LP observations of 3 ultramassive (logM/M_sun~11.5) quiescent galaxies spectroscopically confirmed at z~3.5, resulting in the first spatially resolved spectroscopic study of ultra-massive quiescent galaxies in the first 2 billion years of cosmic history. These rest-frame optical data will allow us to: 1) Measure spatially resolved stellar population ages from features such as Dn(4000) and Hdelta, the latter of which is not observable from the ground at z=3.5, to probe when the stars in these systems formed, 2) Constrain residual dust-corrected star formation across the face of the target galaxies to within 1 M_sun/yr using Balmer-decrement corrected Halpha, which is also not observable from the ground at this epoch, to measure how uniformly quenched these systems are, 3) Look for evidence of galaxy rotation, allowing for accurate characterizations of velocity dispersion and dynamical mass, and 4) Probe AGN activity through rest-frame optical line ratios (Hbeta, [OIII], Halpha, [NII]) as a possible quenching mechanism. Together, these insights will shed light on the assembly of stellar mass and quenching processes in these extreme and mysterious distant galaxies which must have formed stars at incredibly high rates and then halted their star formation activity equally abruptly.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 2918
Program Title: Does the Stellar Initial Mass Function Depend on Metallicity?

Principal Investigator: Cohen, Roger

PI Institution: Rutgers the State University of New Jersey

The universality of the stellar initial mass function (IMF) is one of the most pervasive unsolved problems in astrophysics, with implications ranging from star formation to galaxy evolution and beyond. Incredibly, the question of whether the low-mass (<1 Msun) IMF depends on metallicity remains unanswered, with both observations and simulations providing ambiguous evidence. We propose the deepest and most precise IMF measurement ever made outside the solar neighborhood, enabling us to confirm or refute the metallicity dependence of the low-mass IMF. We will use a single NIRCam pointing to image N>18k individually resolved stars down to 0.15 Msun in the Small Magellanic Cloud. We have harnessed extant imaging and spectroscopy to carefully select a field with a spectroscopically verified metallicity of 8% solar. The resulting imaging will allow us to: 1) Measure the lognormal characteristic IMF mass (setting the peak of the IMF) to 10% precision, and lognormal IMF width to 20% precision, for direct empirical comparison to the local Milky Way disk IMF; 2) Statistically discriminate between an IMF that is intrinsically lognormal versus a power-law, with broad implications for star formation theory. Such an IMF measurement is uniquely feasible with JWST: The simultaneous SW+LW imaging capability of NIRCam is critical for selecting against compact background galaxies that have thwarted previous attempts to measure the low-mass stellar IMF using optical and/or near-infrared colors alone.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 2919
Program Title: Life After Death: Finding Water in a Planetary Disk around a White Dwarf

Principal Investigator: Kilic, Mukremin

PI Institution: University of Oklahoma Norman Campus

The InfraRed Spectrograph (IRS) on the Spitzer Space Telescope provided low-resolution spectroscopy of eight dusty white dwarfs. However, only two had sufficient signal-to-noise ratio for a mineralogical analysis, G29-38 and GD 362, and only one (GD 362) shows potential emission features near 6 microns that could be due to water vapor. We propose to obtain high signal-to-noise ratio, medium resolution spectroscopy of GD 362 with the JWST to detect, for the first time, the water vapor features at high significance, resolve them, and constrain the abundance of water in a remnant planetary disk around a white dwarf. This is a unique opportunity: GD 362 is a unique target, and the JWST spectroscopy will enable us to constrain the composition of the disk, including water ice, water vapor, hydrated minerals, and aqueous alterations, as well as gas phase species. Even a non-detection of water would be significant as it would constrain the origin of the tidally disrupted exomoons and exo-asteroids around this white dwarf. The long term evolution of disks around white dwarfs is also of prime interest; by modeling the silicate emission feature, we will constrain any mineralogical differences compared to the Spitzer IRS observations of GD 362 from early 2000s.

Proposal Category: GO
Scientific Category: Galaxies
ID: 2926
Program Title: A pathfinder study of the physical properties of the earliest galaxies. MIRI spectroscopy of GN-z11, a galaxy at redshift 11

Principal Investigator: Colina Robledo, Luis

PI Institution: Centro de Astrobiologia (CSIC/INTA) Inst. Nac. de Tec. Aero.

JWST has already revolutionized the study of the early galaxy formation in the Universe with the unambiguous spectroscopic identification of several galaxies at redshifts above 10 and up to 13.2. High-redshift ($7 < z < 9.6$) sources do show strong Hbeta+[OIII] emission lines, characterized by extremely high rest-frame equivalent widths ranging from 1000A to 3200A. The MIRI spectrograph (MRS) is the only instrument onboard JWST that can, for the first time, provide the opportunity of detecting these strong optical emission lines ([OIII]4959,5007A, Halpha, Hbeta) at the highest redshifts ($z >10$), during the early phases of the formation of galaxies and reionization in the Universe. We propose MRS spectroscopy of GN-z11, the brightest known galaxy at redshift beyond 10. Key properties such as the nebular extinction, star formation rate, ionization conditions, dynamical mass, metallicity, ionizing photon rate and production efficiency will be spectroscopically derived for the first time in a galaxy at a redshift of 11. This proposal represents a pathfinder study of the earliest galaxies when the universe was less than 500 million years old. The proposed observations will use the unprecedented and unique capabilities of MIRI/JWST to investigate the physical properties of the population of the earliest bright or weak-lensed galaxies in the Universe, into the early phases of the Epoch of Reionization of the Universe.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 2950
Program Title: Exploring sulfur dioxide in H/He-rich hot gas giant atmospheres

Principal Investigator: Waters, Rens

PI Institution: Radboud Universiteit Nijmegen

The recent detection of sulfur dioxide (SO2) in the atmosphere of the hot Saturn-mass planet WASP-39b by the JWST exoplanet ERS team opens an exciting new tool to study H/He dominated hot planets. The presence of SO2 can be understood as a result of upper atmosphere photochemistry; its abundance is a strong function of the chemical composition (both metallicity and C/O ratio) of the atmosphere. This is because SO2 is the result of the photodissociation of water to OH and a subsequent reaction with atomic sulfur. Because both oxygen (water) and sulfur abundances scale with metallicity, the upper atmosphere SO2 abundance can increase by several orders of magnitude for planets with 10 times the solar metallicity and solar to sub-solar C/O. The presence of SO2 therefore opens a new venue to determine the atmospheric metallicity and C/O ratio and offers for the first time access to an important chemical element. We propose to obtain transmission spectra using JWST/MIRI in LRS slitless mode in order to measure the presence and abundance of SO2 in three carefully chosen hot planets with H/He dominated atmospheres in which water has been detected. These observations will allow us to (1) test photochemical atmosphere models that predict a strong dependence of SO2 on metallicity and C/O ratio, (2) establish the impact of different stellar radiation properties on the upper atmosphere photochemistry, and (3) constrain the formation history of the planets.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 2957
Program Title: The search for Population III stars in low-metallicity 7<z<9.5 galaxies

Principal Investigator: Uebler, Hannah

PI Institution: University of Cambridge, England GBR

The detection of Population III (PopIII) stars is one of the major observational challenges in modern astronomy that can uniquely be addressed with JWST. Motivated by theoretical predictions, we propose to search for PopIII stars in the vicinity of low-metallicity (<5% Z_solar) galaxies at redshifts z=7-9.5. The primary galaxies have imaging from JWST and/or HST, and their integrated spectra have been taken with NIRSpec-MSA. Here we propose to map the surroundings of these galaxies with NIRSpec IFS. NIRSpec-IFS has the distinctive imaging-spectroscopic capabilities to disentangle the characteristic spectral features of PopIII stars close to the primary galaxies, in the wavelength range where PopIII features are predicted to be strongest.

Proposal Category: GO
Scientific Category: Galaxies
ID: 2959
Program Title: Resolving early galaxy disks at z~8 with NIRSpec-IFS

Principal Investigator: Scholtz, Jan

PI Institution: Kavli Institute for Cosmology, Cambridge

We propose deep, high spectral resolution (R2700) NIRSpec IFS observations of three lensed star-forming galaxies at z=7.5-8.5 in the SMACS J0723.3-7327S cluster. These galaxies were recently observed with the NIRSPEC MSA in R1000 as part of the Early Released Observations with strong detection of rest-frame optical emission lines, while still representative of `normal' star-forming galaxies (SFR~8-30 Msol/yr). Furthermore, these lensed galaxies already show spatial extension and or signs of velocity gradient in the MSA 2D spectra, making them ideal targets for this kinematical study. Using these deep high-resolution (FWHM=120km/s) observations of [OIII] and Hbeta, we will derive the kinematical properties of these galaxies at the very early stages of galaxy evolution and test if these sources are dominated by turbulent gas or orderly gas-rich disks. This analysis will reveal if smooth accretion from the cosmic web or major mergers contributes most to the build-up of stellar and baryonic mass 700 million years after the Big Bang. This will be the first time this experiment is performed using optical-emission lines at the epoch of reionisations and at such a high resolution (~0.15 arcseconds). Furthermore, we will also search for star-formation driven outflows in the [OIII] emission line in these galaxies including in the suspected AGN in our sample.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 2961
Program Title: Vaporized rocks: detecting silicate cloud precursors in ultra-hot Jupiters

Principal Investigator: Molliere, Paul

PI Institution: Max Planck Institute for Astronomy

The James Webb Space Telescope has begun to unambiguously reveal the presence of silicate clouds in exoplanet atmospheres. Here we propose to use it to uniquely identify SiO, a gaseous precursor of said clouds, in the dayside emission of the ultra-hot Jupiter WASP-121b, which is so hot that all condensates evaporate. We estimate that we can detect the fundamental vibration band of SiO at 8 sigma in a single-eclipse measurement with MIRI LRS. Together with archival NIRSpec and NIRISS eclipses from GO 1 and GTO programs, which determine the oxygen abundance, we will constrain the atmospheric silicon-to-oxygen ratio ([Si/O]) with a precision of 0.13 dex. This abundance ratio is a proxy of the relative importance of rock and volatile accretion during planet formation. It is highly informative for formation models, potentially allowing us to constrain the contributions of pebble vs. planetesimal accretion. The relative importance of these two processes in the so-called core accretion paradigm is hotly debated. Our measurements would be complementary to the frequently cited C/O abundance ratio, for which disk processes such as pebble evaporation lead to a much less clear interpretation than previously thought. The first direct detection of SiO may therefore allow us to constrain planet formation from a new and highly informative angle.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 2965
Program Title: Clouds or Chemistry?: Pinpointing the drivers of variability across the L/T transition via the benchmark L/T binary WISE 1049AB

Principal Investigator: Biller, Beth

PI Institution: University of Edinburgh, Institute for Astronomy

We propose for 7 hours of MIRI LRS monitoring + 7 hours of NIRSPEC prism spectroscopic monitoring of the benchmark binary brown dwarf WISE 1049AB, the closest, brightest brown dwarfs known. Despite sharing the same age, and similar masses, effective temperatures, and viewing angles, WISE1049B is highly variable (5-15%) with a period of ~5 hours, while WISE1049A is <3% variable in the near-IR, with a period of ~7 hours. This is a unique opportunity to isolate two points along the critical L/T spectral type transition. JWST enables access to key molecular features across the near-IR with NIRSPEC and to the 10 um silicate feature with MIRI, which provide key tests for theoretical explanations of the observed variability, in particular: 1) variability due to temperature fluctuations from enhanced diabatic convection (Tremblin et al. 2020) will cause enhanced variability in methane absorption features, no variability in the silicate feature at 9-10 um, and a ~180 degree rotational phase shift between 1.1-1.7 um and 4-5 um lightcurves, while? 2) variability due to high-altitude silicate clouds (Luna and Morley 2021) will produce no variability in methane absorption features but enhanced variability at 9-10 um.? Our proposed observations will also determine the spatial extent of asymmetric top-of-atmosphere structures in WISE1049AB as a function of wavelength / depth and enable the first phase-resolved spectral retrieval analysis of variable brown dwarfs, as well as the most accurate measurement of bolometric luminosity for each of the components to date. The separation between components is decreasing; after Cycle 2, these observations will not be possible again until 2028.

Proposal Category: GO
Scientific Category: Galaxies
ID: 2969
Program Title: Distant Sparkles: Are We Seeing Ancient Globular Clusters at Cosmic Noon?

Principal Investigator: Mowla, Lamiya

PI Institution: University of Toronto

The Sparkler, discovered in Webb's First Deep Field, caught the world's attention with its bright resolved star clusters shining like fireworks. This galaxy at z_spec=1.38 (age of the Universe only 4.7 Gyr) with a magnification of 10-100, gives us a unique opportunity to perform detailed photometry and SED modelling on the resolved sparkles. Contrary to the expectation that these are young, star-forming clusters, detailed star formation history analysis indicates that the sparkles may have formed a scant 500Myr-1Gyr after the Big Bang (Mowla & Iyer et al. 2022, Claeyssens et al. 2022). While this hints that the sparkles may be ancient globular clusters (GCs) at z=1.38 (a use-case previously unimagined with JWST!), their high stellar surface density and metallicity, combined with the the large uncertainties on the sparkles from photometric constraints, make it difficult to rule out the scenario that they may be peculiar dusty young star clusters or ultra-compact satellites. We propose detailed follow-up observations using NIRSpec IFU PRISM+G140M that are designed to: (i) confirm that the sparkles are indeed old star clusters, (ii) precisely determine their physical properties and place them in the context of GC scaling relations, and (iii) analyze the properties of the host galaxy to determine what makes the Sparkler so unique. This proof-of-concept will serve as a pathfinder for other high-redshift GC studies that leverage JWST's incredible angular resolution combined with the magnification from massive galaxy clusters.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 2970
Program Title: The volatile content and C/O ratio of old disks: constraints on young planet atmospheres

Principal Investigator: Pascucci, Ilaria

PI Institution: University of Arizona

Sub-Neptunes are the most common type of planets inside 1 au. Their cores have likely formed via pebble accretion and their primordial envelopes accreted from the gas disk. There are hints of large scale inward drift of icy pebbles, possibly contributing to form sub-Neptunes, in ~1-3 Myr-old solar-type protoplanetary disks (Mstar~0.4-1.5Msun). The chemical inventory of these young disks will be soon characterized in detail via GTO and Cycle1 MIRI-MRS programs. Unfortunately, disks at later evolutionary stages, when sub-Neptunes likely accrete their envelopes, are not covered in these programs. Here, we propose MIRI-MRS observations of a well-characterized sample of ~5-10 Myr-old solar-type protoplanetary disks to reveal their chemical inventory and, by comparing with the young disks, to constrain how it evolved. By covering ~3 orders of magnitude in millimeter flux, hence dust (pebble) mass, we will also test the prediction that the C/O elemental ratio inside the snowline becomes supersolar at these old ages, especially toward the faintest disks with the smallest dust content. Our observations will provide a glimpse into the chemical composition of gas that is accreted to form the primordial atmosphere of sub-Neptunes which is critical for the subsequent atmospheric loss and chemical evolution.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 2981
Program Title: Exocometary molecules at the epoch of volatile delivery

Principal Investigator: Matra, Luca

PI Institution: Trinity College Dublin

The presence of exocometary gas in young (10-100 Myr) debris disks presents a unique opportunity to probe the composition of exocomets during the late stages of terrestrial planet formation. This is the evolutionary stage when ice-rich impacts are proposed to change the volatile environment of terrestrial planets, setting the stage for prebiotic chemistry. In these young exocometary belts, high concentrations of debris result in frequent collisions and release of molecular gas, which can be observed in absorption against the stellar background in edge-on systems. We propose a JWST/NIRSpec G235H near-IR survey of exocometary molecules released in the ~15 Myr-old exocometary belt around A star HD110058. This young exocometary belt is most promising target being edge-on, and the richest in molecular CO gas based on strong absorption detected by HST-STIS, and emission detected by ALMA revealing its structure. With JWST's sensitivity in space, our main goal is to prove for the first time that exocomets hold a reservoir of H2O (and CO2), dominant species in Solar System comets, in the crucial epoch of volatile delivery where they may be transported to forming terrestrial planets. By surveying OH, H2O, CO2, and CO with NIRSpec and exploiting the HST-JWST-ALMA synergy, we will compile a comprehensive inventory of key volatiles in a young exoplanetary system. This will allow us to conclusively determine whether exocometary compositions around HD110058 are similar to comets in our Solar System, and will demonstrate the feasibility of future exocometary compositions studies around other planetary systems with JWST.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 2987
Program Title: Resolving HII Regions and ISM Structure Across the Milky Way Analog NGC 253

Principal Investigator: Leroy, Adam

PI Institution: The Ohio State University

We propose to survey mid-IR emission from the the whole disk of the closest massive, star-forming southern galaxy: the prototypical spiral NGC 253. At the 3.6 Mpc distance to NGC 253, MIRI achieves 5 pc resolution in the PAH-tracing F770W band and 12 pc resolution in the continuum-dominated F2100W band, which allows the prospect (only possible in the closest galaxies) to resolve individual HII regions and ISM structures including molecular clouds and filaments. Pairing JWST with a unique full-galaxy 100 pointing VLT/MUSE map, we will measure resolved PAH and continuum profiles for > 6,500 HII regions. This will allow us to build a quantitative, data-driven model for the multiwavelength structure of HII regions as a function of powering luminosity and evolutionary state. Also building on investments by ALMA and MeerKAT, our survey will span from the gas-rich inner galaxy out to atomic-dominated regions analogous to the Solar Circle (rgal > 10 kpc), achieving a sharp view of the ISM over c. 300 kpc^2. The inclination of NGC 253 acts to our advantage here: we can easily distinguish individual regions and the inclined view gives access to vertical structure in the arms and bar. Overall, with a 22h investment, JWST can produce a revolutionary view of both HII region and neutral ISM structure that spans across the whole area of a prototypical spiral.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3010
Program Title: Spectroscopy of molecules and dust production in carbon stars

Principal Investigator: Sloan, Greg

PI Institution: Space Telescope Science Institute

We will observe nine carbon stars in the Large Magellanic Cloud with the Medium-Resolution Spectrometer (MRS) on MIRI. The spectral resolution and sensitivity of the MRS, coupled with the knowledge gained from recent infrared space telescopes, have created a unique opportunity. The proposed spectra will resolve the line structure within the mid-infrared absorption bands from the carbon-rich molecules which are the building blocks of the dust these stars form. The spectra will probe the chemistry and physical conditions in the molecular layer around each star. The sample covers the full range of molecular band strengths in relatively dust-free stars and the full range of mass-loss rates in stars with strong dust excesses. The spectra will probe the properties of the material from which dust condenses and test possible triggers of the final phase of strong mass loss that ends the lives of most stars.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3017
Program Title: High-resolution imaging of a compact lensed quasar at z=5.07 and a compound lensing system

Principal Investigator: Yue, Minghao

PI Institution: Massachusetts Institute of Technology

High-redshift lensed quasars are powerful tools to probe the evolution of SMBHs and their host galaxies in the early universe. The population of lensed quasars at high redshifts is largely unexplored, with only one lensed quasar reported at z>5 (J0439+1634 at z=6.52). Recently, J0025-0145 (z=5.07) has been identified as a lensed quasar, which is the second lensed quasar discovered at z>5. HST imaging unambiguously shows the existence of the foreground lensing galaxy, and the high apparent Eddington ratio suggests that J0025-0145 has a high magnification (>~80). However, the lensing structure of J0025-0145 is unresolved even in the HST images; instead of multiple lensed images, the quasar appears to be a single extended object. Here we propose NIRCam imaging for J0025-0145 in the F070W and the F480M filters. The F070W imaging delivers a PSF size that is ~3x sharper than HST and will safely resolve the lensing structure; the F480M filter detects long wavelengths where the quasar host galaxy has prominent flux. We will construct an accurate lensing model and measure the magnification for the background quasar. Aided by lensing magnification, J0025-0145 provides an exceptional chance to measure the stellar emission and morphology of a high-redshift quasar host galaxy, shedding light on the SMBH-host coevolution in the early universe. The proposed observation will yield a bonus science, i.e., constraining the properties of dark matter and dark energy using a triple-source compound lensing system in the field. With a very modest time request of 2.49 hours, this proposal will lead to high-impact results in both high-redshift quasar studies and cosmology.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3034
Program Title: Building on ALMA: a JWST legacy survey of the chemical evolution of planet-forming disks

Principal Investigator: Zhang, Ke

PI Institution: University of Wisconsin - Madison

We propose a JWST-MIRI program to systematically trace the chemical evolution over the lifetime of planet-forming disks, using the complete sample of 30 disks recently observed by the ALMA survey of Gas Evolution in Protoplanetary disks (AGE-PRO, 103h). This sample is the first systematically selected sample to study gas properties at three key evolutionary phases of planet-forming disks: the embedded disk phase, the middle age, and the end of the disk lifetime. The ALMA observations uniquely determine the mass distributions and chemical structures of the outer disk region (>20 au). JWST MIRI spectra will constrain the abundances of the main volatiles (e.g., H2O, CO, CO2) in the terrestrial-planet forming region (<10au). By combining JWST/ALMA observations of the full-age-range sample, this program will provide the very first answers to two fundamental questions of the chemical evolution during planet formation: (1) How do the volatile budgets in the gas of the terrestrial-planet-forming region evolve over the disk lifetime? (2) How do pebble growth and drift affect volatile compositions in the inner and outer regions of planet-forming disks? The results will be a key legacy dataset to test theories of chemical evolution in planet formation, and provide an essential context to link the atmospheric compositions of exoplanets to their formation and migration history.

Proposal Category: AR
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3038
Program Title: An archival study of AGN host galaxies with JWST NIRCam imaging

Principal Investigator: Zhuang, Mingyang

PI Institution: University of Illinois Urbana-Champaign

JWST's unparalleled imaging capabilities are starting to revolutionize the field of AGN host galaxy studies at high redshift. As JWST rapidly accumulates NIRCam imaging data across extragalactic fields, it is essential to understand the systematics of the instrument and develop efficient and robust methodologies for high-z AGN host measurements. This program will utilize archival NIRCam imaging data to perform a comprehensive analysis of the point-spread-function (PSF) as functions of field location/rotation, filters, dither patterns and star properties, and apply the results to AGN host measurements in well-covered extragalactic fields. The main deliverables from this program include: (1) detailed PSF characterization of NIRCam imaging and optimal strategies to construct robust PSF models for AGN host studies; (2) detailed simulations of mock observations to quantify the caveats and limitations of host measurements in high-z (broad-line) AGNs with NIRCam imaging; (3) measurements of host galaxy stellar properties for type 1 AGNs across much of the cosmic history to investigate the low-to-intermediate mass range of the black hole mass - host stellar mass relation, and to systematically discover and characterize the populations of galactic-scale dual and offset AGNs; (4) a detailed comparison of type 1 and type 2 AGN hosts up to z~3. The technical development and science results from this program will build solid ground to capitalize on the unique capabilities of NIRCam imaging, and enable broader science in the field of AGN and galaxy evolution.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3045
Program Title: Witnessing the Maturing of Teenage Galaxies at z = 4 – 6 with a Comprehensive UV - Optical - Sub-mm Benchmark Sample for the Community

Principal Investigator: Faisst, Andreas

PI Institution: California Institute of Technology

With NIRSpec IFU observations of 18 representative main-sequence galaxies at z=4.4-5.7, we complete the highest-redshift kpc-resolved rest-frame UV to far-IR benchmark sample to study how the first galaxies mature and grow to become the galaxies we observe at later cosmic times. Capitalizing on more than 10 years of observations with ALMA and other observatories, and combined with the newest JWST imaging data, all 18 galaxies have (i) high (<0.2”) and low (>0.5”) resolution ALMA sub-mm observations providing C+ and dust continuum measurements on kpc and extended scales (ii) optical JWST/NIRCam imaging probing their optical continuum, and (iii) other ancillary data including rest-frame UV imaging and spectroscopy. The proposed NIRSpec IFU observations add crucial spectroscopy of all main optical emission lines to this sample to constrain key properties at kpc-scales (0.1”-0.2”), including stellar masses, star-formation histories, dust attenuation, kinematics, photoionization, metallicity, and other chemical properties. With these kpc-resolution matched observations, we will jointly observe stars, gas and dust to (i) study how and where stars are formed, (ii) analyze in detail the interstellar medium, and (iii) explore and constrain the diverse dust properties and dust production mechanisms. To-date, this is the only sample with kpc-resolution multi-wavelength photometric and spectroscopic observations from rest-frame UV to far-IR at these redshifts, hence it will have a long-lasting impact on our understanding of galaxies living in the midst of a transformational phase between primordial and mature galaxy evolution shortly after the epoch of reionization.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3050
Program Title: A Hot View of Cold Gas

Principal Investigator: Goldsmith, Paul

PI Institution: Jet Propulsion Laboratory

We propose to carry out MRS observations of molecular hydrogen (H2) in a region at the edge of the Taurus molecular cloud to investigate turbulent dissipation (TD). H2, the main gas component of the star-forming interstellar medium, has largely evaded detection in molecular clouds due to its lack of permanent electric dipole moment and wide energy level spacing. Even its lowest rotational transitions require higher energy collisions than those at molecular clouds temperatures, but can be excited in regions of intense TD. The Spitzer detection of H2 emission in the proposed region indicates temperatures far in excess of what could be produced by standard heating sources. JWST offers, for the first time, angular resolution and sensitivity sufficient to resolve the expected scale size of TD regions. By measuring the flux and distribution of H2 rotational emission, we will determine the rate of TD and its importance for heating molecular regions and thereby controlling the rate of star formation. Models predict SNR>10 H2 detection in the 0.25" (0.0002 pc) MRS pixels. Two 4x4 mosaics of the S(1) line (a total FoV of 21”x25”) will fully sample the TD regions in two representative environments. The huge resolution improvement provided by JWST will allow the first definitive observation of TD and will be a significant step forward in understanding the turbulence regulation of star formation, and hence the evolution of galaxies. The TD in Taurus should not be unique, but this is a favorable region to isolate TD-produced H2 emission. Thus, if successful, the proposed observations promise a view in JWST's infrared window of ‘hot’ gas in previously assumed 'cold’ molecular clouds.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 3055
Program Title: A TRGB calibration of Surface Brightness Fluctuations

Principal Investigator: Tully, R.

PI Institution: University of Hawaii

If the holy grail of a 1% measurement of the Hubble constant from measurements of galaxy distances and velocities is to be achieved, it will be essential to complement the current effort based on Population I star Cepheid and Type Ia supernova measurements. An alternate path that promises comparable accuracy involves the Population II route through tip of the red giant branch (TRGB) and surface brightness fluctuation (SBF) distances. This path requires implementation of 4 steps: (1) parallax zero-point calibration of TRGB, (2) transfer of the TRGB calibration to SBF, (3) full vetting of the SBF methodology, and (4) exploitation of SBF to a large sample at large distances. The current program addresses the second step: the connection between TRGB and SBF distance scales. These two methodologies are physically connected; the constancy of energy release from the brightest stars on the red giant branch when degenerate helium cores commence burning to carbon. With TRGB, the individual brightest RGB stars are observed; with SBF, the unresolved mottling caused by these stars is recorded. In detail, metallicity-age effects are such that optimal passbands and positioning of targets are different for TRGB and SBF measurements. In the case of TRGB, there is relative constancy at low metallicities in F090W and fields in halos are favored where low metallicity stars are dominant. With SBF, there is relative constancy at high metallicities in the F150W passband and such stars are dominant in the centers of the E-S0 systems to be given attention. With the extended spatial coverage of NIRCam, the observations required for TRGB and SBF studies can be acquired simultaneously.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3073
Program Title: Spectroscopic confirmation of an unexpected population of bright galaxies at cosmic dawn

Principal Investigator: Castellano, Marco

PI Institution: INAF, Osservatorio Astronomico di Roma

The discovery of a large number of bright galaxies at z>10 in the first JWST NIRCam fields is questioning our understanding of galaxy evolution at cosmic dawn. The surprisingly high number density compared to theoretical models may imply that the evolution of early star formation is decoupled from the evolution of dark matter halos. Spectroscopic validation of the photometric selections and an assessment of the role of cosmic variance on early UV LF estimates are needed to confirm these findings. The present proposal will clarify these issues by targeting the field behind the cluster Abell-2744 where the most remarkable examples of this unexpected population have been reported. We will observe with NIRSPec PRISM six robust candidates at z~9-12. The sample includes GHZ1/GLASS-z10 at z~10-11 and GHZ2/GLASS-z12 at z~12-12.5, that stand out for their brightness and robustness assessed by several independent investigations, and four robust candidates that possibly form an overdensity at z~10 together with GHZ1/GLASS-z11. The proposed observations will secure the redshift and SFR of the targets with SNR>5-10 measurements of both their Lyman break and [OII]3727 line, while obtaining deep limits on Ly-alpha and on UV emission lines. JWST spectra will confirm this new population, assess the presence of an overdensity at z~10 and of early ionized bubbles in the field and detect whether the objects host an AGN or extreme stellar populations. Coordinated six-band NIRCam parallel observations on two flanking fields will extend the selection of z>9 galaxies in the region and the mapping of the potential overdensity at z~10.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3077
Program Title: TRAPPIST-1 Planets: Atmospheres Or Not?

Principal Investigator: Gillon, Michael

PI Institution: Université de Liège

Small rocky planets are now known to be very frequent in temperate orbits around low-mass M-dwarfs. The most pressing question regarding these ubiquitous planets concerns their capacity to maintain significant secondary atmospheres despite the adverse environment (high XUV fluxes, winds) and history (long pre-main-sequence) brought by their small host stars. Here, we propose to use MIRI to determine unambigously if the two inner planets of the TRAPPIST-1 system are bare rocks or not by complementing the Cycle 1 measurements of their daysides' thermal emission at 15microns with the observation of their combined thermal phase curve. The presence of an atmosphere around at least one of the two planets would not only be a very encouraging prospect for the presence of atmospheres around the five cooler outer planets of the system, but it would also represent a critical step in the study of M-dwarfs' rocky planets and their potential habitability.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3079
Program Title: BEES: Black hole Extended Emission Search

Principal Investigator: Eilers, Anna-Christina

PI Institution: Massachusetts Institute of Technology

Observations of high-redshift quasars hosting supermassive black holes (SMBHs) with billion solar masses less than 1 Gyr after the Big Bang challenge our understanding of black hole growth. In the standard black hole growth picture these quasars need to accrete matter continuously at the Eddington limit over timescales comparable to the age of the universe at that time, i.e. ~1e9 years. However, recent estimates of the quasars' lifetimes based on the line-of-sight proximity effect suggest lifetimes several orders of magnitude shorter than expected. Such short lifetimes and the rapid concurrent SMBH growth can be explained by invoking either highly radiatively inefficient ``super-Eddington'' accretion rates, or obscured, dust-enshrouded SMBH growth phases. In order to break this degeneracy, this proposal aims to spatially map the ionizing imprint of the quasars' emission on the surrounding circumgalactic gas, in order to provide a model-independent lifetime estimate perpendicular to our sightline to the quasar, based on the light travel time of the quasar's radiation. A comparison between these two quasar activity timescales will either confirm the short lifetimes and thus require ``super-Eddington'' accretion rates to explain the rapid SMBH growth, or show a discrepancy, indicating evidence for time-variable obscuration effects along our line-of-sight. Either observational result will present novel insights into the early growth phases of SMBHs. The spatially resolved line diagnostics from the proposed NIRSpec/IFU observations will also allow us to distinguish between gas photoionized by the quasar or by the long sought-after stellar light of their host galaxy.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3084
Program Title: First spatially resolved characterization of a radio-driven outflow at z~6

Principal Investigator: Banados, Eduardo

PI Institution: Max Planck Institute for Astronomy

The interactions between radio jets and the interstellar medium play a defining role in the co-evolution of supermassive black holes and stellar masses in galaxies. However, observations of such feedback processes are currently limited to cosmic noon (z~2-3) and non-existent at earlier cosmic epochs. The lack of constraints on kinetic feedback from high-redshift (z~6) quasars leaves great uncertainty in theoretical models of early galaxy and black hole growth. Here we propose NIRSpec IFU observations to finally investigate this frontier, targeting the z~6 quasar hosting the largest galactic-scale (~1.7 kpc) radio jet known at this cosmic epoch. ALMA observations revealed that the jet is co-spatial with an outflow traced by [CII] gas. Through our observations, we will probe the morphology and kinematics of the warm ionized gas in [OIII] (as well as other key outflow tracers such as H-alpha and H-beta). We will test whether the gas shows signs of interaction with the radio jets and the [CII] outflow. If the [OIII] is radio-driven, we can set novel constraints on the apparent striking absence of giant radio jets at z>4. We will establish whether these jets exist, but the CMB quenches their radio emission or if the ISM conditions in the early Universe prevent their existence. Finally, this program will provide the first spatially resolved multi-phase characterization of AGN feedback processes underway during the formation of a massive galaxy in the Universe's first billion years.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3087
Program Title: Reaching ~0.1 arcsec inner working angle for NIRCam coronagraphic imaging

Principal Investigator: Ren, Bin

PI Institution: IPAG (Institut de Planétologie et d'Astrophysique de Grenobl

Depending on the physical sizes of the coronagraphic round masks on NIRCam, they can image the surrounding environments of central bright sources down to ~0.4 arcsec inner working angle (IWA). Nevertheless, to image closer-in regions, the roll restriction of JWST poses fundamental limits on the coverage of bar masks. With the established on-sky measurement of the ~1.1 mas pointing stability of JWST, we can push beyond the IWA for the NIRCam round masks. By incrementally dithering along the hexagonal direction of the masks, and with carefully designed exposure times, we could image the surroundings of central sources down to 0.1 arcsec or less. We propose to perferm such an instrumental calibration exploration for the MASK210R occulter of NIRCam, and thus push the supported IWA to one that supercedes the stated values. Using a total of 1.5 hours of on-target exposure for the prototypical debris ring around HR 4796A and its point spread function star, we expect to recover the minor axis of the ring at a radius of ~0.15 arcsec. Upon the completion of this program, we will provide NIRCam technical report to establish formal guidelines in using this mode for future users. By establishing a ~0.1 arcsec IWA for NIRCam, we will provide the access to close-in planets, close-in substructures (both circumstellar and circum-quasar): all these regions are where we have identified evidence for planet-disk interactions or circumnulear structures, which are hidden with other high-contrast imagers or ALMA but uniquely accessible by JWST.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3131
Program Title: The nature of the compact object in SN 1987A

Principal Investigator: Larsson, Josefin

PI Institution: Royal Institute of Technology

JWST GTO observations of Supernova (SN) 1987A in Cycle 1 have dramatically improved our understanding of this iconic event. The observations show the presence of narrow lines from highly ionised argon at the very center of the remnant, which provides the first clear electromagnetic signal from the compact object created in the explosion. However, the nature of the ionising emission and the properties of the compact object are poorly constrained from the existing medium-resolution NIRSpec observations. We propose to observe SN 1987A with the high-resolution mode of the NIRSpec IFU to determine the properties of the compact object. This will be done by searching for additional weak lines from the compact object and by measuring the detailed line profile and temporal evolution of the detected [Ar VI] line. Only JWST offers spatially resolved spectroscopy with sufficient angular resolution to detect faint narrow lines overlapping with the ejecta emission. The observations will also be used to determine the 3D distribution of ejecta, which reveals the properties of the explosion itself, and to follow the time evolution of the shock interaction. SN 1987A will be the first SN where the properties of the progenitor star, neutrino burst, explosion, and resulting compact object can be connected.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3134
Program Title: The Origins of Hostless Short Gamma-ray Bursts

Principal Investigator: Gompertz, Benjamin

PI Institution: University of Birmingham

Short gamma-ray bursts (SGRBs) are explosive transients that can be seen at cosmological distances. They have been confirmed to be driven by compact object mergers and to produce kilonovae, the radioactive signature of heavy element nucleosynthesis. SGRBs are therefore valuable markers for r-process enrichment throughout the Universe, and for the rates and merger delay times of compact binaries through cosmic time. Because they fade fast, their redshifts must be derived via association with a likely host galaxy, whose redshift is measured as a proxy. However, in a number of cases no suitable host is seen to HST depths, despite precise (sub-arcsecond) localisations of the burst position. This could indicate that the compact binary travelled a substantial distance from its host before merging, or that there is a faint and/or distant host galaxy as-yet undetected at the burst location. Here, we propose NIRCam photometric observations with JWST designed to disentangle these possibilities by searching for faint hosts in the redshift range $2< z < 3.5$, which is poorly constrained by the available HST observations. Either outcome - highly kicked or high redshift - has profound implications for our understanding of the evolution of the Universe, encompassing binary evolution, natal kicks, merger delay times, gravitational-wave rates and follow-up strategy, r-process enrichment, and galaxy evolution.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3149
Program Title: A possible runaway supermassive black hole at the tip of a 62 kpc long linear feature

Principal Investigator: van Dokkum, Pieter

PI Institution: Yale University

It has long been predicted that supermassive black holes (SMBHs) can be ejected from their host galaxies, through gravitational recoil or a three-body interaction after multiple galaxy mergers. So far no runaway SMBHs have been securely identified. A new candidate was recently serendipitously found in HST/ACS data. F606W and F814W images, combined with Keck spectra, show a striking linear feature at z=0.964 with a length of 62 kpc. Strong and complex emission lines are detected all along the feature, including a bright knot of [OIII] emission at the tip. The linear feature has been interpreted as the wake behind a runaway SMBH, with the observed continuum and line emission produced by shocks and star formation in the circumgalactic medium. Here we propose to obtain spatially-resolved spectroscopy of the region near the tip, using the NIRSpec IFU. The spectra cover the important diagnostic lines [OIII], Halpha, [NII], and [SII]. The primary goal is to search for the expected highly red- or blue-shifted broad emission lines that are associated with the SMBH itself, either from bound gas that escaped with it or from accretion onto the black hole. A detection would be definitive evidence for the existence of runaway supermassive black holes, fifty years after they were predicted. A secondary goal is to map the morphology of the ionized circumgalactic medium.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3153
Program Title: Why do some 50 Myr old stars still accrete?

Principal Investigator: Long, Feng

PI Institution: University of Arizona

The outcome of planet formation is largely determined by how the disk dust and gas evolve. Recent studies have identified a new class of disks that surround late M type stars (>M4.5) at ages of 40-60 Myr and with spectroscopic evidence of active accretion. The strong infrared excess and broad H alpha emission lines are hallmarks of gas-rich primordial disks. Given the typical disk lifetime of 3-5 Myr, surviving for ~10 times longer is very surprising. If these are indeed primordial disks, their survival would revise our understanding of disk dissipation and planet formation around M dwarfs. On the other hand, their infrared excess levels are also consistent with a type of unusually dust-rich debris disks that are believed to have experienced a recent giant collision, along with more compatible ages. We propose to use MIRI/MRS to study the gas and dust content in these peculiar disks and to determine their evolutionary status. The detection of abundant C-bearing molecules with a high C/O ratio, characteristic of young M dwarf disk chemistry, would suggest a long-lived gas-rich disk, while the presence of a large amount of silica dust would point to a recent high-energy collision. Both scenarios will have important implications for planet formation, as the former provides clues for the build-up process of compact systems like TRAPPIST-1, while the latter dives into the active stage of terrestrial planet assembly.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3154
Program Title: Testing the C/O Ratio Prediction for Hot Jupiters from Disk-Free Migration

Principal Investigator: Ahrer, Eva-Maria

PI Institution: The University of Warwick

Almost three decades have passed since the first discovery of a hot Jupiter and many have been discovered since then. However, their formation and migration mechanisms are not yet understood and we lack methods that can clearly determine whether a hot Jupiter has moved through either disk-free or disk-driven migration or has formed in situ. With this programme we will observe a hot Jupiter that orbits a star in a binary system in a misaligned and retrograde way. Theory predicts that it must have migrated via disk-free migration, which in turn notably restricts the value the carbon-to-oxygen (C/O) ratio of the atmosphere can be. We will test this C/O prediction by measuring the abundances of carbon- and oxygen-bearing molecules in the atmosphere of WASP-94Ab in one transit, utilizing JWST's unique capabilities to provide high-precision time-series observations in the infrared wavelength range. We will determine the C/O ratio of WASP-94Ab and be able to confirm or refute the theory prediction. If it matches, we will provide the first atmospheric characterization of a hot Jupiter that we know must have migrated via disk-free migration. If it does not match, we will provide evidence for other processes in planet formation theory that have been missed so far.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3158
Program Title: JWST/MIRI unravels the impact of AGN feedback on star-formation at cosmic noon

Principal Investigator: Mainieri, Vincenzo

PI Institution: European Southern Observatory - Germany

Detailed 3D zoom-in hydrodynamical simulations predicted a wide range of possible effects that energetic AGN-driven outflows have on their galaxy host's gas content: from no impact on to significant destruction of dense gas clouds in the nucleus and rapid suppression of star-formation. Observations are therefore key to determine which theoretical scenario is correct; however, they have been severely limited, prior of the JWST era, by their inability to have a reliable tracer of recent (<10 Myr) star-formation in luminous (log(Lbol)=45-46 erg s-1) AGN at z~2. With JWST/MIRI, we will ovecome this limitation by using the PAH[6.2 micron] emission to reliably trace, in a spatially resolved fashion, the recent star-formation. We target four AGN at z~2 with already identified ~6kpc wide ionized outflows based on deep SINFONI-AO observations. We will combine the MIRI PAH maps with the already available ionized outflow maps, as traced by [OIII], and ALMA maps tracing star-formation on ~100 My timescales (from rest-frame FIR continuum observations). This unique set of observations will allow us to answer the following questions: 1) are these AGN outflows able to rapidly suppress star-formation? 2) are these AGN outflows driven by radiation pressure on dust or are thermally driven?

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3162
Program Title: Does star formation require molecular gas?

Principal Investigator: Glover, Simon

PI Institution: Universitat Heidelberg

We propose to carry out a strong test of the hypothesis that star formation requires the presence of molecular gas. To do this, we will search for H2 rotational line emission from the extremely low metallicity star-forming dwarf galaxy I Zw 18 using the MIRI IFU. Successful detection of this emission will allow us to constrain the molecular gas mass in I Zw 18, enabling us to compare it with the predictions of the H2-regulated star formation model. Alternatively, non-detection of the lines will allow us to rule out the presence of any significant mass of H2, providing strong support for models in which the presence of H2 is not necessary for star formation. In addition, because we require observations in all three grating settings to cover the H2 lines, our proposed observations will yield deep MIR spectra of I Zw 18 covering a broad range of wavelengths and including a number of nebular emission lines and PAH features. These observations will therefore enable a very broad range of additional science.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3166
Program Title: Investigating the Role and the Physical State of Molecular Hydrogen in the Central Parsec of the Galaxy

Principal Investigator: Ciurlo, Anna

PI Institution: University of California - Los Angeles

We propose to investigate the distribution, origin, and excitation of molecular hydrogen in the central parsec of our Galaxy. At this scale, the largest reservoir of matter close to the central supermassive black hole is the Circumnuclear Disk (CND). This torus of molecular material has an inner cavity which is UV-irradiated by a cluster of massive young stars surrounding the Galactic black hole. In such an extreme environment, molecular hydrogen is expected to be photodissociated or ionized, but copious H2 has been detected inside the inner cavity of the CND. The origin and excitation mechanism of this molecular hydrogen is unknown. Previous work was done with ro-vibrational lines, which are a limited probe as they only trace the hottest gas. We propose to observe several purely rotational emission lines of H2 with MIRS-MRS. These lines trace a larger fraction of H2 at warm temperatures. We plan to observe H2 both in the inner cavity and in the CND itself, in order to elucidate the excitation mechanism of H2 in both environments, investigate its origin, and compare the internal structure of the CND with existing models. This will allow us to understand the conditions of the gas (in the CND) that will eventually trigger a massive accretion event, and the region (the central cavity) where neutral gas if further along its way toward the black hole. Furthermore, star formation in this extreme environment occurred in the past but whether it is presently occurring is debated. We will be able to better constraint whether the conditions of the gas are suitable for star formation.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3168
Program Title: Ultracool White Dwarfs: Cool or Not So Cool?

Principal Investigator: Blouin, Simon

PI Institution: University of Victoria

Ultracool white dwarfs (WDs) display peculiar energy distributions with very strong collision-induced absorption (CIA) features in the infrared. They are generally thought to be among the coolest, oldest WDs of our Galaxy, and therefore crucial objects for WD cosmochronology. Despite their importance, the very nature of ultracool WDs remains unknown. Some model atmosphere analyses suggest that they have extremely low temperatures and masses (Teff~3500K, M~0.2Msun) while others suggest more moderate temperatures and normal masses (Teff~4500K, M~0.6Msun), implying multi-Gyr discrepancies for their inferred ages. The key difference between these widely diverging assessments is the choice of CIA opacities. JWST can decidedly settle this debate by directly revealing CIA features for the first time through infrared spectroscopy of ultracool WDs. We propose to use NIRSpec and MIRI to obtain low-resolution spectroscopy of three ultracool WDs that we selected for their unique potential to yield the most stringent constraints on competing models.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3171
Program Title: Red Dwarfs and the Seven Giants: First Insights into the Atmospheres of Giant Exoplanets around M-dwarf Stars

Principal Investigator: Kanodia, Shubham

PI Institution: Carnegie Institution of Washington

A primary science goal of JWST is to understand the atmospheres of other worlds and investigate how a planet's atmospheric composition can inform us about its formation and evolutionary history. Of particular interest is the recently-discovered sample of short-period, Jupiter-sized planets orbiting M-dwarfs, which present challenges to our current theories of planet formation. This new sample of planets also represents an extreme regime of planet formation that has not yet been probed in the context of atmospheric characterization. The path to understanding how these systems form therefore begins with a fundamental question: How do the atmospheres of these M-dwarf giant planets compare to giant planets orbiting Sun-like stars? Thanks to the large transit-depths and warm temperatures of M-dwarf giant planets, we can access the absorption features for both water and methane in the planet atmospheres. We therefore have the unique opportunity to observe this new sample of close-in giant planets orbiting M dwarfs with JWST to precisely characterize their atmospheric composition and metallicity, and compare them with their FGK host analogues. In this study, we will obtain transmission spectra of seven M-dwarf short-period Jupiters using the NIRSpec/PRISM to observe between 0.6-5.3 μm, a region where molecular features from water and methane are dominant, which we will use as tracers for atmospheric metallicity. Ultimately, this study will shed light on whether M-dwarf gas giants have similar formation and evolution pathways to their FGK counterparts.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3177
Program Title: Beholding star cluster formation, feedback, and evolution with the 'Evil Eye'

Principal Investigator: Sun, Jiayi

PI Institution: McMaster University

We propose NIRCam+MIRI multi-band imaging for the Evil Eye Galaxy (M64), a unique nearby merger-induced starburst system. We will uncover a large population of deeply embedded star clusters in the dusty, compact, inner disk of M64, where the high gas surface densities and complex orbital configurations provide very favorable conditions for massive cluster formation and survival. At the 4.4 Mpc distance to this target, NIRCam can resolve massive star clusters and the HII regions they power, yielding accurate size estimates and thus robust quantifications of the strength of various stellar feedback processes. Meanwhile, MIRI can map the multi-phase gas distribution down to the diffuse gas limit (< 10 Msun/pc^2) and resolve the filamentary gas structures that underlie and possibly fuel the dense, cluster-forming hubs. The proximity and compactness of M64 make it possible to address such a rich set of science goals regarding cluster formation, feedback, and evolution with only 3 hours of total charged time. With rich multiwavelength data in hand, this program will provide the last missing piece for a first synthesized study of star clusters, gas clouds, and HII regions in a unique, close-by, merger-driven starburst system.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3181
Program Title: Monitor a variable planetary mass companion with NIRSpec IFU

Principal Investigator: Zhou, Yifan

PI Institution: University of Texas at Austin

Variability is prevalent among brown dwarfs and likely common in directly imaged exoplanets. Spectral variability has revealed 3D atmospheric structures and probed underlying atmospheric dynamics in brown dwarfs and wide-separated planetary-mass companions. Temporal spectral variations also induce significant uncertainties for interpreting spectral snapshots, underscoring an urgent need for precision spectral time series of directly imaged exoplanets. Observing spectral variability in directly imaged exoplanets has been proven to be challenging with ground-based AO instruments. JWST commissioning and ERS results show that NIRSpec IFU is an ideal instrument for precision high-contrast spectroscopic time-series observations. We propose a pilot study to demonstrate the time-series observing capability of NIRSpec IFU. We identify 2M1207b, a known variable 4 Jupiter-mass companion, as the best target and craft a NIRSpec IFU PRISM monitoring campaign. We will jointly adopt reference star and spectral differential imaging to eliminate flux contamination from the host star and expect to achieve 0.1\% light curve precision. The broad wavelength coverage and excellent photometric stability of JWST will allow us to unveil the cloud structures and probe spatial variations of CO-methane chemistry in a planetary atmosphere in unprecedented detail. We will also characterize possible systematic noise in IFU high-contrast time-series observations and build the foundation for an exoplanet monitoring survey. Our program will establish NIRSpec IFU as a powerful planet mapper and an essential instrument for probing clouds and circulation in planetary atmospheres.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3189
Program Title: The Nature of Mineralogical Dichotomy in Extreme Debris Disks

Principal Investigator: Su, Kate

PI Institution: University of Arizona

The variable emission of young, extreme debris disks (EDDs), as monitored by warm Spitzer, provides a unique window to explore large-scale collisions in the terrestrial planet zone during the oligarchic and chaotic phases of planet formation. Some of these systems where Spitzer mid-infrared spectroscopy was obtained reveal an intriguing dichotomy in the dust mineralogy of impact-produced debris -- one third of them show silica-rich fine dust, likely created from the evaporating bodies in a hyper-velocity giant collision, while the others show forsterite-rich fine dust, evidence for high-temperature thermal alteration, a condition commonly expected in major collisions of large asteroid-size bodies. The nature of this apparent mineralogical dichotomy is unknown. In this program, we will conduct a detailed mineralogical investigation for 11 newly identified EDDs that exhibit various degrees of infrared variability (indications of collisions between large bodies) revealed by WISE. The all-sky WISE data has substantially expanded the sample of EDDs over those found with Spitzer, and make possible for the first time meaningful comparative studies of their properties. Using MIRI/MRS mode, we will quantify the presence of silica dust in different polymorph forms that trace different levels of formation pressure, and directly connect the resulting impact conditions with the sizes of impact bodies (planetary embryos or large asteroids).

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 3195
Program Title: Are M-Type asteroids the remnant core fragments of the planetesimals?

Principal Investigator: de Kleer, Katherine

PI Institution: California Institute of Technology

The existence of iron and stony-iron meteorites, as well as our current understanding of planet formation, indicate that many of the early planetesimals must have been sufficiently heated to have undergone differentiation and core formation. The remnants of this process – the parent bodies of the iron meteorites - should be present in the asteroid belt in the form of large core and core/mantle fragments. The M-type asteroids have been hypothesized to represent such objects, but results the past decade continue to reveal that the reality is more complicated than this simple picture. The compositional information that can be obtained from the ground is limited because M-type asteroids are (by definition) lacking distinctive spectral features in the visible and near-infrared, and the diagnostic mid-IR bands are blocked by telluric absorptions. We propose to obtain 5-28 micron spectra of a representative set of M-type with MIRI/MRS; numerous diagnostic spectral features are present in this range that will differentiate between the candidate hypotheses for the surface mineralogy of these bodies and identify the best spectral match with meteorite classes. The proposed program will address the outstanding question of the composition of the M-type asteroids and whether they are the parent bodies of the iron meteorites.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3201
Program Title: The Utility of Self-Consistent Models and Photochemistry in Understanding Transiting Planet Atmospheres

Principal Investigator: Fortney, Jonathan

PI Institution: University of California - Santa Cruz

"Self-Consistent" or "Radiative-Convective Equilibrium" (RCE) models are the workhourse of planetary atmosphere modeling. Such models iterate to a solution for the mean atmospheric pressure-temperature profile and molecular abundances with all physics and chemistry known. Grids of RCE models are essential for predicting and explaining trends for transiting planet atmospheres, which retrievals cannot provide. These models are essential to the interpretation of exoplanet spectra, as it is only in comparison to RCE models that finding can be characterized as "expected" of "unexpected." Such models are the standard for data/model comparison for imaged planets and brown dwarfs, alongside retrievals. We propose to signficantly increase the usage and utility of RCE models for transiting planets by computing a grid to RCE model atmospheres in chemical equilibrium for every Cycle 1 and 2 target in the sub-Neptune to gas giant mass range. We will then push the science of RCE models forward by coupling two open source python tools, PICASO for atmospheric structure, and VULCAN for photochemistry, together. This coupling will yield the first open source tool, readily usable by any investigator, to examine the role of photochemisty and vertical mixing on atmospheric abundances, temperature structure, and spectra.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3207
Program Title: Lifting the Veil: An Open Source Haze Model for Exoplanet Atmospheric Characterization

Principal Investigator: Gao, Peter

PI Institution: Carnegie Institution of Washington

Clouds and hazes are common in the atmospheres of exoplanets. These small particles impact atmospheric radiative transfer and chemistry, and impede our efforts to characterize atmospheres through remote sensing. The extensive, continuous wavelength coverage and greater precision of JWST will likely reveal further impacts of clouds and hazes, including their complex spectral behavior, which depends on the particle size distribution and optical constants. Photochemical hazes, in particular, are a cause for concern due to uncertainties surrounding their formation and composition and their preference for the cooler, higher metallicity atmospheres of sub-Neptunes - a major class of targets for current and future JWST programs. We propose to build an open source, fast, flexible, and physical model of photochemical hazes that can be used to interpret JWST data for nearly all exoplanets. It will be derived from an oft-used and well validated aerosol microphysics code and updated to take into account new coding practices and advancements in our knowledge of haze physics. The code will be stored on github and open to use by anyone in the exoplanet community for both interpreting data and studying the impact of hazes on atmospheres. We will further use the code to generate a grid of models for a variety of haze and planetary parameters to study trends in haze properties and to facilitate comparisons to data.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3215
Program Title: Unveiling the Redshift Frontier with JWST

Principal Investigator: Eisenstein, Daniel

PI Institution: Harvard University

We will conduct a deep 6-filter medium-band JWST/NIRCam imaging survey designed to robustly identify galaxies at the redshift frontier, z>15. The abundance and properties of these infant galaxies are extremely sensitive to assumptions in models of galaxy formation and offer the opportunity for novel discoveries about the physics of the early Universe. We propose to reach a depth, 2 nJy (5-sigma, 0.1" radius), capable of detecting these galaxies in a wide range of scenarios. We argue that medium-band imaging from 1.62 to 3.35 microns is critical for isolating the sharp Ly-alpha dropout and separating these galaxies from mid-redshift contaminants. Our survey leverages 55 hrs of Cycle 1 wide-band GOODS-S observations and will produce a superb 14-band NIRCam data set for legacy science. We will conduct this survey as Coordinated Parallels to deep NIRSpec multi-object spectrocopy. We will obtain exquisite spectroscopy, up to 59 hrs with the PRISM and 47 hrs with the G395M grating, of nearly 200 NIRCam-selected z>5 galaxy candidates in and around the Hubble Ultra Deep Field. These spectra will provide detailed information about individual high-redshift galaxies, not just stacks or averages, allowing us to study the chemical enrichment, stellar populations, star-formation histories, and nuclear black holes in the first billion years of the Universe.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3222
Program Title: Cask-strength clouds: high percentage of methanol and HDO ices

Principal Investigator: Drozdovskaya, Maria

PI Institution: University of Bern

Understanding the chemical inventory from clouds to planets is a major task in astrochemistry. Low-mass star-forming regions are teeming with complex organic molecules, but the exact combination of gas-phase and grain-surface chemical processes responsible for their synthesis is intensely debated. A key question is to what extent such molecules stem from the prestellar cores that birth the protostars? The trail of water, the dominant volatile, has been intensively studied through deuteration. The HDO/H2O ratio has been used to demonstrate that the water in cores may be connected with water in protoplanetary disks, comets, and the Earth’s oceans. However, only a tentative measurement of this ratio exists for interstellar ices, where these molecules originate from. We seek to investigate the chemical composition of ices in the L1689N dark cloud that houses the best-characterized, chemically diverse low-mass protostellar system IRAS 16293-2422 A/B, and the adjacent prestellar core I16293E with some of the highest measured levels of deuteration. With NIRSpec MOS, we will determine the abundances of CO, CO2, H2O, and CH3OH ices in at least a dozen positions in this cloud. We will verify if the tremendous chemical wealth of IRAS 16293-2422 A/B is correlated with high mthanol ice column densities as expected in the scenario of grain-surface chemistry. The requested sensitivity will constrain HDO ice in the most D-rich I16293E source. Finally, we will probe for the first time if the ice available for the formation of protostars and protoplanetary disks depends on the age of birth cloud and the number of stars that have already formed there.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3225
Program Title: What are the real mass loss rates of massive stars?

Principal Investigator: Garcia, Miriam

PI Institution: Centro de Astrobiologia (CSIC/INTA) Inst. Nac. de Tec. Aero.

Mass loss is a key physical process ruling the evolution of massive stars, whose impact propagates into galactic evolution, population synthesis models, the interpretation of high-redshift galaxies, explosive events like SN, and our understanding of the First Stars. However, there are currently substantial uncertainties in the low-metallicity (Z), low-luminosity regimes where the classical diagnostics, H-alpha and UV P-Cygni profiles, fail to yield true mass-loss rates. Only upper limits exist for most of the parameter space of interest and this is insufficient to inform the models of evolution. In contrast, the Br-alpha line in the mid-IR breaks this degeneracy, enabling accurate determination of very low mass loss rates that are also independent from assumptions concerning wind inhomogeneities and wind X-ray emission. The technique has already been demonstrated for bright O-stars in the Milky Way. However, our primary low-Z laboratory is the Small Magellanic Cloud (SMC), where Br-alpha spectroscopy of O-stars is simply impossible for any facility other than JWST. We propose to exploit JWST's superb sensitivity in the thermal IR to determine the mass-loss rates of SMC O-stars with thin winds for the first time. Our results will serve to anchor the physics of radiation-driven wind theory that is so crucial for our understanding of massive star evolution and their impact on the Universe.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3226
Program Title: Extremely metal-poor galaxies as laboratories for the first galaxies

Principal Investigator: Schaerer, Daniel

PI Institution: University of Geneva, Department of Astronomy

We propose to obtain the first complete mid-IR (5-25 micron) spectra of five of the most metal-poor, compact star-forming galaxies - with metallicities 12+log(O/H)=6.98-7.23 - known so far. The H recombination lines and the numerous fine-structure lines of Ne, Ar, S, Mg, and others will provide unique constraints on the ionizing radiation field of these galaxies over a wide range of energies. This is of prime interest to help solving a long-standing problem of metal-poor galaxies, whose hard spectra represent a major challenge for stellar population and photoionization models. The mid-IR lines will allow us to determine accurate nebular abundances of Ne/H, Ar/H, and others, avoiding the temperature dependence of the "direct method" employing optical emission lines. The O/H abundance ("metallicity") derived from the mid-IR spectra will thus provide a fundamental test of the 'golden standard' of extra-galactic metallicities, which could be systematically biased and underestimated due to electron temperature variations on spatially unresolved scales. The mid-IR spectra will provide unique empirical information on a variety of physical mechanisms (photoionization, X-ray ionization, shocks) which may be present in these extreme objects. They will also be combined with multi-wavelength observations from HST, 10m class telescopes, VLA, GMRT, and others, to yield the most detailed description of the ISM and radiation field of extremely metal-poor galaxies. The proposed JWST observations will have an important impact on the interpretation of upcoming JWST spectroscopic observations and on our understanding of the most metal-poor and first galaxies in the early Universe.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3228
Program Title: The volatile inventory of the terrestrial planet forming zone: a study of transport from the outer to the inner disk with JWST and ALMA

Principal Investigator: Cleeves, Ilse

PI Institution: The University of Virginia

To date, observations of both planet-forming disks and exoplanets show a large degree of chemical heterogeneity. Many observed disks have gas-phase compositions inconsistent with known exoplanets' atmospheric compositions. Is this discrepancy real? And are chemical variations across known disks intrinsic or are they instead a result of an incomplete or unrepresentative sample? And if they prove real, what are the most important physical mechanisms driving disk composition? We propose to address these questions by analyzing sensitive JWST MIRI spectroscopy for a sample of 40 disks whose chemistry will be surveyed with ALMA as part of the Disk-Exoplanet C/Onnection Cycle 9 Large Program. While the ALMA program proposes to constrain the outer disk C/O ratio, only with JWST MIRI is it possible to determine the composition, including C/O, of the terrestrial planet forming zone. By combining ALMA, JWST archival data (18 disks), and the observations proposed here (22 disks), this program has the potential to unlock not only how diverse are planet forming environments, but also the physical/chemical origins of this diversity.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3231
Program Title: Panchromatic Phase Curve of the Highest-S/N Hot Neptune

Principal Investigator: Crossfield, Ian

PI Institution: University of Kansas Center for Research, Inc.

Planets are complex three dimensional objects whose temperature, chemistry, and clouds vary throughout their atmospheres. Phase curve spectroscopy provides great insight into the atmospheric structure of giant exoplanets, but such observations are sorely lacking for Neptune-size exoplanets. We propose to measure the spectroscopic thermal phase curve of hot Neptune LTT 9779b with NIRSpec/G395H (3-5 micron) to measure the planet's global thermal and molecular structure via two day-side eclipse spectra, one transmission spectrum, and longitudinally-resolved emission spectra via a full-orbit phase curve. Our program will (i) measure the planet's global molecular abundances to a precision of <0.5 dex and its C/O ratio to better than 10% at the day-side, night-side, terminator, and at intermediate longitudes, (ii) measure cloud properties at all longitudes to compare to the ubiquitous night-side clouds and patchy terminators seen in hot Jupiters, and (iii) provide the definitive hot-Neptune benchmark against which to compare the next generation of models of small exoplanet atmospheric circulation, chemistry, clouds, and global thermal structure. LTT 9779b is the single best exo-Neptune for these studies because it has: (1) a broadband phase curve and SED already measured with Spitzer; (2) a short, 19-hour orbital period that permits a full-orbit JWST phase curves in a Small program; (3) a hot day-side and bright star that yield high S/N; and (4) a complementary Cycle 1 NIRISS/SOSS phase curve at 1-2.6 micron. However, our simulations show that a combined NIRISS+NIRSpec analysis is necessary to usefully measure the planet's global atmospheric properties.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3235
Program Title: C,N,O in a Temperate Jupiter: Bridging the Gap Between Solar-System and Exoplanet Atmospheres

Principal Investigator: Fortney, Jonathan

PI Institution: University of California - Santa Cruz

We propose to use NIRSpec PRISM to measure the 0.6-5.5 micron transmission spectrum of planet PH2b, a 300K, temperate giant planet in orbit around a Sunlike star. The planet resides in a narrow region of temperature space where methane, ammonia, and water are the dominant C, N, and O-bearing molecules, respectively, and are found in the gaseous state, rather than condensed into clouds. It is the only known transiting gas giant in this temperature class around a bright Sunlike star. This makes the determination of atmospheric N/O and C/O ratios possible, which can be compared to Jupiter and connected to models of planet formation. Important additional science includes connecting the planet's atmospheric metallicity to the planet's bulk metallicity and comparing atmospheric abundances to those of directly imaged planets and brown dwarfs in the same cold temperature regime.

Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 3245
Program Title: Up to the Task? A New Generation of Atmospheric and Interior Models of Brown Dwarfs for the JWST Era

Principal Investigator: Mukherjee, Sagnick

PI Institution: University of California - Santa Cruz

JWST's spectroscopic capabilities, along with its ability to measure brown dwarf luminosities with unprecedented precision, will bring about revolutionary advances to brown dwarf science. However, theoretical atmospheric and evolutionary models are critical to enable these advances. JWST data has already shown that available state-of-the-art models for brown dwarfs are insufficient to leverage their full scientific potential. We aim to upgrade these models in three major ways. First, both clouds and vertical mixing are expected to significantly influence the atmospheres of JWST targets like early T-dwarfs (with silicate clouds) and Y-dwarfs (water clouds). However, no atmospheric model has sufficiently explored clouds and vertical mixing simultaneously and self-consistently. We propose to upgrade our atmospheric models to treat both clouds and vertical mixing in a self-consistent framework. Second, we propose to build a grid of brown dwarf atmospheric models, with a large range of previously under-explored parameters like metallicity, atmospheric C/O ratio, and atmospheric vertical mixing. Such a grid will be important to constrain the atmospheric chemistry of brown dwarfs from JWST spectroscopy. Lastly, to properly connect the very precise JWST luminosity measurements to brown dwarf mass and radius, we require evolutionary models that are sensitive to parameters like metallicity, C/O ratio, and atmospheric mixing. Such models are not yet available. We will compute a new generation of evolutionary models for brown dwarfs, sensitive to these parameters, which will enable the community to reliably connect the bulk properties of brown dwarfs to their measured luminosities.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3248
Program Title: The Variable Stars in the ERS WLM Observations

Principal Investigator: Skillman, Evan

PI Institution: University of Minnesota - Twin Cities

We propose an archival analysis of the RR Lyrae population in the JWST ERS target WLM to develop and release tools for analysis of RR Lyrae with JWST. RR Lyrae observations have become commonplace components of nearby galaxy studies with the HST and the same should be true for JWST. However, JWST's observational mode provides challenges for RR Lyrae observations not encountered with the HST. These challenges include: (1) the inability to interleave observations with different filters, which can introduce aliasing and other sampling effects; (2) Due to data volume constraints, the JWST pipeline does not provide images suitable for variable star analysis and thus must be extracted through tailored reductions; (3) RR Lyrae variability amplitudes are smaller at longer wavelengths requiring new calibrations in JWST bandpasses. ERS observations of WLM provide an excellent sampling of RR Lyrae, but they are not being analyzed as part of the ERS program. We will compare the JWST RR Lyrae data with the archival HST observations of the same stars in order to produce a calibration of RR Lyrae with JWST filters that is anchored to Gaia observations. This program will provide the only guidance to date on how to extract and analyze extragalactic JWST observations of RR Lyrae. It will help to establish a foundation for the JWST Pop II extragalactic distance ladder.

Proposal Category: AR
Scientific Category: Galaxies
ID: 3252
Program Title: New Predictions for Galaxy Metallicity Scaling Relations in the JWST Era: Departures from Equilibrium Models and Implications for the Cosmic Baryon Cycle

Principal Investigator: Faucher-Giguere, Claude-Andre

PI Institution: Northwestern University

JWST is poised to revolutionize galaxy chemical abundances. First, it will enable accurate measurements of galaxy metallicities at high redshift using faint, temperature-sensitive emission lines and recalibration of the strong line method to high-z conditions. Second, it will qualitatively extend the redshift and mass ranges over which metallicities are measured. Scaling relations, which include the mass-metallicity relation (MZR) and the fundamental metallicity relation (FMR), encode extremely valuable information about fundamental galaxy evolution processes, including inflows and outflows. Analytic gas regulator models have been widely used to interpret the MZR and FMR. However, these models typically assume steady-state equilibrium conditions. In contrast, observations and simulations suggest that high-z and/or low-mass galaxies have highly time-variable (bursty) star formation rates (SFRs), inflows/outflows, and ISM conditions. The short time scales involved may strongly affect the predicted scaling relations and their scatter, and how chemical abundances relate to inflow and outflow properties. We will use high-resolution galaxy formation simulations to make new predictions for the MZR and FMR, with particular attention to regimes newly probed by JWST. The deliverables will include: (1) full predicted scaling relations from z=0 to z~10; (2) quantification of scatter and deviations from standard relations, and how these correlate with regimes of bursty vs. steady star formation; (3) systematic tests of gas regulator models using realistic non-equilibrium simulations; (4) comparisons of predictions to available observations; and (5) inferred wind mass loading factors.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3254
Program Title: Direct detection of kinematically-detected protoplanet candidates

Principal Investigator: Benisty, Myriam

PI Institution: Institut de Planetologie et d'Astrophysique de Grenoble

To understand how a planet forms and accretes its atmosphere, we must first detect a sample of protoplanets which are in this late stage of their formation. The presence of such protoplanets is readily inferred with high spatial and spectral resolution observations from the Atacama Large Millimeter Array, revealing the characteristic kinematic signatures associated with embedded, giant protoplanets. Forward modeling of these hydrodynamic features yields robust constraints on the locations and masses of the perturbing protoplanets, providing a sample which represents the best opportunity to study the process of atmospheric accretion. We have selected the four most promising sources to observe with MIRI to: (1) confirm the planetary nature of the kinematic features observed at sub-mm wavelengths, and (2) place initial constraints on the luminosity of the protoplanets. These goals are the critical first steps in developing comprehensive multi-wavelength follow-up observations of these protoplanets. Extensive modeling has demonstrated that coronographic observations at 11.4 um with JWST/MIRI allow for the most sensitive searches for such objects, balancing the intrinsic wavelength-dependent brightness of the young protoplanets with the expected extinction from surrounding disk material. At these mid infrared wavelengths, space-based observations are essential for these goals owing to the stability and sensitivity unachievable by ground-based facilities.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3257
Program Title: A systematic search for warm molecular gas in AGN and star forming galaxies at z=2 with MIRI

Principal Investigator: Kakkad, Darshan

PI Institution: Space Telescope Science Institute

Feedback from Active Galactic Nuclei (AGN) have become the cornerstones of cosmological hydrodynamical simulations and they are believed to regulate the star formation in their host galaxies. A promising way to gauge the impact of AGN on the interstellar medium is by tracing their molecular gas content, as the gas experiences an immediate impact of the radiation, jets or outflows from the AGN, compared to star formation. Recent ALMA observations targeting CO emission in mass-matched sample of AGN and non-AGN host galaxies at high redshift have suggested that AGN display lower cold molecular gas content compared to their non-AGN counterparts. One of the hypothesis to explain this difference is the molecular gas in AGN host galaxies could be present in the warm molecular gas phase, traced using rest-frame near-infrared ro-vibrational transitions. This proposal aims to trace warm molecular gas via rest-frame H2 2.12 um transition in a mass-matched sample of AGN and non-AGN host galaxies at z~2.2 using MIRI/MRS. The selected sample is complemented by ground-based ionised gas and cold molecular gas observations. We will test if AGN host galaxies show a systematic difference in their warm molecular gas content compared to the non-AGN galaxies. We will also compute the total gas mass (ionised+molecular) in these galaxies which will provide a key input to current models of AGN feedback.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3263
Program Title: The First Atmospheric Study of a Bona Fide Water World

Principal Investigator: Luque, Rafael

PI Institution: University of Chicago

Water worlds have been proposed as an explanation for the origin and composition of sub-Neptunes. The hypothesis has regained momentum thanks to new developments in planet formation models, individual planet discoveries, and demographic studies of precisely characterized samples. Alternatively, the more widely assumed scenario suggests that these planets are indeed gas dwarfs, i.e. Earth-like cores with primordial H/He envelopes accounting for a small percentage of their total mass. TOI-1685b, however, does not fit into this picture. The 16-hour orbit planet has a low bulk density inconsistent with being a bare rock despite having a high equilibrium temperature (Teq~1070K). If the planet had a primordial H-rich atmosphere, it would have been stripped long ago. With a water-rich core, however, its size and bulk density are naturally explained. We propose to observe a full-phase curve of TOI-1685b using NIRSPEC G395H, the optimal trade-off to maximize the information content of the primary transit while detecting the planet's thermal emission. In one fell swoop, our observations will provide meaningful transmission and emission spectra to measure molecular abundances and a broadband phase curve to break the degeneracy of metal-enriched atmospheres with high mean molecular weight ones in transit. By distinguishing between gas dwarf and water world scenarios, TOI-1685b opens a window to unveil the true nature of sub-Neptunes for the first time. The dataset has therefore a legacy component with valuable information to aid observers, theorists, and modelers to investigate the properties of a completely new type of planet with no analog in the solar system.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3271
Program Title: Characterizing the End Stage of Exoplanetary Systems

Principal Investigator: Su, Kate

PI Institution: University of Arizona

?Planetary systems are ubiquitous around young and old stars. In addition to planets orbiting a star, a planetary system also harbors minor bodies like asteroids and comets, signaling their presence as circumstellar dusty and gaseous material. Through various observing techniques (e.g., infrared excesses and metal pollution in white dwarf atmospheres), we now know that dusty material exists around hundreds of white dwarfs, the end stage of the majority of the stars. Standard models suggest that these dusty disks are formed by the tidal disruption of a scattered planet or minor bodies, feeding heavy elements onto white dwarfs that pollute their otherwise pure hydrogen or helium atmospheres. To better understand the formation and evolution of dusty disks around stellar remnants, we propose MIRI/MRS observations for a sample of bright dusty white dwarfs that show distinct 10 micron silicate features revealed from low-resolution Spitzer data. We aim to combine these data with state-of-the-art models to comprehensively probe the dust composition and geometric structures in the disk, and assess its dynamical stage by comparing with theoretical expectations. Detailed dust mineralogy derived from the data will allow for a direct comparison with the metal abundance measured from the atmospheric pollution, and shed light on the size and formation condition of disintegrating bodies.

Proposal Category: AR
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3273
Program Title: Eureka!: An Open-Source Pipeline for JWST Time-Series Observations

Principal Investigator: Stevenson, Kevin

PI Institution: The Johns Hopkins University Applied Physics Laboratory

The reduction of JWST time-series observations (TSOs) of transiting exoplanets requires careful analysis using customized software that is not provided as part of STScI's official "jwst"' software package. These custom data reduction pipelines are seldom open-source and oftentimes lack documentation, thorough testing, and general user support. This creates a members-only environment for those that have access to one of the few validated pipelines. Without access to or training for such software, new researchers trying to enter the field face a daunting barrier. The philosophy behind the Eureka! project is to facilitate a community-supported, open-source pipeline that is modular in design and easy to use. The Eureka! pipeline has been an unmitigated success, with a handful of publications in the first six months of JWST science operations. We propose to build on this momentum by (1) adding support for additional TSO instrument modes, (2) enhancing the light curve fitting stage, (3) incorporating new and improved algorithms, and (4) addressing a growing list of unresolved issues and suggested enhancements brought on by people's experiences with Cycle 1 data. The ultimate goal is to build a robust and stable end-to-end pipeline that will service the transiting exoplanet and brown dwarf communities over the next decade of JWST science operations.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3279
Program Title: Calibrating NIRISS order 3 for very bright time-series observations with JWST

Principal Investigator: Hoeijmakers, Jens

PI Institution: Lund University

The exquisite sensitivity makes JWST sensitive to saturation when observing bright stars. In particular shorter wavelengths are quickly lost when observing strategies that rely on limited saturation or faster read-out modes are used. This is particularly problematic for some of the most important exoplanet systems, that have very bright host stars (J<6), and that are consequently nearly or completely inaccessible by JWST, even though these systems are best suited for spectroscopic follow-up NIRISS SOSS Order #3 covers wavelengths between 600 and 924 nm, and has a weak effective throughput compared to the brighter Orders #1 and #2, and has consequently not been commissioned. However, it's inefficiency makes it less susceptible to saturation and ideal for situations in which moderate spectral resolution (R~2000) spectroscopy of very bright sources is required. In this proposal, we aim to perform calibration time-series observations of a bright exoplanet transit, to determine the effectiveness and stability of Order #3, as well as to assess the performance of Order 2 and 1 under conditions of extreme saturation. These observations may later be used to motivate the commissioning of NIRISS SOSS Order 3 as a supported mode for general observations of very bright targets with JWST, at relatively short wavelengths.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3290
Program Title: A complete spectroscopic census of the faintest galaxies and AGN at the dawn of galaxy formation

Principal Investigator: Hayes, Matthew

PI Institution: Stockholm University

As JWST has recently provided transformative new insights into the first galaxies and AGN, many uncertainties still surround these results. For example: (1.) The stellar and chemical conditions of the first galaxies need to be measured to provide accurate early-time constraints for galaxy evolution theory. (2.) The ionizing photon budget for reionization needs to be firmly anchored for large-volume simulations. (3.) The contribution of the first supermassive black holes (SMBH) needs to be determined, and accurate scenarios for their seeding and growth must be established. Observationally, we must determine the metallicities and ionizing continua of the faintest galaxies at the highest redshifts, and simultaneously take an accurate census of rapidly accreting black holes at the same epoch. We have devised an innovative method to use NIRSpec to perform a blind survey for the faintest emission line sources at redshifts 7-11. We will use this to take a very deep exposure of the Hubble Ultradeep Field, that will identify fainter sources than previously possible, and without the bias of photometric preselection. By measuring fluxes of ultraviolet emission lines, we will infer the chemical and thermodynamic properties in the interstellar media of the first low-mass galaxies, and unambiguously identify the AGN that reside unnoticed among the population. The sensitivity of these new observations will be sufficient to place unique constraints on the abundance of black hole seeds at early times, and provide foundational, realistic input for the next generation of cosmological simulations.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3293
Program Title: JWST's GLIMPSE: gravitational lensing & NIRCam imaging to probe early galaxy formation and sources of reionization

Principal Investigator: Atek, Hakim

PI Institution: CNRS, Institut d'Astrophysique de Paris

Low-mass galaxies hold the key to the formation process of the first galaxies: the interplay between gas accretion which fuels star formation and the subsequent stellar feedback which inhibits further star formation is likely reflected in the prevalence of low-mass galaxies at early epochs, a few hundred million years after the Big Bang. We propose to combine the power of strong gravitational lensing with ultra-deep NIRCam imaging to achieve three main goals: (1) to measure the prevalence of faint galaxies at z>6 to establish, for the first time, key observational benchmarks for galaxy formation models, which have never been confronted to this uncharted territory; (2) strongly constrain the contribution of the faintest galaxies towards cosmic reionization; (3) probe the typical galaxy population during the Dark Ages, that remains out of reach of current programs. Despite heroic integration times, current deep JWST programs achieve at best the same intrinsic depth as the Hubble Frontier Fields (HFF, ~31 mag). Here, we propose to extend this observational frontier into the JWST era by using the best HFF lensing cluster AS1063 to push down to 30.6-31 mag, which corresponds to an intrinsic depth of 33-35 mag. We will detect galaxies at z>6 more than a thousand times fainter than the Milky Way. Combined with increasingly powerful numerical simulations, this body of work will radically transform our understanding of galaxy formation and the epoch of reionization. This unprecedented dataset will showcase the full potential of JWST. In the spirit of the HFF and deep JWST programs, our team commits to rapidly releasing high-quality data products and catalogs to the community.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3295
Program Title: Is there enough? Cosmic dust formation in normal core-collapse supernovae in the first ~5 years post-explosion

Principal Investigator: Sand, David

PI Institution: University of Arizona

Dust is abundant in the early universe, and core collapse supernovae (CC SNe) are a likely source. However, existing observations of CC SNe in the near- and short mid-infrared yield dust masses ~2-3 orders of magnitude lower than expected. One possible solution is that this dust is hiding deep in the mid-infrared, at temperatures of ~100-200K, or that it is created over a longer time span than some models predict. JWST+MIRI is able to probe both warm (~300-500K) and cold (~100-200K) dust with unprecedented sensitivity. The goal of this proposal is to provide a snapshot of dust formation and evolution in normal CC SNe at three different phases: 1-2, 2-5, and 5+ years after explosion. We will obtain MIRI imaging of a sample of nine normal CC SNe, three in each age range, chosen based on their comprehensive ground-based data sets and observational properties, and not for any dust signatures, which will provide an unbiased look at typical dust production. With JWST spectral energy distributions out to ~25 microns, we will be able to quantify and characterize the amount of cold and warm dust associated with normal CC SNe as a function of time since explosion, explore links between dust formation and other SN properties, and address the issue of cosmic dust formation in the early universe.

Proposal Category: AR
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3303
Program Title: Pinpointing Early Supermassive Black Holes and Star Formation with JWST and Chandra

Principal Investigator: Sterling, Joseph

PI Institution: University of Miami

With this proposal we aim to study archival data of z$>$5 candidate JWST Star-Forming-Galaxies and Early QSO from the COSMOS-Webb, CEERS and PEARLS in conjunction with deep Chandra archival data to probe the early Universe by means of stacking analysis. Our goal is to determine a) constrain the high-z Star Formation Rate (SFR)-L$_X$ efficiency by deriving Chandra X-ray luminosities and SFRs obtained by JWST; b) the abundance of AGN-like X-ray sources at z>5 in order to shed new light on early SMBH growth and c) compute the space density and X-ray throughput of early AGN candidates and compare them with predictions of SMBH seeding models.

Proposal Category: AR
Scientific Category: Galaxies
ID: 3305
Program Title: Analyzing Giant Clumps in JWST Images of Star-Forming Galaxies to Constrain Feedback

Principal Investigator: Guo, Yicheng

PI Institution: University of Missouri - Columbia

A majority of star-forming galaxies at redshifts z > 1 have giant stellar clumps that are much more massive than star clusters in nearby galaxies. The masses and lifetimes of such clumps in high-resolution galaxy simulations strongly depend on the supernova feedback assumed, which remains one of the main uncertainties in galaxy formation theory. Accurate measurements of the observed clump stellar masses and lifetimes can provide new and independent constraints on feedback models. NIRCam data will dramatically improve on HST in both resolution and depth, as well as opening the window of rest-frame optical and even IR emission beyond z ~ 3. This improvement will allow measurement with unprecedented accuracy of the clump stellar population properties in z ~ 1-3 galaxies, and at even higher redshifts up to z=7. We propose to use JWST/CEERS survey to detect and analyze clumps by using two methods: (1) standard source detection and (2) novel machine learning (ML), both together providing a comprehensive view of clumps. In order to train ML, we will generate training sets of mock images at JWST resolution and filters. Besides the accurate measurements of clumps and strong constraints on feedback models, the proposed research will also provide the following value-added products: (1) a public catalog of stellar mass, age, dust extinction, star formation rate, and their uncertainties of clumps in galaxies at z ~ 1-7, derived with Bayesian SED fitting; (2) a public database of mock NIRCam images of state-of-the-art cosmological simulations with corresponding simulation metadata; and (3) all codes and documentation created for the analysis of JWST images via GitHub.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3315
Program Title: Measuring the Interior Composition of a Terrestrial Planet

Principal Investigator: Wright, Jason

PI Institution: The Pennsylvania State University

The disintegrating ultra-short period exoplanet K2-22b offers us the opportunity to probe the interior composition of a rocky exoplanet for the first time. We propose to do so by measuring the transmission spectrum and phase curve of the dust evaporating from K2-22b using MIRI LRS slitless spectroscopy. We propose to observe two transits, as well as a complete phase curve of the orbit from one transit to another, for a total of four transit observations of K2-22b. By comparing the transit transmission spectra to detailed extinction and scattering models, we can determine the mineralogical make-up of the dust outflowing from K2-22b, and therefore the composition of the planet's interior. The phase curve data will allow us to measure the temperature and spatial extent of the dust, which will further constrain its morphological properties, as well as the dynamics of the dust-outflow around the planet itself. The relative mineralogical abundances in the dust will allow us to determine whether it is crustal, mantle or core material that is evaporating. Assuming mantle material is evaporating, these observations will determine the Mg/Si and Fe/Si ratios of the planet -- which drives important questions of interior dynamics and habitability.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3322
Program Title: Determination of the Star-by-Star Elemental Abundance Trends in Nearby Galaxies: Are the Disks Bimodal?

Principal Investigator: Nataf, David

PI Institution: The Johns Hopkins University

The evolution of chemical abundances is driven by the nature of stellar populations and gas mixing processes. Abundances of elements therefore are primary tests of models of galaxy evolution and the operation of the baryon cycle. Cosmic chemical elements fall into two main groups, alpha elements formed rapidly in core collapse supernovae and the Fe-peak group, primarily from more slowly evolving populations of type I supernovae. We propose to use the unique capabilities of JWST to measure [Fe/H] and [Alpha/Fe] ratios in millions of evolved stars in the galaxies M31 and M33, using a combination of six NIRCam filters. In the Milky Way the origin of the bimodal [Fe/H]-[Alpha/Fe] distribution has yet to be fully described and is not observed in our dwarf satellites. Bimodal [Fe/H]-[Alpha/H] distributions are challenging to simulate in Lambda-CDM models of galaxy evolution. Models require fine tuning, and different approaches do not agree and it is essential to understand if the Galactic situation is unusual. Alpha element abundance distributions in galaxies other than the Milky Way and its satellites are too limited to reliably reveal overall [Fe/H]-[Alpha/Fe] patterns. M31 and M33 are nearby with abundant pre-existing data. They are prime targets for pilot studies to validate our JWST methodology to measure both [Fe/H] and [Alpha/Fe] for individual stars while offering a test on the commonality of bimodal [Fe/H]- [Alpha/Fe] distributions. This novel project will fundamentally advance our ability to apply chemical evolution models to nearby galaxies and thereby also frame the results from detailed Milky Way studies.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3324
Program Title: Sgr A* as Particle Accelerator: What Drives the Black Hole's Variable IR and X-ray Emission?

Principal Investigator: Hora, Joseph

PI Institution: Smithsonian Institution Astrophysical Observatory

The Galactic Center offers the closest opportunity for studying accretion onto a supermassive black hole, Sagittarius A*. Sgr A*'s fluctuating emission is detected across the electromagnetic spectrum and may originate in the accretion flow or jet. Recent models indicate that variability can be produced by particle acceleration in different types of reconnection events. These models produce unique spectral characteristics imprinted on the variable emission in the MIR. Measurements of the spectral energy distribution in this wavelength regime during quiescent and flaring episodes in concert with X-ray monitoring will enable us to distinguish between models and constrain the energy budget of the emission region. In addition, the circumnuclear environment of Sgr A* contains dozens of IR sources and structures that are critical to understanding both the accretion-feeding processes and the nature of the cluster of stars and dusty gas features near it. We propose MIRI MRS IFU time-series spectral monitoring of Sgr A* and its surrounding region, along with simultaneous Chandra observations, to characterize the black hole's MIR and X-ray emission in different flux density states, determine the nature of the emission, and constrain models of the accretion and radiation processes. Only JWST has the high angular resolution and sensitivity in the mid-IR to probe this complex and dynamic region.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 3325
Program Title: Mapping the Most Extreme Protoclusters in the Epoch of Reionization

Principal Investigator: Wang, Feige

PI Institution: University of Arizona

Theoretical models predict that the earliest billion-M_sun supermassive black holes (SMBHs) form from massive dark matter halos and trace the formation of protoclusters in the early Universe. We propose to study the two most extreme galaxy overdensities anchored by luminous quasars at z~6.6, discovered from JWST Cycle-1 observations of ~20 quasar fields. Both systems show Mpc-scale filamentary structures with galaxy overdensity >10, centered on the quasars. However, the existing observations consist of single NIRCam/WFSS pointings that do not yet cover the full protocluster structure and are limited to redshift measurements of luminous member galaxies. In Cycle-2, we will: (1) carry out NIRCam/WFSS mosaic observations covering >3 times wider area, to fully map the large-scale structure and the kinematics of the protocluster member galaxies by discovering 80 protocluster member galaxies. The NIRCam observations will also discover more than 200 field galaxies at 5.3<z<7. (2) obtain deep NIRSpec/MSA spectroscopy for ~150 [OIII] emitting galaxies identified from NIRCam/WFSS and additional photometrically selected Lyman break galaxies (LBGs) up to z~12, which will enable the first statistical characterizations of environment-dependent galaxy formation and AGN activities in the EoR. (3) obtain deep NIRSpec/IFU observations of the two central quasars to shed light on the formation of the central luminous quasars, progenitors of the brightest cluster galaxies. The proposed observations will provide the first comprehensive study of the connection between the growth of the first-generation SMBHs, massive dark matter halos, and large-scale structures traced by galaxy overdenities.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3337
Program Title: Solving a Solar Neighborhood Crime Scene by Imaging 14 Her c

Principal Investigator: Bardalez Gagliuffi, Daniella

PI Institution: Amherst College

We propose to directly image 14 Her c, the outer planet of the clearest example of a system survivor of dynamical disruption potentially undergoing Kozai-Lidov oscillations. With one image from JWST/NIRCam we will be able to detect one of only two field-age giant exoplanets amenable for direct imaging. This image will constrain the relative astrometry between the star and the planet, crucially improving our posteriors of planet mass and inclination, as well as all orbital parameters. The 14 Her system will serve as a crucial benchmark: the first well-characterized system across multiple techniques (accelerations, RV, direct imaging) with two mutually perpendicular, wide-separation planetary orbits to inform dynamical mechanisms that may be more widespread across planetary scales. Additionally, we will contextualize this planet in a color-magnitude diagram with Y dwarfs of similar temperature (many of them targeted with JWST GO programs) and Eps Indi Ab, the other field-age giant planet scheduled for direct imaging with JWST. Our observations provide a rare opportunity to probe an exoplanetary system contemporary to our own.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3348
Program Title: Crouching Galaxy, Hidden Stars: Observational Tests of Cluster Formation Theories

Principal Investigator: Chandar, Rupali

PI Institution: University of Toledo

Intensely star-forming galaxies provide a unique laboratory to study the relationship between star and cluster formation. The current generation of cosmological simulations, although starting from very different approaches and input physics, have converged in their predictions for the outcomes of the star formation process for galaxies with high star formation rate densities. Essentially, all modern simulations predict that ~50-80% of stars are born in compact clusters when star formation is very intense. While current observational results are inconsistent with these predictions, they are based on UV/optical studies with HST which almost certainly miss many (and possibly most) of the youngest, most massive, deeply embedded star clusters in extreme star-forming galaxies. We propose new NIRCAM observations of NGC 3690 and IC 4687, two dust-enshrouded mergers which have some of the highest star formation rates and surface densities in the nearby universe. Our 6-filter observations are designed to efficiently detect embedded clusters and to estimate their ages and masses. From the complete JWST+HST census of massive clusters, we will determine the fraction of stars that form in clusters, and construct and fit the initial cluster mass function. We will establish if these new results, which account for all clusters (obscured and unobscured), agree with predictions from hydrodynamic simulations, or if new physics still needs to be considered.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3362
Program Title: JWST in Technicolor: Finding and Mapping the Most Extreme Star Forming Galaxies in the Epoch of Reionization with Medium and Narrow Bands

Principal Investigator: Muzzin, Adam

PI Institution: York University

We propose a NIRCam imaging program of the Hubble Frontier Fields Parallel Fields in 8 broad/medium/narrowband filters. Building upon the existing treasury data from JWST and HST, these fields will have 29-band space telescope imaging covering 0.4 - 5.0 microns and will be the only fields to contain the full suite of all 20 NIRCam broad and medium bands, providing an exceptional “technicolor” dataset to the community. The key addition to existing data is imaging in the reddest medium bands (F430M/F460M/F480M) and bluest narrow bands (F164N/F187N) which enable multiple science goals: 1) The detection and characterization of the most extreme emission line galaxies (1000A < EW < 5000A) at 5 < z < 12 based purely on their line fluxes. 2) Substantially improved measurements of the stellar mass function of galaxies at 5 < z < 12. 3) Resolved 2D mapping of emission lines at 1 < z < 12. 4) Detection of ultra-low metallicity galaxies with strong HeII emission at 9 < z < 12. By selecting galaxies based only on their emission line fluxes, this will be the first line-flux-limited imaging survey and will unveil previously undetected reionization sources such as dusty galaxies without clear continuum breaks, as well as ultra low-mass galaxies (6 < LogM < 7) that are too faint to be well-detected in continuum. We will also conduct parallel WFSS observations with NIRISS in F090W which will allow the study of Ha emitters in the HFF cluster galaxies and LyA at 5 < z < 7. Given the legacy value of these data we are requesting no proprietary time and commit to delivering reduced data products and catalogs to the community in advance of the Cycle 3 deadline if scheduling permits.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3368
Program Title: A JWST Survey of Ultraluminous Infrared Galaxies

Principal Investigator: Armus, Lee

PI Institution: California Institute of Technology

One of the major discoveries from the IRAS mission was of a population of extremely luminous, or “Ultraluminous” Infrared Galaxies (ULIRGs) having infrared luminosities above 10^12 Lsun. ULIRGs emit more than 90% of their luminosity in the mid and far–infrared from dust, and they are ideal local laboratories for studying star formation, the growth of supermassive black holes and the effects of energetic feedback and galactic winds in galactic mergers. ULIRGs offer a rare, high-resolution look into dynamic processes that occur much more frequently in rapidly evolving galaxies at high-redshift. In the mid-infrared, ULIRGs show a large range of spectral properties including emission from ionized atomic and warm molecular gas, warm dust and stochastically heated smalll dust grains, together with absorption from ices and warm and cold molecular gas. Despite extensive study with ground and space based telescopes, there are still a number of outstanding questions about the physics of ULIRGs that can be uniquely addressed with the advanced capabilities of JWST. We propose to obtain MIRI MRS and NIRSPec spectra along with MIRI and NIRCam imaging of 15 ULIRGs to complete the study of the mid-infrared properties of a flux-limited sample of the brightest ULIRGs in the local Universe at unprecedented sensitivity and spatial-spectral resolution. These data will be valuable in their own right, and they will provide a rich legacy for studies of the distant Universe with JWST and future infrared telescopes.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3375
Program Title: Dancing 1 - 14 micron spectra to solve the cloudy and chemical puzzle of brown dwarf variability

Principal Investigator: Whiteford, Niall

PI Institution: American Museum of Natural History

Time-series observations of rotational modulations in brown dwarfs and planetary-mass companions are a powerful tool to characterize ultra-cool atmospheres. Nearly 100 of these objects have been shown to have rotational variability with the long-term assumption that this was being driven by evolving heterogeneous cloud coverage, but this has never been unequivocally proven as there has never been a mid-IR spectral variability campaign where the signatures of such clouds are detectable at $\sim$10\micron{}. In the last decade, chemical disequilibrium-induced convection has been proposed as another potential mechanism that can explain rotational variability, with the spectral signature for this being most prominent between 3 to 5 \micron{}. This debate can only be settled by using JWST's mid-IR spectral capabilities. Therefore, we propose spectral monitoring of VHS 1256 b, the most variable substellar object. Specifically, we will combine extremely high S/N and interleaved NIRSpec/PRISM, NIRSpec/G395H/F290LP, and MIRI/LRS spectroscopy to map the evolution of the near-IR variability relative to the signatures of the two proposed mechanisms across a full 22-hour rotation. VHS 1256 b was a JWST ERS target which resulted in a high-quality 1 to 28 \micron{} spectrum. Our program will add a unique and critical dimension to the analysis of this data and allow us to break a model degeneracy which will have a stark implication on both 1- and 3-D modeling approaches. We wave the proprietary data period and will make any resulting data reduction tools available to the community in order for it to serve as a springboard for similar variability investigative proposals in future cycles.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3383
Program Title: JWST Wide Area 3D Parallel Survey

Principal Investigator: Glazebrook, Karl

PI Institution: Swinburne University of Technology

We propose to take advantage of the unique opportunities offered by Pure Parallel Mode to perform a wide area near-infrared spectroscopic survey with JWST/NIRISS. We propose a slitless spectroscopy campaign covering 1000 arcmin^2 via bonus parallel observations, providing F150W+F200W rest frame optical 2D spectra and secure redshifts for 60,000 galaxies at 1<z<5. This will be the definitive spectroscopic benchmark from `Cosmic Noon' to `Cosmic Dawn', with good completeness out to z=5, and probing environments from the field to rich proto-clusters. Continuum + emission line spectra will be obtained for galaxies down to low masses, enabling 1D and 2D measures of dust corrected star-formation rates, metallicities, and stellar population ages. Such a large area redshift survey will allow us to measure 3D clustering in the cosmic growth era revealing the detailed connection between dark matter halos and assembling baryons. It will also provide a benchmark set of stellar mass functions for complete spectroscopic type defined samples, address the origin of galactic quenching, provide 2D abundance and age measurements of galaxies measuring galactic buildup and provide a census of rare z>11 bright galaxies and other rare objects at all redshifts. The size of the survey will also enable data driven discovery with advanced machine learning approaches revealing novelties and surprises in the early Universe.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3384
Program Title: Testing the Jet Origin of the Mysterious Infrared Excess in Quiescent Black Hole Binaries

Principal Investigator: Hynes, Robert

PI Institution: Louisiana State University and A & M College

We will observe the quiescent black hole X-ray binary V404 Cyg with JWST/MIRI and ALMA. This is a prototype of the class of 'electromagnetic black holes' with normal stellar companions, in contrast to binary stellar mass black holes identified by LIGO. V404 Cyg exhibits an IR excess in Spitzer observations above that expected from either the secondary star or the accretion disk. Two explanations are proposed. Either it originates from synchrotron emission from a relativistic jet that persists into quiescence or from a large, cool circumbinary disk. We will discriminate between these possibilities by using the large throughput and sensitivity of JWST coupled with simultaneous ALMA observations of the radio jet to search for mid-IR variability and multiwavelength correlation and measure the mid-IR-mm spectral energy distribution. No short timescale variability is expected from a circumbinary disk so variability, especially if correlated with ALMA, would falsify the disk model and confirm mid-IR jet emission. On the other hand, if ALMA sees variability but JWST does not, this will support the circumbinary disk interpretation with profound implications for compact binary evolution. Joint JWST-ALMA observations of the jet would probe jet formation close to the black hole at extremely low accretion rates, and would be compared to predicted multiwavelength lightcurves from models of internal shocks in jets. These observations when compared to observations from V404 Cyg in outburst would allow a study of jets spanning five orders of magnitude dynamic range in luminosity.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3385
Program Title: The first comparative atmospheric study of a Jovian planet and a sub-Neptune in the TOI-1130 system

Principal Investigator: Huang, Chelsea

PI Institution: University of Southern Queensland

The Solar system has a unique architecture: it hosts planets with drastic mass differences. Exoplanet systems with similar characteristics hold the key to generalize our understanding in how giant planets influence the formation and evolution of planetary systems. We request JWST NIRSpec and NIRISS observations to measure the transmission spectra of the TOI-1130 system. TOI-1130 hosts a transiting close-in Jovian planet, and an additional, inner transiting sub-Neptune-sized planet. The two planets are in inclination angle resonances, a strong signature of planetary system formed via disk migration. We will compare the absolute and relative atmospheric properties of TOI-1130 b and c, including the carbon-to-oxygen ratio, metallicity, and potentially enhancement of other volatile/refractory species. These measurements will enable us to distinguish between various different formation/evolution scenarios of the TOI-1130 system, presents the first opportunity to deep dive into a unique type of system that has never been studied previously. The outcome of this proposal provide a legacy datapoint in the JWST library of muliplanet systems, as well as a benchmark spectra to compare against other Jovian planets with more ambiguous origins.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3399
Program Title: An Empirical Calibration of the NIRSpec IFU Point Spread Function to Enable High Contrast Imaging Spectroscopy

Principal Investigator: Perrin, Marshall

PI Institution: Space Telescope Science Institute

This GO Calibration effort seeks to obtain a high quality empirical point spread function (PSF) calibration for the NIRSpec IFU. Improved knowledge of the NIRSpec IFU PSF will directly benefit diverse science cases involving precise spectroscopy of “faint things next to bright things”, spanning from imaging spectroscopy of exoplanets, brown dwarfs, and circumstellar disks, to minor bodies and faint rings in the solar system, to studies of quasar host galaxies. For high contrast imaging spectroscopy of exoplanetary systems, NIRSpec has tremendous promise, but making high contrast algorithms work to their full potential on NIRSpec data will require understanding in detail the PSF properties, effects of spatial undersampling, and datacube systematics. However there has not yet been any calibration program dedicated to measuring the NIRSpec IFU PSF. To fill that gap, the observations we propose will provide the first calibration measurements of the NIRSpec PSF with high SNR and high dynamic range (spanning from the PSF core to the outer wings across the full IFU FOV), finely dithered for better spatial sampling, covering 0.95 to 5.3 microns with all the high resolution gratings. The resulting improved knowledge of IFU imaging spectroscopy performance and systematics will benefit diverse studies using NIRSpec from the solar system to exoplanets and circumstellar disks to the distant universe.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3414
Program Title: HH24: A Jet Complex driven by a Young Multiple System

Principal Investigator: Reipurth, Bo

PI Institution: University of Hawaii

HH 24 is a unique complex of 6 jets emanating from a cloud core with an embedded multiple system of at least 8 protostars. Two of the outflows constitute the bright bipolar jet HH 24 E/C, which form the inner part of a 3.1~pc giant HH flow. We propose to study the inner part of the HH 24 complex in two filters: F164N ([FeII] 1.64) and F405N (Brackett-alpha). The resulting images will allow 1) the study of the jets in unprecedented detail, 2) for the first time examine the more embedded parts of the jets, 3) determine spatially resolved kinematics with a velocity resolution of only ~5 km/s when compared to older HST images, and 4) explore processes such as expansion of the jet beam, knot interactions, and sideways ejection in working surfaces. The Brackett-alpha line will be used in conjunction with earlier HST Halpha images to measure the overall change of extinction along the jets. Dereddened fluxes will then allow a determination of electron densities and thus the jet mass and momentum flow. The images and fluxes will be modelled with an advanced gas dynamic code. The E-jet is ejected directly into an evacuated cavity and is perfectly collimated, while the C-jet ploughs through the cloud core and emanates in a highly jumbled flow. Brackett-alpha imaging offers the opportunity to analyze how a jet interacts with a complex environment inside a molecular cloud (already mapped by ALMA in several transitions). The embedded sources studied with ALMA all have masses of 1-2 Msun. We will use continuum filters to search for the expected lower-mass embedded members of the multiple system and identify binary companions.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3417
Program Title: Unveiling Obscured Growth of Supermassive Black Holes in the Epoch of Reionization

Principal Investigator: Matsuoka, Yoshiki

PI Institution: Ehime University

Obscured quasars in the epoch of reionization (EoR) are a key population to fully understand the initial growth of supermassive black holes (SMBHs). While very few candidates have been reported to date, models and observations suggest that such objects are prevalent in the high-z (z > 6) universe, and that the >300 known UV-luminous quasars may represent just a small portion of the early SMBH growth. Recently, an unprecedentedly wide-and-deep survey with Subaru HSC has uncovered a new population of high-z galaxies showing extremely luminous Ly-alpha emission, with clearly distinct properties from any known types of objects in the EoR. Near-IR spectroscopy with ground-based 8-10m telescopes and Chandra X-ray observations have revealed a hint of hidden quasar activity in some of these galaxies, but their nature still remains inconclusive. Here we propose an ambitious NIRSpec program to carry out systematic exploration of this intriguing population. We will observe rest-optical emission lines of 10 objects with the highest Ly-alpha luminosity, in order to pin down the source(s) of line excitation via combination of three diagnostics; BPT diagrams, broad components of H-alpha, and detection of He II 4686. Our immediate goal is to establish the first spectroscopically-confirmed sample of obscured quasars in the EoR. We will use the sample to set a lower limit on the early cosmic density of obscured SMBH growth -- a key ingredient in the models of structure formation happening through the EoR. At the same time, we will exploit the objects without quasar signatures to explore the nature of galaxies emitting such enormous Ly-alpha into the reionizing intergalactic medium.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3426
Program Title: Confirming the population of disk galaxies at z>3

Principal Investigator: Jones, Tucker

PI Institution: University of California - Davis

Early deep-field images from JWST have revealed morphologies of high-redshift galaxies that suggest a surprisingly high fraction of disk galaxies at z>3. If confirmed, these results indicate that disks are able to form and settle at earlier times and lower mass scales than predicted by current cosmological simulations. However, resolved spectroscopic data is required to unambiguously confirm the presence of disk galaxies and characterize their dynamical state. We propose to use the multiplexed NIRSpec MSA in slit-stepping mode to spatially map 40-50 galaxies at z=2.4-3.6 (with 30-35 at z>3) with 3-D spectroscopy. This proposal will chart the nebular emission kinematics, allowing us to determine the true fraction of disks and their dynamical properties (in particular the degree of rotational support versus random motion, V/sigma). We will simultaneously measure resolved star formation and metallicity, to understand how the formation of galactic disks is governed by cosmological accretion and feedback. Our target selection provides good sampling across stellar masses 10^9 - 10^11 Msun, enabling us to probe mass-dependent trends at this epoch. Resolving the formation of disk galaxies at z>3 can only be achieved with JWST's unique spatial and spectral resolution at the relevant wavelengths. This program represents a highly efficient survey of the galaxy population at this epoch, requiring a factor 25x less total integration time than the traditional IFU mode.

Proposal Category: SNAP
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3428
Program Title: Quasar Feedback and Supermassive Black Hole Demographics at z ~ 4-6

Principal Investigator: Liu, Weizhe

PI Institution: University of Arizona

The existence of massive, quiescent galaxies at z~2-4 challenges models of galaxy formation in the context of hierarchical structure formation. Quasar feedback through powerful outflows is one of the most effective mechanisms to quench massive galaxies, but direct observational evidence of such feedback at z>4 is still lacking. We propose a survey program to obtain a rest-frame optical spectroscopy atlas of a statistical sample of luminous quasars at z~4–6, adopting shallow exposures with NIRSpec/IFU G235H or G395H. Our request is ~1 hr per target (assuming a 2100s slew time). Our science goals require a minimum of 20 quasars (and a maximum of 100). The targets will be randomly drawn from a parent sample of ~1000 luminous z~4-6 quasars distributed over ~1/2 of the full sky. The NIRSpec observations will allow us to systematically examine whether quasar feedback via outflows traced by blueshifted [O III] emission lines are effective enough to account for the existence of massive quiescent galaxies at z~2-4. In addition, this program will produce the first high-quality rest-frame optical spectral library of luminous quasars at z~4-6, the most rapid phase of supermassive black hole (SMBH) growth in the early universe, and provide robust measurements of SMBH masses through H-beta and H-alpha lines to map SMBH growth history, characterize key emission diagnostic lines to study AGN ionization, metallicity, and reddening, and detect close quasar companions and extended emission from quasar hosts to probe SMBH-galaxy co-evolution.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3429
Program Title: One-Stop Shopping: Pan-Metallicity PAH Benchmarking in M101

Principal Investigator: Clark, Christopher

PI Institution: Space Telescope Science Institute

We propose using 23 hours of JWST time to pin down the factors driving PAH variation, especially with respect to metallicity, via a comprehensive multi-parameter benchmarking M101. We will use MIRI and NIRCam imaging to map the strengths of the 3.3, 7.7, and 11.3 um PAH emission features across 6 fields in M101. M101 provides an unparalleled ‘controlled laboratory’ for this investigation, and has exquisite ancillary data. Our fields sample 0.93 dex in metallicity, 1.6 dex in neutral gas surface density, 2.6 dex in ionized gas surface density, and 3.0 dex in UV radiation field strength. Our selection of 11 filters will provide > 3500 measurements of each feature strength at S/N > 10, with 2'' resolution, giving us the statistical power to disentangle the phenomena driving PAH evolution. With this data, will be able to tackle open questions about the formation, evolution, and destruction of PAHs; and test existing models in a uniquely wide range of environments.

Proposal Category: AR
Scientific Category: Galaxies
ID: 3432
Program Title: A Unique Characterization of Early Quenching in a Young, Transitional Cluster at z=1.84 with NGDEEP and JEMS

Principal Investigator: Alberts, Stacey

PI Institution: University of Arizona

Environment is a primary driver of galaxy evolution and yet it remains poorly understood even at its extremes in galaxy clusters. We propose a unique study using ultra-deep, archival NIRISS grism spectroscopy and NIRISS/NIRCam imaging to fully characterize the star forming, quenching, and quenched populations in a young, transitional cluster at z=1.84, caught in the process of forming its passive population. Using the immediately public NGDEEP and JEMS surveys, we will disentangle the mechanisms driving early quenching as a function of the cluster accretion history by taking a full census of cluster galaxy properties (star formation histories, stellar ages, metallicities, size/morphologies, signs of merger activity, AGN) down to lower stellar masses (log Mstellar/Msun ~ 7-8) than ever achieved in clusters during cosmic noon. This point is critical: this study will enter the regime in which secular quenching in low-mass galaxies is rare and environmental quenching can be unambiguously identified. This study will set the benchmark for all future studies bridging the transitions from proto-clusters to quenched groups/clusters.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3433
Program Title: Mapping star formation and feedback in clumpy galaxies at redshift ~5

Principal Investigator: Richard, Johan

PI Institution: Centre de Recherche Astrophysique de Lyon

We propose NIRSpec-IFU spectroscopy and NIRCam imaging to probe star formation and feedback in three exceptionally bright and extended, gravitationally lensed, high redshift (z>4) galaxies, representative of the UV-selected population at these redshifts. Key emission lines (e.g. Halpha, Hbeta, [OIII]) combined with existing MUSE/VLT rest-UV observations, are critical to map the gas physical conditions and kinematics from ~100 pc to kpc scales. NIRCam imaging (complemented with HST) will enable us to derive clump physical properties (size, ages, masses) down to 10s pc. We will: 1. probe disk fragmentation theories; 2. test predictions of increased clump star formation densities with redshift; 3. map the starburst propagation while investigating clump survival. Spatially resolving multiple nebular lines will map key parameters of the interstellar medium (ISM) and evaluate the role of clump feedback. We will trace the global kinematics of the ISM and investigate whether star-forming clumps show a trend in velocity dispersion. We will relate the distribution of ionizing radiation originating from the clumps with the global properties of each galaxy, and the overall morphology and kinematics of the circum-galactic medium seen in Lyalpha emission at large scales. These unprecedented studies are fundamental to uncover how star formation operates in normal galaxies at redshift beyond cosmic noon and inform increasingly detailed cosmological simulations. Extensive deep field campaigns will provide an incredible census of unresolved galaxies at these redshifts, but only studies as we propose here will enable us to dissect star formation and feedback that determine their evolution.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3435
Program Title: The JWST Whirlpool Galaxy Treasury

Principal Investigator: Sandstrom, Karin

PI Institution: University of California - San Diego

Characterizing the interplay between the interstellar medium (ISM) and star formation (SF) on small scales (<50pc) and connecting it to the global galaxy properties is crucial to understand galaxy evolution. A unique target for such a study is the iconic Whirlpool Galaxy M51: its almost face-on orientation, outstanding ancillary data, and rich variety of ISM environments is ideal to address fundamental questions about SF, gas, dust, and feedback. JWST will provide crucial missing information about the small-scale dusty ISM and embedded SF. We propose wide-field imaging of M51 in a thorough set of narrow-, medium-, and wide-band filters covering key ISM emission lines, dust features, and continuum. We also propose three spectral maps cutting across different regions of the spiral arm structure. This efficient 14-band imaging and spectroscopy program will create an indispensable dataset, ideally suited to 1) constrain the life cycle of star-forming regions; 2) quantify the dust production rate; 3) and characterize the evolution of small dust grains. We will also produce for the JWST community science-ready catalogs, photometric and spectroscopic mosaics, and extracted line maps in addition to optimized recipes and filter combinations for continuum removal in narrow-band filters. This comprehensive Treasury survey of M51 will be an invaluable resource for the entire extragalactic community.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3436
Program Title: Unmixing the ISM: Identifying Dominant Physical Effects with JWST/MIRI Mapping of M33

Principal Investigator: Rosolowsky, Erik

PI Institution: University of Alberta

We propose to use JWST/MIRI mapping of the nearby disk galaxy M33 to obtain a high resolution map of the neutral ISM as traced by PAH emission. The proposed map will yield a ~1 pc resolution top-down perspective on the neutral interstellar medium (ISM) spanning 4 scale lengths of the galaxy disk and three distinct galactic environments. We will compare these high quality JWST maps to mock observations from state-of-the-art high resolution simulations with a known range and variation of physical conditions. This comparison will use validated statistical measures that will allow us to determine the best matching physical conditions to different parts of the true ISM, thereby determining the dominant physical effects regulating ISM structure. Our data will also localize phases of molecular gas invisible in CO emission, make unbiased maps of the filamentary structures that regulate star formation, and connect feedback driven bubbles and shells to individual high mass stars and young clusters identified in archival HST data. The coordinated parallel observations will map out a different PAH transition at 3.35 μm to measure changes in PAH ionization and measure the brightest regions at even higher (0.2 pc) linear resolution.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 3445
Program Title: Shaken and Stirred: Shocks and Turbulence in the Stephan's Quintet Warm Molecular Filament

Principal Investigator: Appleton, Philip

PI Institution: California Institute of Technology

We propose MIRI MRS spectroscopy of six diverse turbulent regions in the giant molecular shock structure in the Stephan's Quintet group. The 45 kpc shock structure is likely formed ahead of an high-speed intruder galaxy as it collides with an old tidal filament within the main group. Previous Spitzer observations had shown that the dominant emission from the filament is from fragile warm pure-rotational molecular H2 which somehow coexists with million-degree hot X-ray emitting gas. We propose MRS IFU spectroscopy to, a) answer the question about why such strong molecular hydrogen can exist in such a hostile environment in the wake of the 1000 km/s shock wave. We will measure at sub-arcsec resolution, velocity dispersion, bulk kinetic energy, and total luminous power of the clumps of warm H2 revealed in recent ERO JWST MIRI images. We will compare these properties to that of gas in other phases, especially cold H2 mapped on the same resolution by ALMA., b) explore how the dissipation of kinetic energy and mixing of gas phases effects the formation of stars, and c) we will try to understand how the properties of the warm H2 may tie in with the (1500 km/s) extremely broad Ly-alpha shocked gas in the halo of this group. The large extent of the shock, combined with its clean, uncluttered environment (away from major starburst or AGN), make Stephan's Quintet an idea environment to understand how mechnical energy dissipates in multi-phase gas, and how gas cools to form stars. The results will have general significance to many other known (and soon to be discovered by JWST) regions where shock waves pass through large tracts of multi-phase gas.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3449
Program Title: Direct Detection of Molecular Gas in the Extremely Metal-Poor Galaxy Leo P

Principal Investigator: Telford, Grace

PI Institution: Rutgers the State University of New Jersey

Star formation impacts virtually all areas of astrophysics, and yet remains remarkably poorly understood at the low metallicities typical of early galaxies. Observations show that star formation proceeds in molecular gas (largely in undetectable cold H_2) in higher-metallicity galaxies. But the usual tracer of this ISM phase, CO emission, becomes inefficient in metal-poor gas, leaving us without empirical evidence that molecular gas is the dominant fuel for star formation at very low metallicity. Some models predict that stars can form directly from cold HI in these environments, which would profoundly change the trajectory of stellar mass assembly at high redshift. We propose MIRI MRS observations of the closest extremely metal-poor, star-forming galaxy, Leo P (1.6 Mpc, 3% Z_sun) to search for rotationally excited emission from warm H_2. This 100-1000 K material is typically ~10% of the total H_2 mass in star-forming galaxies, so its detection would imply the presence of cold molecular gas. The combination of Leo P's proximity and MIRI's unprecedented spatial resolution and sensitivity in the MIR uniquely enables robust detection of (or a stringent upper limit on) the compact, warm H_2 clouds expected in the metal-poor ISM. Simultaneously, these observations will be sensitive to PAH emission, dust continuum, and fine-structure nebular lines from the galaxy's only HII region, all of which will provide new insight into the impacts of radiation field hardness and intensity in metal-poor environments. This proposal will fundamentally shape our understanding of star-formation physics in metal-poor galaxies, both locally and at high redshift.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3468
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 teh Zwicky Transient Facility (ZTF) 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 survey for ToO observations and anticipate a 5% (or better) measurement of H0, with only 3 hours of JWST time.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3477
Program Title: EPISODE: EC 53, the only known Periodically variable Infant Star to chase the Outburst in the next Dynamical Event

Principal Investigator: Lee, Jeong-Eun

PI Institution: Seoul National University

Despite the importance of episodic accretion in the star formation process and its significant role in changing physical and chemical structures of the protostellar system, coherent observational studies tracing a full cycle of accretion burst from a single protostar have never been performed. Protostellar outbursts are rare and usually unpredictable, making such observations challenging, but one embedded Class I protostar, EC 53, shows cyclical bursts. Using this unique laboratory, we propose NIRSPEC and MIRI IFU observations to trace variations of chemical compositions in response to burst accretion. Spatially resolved NIR and MIR spectra will reveal the distributions of ice and gas species, including complex organic molecules, in the disk and envelope. Time-constrained observations designed to catch the quiescent and burst phases will allow us to directly compare the chemical differences following the changes in the locations of sublimation fronts of the most abundant species (CO, CO2, and H2O) and the changes in the strength of hot molecular emission.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3486
Program Title: Equator-to-Pole Atmospheric Differences in Giant Exoplanet Analogs

Principal Investigator: Vos, Johanna

PI Institution: American Museum of Natural History

With the launch of JWST, we are entering the era of direct exoplanet characterization studies. Based on the handful of directly-imaged exoplanets studied to date, it is clear that interpretation of these discoveries hinges on a thorough understanding of their atmospheres. There is growing evidence that these clouds are inhomogeneously distributed in latitude, with thicker clouds at the equator relative to the poles. If cloud and atmospheric properties change significantly from equator to pole, then the observed spectral diversity among giant extrasolar atmospheres may be explained by viewing angle. JWST provides a unique opportunity to directly test this. We propose to test the latitudinal dependence of cloud and atmospheric properties in a uniform sample of isolated giant exoplanet analogs. Searching for atmospheric equator-to-pole differences in giant exoplanet analogs is essential for understanding the atmospheres of extrasolar worlds ranging from brown dwarfs to bona fide directly imaged exoplanets.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3496
Program Title: How Deep are the Winds in an Extrasolar World?

Principal Investigator: Vos, Johanna

PI Institution: American Museum of Natural History

The vertical structure of atmospheric winds is critical for understanding global-scale circulation on giant planets within our solar system and presumably beyond. Due to their fast rotation, brown dwarfs are in the same dynamical regime as Jupiter and Saturn. Fortunately, their complex atmospheres provide cloud features that allow us to trace the atmospheric dynamics. We propose for 15 hr of monitoring with JWST/NIRSpec to measure the first vertically-resolved atmospheric wind speeds in any extrasolar atmosphere. This program will revolutionize the study of giant extrasolar atmospheres by providing a new method of probing atmospheric dynamics through vertically-resolved wind speeds.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3503
Program Title: Mapping the rapidly evolving interstellar medium of emerging young star clusters

Principal Investigator: Adamo, Angela

PI Institution: Stockholm University

Thanks to JWST’s game-changing capabilities the critical but poorly understood process of star cluster emergence from their natal clouds can be observed in a range of extragalactic environments beyond the Local Group. NIRCam imaging studies sampling stellar continua, Paa(1.87 micron), Bra(4.05 micron) and 3.35 micron PAH emission of the spiral NGC628 have revealed ~1800 candidate emerging clusters (eYSCs). Within this large sample, variations in the SEDs and MIR colors of the eYSCs suggest a rapid evolutionary sequence of the HII and photo-dissociation regions (PDRs) as the clusters clear their surroundings. The details of this fundamental process will be established through spectroscopy. We propose a pilot NIRSpec/MSA 1-5 micron study of a representative sample of ~100 eYSCs in NGC 628 to measure rapid evolutionary changes occurring on the ~10 pc scales of star clusters. This dataset will: 1) Diagnose stellar feedback (e.g., photoionisation and shocks) using H and He recombination lines and the de-excited [FeII] transition. 2) Explore the properties of warm molecular gas from H2 emission and its relationships to the rapidly evolution of the PDRs. 3) Extend our understanding of PAH properties by resolving the strengths of the 3.35 mu PAH emission in its fundamental (aromatic and aliphatic) components as a way to chart the evolution of dust properties as clusters emerge. These unprecedented results can only be achieved with JWST spectroscopy and will be fundamental to inform our understanding of the separation of star clusters from their molecular fuel supplies while also informing radiative models used to study the larger scale IR emission of local and distant galaxies.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3507
Program Title: WHEN DOES THE INITIAL MASS FUNCTION BECOME BOTTOM-HEAVY?

Principal Investigator: Barone, Tania

PI Institution: Swinburne University of Technology

The stellar initial mass function (IMF) is a critical assumption underlying nearly every galaxy observable, yet it remains poorly constrained especially at high (z>0) redshifts. The low-mass end of the IMF (M < 0.4 Msun) significantly affects the mass-to-light ratio (M/L), and therefore measurements of key galaxy properties including the stellar mass, dark matter content, and supermassive black hole mass all depend on its assumed shape. The problem is that measuring the low-mass end of the IMF is difficult due to how intrinsically faint these stars are. Additionally, low-mass stars have a similar surface temperature to evolved giant and supergiants yet are orders of magnitude fainter. Disentangling a large population of dwarf stars from a sprinkling of evolved giants requires both gravity sensitive spectral absorption features and an old, evolved stellar population. However, these gravity sensitive features only vary with the IMF at the 1% level, and therefore very high signal-to-noise (S/N>~150) spectra are required. As a result, measurements of the low-mass IMF using gravity sensitive features has never been done at z>1. Here we propose to observe 2 strongly lensed massive quiescent galaxies at z~1 with JWST NIRSpec IFU which will allow for deep (integrated S/N>~150) coverage of multiple key IMF sensitive features. The two galaxies have well defined stellar population properties (age, metallicity, and alpha-abundance) from rest-frame optical spectroscopy, which are needed to disentangle chemical abundance patterns from IMF variations. These observations will be the first of their kind, and will provide a provide a key test for galaxy formation and evolution theories.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3510
Program Title: Calibrating the Balmer Decrement against Everything in NGC 4214

Principal Investigator: Choi, Yumi

PI Institution: University of California - Berkeley

Dust is ubiquitous where star formation takes place, and thus has a strong impact on emerging photons from star-forming galaxies. Thus, accurate dust correction is essential to derive the intrinsic properties of a galaxy. The Balmer decrement is one of the most widely used methods for dust corrections up to intermediate-redshift Universe, and it will play the key role in the JWST era because the Balmer emission lines are now accessible in earlier Universe. Despite its widespread use and future potential, the Balmer decrement is known to underestimate the optical depth, which inevitably propagate into the inferred properties of galaxies. The underestimation is magnified at higher redshift, where it is extremely challenging to constrain the detailed knowledge of underlying mechanisms governing dust/starlight interaction at ~1 pc scale. We propose to leverage the unique capability of the NIRCam's HST/UVIS-comparable spatial resolution in the near-infrared to tackle this problem. We will obtain panchromatic NIRCam imaging of the low-metallicity starburst galaxy NGC 4214 to establish a robust empirical calibration for the Balmer decrement down to ~0.5 pc. By combining our proposed imaging with archival HST data, we will investigate the degree of underestimation in the Balmer decrement as a function of local interstellar medium conditions, local dust properties, star formation rate intensity, and spatial resolution from ~0.5 pc to ~2 kpc scales. Our measurements will serve as the new standard for determining dust corrections for distant galaxies.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3514
Program Title: Panchromatic view of an Adolescent and Frigid Jovian Exoplanet

Principal Investigator: Bonnefoy, Mickael

PI Institution: Institut de Planetologie et d'Astrophysique de Grenoble

Direct imaging has started unveiling the physical and atmospheric properties of young and hot (700-2700K) Jovian exoplanets. The recent detection of COCONUTS-2b, a 6MJup planet at 6471au from its host star challenges proposed formation models. The object is the coldest exoplanet identified around a star younger than 1Gyr, offering to extend our knowledge of the atmosphere of cool young Jovians at frigid temperatures where a larger diversity of molecular compounds condense and leave deep imprints in infrared spectra. We propose to conduct an in-depth spectroscopic investigation of that exoplanet from 0.6-14microns with the JWST. We will determine accurately the bulk characteristics (mass, Teff, luminosity) of the object to better understand its formation. We will study the magnitude of non-equilibrium chemistry and formation of resurgent clouds proposed to happen at these extreme Teffs. We will constrain the abundances of key formation tracers (C/O, M/H, S/Fe, P/Fe) to better understand the object origin. To conclude, we will measure for the first time the abundance of CH3D -- and D/H -- in the atmosphere of an exoplanet. The companion is both exceptionally bright, cold, and should not have been fusing deuterium to allow for that measurement. Deuterium abundance could be used to improve the Deuterium-burning models, setting the dividing line between planets and brown-dwarfs. We will also compare the D/H to ISM, protoplanetary disk, and Jupiter values to draw a consistent picture of the formation of that exoplanet and contextualize our Solar System.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3516
Program Title: All the Little Things: Pop III Signatures & the Ionizing Photon Budget of Dwarf Galaxies in the Epoch of Reionization

Principal Investigator: Matthee, Jorryt

PI Institution: ETH Zurich

The lowest mass galaxies in the first billion years hold the key to two frontiers of observational cosmology: (i) finding the most metal-poor first generations of stars, including metal-free Pop III stars; (ii) identifying the sources that drove cosmic reionization. The inherent faintness of these galaxies and the need for sensitive rest-optical spectroscopy of large samples have been the main limitations. Here we propose a NIRCam grism survey at JWST's most sensitive wavelength (3-4 micron), in an optimally designed mosaic, around the powerful lensing cluster Abell 2744. Leveraging the grism's spatial resolution, in some cases amplified by lensing, we will perform a flux-limited survey for metal-poor (perhaps metal-free) pockets of star formation within ~200 faint (M_UV<-16) galaxies at z~5-7. If not for Pop III stars themselves, this search promises to reveal Pop II stars that may have been directly enriched by Pop III supernovae, analogs of which have been observed in Milky Way dwarf galaxies. We will, for the first time, directly measure the distribution of ionizing efficiencies among faint galaxies at z~7 using Balmer lines exactly in the luminosity regime where reionization models have major differences. Along with simultaneous deep F090W imaging on the cluster, our survey is expected to yield ~3000 spectroscopic redshifts from z~1-7, vastly enhancing the legacy value of the A2744 field. Crucially, we will measure redshifts for multiply imaged sources in ~80% of the A2744 mosaic that is yet to be covered by spectroscopic surveys, including two high magnification regions, thereby constraining the lensing model underpinning all community science in this field.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3522
Program Title: Spectroscopic characterization of the smallest and coolest directly imaged exoplanet 51 Eridani b

Principal Investigator: Ruffio, Jean-Baptiste

PI Institution: University of California - San Diego

We propose to spectroscopically characterize the atmosphere of 51 Eridani b, the lowest-mass (2-4 MJup) and coolest (Teff~600-850 K) directly imaged exoplanet. We will obtain R~2,700 fixed-slit NIRSpec spectra between 3-5 um, targeting the peak flux of this young Jupiter and enabling the detection of molecular lines from species such as CH4, CO, CO2, and H2O. These detections will be used to derive the metallicity, carbon-to-oxygen ratio, disequilibrium chemistry, and cloud properties of 51 Eri b. With its low temperature and partially cloudy or wholly cloud-free atmosphere, 51 Eri b is one of the most interesting directly imaged exoplanets for the purpose of comparative exoplanetology, representing a bridge between wide-orbit super-Jovian worlds and our own Jupiter.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 3526
Program Title: Probing Reionization and Early Cosmic Enrichment with the MgII Forest

Principal Investigator: Hennawi, Joseph

PI Institution: University of California - Santa Barbara

Understanding how reionization occurred and the nature of the early sources that drove it are among the most important open questions in cosmology. In the process of producing the roughly three ionizing photons per hydrogen atom required to reionize the IGM, the same massive stars explode and eject metals into their surroundings, enriching the Universe to a metallicity of Z~10^-3. While the overly sensitive Ly-alpha transition makes Gunn-Peterson absorption an ineffective probe of reionization at z>6, strong low-ionization transitions like the MgII 2796,2804 doublet will give rise to a detectable 'metal-line forest', if the metals produced during reionization pollute the neutral IGM. A novel statistical approach leveraging techniques from precision cosmology has recently been developed to detect this signal, thereby allowing one to constrain early IGM enrichment and trace the history and topology of reionization with cosmic time. We request deep NIRSpec observations of six z>7 quasars to realize this qualitatively new absorption spectroscopy experiment. These new data will be combined with comparable quality spectra of two z > 7 quasars from approved programs to yield a statistical sample of eight absorption spectra with unprecedented sensitivity (S/N ~ 80). With this combined sample, we expect to make a 10sigma detection of the MgII forest, and jointly constrain the metallicty [Mg/H] and the neutral fraction to a 1sigma precision of 0.04 dex and 8%, respectively. If the IGM is pristine, we will constrain [Mg/H] < -3.94 at 95% confidence, close to the critical metallicity of -4 that defines the transition from the PopIII to PopII star-formation mode.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3533
Program Title: A JWST high-definition view of an extremely metal-poor interstellar medium

Principal Investigator: Aloisi, Alessandra

PI Institution: Space Telescope Science Institute

JWST has only just begun the quest to understand star formation in the metal-poor, low-mass dwarf galaxy population around the Epoch of Reionization and beyond. However, spatially-resolved studies will remain elusive. The most extreme blue compact dwarf galaxies (BCDs) in the Local Universe have properties that are reminiscent of this high-z dwarf population, and could provide a detailed answer to the question of how stars form in a low-metallicity environment. Here we propose MIRI/MRS spectroscopy of the most extreme BCD, I Zw 18, at a distance of 18.2 Mpc. Its extremely low metal abundance (2-3% solar), and its high specific star-formation rate (sSFR = 10^-7 - 10^-8/yr) powered by two massive star clusters, make it the best approximation we have for star formation in the nearly pristine interstellar medium (ISM) at early epochs. Our observations are designed to map at 25-50 pc resolution the constituents of the ISM in this well-studied iconic target. We will analyze the warm H2 properties through spatially-resolved H2 excitation diagrams; identify PAH features around the HII regions driven by the two massive star clusters; and finally assess the hardness of the interstellar radiation field through fine-structure lines. Only JWST can provide the ultimate characterization of the structure of the ISM in extreme low-metallicity environments, and shed light on the local star-formation processes that govern galaxy formation and evolution in the early Universe.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3535
Program Title: Unveiling the AGN-host connection with PAH molecules

Principal Investigator: Garcia Bernete, Ismael

PI Institution: University of Oxford

Supermassive black holes (SMBHs) are believed to play an instrumental role in the evolution of their hosts. There is evidence that the AGN interacts with the dust and gas in the host galaxy. Material is also driven inwards from the interstellar medium of the host galaxy to fuel the central engine that could initiate star formation. Numerical simulations predict that in active galactic nuclei (AGN) star formation in the nuclear region is should be tightly correlated with the growth of the supermassive black hole. Capitalising on existing JWST cycle 1 programs and targets we propose to obtain NIRSPEC/IFU & MIRI/MRS 2.9-28.5 micron observations of the central <350 pc regions of 3 well known nearby Seyfert galaxies, achieving typical resolutions of 10-60 pc. Using spectral signatures from Polycyclic Aromatic Hydrocarbons (PAHs) and a host of mid-infrared fine structure lines and H2 rotational transitions our goals are two-fold: (1) to probe the effects of the central AGN on the the interstellar medium (ISM) of the host galaxy as a function of distance from the central engine. PAH emission and low excitation fine structure (FS) lines will also be used to trace nuclear star formation. (2) to investigate the role of the warm molecular gas in shielding PAH molecules (protect them from the AGN radiation field). This investigation is of paramount importance as PAHs are routinely used to measure SFR in AGN.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3538
Program Title: Unveiling the properties of high-redshift low/intermediate-mass galaxies in Lensing fields with NIRCam Wide Field Slitless Spectroscopy

Principal Investigator: Iani, Edoardo

PI Institution: Kapteyn Astronomical Institute

In its first months of activity, the James Webb Space Telescope (JWST) has shown to the whole astronomical community its great performance in terms of sensitivity and resolution, enabling the detection of the first statistical samples of galaxies at redshift z > 5. To date, our knoweledge of the physical properties of these objects is still strongly limited to the brightest and most massive galaxies. Thanks to JWST and the proposed observations, we will finally reach and characterise the main properties of the bulk of the galaxy population at such high redshifts: the low/intermediate mass galaxies. To do so, we ask to observe with the Wide Field Slitless Spectroscopy (WFSS) mode of the Near Infrared Camera (NIRCam) on board JWST three galaxy clusters: Abell 2744, Abell 370 and MACS J0416.1-2403. The depth of the proposed observations (3x deeper than the currently available JWST spectroscopy in extra-galactic fields), together with the lensing power of the galaxy clusters, will grant us access to this region of the galaxy's parameter space that is still left unexplored. The proposed 2.6-5.1 micron spectroscopy, in synergy with the wealth of imaging data available for our three target fields, will allow us to robustly constrain the star formation rate, stellar mass, the stellar population age and the properties of the interstellar medium of galaxies at z>5. Our request for no proprietary time underlines the importance and legacy value of the proposed observations, which will bring valuable and missing complementary data to these three well-studied lensing fields.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3543
Program Title: Old Galaxies in the young Universe: ultra-deep continuum spectroscopy before cosmic noon

Principal Investigator: Carnall, Adam

PI Institution: University of Edinburgh, Institute for Astronomy

We propose ultra-deep rest-frame optical NIRSpec MSA spectroscopy for a large, representative sample of ~120 galaxies before cosmic noon. Our priority 1 targets are 15-20 of the highest-redshift massive quiescent galaxies (2.5<z<5), including 2 objects at z>4. For these, we will a.) confirm redshifts and the absence of star formation to calculate robust number densities, b.) measure formation and quenching times, and c.) constrain stellar metallicity and alpha enhancement to probe star-formation physics in massive galaxies during the first billion years. Current simulations fail to reproduce the number density of the earliest quiescent galaxies: we will measure their detailed physical properties to understand what is missing from such simulations. We will target the UDS field, which contains ~1000 high-redshift galaxies benefiting from ultra-deep optical spectroscopy from VANDELS, a 1000-hour investment of VLT VIMOS time. The UDS will also benefit from JWST PRIMER imaging. Our priority 2 targets are 25-30 massive quiescent galaxies at 1<z<2.5 with VANDELS rest-frame near-UV spectra, which we will extend into the rest-optical to measure stellar metallicities, as well as to constrain residual/rejuvenated star-formation + AGN activity. Our priority 3 targets are 50-60 VANDELS star-forming galaxies at 2.5<z<6, for which we will measure rest-optical emission lines to constrain gas-phase metallicities, SFRs and dust attenuation levels. These will be combined with far-UV stellar metallicities and Lyman alpha fluxes from VANDELS to constrain alpha enhancement and the physics of Lyman alpha escape. We will finally observe ~10 of the highest-redshift (z>8) PRIMER galaxy candidates.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3547
Program Title: Revealing the early phase of the co-evolution of galaxies and super-massive black holes at a z=3 proto-cluster core

Principal Investigator: Umehata, Hideki

PI Institution: Nagoya University

A tight correlation between a mass of a central super massive black hole (SMBH) and a galaxy spheroid mass has been discovered in the local universe. Understanding the origin of this "co-evolution" of galaxies and SMBHs has been a major goal of modern astronomy. While the co-evolution has been usually investigated using optically selected quasars for years, such an approach only must be insufficient. Since the key phase in which galaxies and SMBHs assemble masses very rapidly is predicted to be highly obscured by dust, it is of fundamental importance to directly measure the mass of (proto-)bulge and galaxies together with the BH mass in the heavily obscured phase in the early universe. In this program, we propose NIRCam imaging and MIRI MRS spectroscopy of ADF22.A1, a z=3.09 bright DSFG located at a z=3.1 proto-cluster core. ADF22.A1 is a HyLIRG-class DSFG and hosts a heavily obscured, but intrinsically bright, AGN at the core, which offers an invaluable target to understand the early phase of the co-evolution. Recent intensive ALMA surveys uncover that ADF22.A1 has a proto-bulge and extended, rotating disk, also showing signatures of spiral arms and clumps. The four-band NIRCam imaging (F115W, F200W, F356W, and F444W) will measure stellar morphologies, tying the ALMA-indentified substructures with the stellar regime, and stellar masses for both galaxy and bulge. The MIRI MRS enables the BH mass measurements utilizing Pa-alpha line as a tracer. We will unveil the early stage of the co-evolution, which has been hidden for years, finally.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3548
Program Title: Exometeorology: Weather on an Isolated World Beyond Our Own

Principal Investigator: Vos, Johanna

PI Institution: American Museum of Natural History

With the launch of JWST, we are entering the era of direct exoplanet characterization studies. Based on the handful of directly-imaged exoplanets studied to date, it is clear that interpretation of these discoveries hinges on a thorough understanding of their condensate clouds. Spectroscopic time-series monitoring provides a means to investigate these clouds in detail. We propose to obtain phase-resolved coverage of the highly variable, isolated exoplanet analog SIMP J0136+09 by observing one full rotation each with the NIRSPec and MIRI instruments. By obtaining complete longitudinal information of an extrasolar atmosphere at 1-14 μm we will perform the most detailed phase-resolved atmospheric investigation of any extrasolar atmosphere to date. The proposed program will enable us to 1) Pinpoint the mechanisms driving variability 2) Perform spatially-resolved atmospheric retrievals on an imaged extrasolar atmosphere for the first time The results of this program will provide crucial insight on the importance of time-varying atmospheric processes for brown dwarfs, isolated planetary-mass objects and bona fide directly-imaged exoplanets.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3557
Program Title: A JWST Search for Missing Methane

Principal Investigator: Madhusudhan, Nikku

PI Institution: University of Cambridge

The “Missing Methane problem” is one of the central mysteries in the exploration of exoplanetary atmospheres. Whereas methane (CH4) is ubiquitous in the atmospheres of solar system giant planets, it has yet to be robustly detected in temperate exoplanetary atmospheres. Molecules such as CH4 and ammonia (NH3) are expected to be prominent carriers of carbon and nitrogen in H2-rich atmospheres at temperatures below ~800 K. The presence or absence of CH4 in such atmospheres has major implications for our understanding of planet formation, atmospheric processes, and searches for chemical signatures in habitable-zone exoplanets. We propose a comprehensive JWST program to address this long-standing problem with high-precision transmission spectra over the 1-10 micron range for a homogeneous sample of four temperate mini-Neptunes orbiting bright M dwarfs. These observations will be obtained using a combination of NIRISS, NIRSpec G395H and MIRI LRS instruments. The observations will provide unprecedented constraints on the atmospheric compositions of these targets, robustly resolving the Missing Methane problem and providing important insights into disequilibrium processes in the atmospheres. These observations will also allow us to a) constrain theories of planet formation and evolution of sub-Neptune planets by determining their atmospheric metallicities and elemental ratios, b) build the first mass-metallicity (M-Z) relation in the sub-Neptune regime and c) test the extension of solar system M-Z relation in C/H to lower masses. Our program will pave the way for future searches of hydrocarbons and signatures of chemical disequilibrium in habitable-zone exoplanets.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3558
Program Title: The First Spectrum of the Coldest Halo Brown Dwarf

Principal Investigator: Meisner, Aaron

PI Institution: NOIRLab - (AZ)

For nearly a decade, JWST GTO target WISE 0855 (Teff ~ 250 K, d ~ 2 pc) has stood as the coldest known brown dwarf. Perplexingly, intense searches for WISE 0855 analogs have turned up no objects as cold or cooler to date. One emerging possibility is that the very coolest brown dwarfs — like giant (exo)planets — have diverse properties, and thus our past searches have been misguided. Because brown dwarfs cool over billions of years as they age, the coldest substellar objects may preferentially be the oldest, but until recently no halo brown dwarfs had been conclusively identified. WISEA 1534-1043 (a.k.a. The Accident) is a newly discovered brown dwarf with halo kinematics and observational properties completely unlike those of any other known (sub)stellar object, though strongly suggestive of low metallicity. At just 16 pc distant and with Teff <~ 400-550 K, WISEA 1534-1043 may be the first member of a vast, previously overlooked halo brown dwarf population. Our JWST NIRSpec/MIRI spectroscopy and MIRI photometry of WISEA 1534-1043 will (1) determine this unique object’s bolometric luminosity, temperature, and metallicity (2) complete WISEA 1534-1043’s kinematic profile (3) reveal chemistry at low metallicity via retrievals (4) serve as a touchstone data set steering future development of low-metallicity, low-temperature brown dwarf and exoplanet atmospheric/evolutionary models and (5) guide future searches for the coolest brown dwarfs. Incredibly faint at short wavelengths (J = 24.5 Vega), high-quality spectroscopy of WISEA 1534-1043 is infeasible with any facility other than JWST.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3559
Program Title: NIRCam monitoring of the inner accretion flow of Sgr A* synchronous with EHT imaging of the black hole shadow

Principal Investigator: Yusef-Zadeh, Farhad

PI Institution: Northwestern University

We propose a second epoch of simultaneous JWST + EHT observations of Sgr A* during a campaign in April-May 2024, led by the EHT. The analysis of variable flaring events provides the local and global characteristics and physics of Sgr A*'s accretion flow close to the event horizon, which will have a significant impact on our understanding of massive black holes in the nuclei of other galaxies. JWST Cycle 1 observations in coordination with the EHT are scheduled in April 2023. The proposed second-epoch observations are needed to model and correct the sub-mm variability in the next EHT imaging observations of Sgr A* and to futher constrain long-term statistical variability trends in the near-IR, which will be accomplished by combining three previous epochs of HST observations of Sgr A* in 2004, 2007, and 2014 at similar NIR wavelengths. Long-term projects such as this need regular investments or else they simply can never be done. This long-term project is low-risk, and high reward, as we propose the first study of Sgr A*'s year-to-year variability using long duration, high sensitivity, simultaneous observations at two NIR wavelengths. We will be able to detect the generic low-level NIR flickering that comes from the underlying inner accretion flow, as opposed to rarer, sporadic more powerful events. This will allow us to probe for the first time the physical models of the accretion flow, which predict different mean fluxes and statistical fluctuations. We will compare the two epochs of JWST observations to older HST data and investigate the variability of Sgr A* on decadal timescales, providing critical input parameters for simulations of the black hole accretion flow.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3567
Program Title: A deep dive into the physics of the first massive quiescent galaxies in the Universe

Principal Investigator: Valentino, Francesco

PI Institution: European Southern Observatory - Germany

The spectroscopic confirmation of numerous galaxies already quiescent at z=3.5-4 defies our understanding of the early evolution of massive galaxies. State-of-the-art cosmological simulations struggle to reproduce the number densities and properties of such quiescent objects at increasing redshift, and completely fail at z~4. While ground-based observations have been instrumental to drive the initial study of these intriguing galaxies, they are largely insufficient to derive robust stellar velocity dispersions, ages, metallicities, and rest-frame optical sizes, all fundamental ingredients to understand the physics regulating their life cycle. Here we propose to derive all these quantities for a fully representative sample of 11 spectroscopically confirmed massive quiescent galaxies at z=3.5-4 with NIRSpec/MSA medium resolution spectroscopy and NIRCam imaging. The proposed observations will allow us to (1) detect slight short-timescale SFR residuals or faint AGN from emission lines; (2) derive stellar ages, metallicities, and robustly reconstruct SFHs via spectro-photometric modeling; (3) determine their stellar structure and dynamics by measuring velocity dispersion and sizes; (4) establish the existence of surrounding overdense environments, as expected given their large stellar masses. JWST is the only facility that can allow us to achieve these goals, as this program is unfeasible from the ground. This deep multiplexing spectroscopic search will have high legacy value as all main targets are in some of the most intensely studied cosmological fields with exquisite ancillary coverage and plenty of potentially interesting fillers for the MSA.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3571
Program Title: MIRI observations of YSO candidates for Unambiguous Evidence of Star formation in the 10pc Molecular Ring Orbiting the Galactic Center Black Hole

Principal Investigator: Yusef-Zadeh, Farhad

PI Institution: Northwestern University

There is mounting evidence for signatures of star formation, such as methanol and water masers and bipolar outflows, at the center of the Galaxy. While these signatures are widely accepted for star forming regions in the Galactic disk, the extreme environment, particularly irradiation by OB stars and the disturbed nature of the circumnuclear molecular ring (CNR), suggest that in principle the signatures could be produced by shocks and external irradiation. The CNR shows a population of very dense clumps that appear to be marginally gravitationally unstable. What is needed is an unambiguous tracer, ideally the direct detection of Young Stellar Objects (YSOs). This demands the unique capabilities of JWST. The increased sensitivity, resolution, and wavelength coverage of JWST will untangle the process of star formation in the crowded and complex region of the nucleus of our Galaxy. The observational program proposed here will search for IR-excess sources from bipolar molecular outflows and uncover IR-excess sources in the molecular ring and search for YSOs in a site where numerous tracers of outflows are detected. This is the first time that there is sufficient sensitivity for a complete census of low- and high-mass ongoing star formation in the circumnuclear molecular ring, thus providing an accurate estimate of the star formation rate near the supermassive black hole. These observations will also be the seed for a more extensive mid-IR imaging survey of the entire Galactic Center region in later observing cycles, which will have tremendous potential for a wide variety of archival research programs in this remarkable and unique region of the Galaxy.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3589
Program Title: How big do stars get? A NIRCam view of cool supergiants in, NGC 4449, a key low-metallicity environment

Principal Investigator: Patrick, Lee

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

The currently detected black-hole, black-hole (DBH) merger population have brought to focus the lack of understanding of how massive stars end their lives in the >30 solar mass regime, both as single stars and within binary systems. In this respect, the empirically observed limit on the luminosity of cool supergiant stars (CSGs), the Humphreys-Davidson (HD) limit, is of primary importance, particularly given the tension between the stellar evolutionary model predictions and observations at sub-solar metallicities. This brings about the question: how large and luminous do massive-star progenitors of black holes become at low metallicity? The most well studied examples of sub-metallicity massive star populations (in the Large and Small Magellanic clouds) have proved insufficient to rule out brief violations of the HD limit, which is the result of low number statistics. To this end, we propose to observe the complete CSG population of the LMC-like starburst galaxy NGC 4449 with NIRCam. These observations will allow the identification of the CSG population and the reconstruction of the optical-to-infrared spectral energy distributions to accurately determine their luminosities. As well as having a high legacy value, these observations will allow us to determine, to a much greater level of statistical accuracy whether nature permits violations of the HD limit, which directly impacts both the interpretation of the observed core-collapse supernova population and the feasibility of DBH formation channels.

Proposal Category: AR
Scientific Category: Stellar Physics and Stellar Types
ID: 3593
Program Title: Towards Solving the Stellar Inhomogeneity Contamination of Exoplanet Transmission Spectra Problem with Star Spot and Faculae Spectra

Principal Investigator: Seager, Sara

PI Institution: Massachusetts Institute of Technology

Stellar surface inhomogeneities, such as spots, faculae, and magnetic network contaminate and, in some cases, overwhelm the planetary signal in transmission spectra (see, e.g. a detailed review by Rackham et al. 2022). In particular the lofty goal of analyzing Earth-size planet atmospheres in the habitable zones of M dwarf stars may be prevented until we can disentangle the star surface inhomogeneity from the exoplanet atmosphere signal, e.g., Trappist-1. So far, astronomers have tried to remove the magnetic contamination of transmission spectra by using non-magnetic stellar models—a hotter star to model faculae and a cooler star to model star spots. Yet this approach dramatically fails to reproduce the complex wavelength dependence of magnetic contamination (Witzke et al. 2022). Thus, a more comprehensive approach based on realistic magnetohydrodynamics (MHD) simulations of stellar atmospheres and magnetic features within these atmospheres is needed. The magnetohydrodynamics simulations have reached a high degree of maturity and have already revolutionized solar and stellar physics. Now they are ready to address the big challenge facing exoplanetary science and allowing us to overcome the barrier imposed by magnetic contamination. We propose to generate a “library” of star spot and star faculae spectra of M and K stars for the community to use in furthering understanding contamination of transmission spectra light curves for atmospheres of exoplanets and, in particular, of rocky exoplanets transiting M dwarf stars.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3596
Program Title: Time-dependent dust heating and reverberation in the disk of the highly accreting classical T Tauri star DR Tau

Principal Investigator: Kospal, Agnes

PI Institution: Konkoly Observatory

The innermost part of circumstellar disks around young stars, where terrestrial planets form, is a vigorous dynamical environment. The location of the inner radius of the dust disk is an important parameter which shapes the accretion process, the amplitude and timescale variability processes, and even the efficiency of planet formation. Located at a fraction of an au, measuring this radius is very challenging, even for infrared interferometers. Here, we propose a novel method, the dust reverberation technique, to measure the inner dust disk radius in the highly accreting, highly variable classical T Tauri star DR Tau. Taking advantage of the supreme cadence and precision of NIRISS for spectrophotometric time series, we will make a pioneering reverberation experiment, one of the first of this kind on a young star. We will obtain 0.8-2.8 um spectra with 7 sec cadence uninterruptedly for 2 hours. In this data stream, we will look for optical brightness fluctuations due to the variable stellar/accretion radiation, and search for their reverberation signal in the infrared domain, emitted by dust particles whose temperature changes due to the varying irradiation. We will repeat the observations a few months later, sampling a different brightness state of the star/disk system. Our experiment will enable us to measure the inner radius of the dust disk in a model-independent way. We will also determine the variations of the accretion rate, the dust temperature, and the emitting surface in the disk. Our results will help to connect the accretion process and disk changes and may establish the reverberation technique as a standard tool of protoplanetary disk studies in the future.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3615
Program Title: Exploring the boundary between rocky and gaseous planets with WASP-47 e

Principal Investigator: Zieba, Sebastian

PI Institution: Max Planck Institute for Astronomy

Ultra-short-period (USP) planets have orbital periods shorter than a day and are therefore being blasted by radiation from their host stars. The majority of these small USP planets have bulk densities consistent with Earth-like compositions, with two notable exceptions clearly showing lower densities: 55 Cnc e and WASP-47 e. Both planets lie directly in the radius valley between super-Earths and sub-Neptunes, providing an exciting opportunity to test the boundary between rocky and gaseous planets. In addition, both planets orbit in multi-planet systems with similar architectures, possibly implying a similar formation history. Compared to 55 Cnc e, WASP-47 e is advantageous because the other planets in the system are transiting, offering an opportunity for comparative planetology. The host star is also fainter, so observing WASP-47 e doesn't push the performance of the detectors on JWST to the extreme limit that 55 Cnc does. Two secondary eclipse observations of WASP-47 e will distinguish at 4.5 sigma significance whether the planet is a bare rock and possibly part of a proposed exotic class of exoplanets without cores, or whether it holds onto a CO- and CO2-rich atmosphere, which is expected from a remnant atmosphere affected by photoevaporation.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3621
Program Title: Confirming a Giant Planet Around the White Dwarf GD 140

Principal Investigator: Venner, Alexander

PI Institution: University of Southern Queensland

White dwarfs represent the end state of evolution for the vast majority of stars in the galaxy. Planets are now known to be ubiquitous companions to stars, yet very little is known about their fate after their host stars after they become white dwarfs. We have discovered a candidate giant planet orbiting the nearby young white dwarf GD 140 based on evidence from astrometry and Spitzer photometry. We request 0.8 hours of MIRI imaging observations to detect and confirm this planet candidate. We will accomplish this by detecting a mid-infrared excess in GD 140's spectrum arising from planetary thermal emission. The planet is predicted to outshine the white dwarf beyond 12 micrometres, allowing us to confirm the planet with overwhelming confidence and precisely measure its temperature and mass. Additionally, we will be able to fully resolve the planet if it lies more than approximately 0.8 arcseconds (>12 AU) from the white dwarf. The confirmation of this planet would represent a significant addition to the small number of known planets around white dwarfs, and would offer immense opportunities for further study such as characterising its orbit and atmosphere.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 3629
Program Title: Direct detection of molecular gas reservoir in the circumgalactic medium of a brightest cluster galaxy

Principal Investigator: Man, Allison

PI Institution: University of British Columbia

We seek to conduct a pilot observation with MIRI/MRS to map the warm molecular hydrogen in the circumgalactic medium (CGM) of the brightest cluster galaxy (BCG) of MACS1931-26. The target harbours one of the largest known H2 reservoir in a cluster core revealed by ALMA. Its cold gas, as traced by CO, is spatially extended over a tail of ~30kpc beyond the BCG core. Submillimeter observations using single-dish and interferometry reveal extreme thermal and excitation conditions in the CGM gas: the dust and gas is thermally decoupled, and the CGM is unusually highly excited. A plethora of evidence points to a drastically different condition in the CGM than typical gas found in galaxies: the thermal gas states are dominated by highly energetic particles rather than FUV-photons from young stars as in galaxies. JWST/MIRI is uniquely capable of revealing a potentially massive warm H2 reservoir in the CGM. We propose a pilot observation with MIRI/MRS to map the 3D structure of the warm molecular gas in the BCG core and the extended CGM tail of MACS1931, in order to: (1) detect and map the spatial extent and temperature distribution of the warm H2 emission; (2) compare the warm H2 emission to the cold H2 emission mapped by CO. The H2 0-0 S(1) and S(5) line maps will enable us to measure the total gas mass and temperature distribution. By probing the CGM gas across a range of temperatures, we will scrutinize the impact of AGN feedback on the baryon cycle, and assess the role of shocks and turbulence in the heating and cooling of the CGM.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3647
Program Title: GJ504 b is really cool: a new atmospheric window into Jupiter’s evolution with JWST/MIRI

Principal Investigator: Patapis, Polychronis

PI Institution: Eidgenossische Technische Hochschule Zurich (ETHZ)

The connection between the formation pathway and atmospheric evolution of the young, hot, and widely separated directly-imaged exoplanets and our Solar System gas giants like Jupiter is not well understood. GJ 504 b is the coldest planetary-mass companion (PMC) orbiting a solar-like star on a solar system scale orbit (43 AU) found to date. With an estimated temperature of ~500 K, it is the only PMC that bridges the gap between the population of directly-imaged young exoplanets (~1000K) and our own Jupiter (~130 K). We aim to unveil the mid-infrared spectrum of GJ504b with MIRI/MRS, that is expected to show many pronounced molecular features at these wavelengths, most notably ammonia. Studying the atmosphere will help us understand whether PMCs at lower temperatures still retain the signposts of their hotter counterparts, namely disequilibrium chemistry and clouds, therefore putting the first constrains on this stage of gas giant atmospheric evolution. By measuring the abundances of H2O, CO, CH4 and NH3 we will be able to calculate elemental abundance ratios of C/O and, for the first time, N/O, which in conjunction can provide insights into the formation location and possible migration of the planet. The precision we expect with our measurements of C/O and N/O will be able to distinguish within 3 sigma whether GJ504 b is enriched (like Jupiter), solar, or depleted (like a recent measurement of a cool brown dwarf WISE 1828), potentially showing that it truly is a snapshot of Jupiter in its adolescent years.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3652
Program Title: Age and Confirmation of White Dwarf Exoplanet Candidate WD 0141-675b

Principal Investigator: LIMBACH, MARY

PI Institution: University of Michigan

We request 1.7 hours MIRI and NIRSpec observations to confirm, characterize and determine the age of the white dwarf exoplanet candidate WD 0141-675b. The candidate, identified with Gaia astrometry, has a mass of 9 Jupiter masses and an orbital period of 33 days. There is no other existing observatory capable of independently confirming this exoplanet. The planet orbits only 0.17 AU from the white dwarf, close enough that it could not have survived the red giant phase of its host star at its current location without engulfment. How the planet arrived at its current location is a mystery. Given the planet-host separation and planet mass it is nearly impossible to explain with existing white dwarf exoplanet formation theories. We propose to use JWST MIRI and NIRSpec to detect IR excess from WD 0141-675b's thermal emission spectrum. A detection will measure the planet's temperature and probe its atmospheric composition, while a non-detection would refute the existence of the planet. If confirmed, WD 0141-675b would be the first white dwarf planet with a known mass and temperature, allowing for a precise determination of the exoplanet's age and therefore time of formation providing a pivotal clue to the planet's origin. Either way, JWST observations will help us understand and confirm this unique planet and the mysterious processes that shape planetary systems after the main sequence.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3655
Program Title: Investigating the impact of quasar-driven outflows on recent star formation

Principal Investigator: Ramos Almeida, Cristina

PI Institution: Instituto de Astrofisica de Canarias

Active galactic nuclei (AGN) drive gas outflows that can affect the galaxies' interstellar medium (ISM) by sweeping out, heating, and/or mixing the gas needed to form new stars. Indeed, cosmological simulations require AGN feedback to regulate star formation and produce realistic numbers of massive galaxies. However, we are still far from understanding how AGN feedback couples with the host galaxies, which is what ultimately determines its efficiency. The goal of this proposal is to measure the impact of quasar-driven outflows in different locations of the host galaxies by comparing their 3D properties with the spatial distribution of PAHs, which probe recent star formation (ages<10 Myr). To do so we request MIRI/MRS observations of a sample of 5 nearby obscured quasars with well-characterized ionized and cold molecular outflows. By comparing the 3D outflow and recent star formation properties we will investigate under which circumstances quasar-driven outflows affect star formation in the host galaxies and, in particular, the importance of the coupling between the outflows and the ISM. This will be the first spatial comparison of outflows and PAH/star formation done for a sample of nearby luminous type-2 quasars.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3659
Program Title: What quenched the first massive quiescent galaxy? A comprehensive analysis from stellar kinematics to gas emission lines

Principal Investigator: D'Eugenio, Francesco

PI Institution: Kavli Institute for Cosmology, Cambridge

Most models expect that the most massive central galaxies are quenched by Active Galactic Nuclei (AGN) feedback, yet how this quenching happens is yet to be understood. This question is critical not only to our understanding of galaxy formation/evolution, but also for the physics of the baryon cycle and of AGNs themselves. The discovery of massive quiescent galaxies at high redshift poses stringent time constraints on feedback mechanisms. As the redshift frontier moves to higher redshifts, the available time interval between look-back time and quenching becomes necessarily shorter, leaving ever less room for subsequent, confounding evolution. At a redshift z = 4.658, GS-9209 is the highest-redshift, massive quiescent galaxy observed to date, hence it represents the best case study to investigate how these systems quenched in the young, gas-rich Universe. This expectation is confirmed by a recent, very high S/N NIRSpec spectrum of the galaxy, confirming its quiescence and a spectacular broad-line Ha— unmistakable evidence for ongoing gas accretion onto supermassive black hole (AGN activity). We propose to investigate the spatially resolved stellar and emission-line properties of GS-9209 to search for the distinctive signatures of the mechanism that has recently quenched this galaxy.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3662
Program Title: Imaging shepherding and carving planets in debris disks

Principal Investigator: Lagrange, Anne-Marie

PI Institution: Observatoire de Paris - Section de Meudon

Since the discovery of the first debris disk four decades ago, dozens of such disks have been resoved at optical and near IR, or at mm wavelengths with ALMA. These disks often show structures (sharp edges, rings, gaps, warps) that are often attributed to planets. Young debris disks offer then exquisite opportunities for studies of planetary systems formation and early evolution. Yet, shepherding or gap carving planets are still to be detected to definitely assess the origin of the observed features. Available high contrast imaging data suggest that, if they exist, the planets responsible for these structures have (very) low masses, less than typ 1-5 MJup, probably down to 0.1 MJup. Only JWST/MIRI can detect such low mass planets, in well selected disks. Once detected, these planets will offer unique opportunities to study disk-planets interactions, early dynamical evolution of planetary systems, and to reveal the properties of pristine, non irradiated, sub-Jupiters. Applying specific selection criteria to maximize the chances to find these shepherding/carving planets in regions where our solar system giants are located, we identified two pole-on, young, close-by, structured disks. TWA7 shows three ring-like structures peaking between 25 and 100 au, and HD181327 shows one ring-like structure at 80 au. We show that a 0.15 MJup planet can carve the gap between the first two rings. JWST/MIRI observations should allow detecting this planet and will allow detecting planet(s) with masses greater than 0.15-0.3 MJup carving the inner cavity and/or shaping its inner edge. It will allow detecting similar planets with masses greater than 0.3 MJup in the case of HD181327.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3663
Program Title: Big Impact in Little Galaxies? A JWST Investigation of AGN Outflows in Dwarf Galaxies

Principal Investigator: Bohn, Thomas

PI Institution: Hiroshima University

Feedback in dwarf galaxies has been widely regarded as being dominated by stellar processes. However, recent studies are showing a growing number of candidate AGN in dwarf galaxies. Follow-up, deep observations are not only confirming AGN but are also revealing evidence of AGN-driven outflows with sufficient energy to expel gas from their host galaxy. These findings are starting to question whether stellar processes are the dominant source of feedback that regulates star formation in dwarf galaxies. Unfortunately, samples of dwarf galaxies with AGN outflows are extremely rare due to the stringent requirements on resolution and sensitivity. Due to the difficulty of achieving these requirements with current ground-based facilities, we propose NIRSpec IFU observations of a sample of dwarf galaxies to capitalize on the unparalleled resolution and sensitivity of JWST. This program will observe a sample of four dwarf galaxies that show strong evidence of AGN outflows. Our goals include tracing the structure of the outflows by constructing line intensity and kinematic maps using a variety of coronal lines. We will also assess the impact on the host by using a number of tracers of the stellar population and star formation, such as PAH emission, CN absorption, and CO bands. Our program will provide more stringent constraints on AGN feedback models in dwarf galaxy simulations, which can help alleviate some of the outstanding issues, such as the 'diversity' and 'cusp-core' problems. This pioneering program will provide the first infrared IFU observations of AGN outflows in dwarf galaxies, and may fundamentally alter our view of the role of AGN feedback in the low mass regime.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 3665
Program Title: Unveiling Jupiter’s upper atmosphere and constraining atmospheric loss from Giant Planets

Principal Investigator: Stallard, Tom

PI Institution: Northumbria University

The evolution of planetary atmospheres is an essential component in the characterisation of exoplanets, as well as developing an understanding of the scope of habitability within the universe. An important factor in this is atmospheric loss into space. While these loss processes are relatively well-understood at Earth, discrepancies at other planets demonstrate that there are a wide range of conditions that we don't fully understand. Jupiter represents the best possible planet to compare and contrast upper atmospheric processes, with both ongoing and upcoming spacecraft, and as an end-member as far from Earth in the range of possible exoplanets. Here, we propose to scan the limb of Jupiter using the NIRspec-IFU, revealing the energy distribution throughout the atmosphere at that time in both altitude and latitude. These will be taken coincident to Juno radio occultation measurements: the direct comparison between JWST and Juno measurements of ionospheric emission and electron density respectively not only provides context to the specific Juno observations on that day, but also provides a unique key that helps to understand the hundreds of highly variable past occultations taken at both Jupiter and Saturn. In combining JWST and Juno data, we will constrain the highly variable electron measurements for the first time, and provide a broader ionospheric context, highlighting waves moving both altitudinally and latitudinally. In turn, this will help reveal the primary processes that transfer energy in the ionosphere and thermosphere, ultimately giving us a detailed picture of where and how Jupiter’s atmosphere is lost to space.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3670
Program Title: Sinking silicates: tracing rainout across the LT transition

Principal Investigator: Burningham, Ben

PI Institution: University of Hertfordshire

We will target a sample of abundance benchmarked brown dwarfs to create a transformative dataset that will impact substellar, exoplanetary and planetary science. JWST is unique in enabling us to: - determine the dependence of cloud composition on Mg/Si, [M/H] and C/O to critically test cloud models - track the rain out of oxygen across the 2000 > Teff > 1000 K range to empirically constrain calibrations for bulk C/O ratios from atmospheric observations of (exo)planets and brown dwarfs Determinations of bulk compositions of giant planets are widely regarded as keystone evidence for understanding their formation and that of planetary systems. This work started in the Solar system and it continues to present challenges that limit the precision and accuracy of key diagnostics such as the C/O ratio. Relating measured atmospheric abundances to intrinsic (bulk) composition is not trivial. It requires a sound understanding of mixing, quenching and cloud condensation processes. Critically, this includes clouds that may be hidden from view but none-the-less alter the atmospheric composition. This proposal will address these challenges by targeting a carefully selected sample of substellar benchmark binaries that span the same temperature range as directly imaged exoplanets. These systems will be used to calibrate the impacts of clouds, mixing and non-equilibrium chemistry on the measured atmospheric composition in the context of known bulk compositions determined from their stellar primaries. This project will create an empirical anchor for understanding how bulk compositions are imprinted on atmospheric abundances across a crucial regime of atmospheric physics.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3671
Program Title: Radio Jet Feedback in the Nearby Spiral Galaxy M58

Principal Investigator: Lopez, Ivan

PI Institution: Universita di Bologna

We propose MIRI MRS and imaging, NIRSpec IFU, and NIRCam imaging observations of radio jet feedback on the kpc-scale molecular disk of nearby spiral galaxy M58. This is the most luminous nearby example where a low-power radio jet is having an enormous impact on the physical state of molecular gas in the central regions of a spiral galaxy, heating a large fraction of it to 200-3000K. We will spatially and kinematically resolve the jet-ISM interactions at a scale of 10 pc and determine what fraction of the molecular and ionized gas is heated in place and what fraction is entrained in an outflow. This will also yield the molecular and ionized gas outflow rates, which we will compare to the AGN accretion rate and nuclear star formation rates to determine how significant these processes are in regulating both. While confined to the central disk and bulge, AGN jet feedback can potentially have an impact on the recycling of gas and star formation in the larger disk of the galaxy. Crucially, an up-close look at the jet feedback process will greatly improve our understanding of both how efficiently it operates and the potential impact of more powerful jets in radio galaxies and quasars on the global gas content and star formation at high redshift, where it will not be possible to examine the details jet feedback process at such high spatial resolution.

Proposal Category: SNAP
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3690
Program Title: The rest of the iceberg - dusty white dwarfs exposed by JWST

Principal Investigator: Farihi, Jay

PI Institution: University College London

The long-term dynamical evolution and ultimate fate of planetary systems are spectacularly represented by polluted white dwarfs, their dusty and variable debris disks, and their irregular transits. These stellar embers are twice as common as their A- and F-type main-sequence star progenitors combined, and can reveal bulk chemical compositions of major exoplanetary building blocks or exoplanets themselves, with relatively modest resources. Yet despite multiple indications of ongoing dynamical activity, there are few constraints on the frequency, structure, and mass of their debris disks, which limits our understanding of the underlying parent body properties, dynamics that lead to dust production, and the resulting pollution on the white dwarf surface. We propose to use JWST in Survey mode to efficiently build a sample of 40 polluted white dwarfs with MIRI LRS spectroscopy, where the goals are to charcterize the distribution of masses, dominant grain sizes, and orbital radii of their debris disks. Modeling indicates we will observe infrared excess around 50% to 100% of our targets, yielding up to a six-fold increase in the number of 10 micron disk detections, while probing for significantly cooler and more distant dust than previously possible. A Survey at these wavelengths will shatter existing sensitivity limits, where the resulting constraints will be unprecedented for dynamical modeling of debris disks and their parent bodies. Tangible results in the early cycles of JWST will widen opportunities in the scientific community sooner, and enable novel science in subsequent cycles.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3696
Program Title: A population of hidden tidal disruptions in the local universe: Revealing the energetics of the most luminous infrared transients with JWST

Principal Investigator: De, Kishalay

PI Institution: Massachusetts Institute of Technology

The physics of supermassive black holes (SMBHs) underpins all areas of astrophysics. It has long been suggested that SMBHs at the lowest masses ($\lesssim 10^6$\,M$_\odot$) grow substantially by the repeated tidal disruption of nearby stars; yet observational tests remain challenging. While such tidal disruption events (TDEs) are now routinely discovered in optical/X-ray surveys, there is growing evidence that they reveal only a fraction of the population where the SMBH line of sight is unobscured. Combined with most of the accretion luminosity emerging in the opaque extreme ultraviolet bands, both the bolometric radiated energy (tracing the accreted mass) and volumetric rates of TDEs remain highly uncertain. The mid-infrared (MIR) bands, acting as a bolometer for TDE radiation via reprocessed emission from surrounding dust, offer a unique opportunity to alleviate both these problems. By mining public NEOWISE images using state-of-the-art image subtraction methods, we have identified a sample of previously unknown luminous (> 10^{43} erg/s) MIR TDE candidates in nearby galaxies (< 200 Mpc). We propose MIRI/MRS spectroscopy of four sources showing diverse signs supporting their TDE origin in multi-wavelength follow-up. These first-of-their kind MIR observations of TDEs, possible only with JWST, will reveal i) the composition, temperature and geometry of dust heated in TDEs to measure the flare bolometric luminosity and ii) unmistakable evidence for an awakened SMBH via high ionization emission lines. Together, this proposal will provide a stepping stone to the characterization of TDEs in the MIR, and assess their contribution in forming the lightest SMBHs in the universe.

Proposal Category: AR
Scientific Category: Solar System Astronomy
ID: 3701
Program Title: Searching for ultra-faint trans-Neptunian objects in archival NIRCam calibration data

Principal Investigator: Trilling, David

PI Institution: Northern Arizona University

Small objects in the outer Solar System are the most primitive relics of the formation of our Solar System. These small bodies have undergone minimal change over the last 4 billion years and record that era in their chemical and dynamical properties. The residents of this region are often referred to as trans-Neptunian objects, and they are quite difficult to study, as they are distant, have low reflectivities, and are very faint. We propose to measure the size distribution of trans-Neptunian objects as small as 10 km by analyzing hundreds of archival NIRCam calibration datasets. We will detect around 200 objects smaller than 50 km diameter — the largest ever survey of very faint objects in the outer Solar System — with the smallest objects having diameters around 5 km. We will also constrain the mean color of the faint trans-Neptunian population and compare the size distributions between dynamically cold and hot populations. All of the necessary data will be in the public archive by June 30, 2023.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3703
Program Title: Breaking the z=10 barrier with MIRI: redshift confirmation and detection of rest-frame optical emission lines

Principal Investigator: Zavala, Jorge

PI Institution: National Astronomical Observatory of Japan (NAOJ)

The combination of both the better-than-expected science performance of JWST and the discovery of an unexpected population of bright galaxies at high redshifts might have unlocked what we thought impossible: the detection of rest-frame optical emission lines at z>10. Such emission lines are critical to confirm these extreme redshifts and to diagnose the physical conditions in these exciting objects. Here we propose to prove this by obtaining spectroscopic observations with MIRI, the only astronomical instrument capable of detecting these lines at such high redshifts (at z > 9.5, strong rest-optical lines redshift out of NIRSpec). With 9hrs on-source of MIRI/Low Resolution Spectroscopy observations per target, we will detect Hbeta/[OIII] and Halpha in two robust, bright z>10 galaxy candidates recently identified via JWST/NIRCam observations with at least 5sigma significance (or even up to ~15sigma if they are extreme line emitters as other recently confirmed galaxies). This short proposal will also test the efficiency of MIRI as a redshift machine in comparison with NIRCam, NIRSpec, and ALMA, while providing a unique opportunity to further characterize the physical properties of these early galaxies including SFRs, metallicities, dust obscuration, and other parameters.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3704
Program Title: Identifying the fingerprints of heavy r-process elements with the James Webb Telescope

Principal Investigator: Troja, Eleonora

PI Institution: Universita di Roma Tor Vergata

Approximately half of the elements heavier than iron are formed by rapid neutron capture (r-process) reactions, yet the astrophysical site(s) of these processes remain one of the most enduring mystery of modern astrophysics. Compact binary mergers may be a major, if not dominant, source of r-process elements in the universe. However, it remains an open question whether they could reproduce the abundance pattern observed in the solar neighborhood, including the heaviest elements such as actinides and transuranic nuclei. We propose non-disruptive ToO observations of a nearby (z<0.1) kilonova to tackle this question and constrain the formation of heavy r-process elements in the ejecta of a compact binary merger. Heavy elements affect the bolometric luminosity of a kilonova and shape its temporal evolution on timescales of weeks-months after the merger. During this phase, the bulk of the emission shifts to infrared wavelengths, where only JWST can follow its evolution. A luminous and long-lived infrared emission is the hallmark signature of robust r-process production and represents incontrovertible evidence that these mergers enriched our universe of heavy metals.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3707
Program Title: A JWST Census of the Local Galaxy Population: Anchoring the Physics of the Matter Cycle

Principal Investigator: Leroy, Adam

PI Institution: The Ohio State University

A detailed understanding of the gas-star-feedback ``matter cycle'' is key to our picture of how galaxies grow and evolve over cosmic time. JWST imaging of a handful of nearby galaxies has already clearly demonstrated its potential to produce a new view of this cycle. These processes vary in important ways across the galaxy population, so capitalizing on these capabilities requires observing a representative sample of star-forming galaxies. We propose a Treasury to obtain MIRI and NIRCam imaging of nearly all southern massive star-forming galaxies where JWST can achieve the transformational 10-50 pc resolution needed to directly access shells, ISM clouds, and star clusters. The targets all have rich, public ancillary data and collectively span the types of environments where most stars form at z=0. Combined with Cycle 1 data, this will create a Treasury of 74 representative local star-forming galaxies supported by uniform, multi-wavelength coverage from optical to radio. We will map PAH, dust continuum, stellar, and recombination line emission, and use the observations to revolutionize our understanding of the impact of stellar feedback, timescales for star formation, ISM structure, and the properties of young, massive clusters. The data will also play a critical role in calibrating the use IR observations in more distant systems, tracking the life cycle of dust, and understanding the physics of dense, bar-driven nuclear starbursts. As a Treasury, the data will be immediately public and supported by fast releases from our team. In short, the survey promises to do field-defining science and produce a legacy data set of lasting power that benefits the whole community.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3712
Program Title: Warm Jupiters Dis-equilibrium and Thermo-chemistry in Transmission Spectroscopy

Principal Investigator: Cubillos, Patricio

PI Institution: Osservatorio Astronomico di Torino

Warm Jupiters (Jupiter-sized planets with equilibrium temperatures of ~1000 K) are uniquely favorable for atmospheric characterization since (1) they have strong spectroscopic features and (2) their compositions are highly sensitive to temperature variations and subjected to disequilibrium processes. We propose to observe two transits of the warm Jupiter WASP-69b with NIRSpec/G395H and MIRI/LRS (2.8--12.0 um) to make an exhaustive inventory of chemical species. High-resolution ground-based transit observations of this planet have already detected the presence of H2O, CH4, CO, NH3, and C2H2, albeit without quantitative estimations of their abundances. These species and others, like the recently detected SO2, have strong identifiable spectral features in the proposed observing spectral window. Their detectability will depend on their relative abundances, which in turn are determined by the interplay between thermochemical, quenching, and photochemical processes. Thus, by measuring the concentration of multiple atmospheric species with JWST, we will be able to disentangle the impact of the different chemical processes at play. Particularly, we will be able to quantify imporant but pooly known parameter of our chemical models, like the eddy-diffution coefficient Kzz. Ultimately, by combining the WASP-69b physical constraints with that of other similar warm Jupiters observed during cycle 1 (e.g., WASP-80b and WASP-107b), we will start to better understand how these chemical processes shape the atmospheres of exoplanets in general.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 3716
Program Title: The Saturnian satellites as a laboratory for CO2 in the outer solar system

Principal Investigator: Brown, Michael

PI Institution: California Institute of Technology

One of the clearest unifying themes of nearly all Cycle 1 JWST near IR spectra of small bodies from Jupiter outward is the ubiquitous presence of CO2. While CO2 seems to be everywhere, its presence is fundamentally a mystery on almost every object. It is found where it is too hot, it is subliming where it is too cold, and it is mixed and trapped in unknown ways. Though we know little, understanding this poorly studied but incredibly common ice is critical to our understanding of volatiles, clathrates, irradiation, organics, and more throughout the outer solar system. Determining the fundamental parameters that control the presence and state of CO2 through the disparate environments sampled by the Cycle 1 observations is difficult, as it is nearly impossible to separate out the effects of temperature, body size and activity, radiation environment, and formation location. The Saturnian satellite system, including both regular and irregular satellites, however, provides an ideal laboratory for the study of CO2 in the solar system. These objects allow us to study a group of objects with identical insolation, but with a range of diameters (~30 km - 1527 km), environments (in the electron sheet, in the magnetosphere, beyond the magnetosphere), ice exposure (from modest to complete), organic abundance (from insubstantial to substantial) and formation locations (solar vs. planetary disk). Understanding of the distribution and state of CO2 on these satellites will provide the critical parameter space exploration that should allow us to understand the variables controlling CO2 on surfaces throughout the outer solar system.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3722
Program Title: A new window onto star formation regulation in the most intense, dusty starbursts in the early Universe

Principal Investigator: Nesvadba, Nicole

PI Institution: Observatoire de la Cote d'Azur

Dusty starbursts in massive galaxies at redshifts z=2-4 (DSFGs) are the most vigorous sites of star formation known. What processes regulate and limit star formation at the highest rates? Rest-frame optical IFU spectroscopy has been very successful in probing outflows and star formation in main sequence galaxies, but failed to penetrate deep into the most extreme DSFGs at these redshifts. Through MIRI-MRS the bright NIR recombination and H2 lines are now observable at z=2-3, which are our best tracers of star formation and feedback in the nearby Universe, and also a new star-formation tracer, PAH3.3. With MIRI-IFU we will study 12 NIR lines in 3 of the brightest, gravitationally lensed galaxies on the sub-mm sky on scales of 200-300 pc. All have detailed lens models and wide sets of ancillary data including HST imaging and millimeter line and dust interferometry. We will obtain Pa-a, H2 1-0 S(3), [FeII]1.26, and Br-d, which will enable us to map the star formation rates, probe the presence of shocks from supernovae and gas accretion, and to compare their relative impact on the gas. The glow of warm H2 on the turbulent surfaces of molecular clouds has been observed in nearby starburst galaxies, but never in the early Universe, where it would demonstrate that turbulence, perhaps created by feedback or gas accretion, is indeed as widespread in these galaxies as often postulated. We will also search for blue wings of Pa-a and warm H2 that would probe outflowing gas, and be the first evidence of starburst-driven winds in these systems, and compare star-formation rate estimates from Pa-a and PAH3.3 to see whether the latter is a reliable star formation tracer.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3726
Program Title: Examining the Heart of Type Ia Supernova 2021aefx with Ultra-Late Time Spectra

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 still unknown. 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 elements formed in nuclear statistical equilibrium. NIR and MIR ultra-late time spectra with NIRSpec and MIRI are a new probe, enabled by the sensitivity of JWST to address these longstanding questions. We request 19.8 hrs of JWST time to obtain 3 NIR+MIR spectra of SN 2021aefx between 750-1150 days after B-band max light. These observations will be the first ever ultra-late time SNe Ia spectra in the NIR and MIR. These data will: (1) reveal the ions responsible for flux redistribution to the IR in late-time SNe Ia, enabling full use of accurate bolometric light curves; (2) measure the location, composition, and mass of radioactive electron capture elements like 57Co and 55Fe; (3) determine the origin, strength, and evolution of the magnetic field in the SN; (4) probe macroscopic mixing between the electron capture and nuclear statistical equilibrium regions; and (5) and monitor for potential late-onset H/He interaction signatures. This data will be truly groundbreaking and push SN physics and observations into previously unexplored areas. Significant progress will be made in our understanding of the heavy elements in the Universe and SNe Ia as distance indicators.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3730
Program Title: The Hot Rocks Survey: Testing 9 Irradiated Terrestrial Exoplanets for Atmospheres

Principal Investigator: Diamond-Lowe, Hannah

PI Institution: Technical University of Denmark-DTU Space

Five years into the TESS mission and with extensive radial velocity follow-up work from the ground, we now know of dozens of true terrestrial exoplanets---worlds with well-measured radii and masses that imply Earth-like bulk compositions. The sub-set of terrestrial exoplanets amenable for atmospheric investigation all orbit nearby, small, cool stars called M dwarfs. But while M dwarfs are favorable hosts for detecting small planets, their prolonged phases of high-energy activity may irreparably destroy the rocky world atmospheres we want to investigate. We propose to conduct a survey across a sample of 9 irradiated terrestrial exoplanets orbiting nearby early- to mid-M dwarfs to test if they have atmospheres, or are bare rocks. We will use the unique infrared photometric capability of JWST/MIRI in imaging mode to observe our targets as they pass behind their host stars in a secondary eclipse. This method will allow us to efficiently determine which, if any, of the worlds in our sample hint at the presence of atmospheres. Conducting this survey early in the lifetime of JWST will enable us to chart a course to the most promising of our rocky world neighbors to investigate further, or else send us back to the drawing board to invest our time in harder-to-reach cooler targets that are more likely to retain atmospheres. The implications of this work will touch small planet formation and evolution theories, atmospheric models of rocky worlds in the presence of M dwarfs, and the long-term search for biosignatures. We are requesting 80 hours of science time (115 hours charged time) to carry out our survey.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3731
Program Title: Problem Planets: Understanding the Formation of Giant Planets around Low Mass Stars

Principal Investigator: Jordan, Andres

PI Institution: Universidad Adolfo Ibanez

Planetary formation models predict that giant planets should not form around stars with masses less than 0.5 M_Sun. This is due to two fundamental factors: (1) slow accretion due to long orbital timescales, and (2) low protoplanetary disk masses, limiting the available planetary building material. Nature has proven this prediction wrong. The TESS mission has recently enabled the discovery of the first transiting giants around low mass stars. We propose to obtain NIRSpec/PRISM transmission spectra for the only two well-characterized giant exoplanets that transit M dwarfs with masses less than 0.5 M_Sun: TOI-3235b and TOI-5205b. We will characterize their atmospheric enrichment and composition with precisions in [Fe/H] and C/O ratios better than ~0.22 dex and ~0.13, respectively, observing one transit per target. We will use these measurements to constrain the formation pathways for these planets. A modest investment of JWST time will provide the data we need to move forward in elucidating how these planets bypassed the hurdles to their formation.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3738
Program Title: Exploring the dramatic fading of SN2010da / NGC 300 ULX-1 with JWST

Principal Investigator: Beasor, Emma

PI Institution: University of Arizona

Over the last 12 years the enigmatic object SN 2010da / NGC 300 ULX-1 has continually defied expectation. Originally classified as a SN imposter, it was soon discovered that the system was extremely X-ray bright, indicative of a compact remnant accreting material from a donor star. It was recently discovered that the donor star in the system is a red supergiant (RSG) making NGC 300 ULX-1 the only known ULX pulsar with a cool supergiant companion. Over the last 4 years the RSG has faded dramatically across optical to near-IR wavelengths by around a factor of 10, and the molecular absorption features indicative of a cool supergiant can no longer be detected. This suggests either the system is returning to a quiescent state following the 2010 outburst or we are witnessing a never-before-seen RSG phase which cannot be explained by “standard” behaviours such as variability or quiescent winds, and may instead be indicative of the stars’ impending death. As such ULX-1 represents a unique opportunity to probe eruptive mass-loss within an RSG-NS binary, and is a likely progenitor to either a compact object binary system or an elusive Thorne-Zytkow object. We are proposing to use NIRCam IFU and MIRI MRS to uncover the current state of ULX-1 and determine the most likely cause for the fading of the system. Ultimately this data will enable us to constrain the total mass lost in the system via either an eruptive outburst or interaction with the NS.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3743
Program Title: You (Don't?) Spin Me Round: Resolving Disk Formation in High-Redshift Dusty Starburst Galaxies

Principal Investigator: Spilker, Justin

PI Institution: Texas A & M University

The most rapidly star-forming galaxies in the early universe are ubiquitously obscured by dust. Over the last decade, consensus emerged that nearly all such dusty starburts were the result of gas-rich major mergers that triggered the intense star formation and rapid dust production. Recent ALMA observations have challenged this view, finding kinematics consistent with secular rotation-dominated kinematics in the cold atomic gas. These controversial findings have drawn scrutiny from both observational and theoretical perspectives, with explanations ranging from mismatched comparisons with lower-redshift galaxies to unexpected consequences of cosmological gas accretion. We propose to address this controversy head-on, using NIRSpec IFU observations of H-alpha in five z~4-5 galaxies with existing high-resolution ALMA CII 158um data supplemented by inexpensive imaging to map the stellar light. Our observations will give an independent constraint on the galaxy kinematics using a different gas tracer that also avoids the complexities of interferometric ALMA data. We will make the first direct comparisons of the level of turbulent support between the warm ionized and cold neutral gas phases in individual galaxies at z>4, pushing the frontier of large 1<z<3 ground-based samples to the first ~1Gyr after the Big Bang. Together, the combination of deep, high-resolution JWST IFU and imaging data and ALMA CII and dust observations will settle recent controversies in the starburst galaxy kinematics and enable a novel multi-wavelength view of the stars, warm and cold gas, and dust in rapidly-assembling high-redshift galaxies.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 3760
Program Title: Investigating the cause of the 3 μm absorption feature on asteroids

Principal Investigator: Arredondo, Anicia

PI Institution: Southwest Research Institute

Correlating the abundance of hydration on asteroids with their location in the asteroid belt can constrain conditions and subsequent evolution of the early solar system, with additional implications for how water was delivered to Earth. Hypotheses related to the distribution of hydration in the solar system can be tested by observing compositionally similar asteroids in different regions of the asteroid belt. A widely used method for determining hydration on asteroids is through the detection of an absorption band near 3 micron caused by the O-H fundamental stretching mode. The band center and shape of the 3 micron feature has implications for the type and abundance of asteroidal hydration. There is no way to distinguish the cause of the 3 micron feature (H2O, aqueously altered minerals, or a combination of both) without spectra at complementary wavelengths. The MIR spectral region offers an opportunity to disentangle the effects of H2O and aqueously altered minerals on asteroid surfaces. Molecular H2O and aqueously altered minerals have distinct spectral features across the MIR bandpass. The goal of this program is to use MIRI MRS and NIRSpec IFU to distinguish between water ice, aqueously altered minerals, or a combination of both as the compositional component(s) responsible for the 3 micron absorption. We will observe two asteroids that are representatives of two major groupings of asteroids defined by their 3 micron band shapes: (142) Polana and (225) Henrietta. We will compare the spectra from both intruments from labratory spectra of relevant minerals to constrain the compositions of both asteroids and determine the level of aqueous alteration on both.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3762
Program Title: Stringent Tests of Atmospheric and Evolutionary Models with a Benchmark T Dwarf Companion

Principal Investigator: Xuan, Jerry

PI Institution: California Institute of Technology

We propose to collect NIRSpec medium-resolution (R~2700, 1-5 micron) and MIRI low-resolution spectroscopy (R~100, 5-14 micron) for Gl 229 B, one of the closest T dwarf companions with a precise dynamical mass. Previous studies on Gl 229 B have found strong tensions between observations and model predictions, specifically for its atmospheric composition and bolometric luminosity. Our proposed program will measure six different elemental abundances to provide a comprehensive picture of the formation history of Gl 229 B. This will allow us to uncover any deficiencies in the chemical and atmospheric models. In addition, we will measure the vertical mixing coefficient, a highly uncertain parameter, to unprecedented precision, which has important implications for cloud formation and 3D global circulation. The combined 1-14 micron spectra will provide tight constraints on the bolometric luminosity, effective temperature, and radius of Gl 229 B, which will be examined in the context of its dynamical mass and evolutionary models. Combined with knowledge of its atmospheric composition gained from NIRSpec medium-resolution spectroscopy, we can begin to understand what may be missing in the models that have trouble explaining the low luminosity of T dwarfs. By testing these models with exquisite data for Gl 229 B, our proposal will also inform observations of directly imaged exoplanet atmospheres.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3767
Program Title: Characterizing the Sources of Ionizing Photons in the Epoch of Reionization

Principal Investigator: Meyer, Romain

PI Institution: Max Planck Institute for Astronomy

The nature of the sources emitting sufficient Lyman continuum photons to conclude cosmic reionization by z~6 remains elusive. Models of the reionization process governed by either abundant faint galaxies or rare luminous ones can each account for the evolving neutrality of the intergalactic medium. Here we aim to characterize the physical properties of the only four z>5.8 galaxies whose Lyman continuum leakage can be inferred from the double-peaked profile of their Lyman alpha emission. This sample represents an unique laboratory to determine if these sources are solely capable of reionizing their local environment or whether additional fainter sources are required, as well as to compare their properties with those of lower redshift Lyman Continuum leakers. In this NIRSpec IFU proposal, we will detect and spatially map for the first time the rest-frame optical lines of the only reionization-era galaxies with measured escape fractions. We will measure the integrated and spatially resolved rest-frame optical line fluxes and line ratios, the systemic redshift, star-formation rates and history, metallicity, ionizing photon production rates, dust properties and kinematics. This dataset will provide important constraints on their role in reonizing their associated HII bubbles, the physics of ionizing photon leakage in reionization-era galaxies and their evolution with respect to low-redshift Lyman Continuum leakers.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3772
Program Title: N6946-BH1: the first failed superova or a massive stellar eruption?

Principal Investigator: Beasor, Emma

PI Institution: University of Arizona

N6946-BH1 may represent the first case of a red supergiant (RSG) collapsing directly to form a black hole (BH), with no associated supernova (SN). If proven, this would solve the problem of missing high mass progenitors to Type IIP SNe, as well as providing a natural pathway for the formation of stellar mass BHs, as observed by LIGO/VIRGO. However, currently we are unable to rule out that the star is still there but has enshrouded itself following a mass-loss event, similar to Eta Car's 'Great Eruption'. If this is the case, we would expect to see a brightly emitting dust shell at wavelengths >5um. If it has truly collapsed to a BH, there should be no luminous source left in the IR. With JWST we will be able to decisively rule out one of these scenarios. Either we will detect emission from a cool dust shell, indicating the RSG has not disappeared, or we will be able to rule out the presence of a luminous object embedded in a dust shell with 10sigma significance, and conclusively show the progenitor has indeed formed a BH. Whichever case is confirmed, we stress that the results will be profound for stellar evolutionary theory. In the first scenario, this would be the first time an otherwise normal RSG has been obersved to undergo such strong eruptive mass-loss, similar to that experienced by LBVs or the progenitors to Type IIn SNe. In the second scenario, we would be confirming the first direct collapse of an RSG to BH, representing an exciting new challenge for stellar evolutionary theory. Given that we have extensive progenitor information from pre-explosion imaging, this would provide a crucial first data point for the formation of BHs via failed SN.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3777
Program Title: The LAHst of Us: a Sub-kiloparsec View Into The Origins Of a Strongly-Lensed Lyman Alpha Halo at z=3

Principal Investigator: Solimano, Manuel

PI Institution: Diego Portales University

We propose a 4-tile NIRSpec IFU mosaic of the SGASJ1226 system at z=2.92, a pair of interacting star-forming galaxies that is highly magnified thanks to gravitational lensing. Deep and high-resolution VLT/MUSE data revealed a Lyman Alpha halo associated with the clumpy and blue merging galaxies, suggesting the presence of large-scale winds and H I gas reservoirs in their close environment. We will map all the strong rest-frame optical lines on 100-500 pc scales and constrain the conditions that give rise to the extended Lyman-a emission. Using the detailed, resolved nebular emission lines ratios and constraints on the stellar populations, we will: (i) Connect the physical conditions of the star-forming ISM to the extended Lyman-a emission; (ii) Constrain Lya emission mechanisms; (iii) Search for the drivers of the large scale outflow. Combining the proposed JWST data with a wealth of ancillary datasets, including ALMA, MUSE, HST and early-release JWST, offers the unique opportunity to peer with unprecedented detail into the origins of Lyman-a halos.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3779
Program Title: The MIRI MRS Library

Principal Investigator: Gasman, Danny

PI Institution: Institute of Astronomy, KU Leuven

We propose the JWST Cycle 2 Calibration GO program, `The MIRI MRS library' in order to address the need for high spectroscopic fidelity in the mid-infrared. The goal of this proposal is to derive pointing-specific calibration solutions for spatially unresolved (point) sources. These solutions include pointing-specific: detector pixel non-linearity, fringe modulation, spectrophotometric correction, and detector-based point spread functions (PSFs). The MIRI MRS calibration pipeline outputs spectra in the 4.9 to 27.9 micron range with a spectral resolution of 4000-1500. The MRS has yielded never-before seen molecular features, and unprecedented sensitivity on the continuum of dust and ice features. Despite the breathtaking sensitivity of JWST and MIRI, persisting complex calibration issues bias the scientific interpretation of point source data: (1) detector-induced spectral fringes affect the pristine shape of molecular features, (2) amplifier-induced voltage-debiasing affects the pixel response, which in turn affects the shape of the continuum, (3) a significant non-repeatability of the MRS astrometric pointing causes both the fringes, the pixel response, and the detected PSF to be pointing-dependent. This calibration program will aim to fix these persisting issues for the largest majority of the MRS observations of point sources.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3784
Program Title: Mapping the atmosphere or surface of a hot ultra-short-period super Earth

Principal Investigator: Zhang, Michael

PI Institution: University of Chicago

We propose to obtain a spectroscopic (2.0--5.3 um) phase curve of TOI 2445b, a hot (1340 K) 1.33 R_earth super-Earth which has the second highest planet-to-star flux ratio among rocky planets. The phase curve will constrain the planet's dayside and nightside temperatures, phase offset, Bond albedo, and heat recirculation efficiency. The large eclipse depth reduces the impact of the systematics and the large wavelength range captures 80% of the planet's thermal emission, ensuring accurate measurements of these quantities. A significant atmosphere would manifest as a diminished day-night temperature contrast, non-zero phase offset, and if there are clouds, high albedo. If there is significant eccentricity, the resulting tidal heating would be visible as anomalously high thermal emission. If there is no atmosphere, the observations are capable of distinguishing between different surface compositions. A basaltic crust of the type common on solar system terrestrial planets, for example, would be featureless and bright, while a Ca/Al-rich crust would be much colder and fainter. Our observations would shed light on the properties and origins of ultra-short-period planets, and serve as a pathfinder to future studies of the planet.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3786
Program Title: Sizing up silicates at six small stars: characterising planetary debris orbiting white dwarfs

Principal Investigator: Swan, Andrew

PI Institution: The University of Warwick

White dwarf planetary systems are a powerful complement to conventional exoplanet studies, as they record the bulk compositions of planetesimals being accreted by their host stars. Discerning their elemental abundances is now almost routine work, and we will soon be flooded with such data from multi-object spectroscopic surveys. Yet despite the immense benefit of this empirical ground truth to planet formation studies, its true potential can only be realised if the origins of the material are also known. Fortunately, the photospheric metals are supplied to the star from a circumstellar disk, which is observable in the infrared. These disks are dynamic environments, offering rich opportunities for theorists to wind back their evolution, and ultimately to constrain the source reservoirs for the material. We propose near- and mid-infrared observations of a sample of dusty white dwarfs to characterise the mineralogy, grain size, and geometry of their debris disks. Each of these parameters are fundamental to theories of disk evolution, but at present there are almost no data with which to constrain them. Half of our targets exhibit optical emission lines from gas, interpeted as a signature of enhanced collisional activity, and our grain size measurements will test that hypothesis. NIRSpec spectroscopy will measure the thermal continuum, probing disk geometry while also sensitive to previously-unseen emission lines and solid-state features. MIRI spectroscopy, supplemented with longer-wavelength photometry, will measure the solid-state features that trace the disk mineralogy, in particular the silicate feature at 10 microns, whose strength depends on grain size.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3788
Program Title: Alpha Elements and the Baryon Cycle in Isolated Dwarf Galaxies

Principal Investigator: Weisz, Daniel

PI Institution: University of California - Berkeley

We propose to use NIRSpec multi-object spectroscopy to measure [alpha/Fe] for 150-200 red giant stars to a precision of 0.1-0.3 dex in 3 isolated dwarf galaxies with diverse star formation histories (SFHs; ancient, constant, young) as measured by HST. Target stars have ages spanning ~1-13 Gyr, enabling the construction of the first well-constrained [alpha/Fe] vs. [Fe/H] diagrams for low-mass galaxies that have not been significantly influenced by a massive host. Such diagrams have provided deep knowledge of the formation of the Milky Way and its satellites (e.g., star formation efficiencies, Type II and Type Ia supernova contributions, bursty star formation), but are challenging to construct using the faint stars of distant (1 Mpc) isolated galaxies. We will (1) empirically characterize the [alpha/Fe] vs. [Fe/H] trends in each galaxy (i.e., plateau, knee, shin); (2) use semi-analytic chemical evolution models and state-of-the-art cosmological simulations to constrain and infer the baryonic processes that shaped each galaxy's evolution; (3) integrate our measurements into SFH fitting codes to achieve sub-Gyr age resolution at the oldest epochs; (4) measure velocity dispersions to a precision of 5 km/s for ~100 stars in the crowded inner regions of each galaxy. This program will provide unique insights into the evolution of low-mass galaxies in absence of environmental influence. Such systems are key tests of the physics of galaxy evolution. Measuring [alpha/Fe] for large numbers of stars in distant systems is only possible due to the excellent sensitivity and angular resolution of JWST -- no other facility can make these measurements for faint, crowded stars.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3805
Program Title: A NIRSpec Look at the Emission and Gas Kinematics of the SMBH in the Milky Way Dwarf Satellite Leo I

Principal Investigator: Pacucci, Fabio

PI Institution: Harvard University

A SMBH of ~3 million solar masses at the center of the Milky Way satellite galaxy Leo I was recently discovered via dynamical measurements. Extensive multiwavelength data, from radio to X-rays, support the identification of this SMBH with a source, Leo I*. These observations match existing GRMHD simulations of the expected emission. This SMBH would be strikingly similar to Sgr A* but located in a close-by dwarf galaxy, which is under-dense and devoid of gas. Hence, Leo I* provides a uniquely unobstructed look into the central parsecs of a galactic nucleus. We propose to use JWST to probe the emission and kinematic structure of the environment around Leo I*. With high-resolution grating of R ~ 2700 in NIRSpec IFU, we plan to probe regions at >=0.1", or >=0.12 pc, from the SMBH, characterized by velocities of ~200 km/s. These observations will probe the near-infrared spectral shape of Leo I*: from the region ~0.1 pc around the SMBH accreting in ADAF mode, we expect a line-less spectrum due to gas being fully ionized. We will also probe the kinematics of gas/stars at > 0.2 pc from the source, where we expect partially ionized gas. These data will test the ADAF hypothesis and gain insights into the kinematics around the SMBH. The presence of such an over-massive SMBH can inform formation models for black holes, especially regarding the seed formation pathway at high-z. Moreover, at a distance of 0.25 Mpc, this SMBH could be a new target for space-based EHT observations. A NIRSpec observation on a location with robust evidence for emission could be a cornerstone for studying black holes, both in the local Universe and, indirectly, in the high-z one.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3807
Program Title: Deep grism spectroscopy of the complex environment around an extremely red quasar within an ultramassive host at z=3

Principal Investigator: Bertemes, Caroline

PI Institution: Universitat Heidelberg

Extremely red quasars (ERQs) are a fascinating high-redshift population characterised by high luminosities (exceeding 10^47 erg/s), powerful and rapid outflows and massive hosts. We propose to obtain NIRISS wide field grism observations of the field of J1652, an ERQ at z~3 residing within an ultramassive host galaxy (log M > 11.4). Using these data, we will test the picture emerging from newly published JWST/NIRSpec observations which suggest that J1652 may be located in one of the densest protocluster environments at z~3 representing a merger of two or more dark matter halos. In more detail, NIRSpec observations have revealed a morphologically and kinematically complex environment within the 3''x3'' field of view, containing extended structures and several close interacting companion galaxies which span a large spread in velocities (~1000 km/s). The proposed slitless grism spectroscopy will enable us to spectroscopically confirm cluster members on large scales and characterise their ages, masses and ionisation states probing AGN activity. In particular, the program will achieve the depth required to spectroscopically identify quiescent galaxies to study the evolutionary state of the protocluster/overdensity.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3818
Program Title: To be or not to be in equilibrium: Probing disequilibrium chemistry on the warm sub-Neptune TOI-270 d

Principal Investigator: Gapp, Cyril

PI Institution: Max Planck Institute for Astronomy

TOI-270 d is currently the most promising target for the atmospheric characterization of sub-Neptunes using transmission spectroscopy, because its expected signal-to-noise ratio is outstandingly high and because an atmospheric signal was recently found using HST WFC3, increasing the prospects of a H/He-dominated, cloud-free atmosphere producing strong signals. In Cycle 2, it will be targeted using NIRISS SOSS as part of a GTO program and we propose to extend the wavelength coverage by observing a transit of TOI-270 d using NIRSpec G395H. The additional data will cover the strongest absorption bands of CH4 and CO accessible to JWST, key molecules to constraining the role of disequilibrium chemistry in TOI-270 d's atmosphere and its possible interior structure. In the warm temperature of TOI-270 d (Teq = 350 K), carbon should be predominantly present in CH4, whereas CO is expected to be the most dominant carbon-bearing molecule at higher temperatures (> 700 K). However, chemical reaction times increase as temperatures decrease so that disequilibrium processes caused by, e.g., horizontal winds, vertical mixing and stellar radiation are likely to become important, increasing the CO abundance against chemical equilibrium. Indeed, the depletion of CH4 in a few warm (< 700 K) planets observed using JWST and Spitzer have delivered tentative evidence for disequilibrium chemistry in their atmospheres. Our transit observations employing NIRSpec G395H will put tight constrains on the CH4 and CO abundances in TOI-270 d's atmosphere, effectively probing the role of disequilibrium chemistry which the NIRISS SOSS observations alone fail to do.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3823
Program Title: Dusting for PAH Fossil Records from Circumstellar Shells around WR 140

Principal Investigator: Lau, Ryan

PI Institution: NOIRLab - (AZ)

Polycyclic Aromatic Hydrocarbons (PAHs) are a key component of the interstellar medium (ISM) as thermal regulators and tracers of star formation and the chemical enrichment of galaxies. Despite the important role of PAHs, there are still major open questions on their evolution, chemical and structural composition, and origin(s). Recent JWST DD-ERS observations (ERS 1349) have opened a new window into addressing these outstanding issues: MIRI revealed and resolved emission from PAHs formed in the colliding winds of the massive and evolved carbon-rich Wolf-Rayet (WC) binary WR 140. These results have thrust these systems into the spotlight as a potential PAH and carbonaceous dust factories. The JWST observations from ERS 1349 held another surprising result: the past two dust shells formed by WR 140, which are separated by 7.93 years in age, exhibit dramatic changes in their 6 – 9 micron PAH features. Observations of more distant shells around JWST enabled by the mid-IR sensitivity of the MIRI LRS and Imager may therefore hold clues on the evolution of PAHs. In this JWST Cycle 2 GO proposal, we request 6.3 hours of 5 – 14 micron spectroscopic and 7.7, 15, and 21 um imaging observations of the dust shells around WR 140 with the MIRI LRS and Imager to trace the evolution of PAH features over its past 7 dust-formation episodes. The key goals are to (1) potentially unify the four distinct classes of PAHs by testing the resulting spectra against theoretical and laboratory prediction of PAH evolution, and (2) to identify the evolved spectral profile of PAHs formed by WC binaries that enrich the ISM of the Milky Way and galaxies beyond.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3832
Program Title: QUIESCENT BLACK HOLE X-RAY BINARIES IN THE MID-IR: RELATIVISTIC JET OR CIRCUMBINARY DISK?

Principal Investigator: Gallo, Elena

PI Institution: University of Michigan

JWST offers the opportunity to solve a long-standing puzzle about the nature of the mid-IR emission from quiescent Galactic black hole X-ray binaries, i.e., systems with X-ray luminosities well below 1E-4 times their Eddington limit, L_Edd. Spitzer IRAC/MIPS observations of two prototypical such systems, 1A 0620-00 and XTE J1118+480 (1E-9 and 1E-9 L_Edd, respectively) detected clear evidence for mid-IR excess emission above the donor star photosphere spectra. The large error bars at 8 and 24 micron allow for radically different interpretations of this excess emission; either partially self-absorbed synchrotron emission from a relativistic jet, or, thermal emission from circumbinary material that reprocesses the light of the donor star. This GO program aims to leverage the superior sensitivity of JWST/MIRI to ascertain the physical nature of the mid-IR excess seen by Spitzer. If the circumbinary disk scenario proves to be correct, it may even account for the unusually large orbital decay rates of these systems. Either interpretation would have important consequences for our understating of how the jet power scales with accretion rate – a critical question across the black hole mass scale.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3838
Program Title: Does atmospheric composition actually trace formation? Observing aligned vs misaligned hot Jupiters as a testbed

Principal Investigator: Kirk, James

PI Institution: Imperial College of London

A primary motivation behind measuring the composition of exoplanetary atmospheres is to understand planet formation and evolution. A key challenge is determining what variations in atmospheric composition can be attributed to different planet formation histories; a problem made more challenging by the various uncertainties affecting protoplanetary disc composition and planetary evolution. Thus, it needs to be proven that the field’s desire to measure atmospheric composition will lead to insights into their origins. The obvious first step is to identify groups of planets that likely had very different formation pathways and determine whether these planets show any significant differences in their composition. We propose to compare the composition of a sample of hot Jupiters whose orbits are aligned and misaligned relative to their host stars’ spin axes. It is believed that aligned hot Jupiters are the outcome of disc migration, while misaligned ones arise from high-eccentricity migration. This dichotomy in their origins means formation models robustly predict that aligned planets should be oxygen-rich at high atmospheric metallicities. By comparing the relative composition of an aligned and misaligned hot Jupiter sample, we will test if atmospheric composition depends on planet migration and, thus, if atmospheric composition can be used to make inferences about formation.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3840
Program Title: JWST NIRCam Confirmation of the First Directly Imaged Sub-Saturn Mass Exoplanet

Principal Investigator: Bogat, Ell

PI Institution: NASA Goddard Space Flight Center

Around nearby M dwarf stars, ground and space based high-contrast imaging has historically struggled to probe below 1 Jupiter mass at large separations. This population of planets remains poorly constrained around the most common stars in the Galaxy. However, a JWST NIRCam 3-5 micron coronagraphic imaging survey of nearby young M dwarfs reveals routine senstivity to sub-Jupiter mass planets at wide separations (>10 AU). These data have allowed the identification of a first of its kind sub-Saturn mass exoplanet candidate associated with a young M dwarf in the Solar neighborhood. The candidate is 22.5 mag at F444W and detected at >5 sigma significance. It reamins undetected at F356W and limits on its color are consistent with model predictions for young sub-Saturn mass exoplanets. The candidate's photometric properties also rule out common stellar and galactic background sources as contaminants. This candidate is unprecendented and its confirmation can only be pursued by JWST. Here we propose a small 8.43 h program to confirm this sub-Saturn via deeper coronagraphic imaging and a detailed astrometric analysis to verify common proper motion with the putative host star. This is easily achieveble given the star's proper motion (0.4"/yr), the >=11 months between the first observation and those proposed here, and the high astrometric accuracy achievable with NIRCam. Confirmation of this young sub-Saturn candidate will provide the first key constraints on the luminosity and early evolution of low-mass gas giants. It will also drive future theoretical work to model its properties, and undoubtedly lead to future JWST direct imaging to further charcterize this exciting candidate.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3843
Program Title: Resolving Star Formation At the Star Cluster Scale Down to ~30 pc at z=2.5

Principal Investigator: Bayliss, Matthew

PI Institution: University of Cincinnati Main Campus

Understanding the modes and physical scale of star-formation in the distant universe requires resolved studies of individual star-forming regions and their stellar populations. This is a proposal to use one of the most spectacular strongly lensed galaxies known to spatially resolve the properties of dozens of individual compact, star-forming clumps with physical sizes ~<30 pc at z=2.5. The fortuitous strong lensing configuration of the target system provides a truly unique opportunity to perform a spatially resolved census of the diffuse and clumpy star formation and ionized nebular gas in a lensed starburst galaxy at Cosmic Noon. We will obtain broadband NIRCam imaging and NIRSpec IFU spectroscopy to measure the stellar continuum from 0.13-1.3 microns, and nebular emission lines between 0.3-0.9 microns. Spectroscopy will inform spectral diagnostics of the nebular gas (ionization state, metallicity, dust extinction) and map the velocity structure of the galaxy. The spectroscopy and broadband SEDs will be used to jointly constrain the star formation histories and stellar populations of individual clumps and diffuse star-formation across the galaxy. All of this will be done on spatially resolved scales down to ~<30 pc. These analyses will reveal whether the compact star forming regions are associated with the larger galaxy structure, or if they have different phase space and chemical properties that identify them as proto- or newly formed young globular clusters. This program will unpack the diversity of star-forming structures and star formation histories, including any "pure" single-burst star-forming regions, within a starburst galaxy at z=2.5.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3849
Program Title: A Pristine IMF Probe of the Star-Forming Conditions in the Early Universe

Principal Investigator: Gennaro, Mario

PI Institution: Space Telescope Science Institute

Ultra-faint dwarfs (UFDs) are exquisite relics of the high-redshift Universe. Their remnant stellar populations preserve the star-formation conditions from a time prior to the epoch of reionization. Using these fossils, we can quantify how the state of the early interstellar medium affected the process of star formation. The impact of this primordial setting, with gas kinematics and metallicity distinct from today's Milky Way environments, is expected to be encoded in the Initial Mass Function. However, before the advent of JWST, it has been impossible to robustly probe IMF variations beyond the Milky Way using the simple and direct method of counting stars. Resolved stellar population studies with HST have only scratched the surface of possible IMF variations within the Local Group. We propose deep JWST/NIRCam imaging observations to study the stellar initial-mass function (IMF) of the Bootes I UFD satellite, using resolved star counts. JWST/NIRCam can improve our knowledge of the IMF by providing the necessary sensitivity to go beyond the IMF peak, as well as a large field of view in the infrared. Deep and wide IR imaging is necessary to precisely estimate IMF parameters. Bootes I is the ideal candidate in terms of proximity and luminosity, and its ancient star-formation history ended before the onset of reionization. Our study will provide a benchmark for interpreting JWST observations of high-redshift galaxies caught in the act of forming stars, allowing a better characterization of the cosmic history of baryons.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3855
Program Title: Catching stellar winds with the JWST: a NIRspec study of O stars in the low-metallicity young cluster NGC346

Principal Investigator: Oskinova, Lidia

PI Institution: Universitat Potsdam

Massive hot O-type stars are among the top cosmic influencers. Their ionizing radiation and stellar winds determine the physical conditions in young star clusters at times when low-mass stars and their planetary systems are still forming. The JWST opens a new era in studies of star clusters in galaxies across the Universe. To unleash the full potential of the JWST in uncovering the properties of O-stars at low-metalicity, new diagnostics must be developed. We request NIRspec time to obtain the first IR spectra of the nearly complete sample of O-stars in NGC346 - the most massive young cluster in the metal-poor SMC galaxy. Recent attempts to obtain accurate measurements of stellar winds with HST UV spectroscopy reached their limits, as the key diagnostic UV lines formed in stellar winds of O stars with later sub-types vanish at this low metallicity. On the other hand, the hydrogen lines in the IR offer a sensitive diagnostic tool. Utilizing the unprecedented capabilities of NIRspec we will measure spectra of 21 O-stars with a broad range of masses. The new data will be complemented by UV and optical spectra and analysed using modern non-LTE models. For the first time the consistent stellar and wind parameters will be derived for a nearly full spectral range of metal poor O-stars. This program will deliver calibrated measurements of mass-loss rates in O stars and establish near-IR spectroscopy as a key tool for studies of stellar feedback at low-metallicities and in obscured regions. These strategic observations can be performed only by the JWST and will have long lasting impact.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3859
Program Title: Full Characterization of Starlight from a z=6.4 Quasar Host Galaxy

Principal Investigator: Onoue, Masafusa

PI Institution: Peking University

We propose NIRCam multiband observations of a z=6.4 quasar, the host starlight of which was clearly detected in a pilot study with NIRCam F150W + F356W imaging and NIRSpec rest-optical spectroscopy. An eight-filter imaging spectrum of the high-redshift quasar host galaxy will cover from 1,400 to 6,730 angstrom in the rest frame. This rich photometric information enables us to robustly constrain the stellar mass and the stellar population for the first time at z>6. The newly proposed six broad+mediumband filters are carefully selected to capture the key features of a galaxy SED such as 4000 angstrom break. A 2D image-modeling technique will be used to subtract the glaring nuclear emission of the quasar from the images. The multiband detection of the quasar host will also be used to confirm a large quasar-galaxy spatial offset detected in the F150W image. We will also map out H-alpha emitting galaxies leveraging the F480M filter in order to characterize the large-scale environment around the billion-solar-mass black hole hosted by a massive galaxy.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3860
Program Title: Phase Curve Observations of TOI-561 b To Study Atmosphere-Interior Exchange

Principal Investigator: Teske, Johanna

PI Institution: Carnegie Institution of Washington

Ultra-short period (USP) planets, with radii < 2 Rearth and periods < 1 day, are a rare but very valuable planet class that can provide a glimpse at the surface compositions of worlds outside our Solar System. Most USP planets appear ~uniform in their bulk densities, consistent with Earth-like compositions, and half of those with phase curve observations appear to be bare rocks. However, not all USP planets are consistent with the bare rock picture, and whether such planets can host secondary atmospheres of evaporating silicates or outgassed volatiles – giving us a glimpse of what is below the surface – is still an open question. Here we propose to observe a spectroscopic phase curve of the lowest density USP planet yet detected, TOI-561 b, which orbits around an old, metal-poor thick disk star. Our JWST NIRSpec/G395H observations will constrain whether this planet has an atmosphere at all, and if so, the composition of that atmosphere as a function of depth, targeting key features of SiO, CO2, CO, and H2O. Only with JWST observations can the composition of this planet be resolved. Our findings will help elucidate the formation story of under-dense USP planets and connect small planet atmospheric to interior compositions, an important factor in studies of climate evolution of rocky exoplanets.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 3869
Program Title: Extreme Feedback in Action: Fast and Powerful Molecular Outflows in the Local Universe

Principal Investigator: Veilleux, Sylvain

PI Institution: University of Maryland

Fast and powerful outflows may quench coeval star formation in galaxies, impact galaxy morphology and the circumgalactic medium, and regulate supermassive black hole (SMBH) accretion. The likely culprits, fast-accreting quasars, are common at the epoch of peak SMBH accretion but rare locally, making it hard to catch and study this phenomenon in action, even with JWST. Fortunately, there are notable exceptions: local ultraluminous infrared galaxies (ULIRGs). Clear unambiguous signatures of outflows have been detected in these objects on all scales, ranging from X-ray/UV winds on sub-pc scales to galaxy-wide cold-molecular, cool-atomic, and warm-ionized outflows which extend to 10+ kpc. The energetics of these outflows scale with quasar power but current data are still missing the critically important coronal-ionized and warm-molecular gas phases to determine if the quasars in these systems actually affects the host evolution. The planned MIRI/MRS observations of a representative set of 13 local ULIRGs with the most robust outflow energetics to date will be analyzed with the JWST-optimized PSF decomposition software package q3dfit to (1) get an accurate and complete census of the outflow energetics, (2) constrain the dominant mechanisms that launch these outflows and their duty cycles, and (3) characterize the impact of the quasar outflow and intense radiation field on the physical state of the host ISM, coeval star formation activity, and circumgalactic medium. These exquisite data will serve as local templates to help interpret the coarser data from on-going JWST studies of distant obscured quasars. The proprietary period is shortened given the legacy value of the data.

Proposal Category: AR
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3879
Program Title: Aromatics versus Aliphatics: A PAH Diagnostic Tool for JWST

Principal Investigator: Li, Aigen

PI Institution: University of Missouri - Columbia

The so-called "unidentified infrared emission" (UIE) features at 3.3, 6.2, 7.7, 8.6, and 11.3 micron ubiquitously seen in a wide variety of astrophysical regions are generally attributed to polycyclic aromatic hydrocarbon (PAH) molecules. Astronomical PAHs often have an aliphatic component as revealed by the detection in many UIE sources of the aliphatic C-H stretching feature at 3.4 micron, and the aliphatic C-H deformation bands at 6.85 and 7.25 micron. We propose a theoretical study which will facilitate the JWST community to quantitatively determine from JWST data the aliphatic fractions of the UIE carriers --- the ratio of the number of C atoms in aliphatic units to that in aromatic rings. We will calculate the infrared emission spectra of both neutral and ionized PAHs of various sizes and a range of aliphatic contents illuminated by starlight of various spectral shapes. We will develop a "library" of PAH emission spectra and aliphatic-to-aromatic band-ratios of I_3.4/I_3.3, I_6.85/I_6.2 and I_7.25/I_6.2 which can be used by the astronomical community as a quantitative diagnostic tool for determining the aliphatic fractions of PAHs. We will generate a comprehensive series of I_3.4/I_3.3 vs. I_6.85/I_6.2 diagrams and I_6.85/I_6.2 vs. I_7.25/I_6.2 diagrams. These diagrams will allow us to quantitatively determine the aliphatic fraction of PAHs simply by placing the observationally-obtained band ratios in these diagrams.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3886
Program Title: Probing carbon chemistry and dust in the planet-forming zones of brown dwarf disks

Principal Investigator: Grant, Sierra

PI Institution: Max Planck Institute for Extraterrestrial Physics

Brown dwarfs (BDs) are faint, sub-stellar objects and are the link between stars and planets. Low-mass stars tend to have abundant terrestrial planets and the formation and evolution of BDs themselves may be a window into giant planet formation. In contrast to higher-mass disks, BD disks are optically thinner in the mid-infrared giving us access to the gas and dust composition closer to the disk midplane where planets are forming, making them unique objects to study. Spitzer-IRS spectra of BD disks showed generally weak silicate features indicative of dust settling and gas detections that point to a high carbon-to-oxygen (C/O) ratio. The high C/O ratio may be due to 1) oxygen locked up in ice in the outer disk, 2) a carbon-rich chemistry close to the midplane that is only observable in disks with settled dust, and/or 3) the destruction of carbonaceous grains. Any of these scenarios would have a profound impact on the composition of forming planets and JWST-MIRI MRS data are crucial for studying the gas and dust in the planet-forming zones, particularly in these faint targets. Cycle 1 observations are largely focused on higher-mass sources, leaving a need for observations of BDs. We propose to get high sensitivity (SNR>100) spectra for a large and representative sample of 15 low-mass targets to catalog the chemical inventory and study the connection between the gas and dust properties. These targets span a range of ages and, based on low-resolution IRS data, show diversity in silicate feature strength and shape, indicating large variations in the dust properties. We will be able to put these systems into context with higher-mass stars that are observed in larger numbers.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 3889
Program Title: Identifying the heaviest of the heavy elements synthesized in neutron star mergers

Principal Investigator: Kasliwal, Mansi

PI Institution: California Institute of Technology

We now know that binary neutron star mergers are a prolific site of r-process nucleosynthesis where elements heavier than iron are synthesized. However, it is still unknown whether, which and how much of the heaviest of the heavy elements (in the second and third abundance peaks) are synthesized. The key to answering this question is late-time infrared spectroscopy. This is only now possible with the exquisite sensitivity of the JWST NIRSPEC prism and JWST MIRI. The overlap between JWST Cycle 2 and the upcoming fourth gravitational wave observing run presents an unprecedented opportunity to answer this question. Here, we request three non-disruptive target of opportunity observations of neutron star mergers. Our triggers are non-disruptive as our science goals drive us to wait for the ejecta to become optically thin and wait until the heaviest elements dominate the electron heating. Only then will we be able to directly identify multiple heavy elements in the ejecta and robustly determine relative nucleosynthetic yields.

Proposal Category: AR
Scientific Category: Galaxies
ID: 3905
Program Title: Data-Driven Wisp Templates and Flat Fields for NIRCam

Principal Investigator: Johnson, Benjamin

PI Institution: Harvard University

Extracting the most information from JWST NIRCam observations requires addressing several known issues in the NIRCam images such as wisps. We propose to use extensive NIRCam imaging that has been taken during Cycle 1 to construct a large dataset of pixels that have seen only astrophysical and telescope backgrounds. We will use these these pixels to extract, via matrix decomposition, a number of NIRCam background 'templates' that describe the morphology of the wisp straylight and its variation. We will also use the dataset to construct high signal-to-noise `sky flats', both through robust stacking and from components of the matrix decomposition which naturally account for varying backgrounds. We will look for indications of any other effects that may have stable spatial distributions but vary in amplitude. These analyses will require extensive masking of flux from stars and and galaxies. We will release the wisp templates and flat fields to the community along with tools for their use.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3907
Program Title: Unveiling the Early Stages of Massive Binary Formation with JWST

Principal Investigator: Zhang, Yichen

PI Institution: The University of Virginia

Most of massive stars are born in binary systems, therefore understanding massive binary formation is crucial for understanding massive star formation in general. Observational studies of massive forming binaries in the embedded phase are still very limited. JWST provides a new, unique window to study such systems. We propose JWST/NIRCam observations of two forming massive binaries, which are the closest-separation embedded-phase massive forming binaries identified to date. We aim to: 1) directly image the massive binaries utilizing the high resolution and sensitivity of JWST, and characterize the stellar properties and accretion status of individual members in these systems; 2) map the extended emissions of the outflow cavities, to determine the cavity geometries and heated dust distributions, especially in the innermost regions. 3) probe the low-mass young stellar objects (YSOs) forming along with the massive binaries, placing massive binary formation into the context of star cluster formation. To achive the last goal, we also propose joint ALMA observation in 0.85 mm, to significantly improve the detection sensitivities of cold dust structures of the YSOs to achieve of a complete census of the low-mass YSO populations around these massive binaries. These observations will generate important constraints on theories of massive star formation, binary formation, and star cluster formation.

Proposal Category: SNAP
Scientific Category: Stellar Physics and Stellar Types
ID: 3921
Program Title: Building A Modern Sample of Dusty Supernovae with JWST

Principal Investigator: Fox, Ori

PI Institution: Space Telescope Science Institute

While explosive 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 mid-IR wavelengths span the peak of the thermal emission and are best to characterize the dust in these systems. The Spitzer Warm Mission spent over a decade building an impressive sample of dusty SNe at 3.6/4.5 microns, but this was just the tip of the iceberg. These wavelengths were insufficient to probe colder temperatures ~150 K, where a bulk of the dust is thought to reside. A number of questions remain and the phase space of such observations (in terms of dust temperature and SN age) remains relatively unpopulated. JWST offers the opportunity to build a modern, ground-breaking sample of dusty SNe. As Spitzer strategies showed, targeting one SN at a time is not only inefficient, but also risky because of the difficulty in predicting which SNe are IR bright. Here we propose an optimal strategy of using the Survey Mode to obtain MIRI imaging of a large sample of SNe of different subclasses and ages. It is imperative that such a Survey begin early in JWST's lifetime (i.e., Cycle 2) so, like the Spitzer sample, targets of interest can continue to be monitored throughout their lifetime in future cycles. We include 44 targets (~74 hours) roughly equally distributed across the sky. The results will enable a variety of new and important types of scientific investigations. The data will be made public immediately to ensure it benefits the entire SN community.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3925
Program Title: Planets or Giant Collisions in the Fomalhaut Debris Disk System

Principal Investigator: Beichman, Charles

PI Institution: Jet Propulsion Laboratory

Fomalhaut is one of the original debris disk systems discovered through its strong infrared excess and the debris disk phenomenon soon became a signpost of the planet formation process. Direct imaging from the visible through the millimeter has led to a detailed characterization of the distribution of the dust orbiting Fomalhaut. Yet, until now, there has been no convincing evidence for planets in the Fomalhaut system. Most recently MIRI observed the disk revealing dramatic new details and multiple rings in the disk system, including an outer ``Kuiper Belt'' ring at 140 AU, an inner ring, and a broad disk equivalent to the asteroid belt in the Solar System. NIRCam coronagraphic imaging has revealed a half dozen faint targets within and near the debris disk, including Source 1 which coincides with a compact region of enhanced dust emission seen by MIRI within the outer disk. Source 1, or one of the other NIRCam objects, might be planet-mass objects responsible for sculpting the various disk structures. Alternatively, with its unusual colors, Source 1 might be a transient knot of hot dust resulting from a recent collision of planetesimals which produced the excess MIRI emission. The goals of this program are: 1) to provide astrometric conformation (or rejection) for these sources to be associated with Fomalhaut through common proper motion; and 2) to improve the photometry to enable a fuller characterization of these sources. If one or more of the NIRCam objects prove to be part of the Fomalhaut system, then they will be some of the lowest mass planets yet discovered by direct imaging.

Proposal Category: SNAP
Scientific Category: Stellar Physics and Stellar Types
ID: 3930
Program Title: An R~100 MIRI 5-14 micron Spectral Library for Brown Dwarf and Exoplanetary Science

Principal Investigator: Metchev, Stanimir

PI Institution: The University of Western Ontario

We propose a survey program with JWST MIRI to obtain 5-14 micron R~100 spectra of M9-T6 dwarfs. The spectral type range spans the formation, growth, and sedimentation of silicate condensate clouds in the atmospheres of brown dwarfs. Only a few direct detections of silicate clouds exist from R~90 Spitzer Cryogenic Mission observations with the Infrared Spectrograph. A more comprehensive, higher-SNR mid-infrared spectroscopic library will shed light on the condensate content of brown dwarf atmospheres, and in turn, on the reasons behind the diversity in their photospheric appearance, their photometric variability, and cloud dynamics. The library will also offer a spectrophotometrically calibrated basis for interpreting both higher-resolution JWST MIRI spectra of brown dwarfs and MIRI spectra of directly imaged or transiting exoplanets. The survey includes 132 targets, of which 106 are well-characterized through photometric variability monitoring and high-dispersion spectroscopy, and are uniformly spread over the sky. The remaining 26 are at high ecliptic latitudes. Thus designed, the combined sample facilitates scheduling over the entire sky, as desireable of survey programs. A 10% program completion will already more than triple the number of SNR>20 mid-infrared spectra of late-M to mid-T dwarfs. A 20% program completion will ensure sufficient diversity in spectal type to confirm tentative correlations between silicate absorption and fundamental parameters, such as surface gravity amd spin axis inclination.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3942
Program Title: Probing the volcanic outgassing activity of a warm sub-Earth planet

Principal Investigator: Damiano, Mario

PI Institution: Jet Propulsion Laboratory

Among the main sequence stars, the sub-group comprising smaller and cooler stars than theSun, e.g. M-dwarfs, represents the ideal environment to discover and characterize terrestrial planets. With an equilibrium temperature <650K L98-59b is an important target to expand the knowledge on the volcanic outgassing of warm small planets. The measured mass and radius of L98-59b are compatible with a rocky core with an envelope. The radius (0.85 Rearth) places the planet in the Mars-sized regime and given its TSM of ~50, L98-59b is one of the best small planet for transmission spectroscopy characterization. HST observations have ruled out on the possibility of a H2-dominated envelope with the presence of H2O. However, the data is not enough to rule out H2O- or CO2- dominated atmospheric scenarios. We propose to use NIRSpec/G395H to measure the planet’s transmission spectrum at 2.8 – 5.2 microns, and we expect the precision achieved (~17 ppm) to shed light onto the nature of L98-59b possible high mean molecular mass atmosphere.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3947
Program Title: Testing the Giant Planet Hypothesis for Spiral-driven Arms in Protoplanetary Disks

Principal Investigator: Bowler, Brendan

PI Institution: University of Texas at Austin

High-resolution imaging of protoplanetary disks at near-infrared and mm wavelengths has shown that disk substructure is ubiquitous, but the connection to ongoing planet formation remains unclear and actively debated. Spiral features in particular offer unique clues about disk physics and the dynamical interaction between planets and disks. The two leading hypotheses for the origin of spiral structure are gravitational instabilities and dynamical interactions with a giant planet orbiting immediately outside of the disk. We propose to test whether spiral arm structure in protoplanetary disks predominantly originates from long-period giant planets on external orbits using deep JWST/NIRCam coronagraphic imaging. The goals of this program are to (1) establish whether giant planets on external orbits are the primary drivers of spiral arm structure, and (2) identify new giant planets amenable to follow-up atmospheric characterization. This program will take advantage of JWST's extraordinary sensitivity at thermal wavelengths to consistently reach sub-Jovian masses beyond the outer disk radius of each system, regardless of assumptions about the planetary cooling history (hot, warm, or cold initial conditions). Deep observations of this "dynamically informed" sample of protoplanetary disks with spiral-driven arms may represent one of the best opportunities to discover planets with JWST early in its primary mission.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 3950
Program Title: Unlocking the Early Universe for Weak Lensing with JWST: High-Precision Analysis of z=2 Galaxy Cluster XLSSC122

Principal Investigator: Finner, Kyle

PI Institution: California Institute of Technology

XLSSC122 is a galaxy cluster at z=2 with a well-established red sequence. The cluster has a distinct XMM-Newton X-ray detection of the intracluster medium and a 7.6 sigma detection of the Sunyaev Zel'dovich decrement. These two measurements result in contrasting mass estimates. The SZ mass (M200~3e14 solar masses) is extreme for a galaxy cluster at redshift 2. Furthermore, the X-ray peak and SZ centroid are significantly offset, which may indicate a recent merger. We propose 3.3 hours of JWST NIRCam observations to enable a weak-lensing analysis that will map the mass distribution and provide an accurate mass estimate for the galaxy cluster. The high-resolution mass map that we will generate from JWST weak lensing will discern substructure better than current probes of the intracluster medium. With a robust mass estimation from weak lensing, we will inspect the rarity of XLSSC122 with cosmological models and compare the mass-to-light ratio of a galaxy cluster at cosmic noon to local clusters. Our weak-lensing analysis will also test the radial mass profile of a cluster in the early universe. Weak lensing at this redshift has, as of yet, not been achieved. Reaching our goals requires a high number density of background galaxies that is unobtainable with the HST and can only be reached with the sensitivity, resolution, and IR filters of JWST. We provide validation tests that demonstrate the feasibility of weak lensing with the JWST. The JWST will be the telescope that allows high-z weak-lensing studies to thrive.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3954
Program Title: Luminous and dark matter in massive galaxies at z=4-5

Principal Investigator: Lelli, Federico

PI Institution: INAF - Osservatorio Astrofisico di Arcetri

We request JWST imaging for a golden sample of 16 massive galaxies at z=4-5 with existing ALMA [CII] data of the highest quality. The [CII] data reveals regularly rotating disks, allowing for the derivation of rotation curves that trace the total mass distribution. To infer the properties of dark matter (DM) halos, however, we miss a key piece of information: the stellar mass distribution. JWST is the only existing telescope that can spatially resolve the stellar emission in these galaxies. We request MIRI images at rest-frame 1.4 um to set a robust constraint on the stellar mass, as well as NIRCam images in 4 filters to trace surface brightness and color profiles at the same spatial resolution of the ALMA data (0.05"-0.20" corresponding to 0.5-1.0 kpc). We will (1) determine the stellar mass distribution, subtracting any potential central AGN contribution, (2) fit the [CII] rotation curves with mass models accounting for the contributions of stars, gas, and DM, (3) study the evolution of scaling laws such as the Tully-Fisher relation, the radial acceleration relation, and more, (4) study star formation (SF) laws using maps of the total SF rate from rest-frame NUV images (from NIRCam) plus existing FIR maps (from ALMA) together with gas maps from [CII] data, (5) study the environment of these massive galaxies, which are expected to live in the densest regions of the early Universe, detecting possible low-mass satellites. This program will exploit the JWST-ALMA synergy to probe the total mass content (stars, gas, and DM) of massive galaxies at z=4-5. This will provide key clues on the DM nature by tracing DM halos in a cosmic epoch that has been out of reach until now.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 3958
Program Title: The Sickle: Pillars of Creation in the Galactic Center

Principal Investigator: Cotera-Hulet, Angela

PI Institution: SETI Institute

As H II regions expand into their natal molecular clouds, they often create bubbles whose rims contain bright ionization fronts that are often further sculpted into features similar to the beautiful and iconic "Pillars of Creation" first observed in stunning detail by HST, and recently revisited by JWST. Models confirm that these features are sites of current star formation, but questions remain as to whether the stars forming there have been triggered or are simply being revealed as their surrounding cloud is eroded away. Very high-resolution images from nearby regions have enabled these models to be rigorously tested, but for a limited range of environmental conditions. The center of the Milky Way contains some of the most extreme conditions for star formation in the Galaxy, similar to starburst galaxies but observable at spatial resolutions unachievable elsewhere. The unique combination of environmental conditions and proximity makes the Galactic Center an ideal laboratory for testing theories of star formation, which often fail in this enigmatic region. Only one Galactic Center H II region, known as the Sickle, contains structures analogous to the ionic pillars. Until JWST, it has been impossible to observe these features with sufficient resolution to fully explore their nature as possible sites of triggered low mass star formation. We propose to obtain NIRcam and MIRI images of the Sickle pillars. When combined with recent advances in theoretical models, the proposed observations will enable us to address two essential unresolved questions of star formation in the Galactic Center: Is there triggered star formation? Is low mass star formation suppressed?

Proposal Category: GO
Scientific Category: Galaxies
ID: 3960
Program Title: The Effect of Extreme ISM Conditions on Polycyclic Aromatic Hydrocarbon (PAH) Properties

Principal Investigator: Alberts, Stacey

PI Institution: University of Arizona

Polycyclic aromatic hydrocarbons (PAHs) are small dust grains that play a fundamental role in the physical and chemical conditions of the interstellar medium (ISM), from photo-electric heating of interstellar gas to the formation of molecular hydrogen molecules. Their emission in the mid-infrared scales with the interstellar radiation field (ISRF) and as such they are routinely used as tracers of recent star formation out to high redshift. The interplay between grain properties and ISM conditions is complex and poorly understood, however. We propose to observe several PAH features in four local compact dwarf galaxies and a Wolf-Rayet binary system with the NIRSpec and MIRI IFUs. These targets are unique in having low metallicities and extreme ISRFs (as measured by forbidden line ratios) and will provide the definitive test of whether extreme ISM conditions destroy or enhance small grains. Comparisons with sources from the literature with low metallicities and moderate ISRFs will determine the drivers of changing grain properties. This work, only possible with the sensitivity and resolution of JWST, will be the benchmark for studies of high redshift galaxies, which have increasingly strong radiation fields and low metallicities.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3962
Program Title: A NIRSpec pilot program on planet-forming disks around very-low mass stars

Principal Investigator: Tabone, Benoit

PI Institution: Institut d'Astrophysique Spatiale

We propose deep NIRSpec IFU observations from 1.66 to 5.27 micron of two disks orbiting very-low mass stars (VLMS). VLMS host a rich population of potentially habitable planets (e.g. Proxima Centauri b). Because their disks are faint, little is known about the formation of this planet population. The first MIRI-MRS observations of the two targets have already revealed an extremely rich hydrocarbon chemistry, potentially related to the destruction of refractory carbon. This suggests that planets formed around VLMS could have very distinct elemental compositions compared with more massive stars. However, NIRSpec spectroscopic observations of VLMS disks are critically lacking to establish a global view of the inner disk composition. The proposed NIRSpec observations will allow to (1) measure for the first time the C/O elemental ratio in the gas, (2) infer the radial distribution of elements across the disk, and (3) search for new gas-phase species and refractory carbon. This program will provide legacy value to the community by demonstrating the potential of NIRSpec observations of VLMS disks in combination of MIRI-MRS, and by providing necessary constraints to link the composition of exoplanets to their formation history.

Proposal Category: SNAP
Scientific Category: Stellar Physics and Stellar Types
ID: 3964
Program Title: The MIRI Excess Around Degenerates Survey

Principal Investigator: Poulsen, Sabrina

PI Institution: University of Oklahoma Norman Campus

In 2004, Cycle 1 of Spitzer observed ~100 white dwarfs (WDs) in the mid-IR where a handful of IR excesses were detected. This sparked an entire field of WD study looking at remnant planetary systems around dead stars that touches many areas of astrophysics today. In Cycle 2 of JWST, we are faced with a very similar situation--hardly any known WDs have their photospheres detected beyond 8 micron, giving JWST the opportunity to conduct the first wide and shallow survey of the 25 pc WD sample. For modest completion frequencies, we expect to detect IR excesses from cool brown dwarfs, young Jupiters, optically thin dust disks from shredding exo-planetesimals, and cyclotron emission from magnetic white dwarfs with unprecedented sensitivity. With JWST's absolute flux calibration requirement of 2%, we also will find other departures from the expected, such as the additional opacity seen in cool WDs from collion-induced absorption. Whatever is out there, this survey will define white dwarf science (and other fields) with JWST two decades after Spitzer first pointed toward a bright white dwarf.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3969
Program Title: Hot Jupiter Atmospheric Forecast: are mornings cloudier than evenings in other worlds?

Principal Investigator: Espinoza, Nestor

PI Institution: Space Telescope Science Institute

JWST is revolutionizing exoplanet atmospheres. The very first few datasets are already showing how, using the technique of transmission spectroscopy in particular, rich chemical inventories and constraints on key atmospheric parameters can be extracted from this data with an unprescedented level of detail for Jovian and sub-Jovian exoplanets. This very same early JWST data, however, is also pushing the limits of how we classically model and interpret transmission spectra. In particular, signatures of inhomogeneous terminators are already arising from these datasets, a trend theoretical models expect will continue in future datasets. Modeling and understanding how common the effects of inhomogeneous terminators are in the gas giant exoplanet population is critical if we aim to properly study and interpret their atmospheres --- in particular if inferences on, e.g., their links with planet formation are ought to be extracted. Here, we propose the very first survey to constrain the physical properties of inhomogeneous terminators in gas giant exoplanets with JWST. Our carefully crafted sample, which spans gas giant exoplanets between 1000 K and 2000 K, is motivated by state-of-the art atmospheric circulation & cloud formation modelling predictions for the morning and evenings of exoplanets, which we will put to the test. In particular, we aim to constrain whether clouds indeed form higher up in the morning terminators than in the evenings terminators, as predicted by state-of-the-art modelling, and how this cloud location varies with equilibrium temperature.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3973
Program Title: Using planets to dynamically weigh a debris disc for the first time

Principal Investigator: Pearce, Timothy

PI Institution: Universitat Jena

Debris discs (like our Kuiper Belt) are a fundamental component of planetary systems, detected around 20 % of main-sequence stars. They yield powerful insights into planetary system architecture, formation and evolution, but a major issue limits their effectiveness as probes of planetary systems: debris-disc masses are unknown. We aim to dynamically measure an extrasolar debris disc's mass for the first time. We would use JWST to search for planets in the specific system HD 53143, which hosts a narrow debris disc that is the most eccentric known. This makes it highly sensitive to planet-debris interactions. There is considerable evidence that at least one planet is present, and constraining its parameters would let us dynamically measure the debris-disc mass (which must be high enough for self-gravity to maintain the disc shape in the face of planetary perturbations). We ask for NIRCam imaging of the system, which would be sensitive to planets down to sub-Jupiter mass. A planet detection, combined with our novel interaction theory, would constrain the debris disc to be at least 10 to 100 Earth masses (a major advance, since extrasolar debris-disc masses are currently only constrained to be between 0.1 and 1000 Earth masses). Even a non-detection would be beneficial, as it would be combined with existing proper-motion-anomaly, SPHERE and RV data to bound the planet properties and still constrain the disc mass. The result would greatly aid debris and system-formation science, and put our Solar System into context. In addition, this programme offers the opportunity to detect and characterise a ~1 Gyr old exoplanet for the first time.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 3979
Program Title: Are dark, red, small KBOs devoid of volatiles?

Principal Investigator: Benecchi, Susan

PI Institution: Planetary Science Institute

As the New Horizons (NH) spacecraft transects the Kuiper belt it has been obtaining unique solar phase curves, lightcurves, and other information on numerous Kuiper belt objects (KBOs) not possible to obtain with Earth-based facilities. In this proposal we seek to use JWST/NIRCAM to fill out the spectro-photometric information available for these objects investigating for the first time their dominant surface compositions from 0.5-5μm, a wavelength region not yet explored due to ground-based instrument faintness limits and telluric contamination. This project asks the question: Are dark, red, small KBOs devoid of volatiles? It samples objects from d~60-120km assuming an albedo of 0.1 and will be the only dataset available for many years to come with measured shapes and microphysical properties (acquired through high-phase angle NH observations) with which to correlate against compositional properties. The proposed observations include KBOs from all the dynamical classes and as a full sample they will provide key context and constraints for KBO formation models.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3983
Program Title: Searching for Evidence of EUV Photoevaporation in Actively Dispersing Protoplanetary Disks

Principal Investigator: Thanathibodee, Thanawuth

PI Institution: Boston University

The timescale of gas evolution in protoplanetary disks is critical in understanding planet formation. Photoevaporation is considered the dominant mechanism in removing gas from the disk and ultimately determines the disk's lifetime. Photoevaporation models predict different mass loss rates depending on whether the high-energy radiation from the star is dominated by X-ray, EUV, or FUV photons. One of the issues in distinguishing between photoevaporation models is the uncertainty in the level of high-energy radiation that the disk receives from the star. While X-ray and FUV radiation from the star can be measured, the EUV radiation cannot be observed directly due to interstellar absorption. We propose to use MIRI MRS to measure the [Ne II] and [Ne III] lines in 18 T Tauri disks accreting at very low rates. The low mass accretion rates suggest that their disks are actively dissipating, and these rates are consistent with models of EUV photoevaporation. The ratio of these Neon lines can be used to distinguish between different photoevaporation models and test if these disks are indeed undergoing EUV photoevaporation, making this study a definitive test of EUV photoevaporation models.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 3989
Program Title: Spotting the Perturbers: A Coronagraphic Survey of Debris Disk Stars with Common Proper Motion Anomalies

Principal Investigator: Hinkley, Sasha

PI Institution: University of Exeter

Using the NIRCam MASK335R coronagraph operating at 2.1 and 4.44 mcirons, we will directly image the massive planets that are responsible for inducing significant Proper Motion anomalies in a set of seven nearby star systems. Our program distingushes itself from other JWST coronagraphic programs, as each of these systems possess a circumstellar debris disk that has been well-characterized by Herschel, ALMA or scattered light imaging in some cases. These resolved images of the debris disks give clear geometric information about the geometry of the system, which in turn tightly constrain the allowable masses and semi-major axis parameter space for any dynamical perturbers. Our detections of planetary mass companions will thus immediately provide their physical separation (in AU), and (crucially) their dynamical mass. The infrared photometry of these companions, combined with their dynamical masses, will put extremely powerful constraints on evolutionary models of exoplanet atmospheres as well as reveal important information about the early thermal histories of planetary mass companions.

Proposal Category: GO
Scientific Category: Galaxies
ID: 3990
Program Title: A NIRCam Pure-Parallel Imaging Survey of Galaxies Across the Universe

Principal Investigator: Morishita, Takahiro

PI Institution: California Institute of Technology

What are the properties of the first galaxies? When did they form? How did galaxies acquire mass, transform in structure, and quench star formation? JWST was designed to answer these key questions. However, the initial Cycle 1 results, from relatively small areas, are puzzling, pointing towards higher-than-expected star formation activities at the earliest times. To investigate further, a carefully designed and efficient survey is critical. We propose a pure-parallel imaging survey to construct a large and unbiased sample of the universe over 220 sightlines (~0.6deg^2 total area), minimizing cosmic variance. Our NIRCam 8-band imaging, uninterrupted spectral coverage at 0.8-5micron, will enable robust determination of photometric redshift and physical properties of sources at z~2 to z>10 via spectral energy distribution analysis. At no prime-time cost, this will enable cutting-edge investigations in four cosmic epochs: (1) Redshift frontiers at z>10, (2) Epoch of Reionization at 7<z<10, (3) Cosmic Dawn to Noon at 2<z<7, and (4) Modern universe at z<2. We expect to detect 150-800 sources at z>10, >2000 at z~7-10, and ~10^5 >10^9Msun galaxies at z~2-7. Our observations will complement extragalactic imaging programs in Cycle 1 and test theoretical models, including by measuring the star formation efficiency at z>7 and the onset of galaxy quenching. This program will also provide a wealth of relatively bright targets for future spectroscopic follow-ups. To maximize the benefit of this revolutionary observatory, we waive exclusive access and will reduce all images and release high-level science products for immediate community use.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 3991
Program Title: Small Cold Classical TNOs as Witnesses of Outer Nebular Chemistry

Principal Investigator: Grundy, Will

PI Institution: Lowell Observatory

We propose to observe a sample of nine Cold Classical TNOs that are intermediate in size between the very small object Arrokoth explored by NASA's New Horizons mission and much larger objects observed by JWST during Cycle 1. Our purpose is to test whether Arrokoth's anomalously high abundance of methanol ice relative to water ice is typical of small Cold Classical TNOs, pointing to formation in a region of distinctly different nebular chemistry beyond the CO snow line. To learn more about this region of the nebula as well as potential size-dependent processes affecting objects that formed there, we divide our sample between two slices. The 1st slice matches Arrokoth's heliocentric distance, while varying the objects' sizes. The 2nd slice consists of objects at varying heliocentric distance but all of the same size. These two slices will enable us to determine whether or not there are systematic trends with size or with heliocentric distance, thereby shedding light on the processes responsible.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4008
Program Title: The search for regolith on the airless exoplanet LHS 3844 b

Principal Investigator: Zieba, Sebastian

PI Institution: Max Planck Institute for Astronomy

Airless bodies in our solar system are rough and covered with regolith, a layer of dust and fine-grained debris originating from crumbled rocks. We show that well-known and understood processes caused by roughness lead most notably to more emitted flux around the secondary eclipse due to "thermal beaming". We propose to observe one phase curve (= 15 hours) of the rocky exoplanet LHS 3844 b with NIRSpec G395H. Previously, Spitzer observations of the planet showed that it has no significant atmosphere and is most likely an airless bare rock. Its short orbital period and high observability make it a perfect target for phase curve observations. Our proposed program will lead to the first observation of an exoplanet's surface roughness and open a window to the geologic history of LHS 3844 b. Detection of a rough regolith surface implies that LHS 3844 b's surface must have been stable for geologic timescales and undergone space weathering processes (impacts by micrometeoroids, cosmic radiation, or solar wind) that crumbled the rocks into fine-grained regolith. On the other hand, a smooth surface would indicate resurfacing events such as widespread volcanic activity or crustal reprocessing. In addition to the measurement of surface roughness, the phase curve observation will also lead to a precise measurement of the planet's phase-resolved spectrum. This will enable us to characterize the type of rock as a function of longitude, and also search for trace amounts of CO2 that were undetected by previous Spitzer observations.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4014
Program Title: Imaging Planet Formation at its Earliest Stages: Measuring The Extinction Level of an Enshrouded Protoplanet

Principal Investigator: Wagner, Kevin

PI Institution: University of Arizona

We propose to use JWST's unique capabilities in the thermal infrared to measure the level of extinction of a highly attenuated protoplanet, MWC 758c. As one of the youngest planets known, and currently the most reddened by cirumplanetary dust, MWC 758c represents a novel opportunity to study planet formation at its earliest stages. By establishing the level of extinction of MWC 758c, we will constrain the amount of dust within the circumplanetary material. Current ground-based lower limits suggest optical extintion greater than 8 magnitudes, and due to the degeneracy with temperature, a wide range of optical extinction is possible (up to ~90 magnitudes based on existing data, which is on the upper end of planet-formation models). NIRCam's F430M mode, combined with the M335R coronagraph, will be able to constrain MWC758c's temperature to within 100-200K through the strength of molecular absorption features that are not observable from the ground. With temperature known, constraints on extinction will be improved by at least an order of magnitude, even in the event of a non-detection. Simulations suggest that observations with NIRCam will be able to detect MWC758c with SNR>10 for Av<40, and will be able to establish at least an S/N>5 detection for Av<90 under conservative assumptions of of wavefront error between roll angles and reference star. This covers essentially all possible values, and thus even a non-detection would be useful to constrain the amount of extinction to the upper end of its existing range. MWC 758c is a unique target for this scientific case and JWST is the first and only facility capable of measuring its temperature and level of extinction.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4023
Program Title: Complete NIRSpec coverage of Europa's surface: CO2, salt hydrates, and the potential for unexpected discovery

Principal Investigator: Trumbo, Samantha

PI Institution: Cornell University

JWST NIRSpec presents the singular opportunity to observe the surface of Europa across the entirety of its largely unexplored 2.5–5 micron range at a combination of spectral resolution, sensitivity, and spatial resolution inaccessible to any existing or planned telescope or spacecraft mission. Such observations would address decades-old questions concerning the origin and nature of its surface CO2 and its widespread “hydrate” material interpreted to contain ocean-derived salts. Preliminary results from the single Cycle 1 GTO NIRSpec observation of Europa are remarkable, and already reveal new surface absorption features and enticing clues to the possible oceanic origin and perplexing physical state of the CO2. However, it does not provide the complete spatial coverage of Europa’s large-scale resurfaced terrain needed to decisively determine whether the CO2 truly originates from the ocean, nor does it provide any coverage of the compositionally distinct trailing hemisphere, which features an unidentified and unmapped absorption feature at 3.78 microns potentially diagnostic of the composition of inferred oceanic salt hydrates. We propose a straightforward NIRSpec IFU mapping campaign to complete spatially resolved coverage of the surface across the 2.5–5 micron wavelengths in order to (i) determine whether Europa’s CO2 truly originates from ocean material and constrain its physical state, (ii) test the hypothesis that Europa’s 3.78-μm band results from Na/Mg-sulfate salt, and (iii) produce complete spatially resolved maps of Europa’s heterogeneous surface in this poorly explored wavelength range.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4026
Program Title: Hot dust in the nearby metal-poor starburst galaxy CGCG 007-025: A window to the high redshift Universe

Principal Investigator: Sanchez-Janssen, Ruben

PI Institution: United Kingdom Astronomy Technology Centre

Although rare in the nearby Universe, metal-poor starbursting dwarf galaxies are promising sources to be used as benchmarks for the study of the ISM in high-z galaxies. Here we propose MIRI-MRS IFU observations to characterise in detail the dust emission in one of the most compelling local analogues, CGCG007-025. This young, compact, metal-poor starburst is powered by massive stars (including carbon Wolf-Rayets) and features a steeply rising mid-IR SED, indicative of the presence of hot dust. With the enhanced sensitivity and the superb spatial resolution enabled by JWST, we will be able to pinpoint the exact location of the dust emission and characterise it both spatially and spectrally. We will infer the abundances of heavy elements from mid-IR fine-structure lines and compare it with the (possibly biased) optical diagnostics; we will place constraints on the hardness of the radiation field and the extent of the density-bounded region; and we will look for faint PAH emission and search for the elusive trace of silicates. These observations will provide a detailed characterisation of the physical properties of dust under the extreme conditions that were common in primordial ISMs--but with a degree of detail and sensitivity unmatched by any observation of the high redshift Universe.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4028
Program Title: Deciphering Jupiter's Irregular Satellites: A Critical Test of Giant Planet Migration

Principal Investigator: Sharkey, Benjamin

PI Institution: University of Arizona

We propose NIRSpec IFU and MIRI LRS observations of eight of Jupiter’s irregular satellites. These satellites are thought to be captured during planetary migration from regions beyond Jupiter’s formation location, but poor understanding of their compositions limits understanding of their origins. Our proposed spectroscopic observations will test a key prediction of planetary migration models: that Jovian irregular satellites were sourced from the same parent population as Jovian Trojans and dark, organic-rich main belt asteroids. By acquiring spectroscopic measurements of Jovian irregular satellites, this program will determine whether their compositions are consistent with this shared-capture scenario. This data set will also test whether material ejected from irregular satellite collisions is implanted onto the Galilean satellites, constraining a possible key source of organic-rich material within the Jovian system.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4038
Program Title: First Infrared Spectra of a Tidal Disruption Event Dust Echo: Solving the Missing Energy Problem

Principal Investigator: van Velzen, Sjoert

PI Institution: Universiteit Leiden

A tidal disruption event (TDE) of a star by a massive black hole yields a short and luminous flare of radiation, thus providing a unique signpost of otherwise dormant black holes. While the detection rate of optical TDEs is accelerating, our understanding of their optical emission has hit a formidable obstacle: the missing energy problem. The observed electromagnetic output of TDEs is almost four orders of magnitude lower than the gravitational potential energy that must be released when a star is accreted. This missing energy could either be emitted over a much longer timescale than the optical flare, or it could be emitted promptly but in the extreme-UV band. Discriminating between these two models will be required to unlock TDEs as tools for black hole demographics. Fortunately, the infrared reverberation signal from dust heated by a TDE can be used to measure the total energy of the event. These TDE dust echoes have recently been discovered, however their use as bolometers requires a much better measurement of the dust temperature and composition. JWST is ideally suited to make these observations. With a sequence of spectroscopic observations triggered on an IR-bright TDE, we will measure the dust grain sublimation rate by comparing the nuclear hot dust spectrum to its pristine off-nuclear state. And because circumnuclear dust in TDEs is suddenly exposed to UV radiation we will also constrain the grain properties via the temporal variability of the emission lines. These observations will yield the first-ever infrared spectra of a TDE, allowing us to solve the missing energy problem and measure the dust covering factor at sub-parsec scales.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4043
Program Title: Unveiling the build-up of large scale structure in the early Universe

Principal Investigator: Witten, Callum

PI Institution: University of Cambridge

Understanding the formation and evolution of the first Large Scale Structure (LSS) of the universe is a key, unsolved question. Early JWST deep surveys have revealed that some of the brightest galaxies identified by the Hubble Space Telescope are in fact surrounded by fainter galaxies, forming protoclusters – the progenitors of the large clusters that we observe in the local Universe. However, both observational and theoretical constraints have until now limited our understanding of star-formation, metal enrichment and feedback processes occurring within these very first structures. NIRCam Wide Field Slitless Spectroscopy (WFSS) observations will allow us for the first time to perform a spectroscopic search, unbiased by selection, for protocluster members. We therefore propose to obtain deep WFSS using the F444W filter covering the SMACS0723 cluster field that contains the previously identified z=7.66 protocluster in order to observe [OIII] and Hb emission in constituent galaxies. This lensed protocluster offers a valuable opportunity to spectroscopically confirm the constituent galaxies of a likely-AGN hosting protocluster. Moreover, we will constrain their properties allowing us for the first time to understand the evolution of a protocluster through observations of the distribution of star-formation, metallicity and the age of the protocluster shedding unique light on the physical processes governing some of the earliest LSS identified to date.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4050
Program Title: Uncharted Worlds: Towards a Legacy of Direct Imaging of Sub-Jupiter Mass Exoplanets

Principal Investigator: Carter, Aarynn

PI Institution: University of California - Santa Cruz

Here we propose a NIRCam coronagraphic survey of stars within the TW Hya association which will be sensitive to sub-Jupiter mass exoplanets beyond 20 au. JWST is the only observatory with the necessary wavelength coverage and infrared sensitivity to explore this population, and holds the key to exploring their demographics, histories, and atmospheres. These observations will provide the first ever constraint on the occurrence of sub-Jupiter exoplanets beyond 10~au, and are fundamental to our understanding of the demographics of the entire exoplanet population. These constraints will in turn clarify whether the observed gaps within ALMA disks are likely to be generated by the sculpting effects of planets, and will provide valuable information on the influence of planetary scattering, which may be responsible for measured over-abundances of free-floating planets. Finally, these observations will kickstart a new generation of follow-up imaging and/or spectroscopic JWST characterisation observations of discovered objects. With sensitivity to masses as low as 0.1 Mjup at temperatures of 250K, these exoplanets will be fundamentally distinct from any other discovered thus far.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 4056
Program Title: Shedding Light on Early Structure Formation: Disecting the Largest Gas Reservoirs of z=6.6 QSOs

Principal Investigator: Farina, Emanuele

PI Institution: NOIRLab - Gemini North (HI)

QSOs at the end of cosmic reionization are among the most luminous sources in the Universe. Their luminosity is produced by extreme gas accretion onto their central black holes, which grow by 20x in only 100Myr. Simultaneously, QSO host galaxies form hundreds of stars per year, using up gas in the process. Extensive VLT/MUSE observational campaigns recently revealed that z=6.6 QSOs P323+12 and P231-20 are embed in exceptionally large (>20pKpc) and luminous (L>10^44 erg/s) Ly-Alpha nebulae. These are tracer of the enormous cool gas reservoirs that are required to continuously fuel the rapid build up of the earliest QSOs. However, the physical perperties of the gas in the nebulae cannot be constrained due to the resonant nature of the Ly-Alpha emission. NIRSpec IFU observations of non-resonant emission lines such as H-Alpha and [OIII] will characterize unambiguously the total mass and the kinematics of the emitting gas. NIRSpec in IFU mode is absolutely critical for our experiment: it is the only instrument that can provide the high spatial and spectral resolution and the high sensitivity necessary to map with unparalleled accuracy the 3D distribution of the cool gas in these two spectacular systems. This will enable an comprehensive characterization of the circum-galactic medium of two of the brightest and most active QSOs at z>6. This data has the exciting prospect of unveiling 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 galxy formation can be better constrained.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4065
Program Title: Dusty Torus, Molecular Gas, Outflows, and Binary Nucleus in the Powerful Nearby Quasar Cygnus A

Principal Investigator: Ogle, Patrick

PI Institution: Space Telescope Science Institute

Cygnus A is the closest powerful radio galaxy, with a rich observational history. Its MIR-luminous quasar nucleus is enshrouded by dust, allowing detailed studies at NIR wavelengths of AGN fueling and feedback that would otherwise be hindered by the glare of the AGN. We propose a suite of JWST imaging and integral field spectroscopy with MIRI and NIRSpec in order to study the dusty molecular torus, quasar fueling and outflows, and to confirm or refute the presence of a binary supermassive black hole. We propose NIRSpec IFU and MIRI MRS observations to map the kinematics, temperature, and mass of molecular and ionized gas in the host galaxy. This will yield the kinematics and H2 temperature distribution in the 100 pc-scale disk that serves to fuel the AGN and a measurement of the warm H2 and dust mass in the unresolved 10-100pc scale torus. MIRI will also separate the AGN-heated dust continuum from the torus and NLR bi-cone, informing dusty torus models. Spectral maps in spectral lines from multiple ionization states will be used to map the mass, outflow rate, and kinetic power of AGN-driven outflows in relation to the location of the relativistic jet. The MIRI Imager will be used to isolate and measure the luminosity of the secondary nucleus, and to survey star formation throughout the host galaxy. Altogether, these observations will tell us (1) the amount of molecular gas available to fuel the dust-obscured quasar and its depletion timescale, (2) The impact of AGN and jet-driven outflows on the ISM and whether or not they are sufficient to eventually quench star formation, and (3) whether the secondary nucleus hosts an active SMBH.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4078
Program Title: Mass-loss from Io’s volcanic atmosphere: A unique synergy with the Juno Io fly-by

Principal Investigator: de Kleer, Katherine

PI Institution: California Institute of Technology

Material outgassed from Io’s volcanic activity forms its tenuous SO2-based atmosphere, and ultimately becomes ionized to populate Jupiter’s magnetosphere. However, the direct link between Io’s volcanoes and the plasma in the jovian system remains unclear; the gas is not vented at sufficient velocities to escape Io, and the atmosphere should therefore act as a buffer, with mass-loss occurring from the upper bulk atmosphere rather than directly from plumes. The mechanics of this process, and the role of the atmosphere, remain elusive in part because every component of this system is highly time-variable so that linking different components observed at different times is nearly impossible. The Juno extended mission’s close Io fly-by provides a truly unique opportunity to measure particles in the vicinity of Io in situ with Juno, while simultaneously mapping the temperature and column density of Io’s dayside atmosphere with JWST. We propose to measure the SO2 gas in Io’s atmosphere during the 1 hour surrounding Juno’s closest approach, via the 7.3 micron gas band observed with MIRI/MRS. This gas band is clearly seen in JWST ERS observations of Io, which targeted Io’s leading hemisphere. Fortuitously, the Juno fly-by takes place downstream of Io, measuring the lost matter, and also while Io’s trailing hemisphere is visible to JWST. This hemispheric coverage complements the viewing geometry of the ERS data, and we will additionally observe Io across 5-6 microns to measure hemispheric differences in 5.4 and 5.95 micron bands that were newly detected in the ERS data of Io.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4082
Program Title: Putting it all Together: Dynamics and Chemistry Probed Through Transmission Spectroscopy of a Cloud-Free Exoplanet

Principal Investigator: Radica, Michael

PI Institution: Universite de Montreal

It has long been recognized that the atmosphere composition of hot-Jupiters can inform us about their formation and migration processes. Recent studies have highlighted, however, that atmosphere composition is also significantly affected by three-dimensional dynamical effects, and photochemistry driven by irradiation from the host star. Assessing the interplay between these physical and chemical processes and obtaining robust and precise atmosphere composition measurements is inherently difficult, especially given the ubiquity of clouds in hot-Jupiter atmospheres. As one of the few confirmed cloud-free planets, WASP-96b is a prime target to study these effects. We propose the observation of one transit of the cloud-free hot-Jupiter WASP-96b with NIRSpec/G395H to complement the existing NIRISS/SOSS spectrum taken as part of the Early Release Observations program. The full 0.6-5.0μm transmission spectrum will allow us to robustly constrain the composition of WASP-96b's atmosphere, and particularly of carbon-bearing species which are not present in the SOSS waveband. This will in turn provide some of the tightest-yet constraints on the formation history of an exoplanet. Moreover, our observations will enable some of the first direct evidence for dynamics-induced chemistry in an exoplanet, as well as to probe the degree to which photochemistry sculpts its upper atmosphere; effects only observable in the NIRSpec waveband. As WASP-96b is one of the few confirmed cloud-free planets, it is the ideal target with which to study such a large ensemble of physical and chemical processes.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4084
Program Title: Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmospheres

Principal Investigator: Miles, Brittany

PI Institution: University of Arizona

Atmospheric mixing occurs in all substellar atmospheres, from free floating brown dwarfs, gas giant exoplanets, to the gas giants in our very own Solar System. This phenomenon influences the apparent chemistry in observed spectra from these objects. Changes created in the spectrum can also be utilized to measure atmospheric mixing as a function of radial depth, revealing the structure and locations convective and radiative zones within brown dwarf atmospheres. T-dwarfs are the ideal test beds for validating the state of the art models for constraining 1-D atmospheric mixing, due to their relative lack of photospheric clouds and existing ground-based near-infrared spectra. We will execute a program to observe 5 T-dwarfs with the fixed-slit F290LP/395H mode of JWST/NIRSpec for medium-resolution, 3 to 5 micron spectra to complete a sample of 7 T-dwarf with temperatures between 500K - 900K and surface gravities between log(g) 3.5 - 5.5. Using detections of methane, carbon monoxide, and carbon dioxide we will construct 1-dimensional atmospheric mixing profiles for each brown dwarf and understand how the size and extent of convective zones trend with effective temperature and surface gravity. Using the SNR 100 spectra we will also detect or place upper limits on other predicted disequilibrium species like hydrogen sulfide and phosphine.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4087
Program Title: Refining the Mira Distance Ladder with NIRCam Observations of M101

Principal Investigator: Huang, Caroline

PI Institution: Smithsonian Institution Astrophysical Observatory

The recent tension between direct, model-independent measurements of the Hubble constant and the model-dependent values inferred from observations of the CMB has posed the strongest challenge to LambdaCDM in nearly 30 years. However, the burden of proof for a potentially groundbreaking discovery of new physics is high. Thus, alternative routes to the present measurements of the Hubble constant – which rely primarily on Cepheids and Tip of Red Giant Branch as intermediate distance indicators – must be explored in order to verify the current results and to fully understand the role of systematic uncertainties. Oxygen-rich Mira variables are luminous, ubiquitous, NIR and IR standard candles and present a particularly compelling path forward to studying the tension in the era of JWST. Here, we propose to use the high angular resolution and infrared coverage of NIRCam to simultaneously refine the Mira-based distance ladder and re-examine Cepheid crowding in the Type Ia Supernova host galaxy M101. This will allow us to verify the Cepheid results by using an independent ladder subject to different systematics, and by directly reanalyzing the Cepheids in M101. In this joint proposal consisting of one epoch of JWST NIRCam and three epochs of coordinated HST WFC3/IR and ACS observations, we will (1) de-blend the backgrounds of known Cepheids and Miras in M101, (2) improve Mira spectral type classification, and (3) study the effect of dust and mass loss on the Mira PLR. The three HST epochs will allow us to phase the single-epoch JWST observations to mean magnitude and produce Mira PLR in JWST bands for the first time.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4090
Program Title: Follow the trace: Direct detection of a dynamically ejected young planet outside a circumbinary disk

Principal Investigator: Ginski, Christian

PI Institution: Leiden Observatory

Stellar multiple systems offer some of the most challenging environments for planet formation. Tidal interaction of stellar binaries with the planet-forming disks can lead to truncation, formation of cavities, warps and spirals. Dynamic interaction with forming planets can lead to their ejection from the system. Possibly explaining the population of free floating planets or (some) of the gas giants directly imaged at wide orbital separations. Recent observations of a young nearby binary system have revealed a unique opportunity to directly observe this process in action. A newly detected circumbinary disk in the system shows a clear signature of the recent ejection of a planet. Using the superior sensitivity of JWST and NIRCam from space we now propose to directly detect this planet. This will not only give us a unique laboratory to study dynamic star-planet-disk interaction but also will enable future studies of the atmosphere of a planet otherwise inaccessible to direct observations.

Proposal Category: GO
Scientific Category: Intergalactic Medium and the Circumgalactic Medium
ID: 4092
Program Title: How Does Reionization End? A Search for [O III] Emitters in the Most Transparent Regions of the IGM Near Redshift Six

Principal Investigator: Becker, George

PI Institution: University of California - Riverside

Multiple observations now indicate that reionization ended well below z=6, opening the door to new and more detailed tests of reionization models. One such test concerns the relationship between IGM opacity and density near the end of reionization. Late-reionization models predict that quasar Lyman-alpha forest opacities near z=6 should anti-correlate with line-of-sight density due to UV background fluctuations and/or absorption by the last islands of neutral gas. This picture has been supported by Lyman-alpha emitter (LAE) surveys along high-opacity lines of sight, which have found that giant Lyman-alpha troughs are associated with galaxy under-densities. Recently, however, LAE surveys have indicated that the lowest-opacity sightlines at these redshifts also trace under-densities, contrary to expectations. This tension suggests that either the LAEs are missing some high-density regions or important aspects of the reionization process are missing from the models. To address this, we will use NIRCam WFSS to search for [O III] emitters along two quasar lines of sight with the lowest-known Lyman-alpha forest opacities near z=6, regions that have previously been surveyed for LAEs. The [O III] emitters will provide a sensitive and independent tracer of the large-scale densities in these volumes. Conclusively showing that these low-opacity sight lines correspond to cosmic under-densities would have important implications for our understanding of how reionization ends.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4093
Program Title: Fingerprinting the history of episodic dust creation in Wolf-Rayet binaries

Principal Investigator: Richardson, Noel

PI Institution: Embry-Riddle Aeronautical University

Star and planet formation theory, especially relating to the early Universe, requires an accurate dust budget. One source of dust at very low metallicity is thought to be from carbon-rich Wolf-Rayet stars (WCd) in binary systems formed through Roche lobe overflow. In July 2022, JWST+MIRI imaged seventeen dust shells around the WCd binary WR 140, which creates dust every periastron passage (every ~8 years), revealing that the dust survives for at least 150 years following its creation. Such infrared imaging allows us to measure the temperature evolution of the dust and to model the geometry of the shocks that led to the observed emission. We propose to widen the sample with four additional systems (WR 48a, WR 112, WR 125, and WR 137), which allows for the exploration of WCd dust creation over larger physical scales as the binaries are more distant than WR 140, and testing of the survivability of carbon-rich WCd dust in multiple environments. The understanding of the dust survival is crucial to a complete accounting of the dust budget in both early and modern galaxies as these binary stars can form dust faster than the first supernovae in their parent galaxy, and at timescales of millions of years rather than the billions of years needed to form dust with AGB stars or planetary nebulae.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4094
Program Title: A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined with ALMA, MUSE, Chandra, and HST

Principal Investigator: Tremblay, Grant

PI Institution: Smithsonian Institution Astrophysical Observatory

We propose short NIRSpec IFU and MIRI MRS observations of a galaxy-spanning fountain of multiphase gas"pumped" by a supermassive black hole. The data will demonstrate Webb’s singular power to advance our understanding of the black hole feeding and feedback loop in the heart of galaxies, as well as showcase the IFU's exquisite multiwavelength synergy with archival data from Chandra, Spitzer, Herschel, ALMA, VLT/MUSE+SINFONI, and nearly every instrument aboard HST. The Abell 2597 BCG (z = 0.082) is the perfect performance demonstration target for Webb’s low redshift capabilities, hosting an efficiently mappable and spectacular example of chaotic cold accretion, which may trace processes fundamental to galaxy evolution at effectively all mass scales.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4098
Program Title: Exploring the existence and diversity of volatile-rich water worlds

Principal Investigator: Benneke, Bjorn

PI Institution: Universite de Montreal

We propose to use JWST to conduct a targeted search for a long-theorized class of planet known as "water worlds". Due to its large aperture, broad infrared wavelength coverage, and ultra-stable space-based platform, JWST provides the first -- and, for the foreseeable future, only -- opportunity to unambiguously identify water worlds and characterize their atmospheric compositions. We will use NIRISS SOSS and NIRSpec G395H to measure atmospheric transmission spectra for a sample of the five most promising water-world candidates identified by their bulk densities, transmission spectroscopy metrics, and the expected depths of molecular spectral features. By surveying multiple targets, our program will provide vital constraints on the existence of water worlds and will allow us to start characterizing the chemical diversity of their atmospheres. The existence of water worlds has important implications for theories of planet formation, and with compositions dominated by volatiles other than H/He, they represent a new regime of atmospheric chemistry that has until now remained uncharted by observations.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4102
Program Title: Hydrogen-rich sub-Neptune or exposed Neptune mantle? Confirming the nature of the most favorable sub-Neptune for JWST emission spectroscopy

Principal Investigator: Roy, Pierre-Alexis

PI Institution: Universite de Montreal

Sub-Neptunes, despite being the most common outcome of planet formation, are still shrouded in mystery. Despite a decade of HST transmission observations of sub-Neptunes, it is still unclear whether sub-Neptunes form as rocky cores in hydrogen-rich envelopes and lose their envelopes to become super-Earths, or if these planets form independently as ice-rich bodies that host large amounts of water and volatiles. Recently, TOI-824b has been highlighted as a key target to tackle these questions, and as the most favorable target for emission spectroscopy with JWST. Recent Spitzer eclipse observations of the planet suggested that TOI-824b could be an exposed Neptune mantle, a planet with a volatile-rich envelope and little to no hydrogen. We propose to confirm the nature of the keystone hot sub-Neptune TOI-824b through two eclipse observations of the planet using NIRSpec/G395H. With a 1250K equilibrium temperature and a measured hotter dayside temperature, TOI-824b is *by far* the most favorable sub-Neptune for emission spectroscopy with JWST. This program will allow us to robustly confirm the results from the Spitzer survey by measuring the dayside temperature and atmosphere metallicity. We will also constrain the carbon-to-oxygen ratio of TOI-824b using the carbon dioxyde and water abundances provided by the emission spectrum. Together, the metallicity and C/O measurements will reveal the nature of TOI-824b as either a hydrogen-rich planet or an exposed mantle. This result will represent a major step forward in understanding the composition and formation of the ubiquitous sub-Neptunes.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4105
Program Title: Not Your Normal Neptune: Exploring the Chemical Processes at Play in HAT-P-11b

Principal Investigator: Alderson, Lili

PI Institution: University of Bristol

Under equilibrium chemistry conditions, methane is expected to be the dominant carbon bearing species in Neptune-sized exoplanet atmospheres at temperatures below ~ 1000K for most C/O ratios and metallicities. However, observational searches for methane have thus far found only tentative hints of its presence. In order to diagnose the source of the missing methane in extrasolar atmospheres, it is important to be able to tease apart the competing effects of high-metallicity equilibrium and low-metallicity disequilibrium chemical processes, both of which can reduce the molecule's expected abundance. HAT-P-11b, the only Neptune-mass exoplanet with a sub-solar metallicity measurement, is one of the few exoplanets with potential evidence of methane. However, Spitzer observations show relatively flat transit depths in the IR where methane should have significant contributing opacity. Given its intriguingly low metallicity combined with its size and temperature, the ~800K HAT-P-11b is a prime target to examine and perhaps disentangle the chemical and dynamical processes occurring within atmospheres on the CO - CH4 transition. We propose to obtain the 3-5 micron transmission spectrum of HAT-P-11b in order to definitively measure the C/O and [M/H] of the atmosphere and test the validity of current measurements, unraveling the mystery of the missing methane.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4106
Program Title: Extremely massive galaxies in the early universe: a challenge to Lambda-CDM?

Principal Investigator: Nelson, Erica

PI Institution: University of Colorado at Boulder

One of the most remarkable findings from JWST's first month of public data was the discovery of six galaxies at 7<z<10 with extremely red colors implying stellar masses so large they challenge early galaxy assembly models in a standard LCDM cosmology (Labbe+22, Boylan-Kolchin+22). Namely, there are no halos massive enough to contain these galaxies at these redshifts, even if ALL baryons in them were converted to stars. The seemingly more likely possibility is that the stellar mass estimates are too high because the broad-band photometry is dominated by bright emission lines. Interestingly, this solution requires formation times of <10Myr. The first spectroscopic follow-up of one of these candidate massive galaxies has revealed third equally exciting and unanticipated solution: the object is revealed to be a low-luminosity quasar hosting a Milky-way sized black hole at z=5.6. Any result here is exciting: it is a win-win scenario. Here, we propose JWST/NIRSpec spectroscopy that will yield precise redshifts and constrain the emission line contributions that could be boosting the broadband NIRCam fluxes and biasing $M_{\star}$ estimates. The proposed combination of low- and medium-resolution spectra offers the only efficient and comprehensive test of the masses and redshifts of these objects. Whether this program confirms extreme stellar masses, finds more exotic Milky-way black holes, or reveals that galaxies can form in <10Myr, it will pave the way for detailed studies of uncharted discovery space in future JWST cycles.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4111
Program Title: Medium bands, Mega Science: spatially-resolved R~15 spectrophotometry of 50,000 sources at z=0.3-12

Principal Investigator: Suess, Katherine

PI Institution: University of California - Santa Cruz

Early JWST observations have already catalyzed a paradigm shift in our understanding of the distant universe. However, many of these surprising discoveries are based on broad-band photometry, which can often permit contradictory physical interpretations. Here we propose to break these broad-band degeneracies and move towards a new physical understanding of the distant universe by leveraging the transformative power of medium-band imaging to efficiently map both stellar continuum and nebular line emission for large, unbiased galaxy samples. By observing the well-studied Abell 2744 field with all available medium-band NIRCam filters, we will map strong emission features from the cluster itself through the era of reionization. We will simultanously probe multiple emission lines to directly map both star formation and dust obscuration and chart the growth of galaxies across >10 Gyr of cosmic history. Our data will also yield high-fidelity measurements of photometric redshifts (~3x improvement over existing data) and stellar masses (~2x improvement). Lensing from the cluster boosts our effective integration time by up to a factor of 10 and allows us to map emission lines at the highest possible resolution with JWST. Our proposed science can only be done with medium-band imaging: grism is not sensitive enough for continuum emission, and has difficulty disentangling spectral and spatial variations; meanwhile, spectroscopy is subject to small sample sizes and slit losses. This public dataset will add to the legacy value of JWST Cycle 1 observations of Abell 2744 and create the ideal field in which to refine our physical models of the distant universe.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4116
Program Title: Close up samples of Exoplanetary Systems: Characterizing the next Interstellar Object

Principal Investigator: Meech, Karen

PI Institution: University of Hawaii

One of the most significant recent findings in astronomy has been the discovery of two interstellar objects (ISOs) passing through our solar system. The two ISOs discovered to date are strikingly different: 2I/Borisov appeared cometary, while 1I/`Oumuamua looked asteroidal with characteristics that still are not fully explained, but could have been with the JWST program proposed here. A detailed look at ISOs will provide unparalleled nearby access to the chemical and physical conditions of exoplanet formation. Comets and some asteroids are the largely unaltered remnants of the planetary accretion process, tracing both dust and volatiles - H20, CO, CO2 - in the disk. JWST will reveal detailed information about ISOs that we cannot obtain from the ground, such as size and albedo, properties of solid ices and surface materials, and simultaneous measurements of water, CO and CO2. Accordingly, with this 17.4 hr program, we request one ToO (>14 d) to characterize an ISO discovered in Cycle 2. The observing program will depend on whether the next ISO is like 2I/Borisov or 1I/`Oumuamua. IR observations will allow us to estimate an albedo and size. NIRSpec spectra will detect H20, CO, CO2, and water ice bands, while NIRCam deep imaging will search for faint coma

Proposal Category: GO
Scientific Category: Galaxies
ID: 4125
Program Title: Galaxies Under Construction: Resolved Scaling Relations and Stellar Mass Assembly as Revealed by Lensed Star-Forming Clumps at Cosmic Noon

Principal Investigator: Florian, Michael

PI Institution: University of Arizona

The fundamental building blocks of galaxies, star-forming clumps, have long been observable at the tens of pc scale at cosmic noon, the epoch of most vigorous star formation, thanks to HST and the magnification of gravitational lensing. Before JWST, however, it was impossible to precisely constrain the basic properties of these tiny clumps: their ages, sizes, star formation rates (SFRs), dust content, metallicities (Z), and ionization parameters (logU). Now, spatially-resolved spectroscopy with the NIRSpec IFU is revolutionizing the study of clumps in distant galaxies. Its ability to detect continuum in single clumps provides unprecedented constraints on clump ages and masses when combined with NIRCam and archival HST imaging. Its medium resolution gratings detect important diagnostic emission lines on a clump-by-clump level, revealing SFRs, reddening, Z, and logU. Together, these pieces of information will unlock nearly the full story of clumps from formation to (possible) destruction, and in turn, reveal secrets of galaxy formation. How are galaxies assembled? How do clumpy structures form? How do bulges form? How do galaxy-wide scaling relations like the fundamental metallicity relation come to be? Did clumps ionize the universe? We have designed a survey of clump demographics in 8 lensed galaxies (6 new targets and 2 archival), covering nearly over 100 clumps down to at least the 50pc scale, to directly address these questions. Early release observations like those of SMACS0723 have provided tantalizing hints of the answers and demonstrated feasibility, but ultimately were not designed for that purpose. It is time for a survey that is.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4126
Program Title: TOI-125: Comparative Atmospheric Chemistry Within One System

Principal Investigator: Fisher, Chloe

PI Institution: University of Oxford

Characterising and comparing exoplanets from the same system can provide valuable constraints for formation and migration models. In particular, by measuring the C/O ratio of a planet with respect to that of its host star, one can draw conclusions about its formation location and whether it has migrated across the snow and ice lines in the protoplanetary disk. A recent discovery from the TESS mission, TOI-125, contains three sub-Neptunes on relatively close-in orbits. In addition, the comparable radius and gravity of the planets provide a unique opportunity to study similar objects formed in the same disk. We propose to use JWST/NIRSpec in BOTS mode with the G395H disperser to observe a single transit of TOI-125 b and c. Mock retrievals showed these planets can be well-characterised with only one transit in this mode, providing a valuable comparison within this system. Observing and analysing these planets will help us to constrain likely formation-migration scenarios for this system. Although we do not propose to observe TOI-125 d here, since it is more challenging for transmission spectroscopy, it could prove beneficial to return to this planet in a future cycle.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4147
Program Title: A Census of High- and Low-Mass Star Formation in a Galactic Center Molecular Cloud

Principal Investigator: Crowe, Samuel

PI Institution: The University of Virginia

We propose JWST-NIRCam observations of the Galactic Center molecular cloud Sagittarius C, in particular the massive protostar G359.44-0.102 and its surrounding region, in order to take a census of its star formation activity and test theoretical models of massive star formation in this extreme environment. The wider region has already been observed with SOFIA-FORCAST at 25 and 37 microns, as well as Spitzer and Herschel. These data have enabled candidate high-mass protostars to be identified and characterized, but only at quite limited spatial resolution. The proposed JWST observations have three goals: 1) improved characterization of the identified massive protostellar candidates, in particular the main source G359.44-0.102, including outflow cavity geometries, dust content and shock/ionization structures. For example, scattered light from dust is expected to arise from the outflow cavities, thus constraining their structure, illumination and dust content; 2) probe the spatial distribution and number density of the lower-mass YSO populaton to place more direct constraints on the IMF and star formation rate and efficiency in Sgr C. The number of massive protostellar candidates in Sgr C predicts a much larger quantity of lower-mass protostars, which we aim to identify and characterize; 3) study the connection between high- and low-mass protostars to test massive star formation theories.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4181
Program Title: Infrared Spectroscopy of a Neutron Star Merger with JWST

Principal Investigator: Chornock, Ryan

PI Institution: University of California - Berkeley

This proposal seeks to leverage the transformative capabilities of JWST to produce a high-quality spectroscopic dataset for one optical counterpart (kilonova) associated with a neutron star merger (NS-NS or NS-BH) detected by Advanced LIGO/Virgo/KAGRA in their observing run O4. The observations consist of three epochs from 5 to 20 days after the merger: (1) and (2) NIRSPEC + MIRI spectroscopy; and (3) NIRSPEC spectroscopy + MIRI imaging. These observations will: (i) obtain spectroscopy of a sufficiently high SNR and broad wavelength coverage to detect and identify as many spectral features as possible; (ii) measure the ejection velocities in the different ejecta components, and (iii) precisely measure the infrared spectral energy distribution into the mid-IR to constrain the potential presence of emission components beyond those dominating in the near-IR. These data will detect and characterize the emission from multiple ejecta components predicted by numerical simulations of neutron star mergers as part of a multimessenger investigation of the merger process. We waive our proprietary rights to enable the whole community to benefit from these data.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4192
Program Title: Revealing our past faux PAHs: unveiling the hidden drivers of ISM conditions at cosmic noon

Principal Investigator: Alberts, Stacey

PI Institution: University of Arizona

Polycyclic aromatic hydrocarbons (PAHs) are small dust grains that have an oversized influence on the interstellar medium (ISM) of galaxies. Particularly crucial are their role as a catalyst for molecular hydrogen formation, the fuel for new stars, and in regulating the heating and ionization balance of interstellar gas. In turn, PAHs respond to the local radiation field, dominated by young stars, and have been a workhorse tracer of obscured star formation rates at high redshift. This relationship may be fundamental to the peak in cosmic star formation at cosmic noon and can finally be explored with JWST. We propose an efficient program with MIRI/LRS slit spectroscopy to observe two prominent PAH features (at 3.3 and 6.2um) in 22 CO-selected, main sequence galaxies at z~1. These features will 1) evaluate the local "universality" between PAHs and molecular gas under the ISM conditions at cosmic noon, 2) break degeneracies between average grain properties and the radiation field, and 3) tie those grain properties to a galaxy's ability to efficiently form stars. This proposal will set the benchmark for future high redshift studies using dust emission, particularly via the 3.3um PAH which is new discovery space for JWST at high redshift and is the only dust feature that JWST can observed up to z~6 and beyond.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4195
Program Title: Constraining the Oxidation State of the Super-Earth TOI-1685 b

Principal Investigator: Fisher, Chloe

PI Institution: University of Oxford

Characterising the atmosphere of a rocky exoplanet can provide valuable insight into the interior conditions of the planet. In particular, by constraining the ratio of CO2 and CO abundances, we can infer the oxidation state (or oxygen fugacity) of the planet's mantle. In the Solar System, their exists a relationship between planet mass and oxidation state, with larger planets being more oxidized. By constraining the oxidation state of a super-Earth exoplanet, we can determine if novel interior dynamics are operating, contrasting what we know from our Solar System. The super-Earth TOI-1685 b is on an ultra-short period orbit around an M dwarf, and has a low density compared with other similar targets, making it ideal for atmospheric characterisation. We propose to use JWST/NIRSpec in BOTS mode with the G395H disperser to observe four transits of TOI-1685 b. Mock retrievals showed this planets can be well-characterised in this mode, providing valuable constraints on its oxidation state. Due to the lack of super-Earths in the Solar System versus their prevalence around other stars, the information we learn about TOI-1685 b is likely to be widely applicable to thousands of other exoplanets.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4196
Program Title: How to Form a Compact Massive Galaxy: Spatially Resolved Maps of Pa-beta at z=2.3

Principal Investigator: Gibson, Justus

PI Institution: University of Colorado at Boulder

The central density of stars in a galaxy appears to be one of, if not *the* primary determinant of its evolutionary path. At the extreme end, the densest cores at the hearts of today's red-and-dead elliptical galaxies, appear to have formed via an extraordinary -and likely rapid- event that shut off star formation and truncated their in-situ growth, unlike less dense star-forming counterparts. However, the formation of these extremely dense cores (~10$^$11 Msun within a kpc) is poorly understood as distinguishing amongst formation channels requires mapping star formation and kinematic signatures at sub-kpc resolution. Observations are further complicated by dust obscuration and AGN contamination. We propose NIRSpec IFU observations of Paschen-beta and Pa-gamma in a rare, but prototypical massive galaxy core lacking any AGN contamination. Using G395M, we will map Pa-Beta to distinguish between rotation-, dispersion-, or wind-dominated kinematics. The same observations will map the Pa-Beta and Pa-Gamma line strengths, yielding a dust-corrected map of star formation. If the kinematics are dispersion dominated and the star formation is more compact than the stellar continuum, this would suggest a merger- or instability-induced central starburst. Wind-dominated would point to impending rapid (<100 Myr) shut-down of star formation. Rotation-dominated kinematics and more extended dust-corrected star formation would imply gradual, accretion-throttled formation. In this case, it is likely to be the highest rotation velocity ever observed in a normal star-forming galaxy. With an investment of just 2.7 hours, we will place new constraints on the formation of massive galaxies.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4198
Program Title: Multi-Cycle monitoring of the volatile evolution of a returning planetesimal as it approaches perihelion

Principal Investigator: Bolin, Bryce

PI Institution: NASA Goddard Space Flight Center

The 140 km diameter Oort Cloud comet C/2014 UN271 is likely one of the original planetesimals that formed in the protoplanetary disk and will reach a perihelion distance of ~10 au in 2031. Recent NIRSpec observations of UN271 when it was 18.2 au from the Sun show that it produces considerable quantities of CO2 and CO with icy grains. While CO can be active at ~18 au, the detection of CO2, normally active inside 13 au, implies that the comet is hyperactive and may posses other cometary volatiles such as NH3 and amorphous water ice which will become active or crystallize as the comet nears the Sun within the next couple of years. We propose a small muli-Cycle program of 24.66 h with JWST to take near-simultaneous observations of UN271 with NIRSpec and NIRCam to observe the evolution of its volatiles and ices over the next few years. The instruments will be complimentary with NIRSpec providing detailed spectral information the comets near-nucleus coma and NIRCam providing wide-field mapping of volatiles and ices. We will observe UN271 once per cycle with the first observation starting in June 2024 at the end of Cycle 2 when the comet is ~16.3 au from the Sun and ending in June 2026 during Cycle 4 when the comet is 14 au from the Sun. Combined with public NIRSpec data, our observations will provide coverage of the comet over a ~4 au range during which different cometary volatiles may become active such as NH3 and and water ice can crystalize. Observing the evolution of UN271 will provide groundbreaking and exciting constraints on the the volatile contents and evolution of the original planetesimals and protoplanetary disk.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4201
Program Title: The Butterfly Effect: Determining the distribution of ices across a young disk to constrain planet formation

Principal Investigator: van 't Hoff, Merel

PI Institution: University of Michigan

Young disks (Class I) orbiting nascent stars are the birthplaces of planets. In order to link the elemental composition of exoplanets, that JWST will provide in plenty, to their formation history, one needs to determine the chemical composition of both the gas and solids across the disk. With ALMA a stunning progress has been made to map the gas content of disks, but the distribution and compositions of ices remains poorly known. We aim to target IRAS 04302 (the Butterfly Star) with MIRI MRS and NIRSpec IFU, to map the major carbon and oxygen carriers in the ice phase: CO, CO2, CH4 and H2O. The exact edge-on geometry and large size makes this young disk uniquely suited to unveil for the first time the vertical and radial structure of the ices. We will obtain the radial and vertical location of the CO, CO2, H2O snow surfaces, which are setting the C/O ratio of the gas and dust. These observations will demonstrate the impact that JWST will have on the studies of planet formation.

Proposal Category: SNAP
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4204
Program Title: A census of high-redshift kpc-scale dual quasars

Principal Investigator: Chen, Yu-Ching

PI Institution: University of Illinois at Urbana - Champaign

Binary supermassive black hole (SMBH) population over cosmic history is a unique pathway to investigating galaxy/SMBH assembly and predicting low-frequency gravitational waves from the coalescence of binary SMBHs. The high-redshift (z>1.5) regime (i.e., cosmic noon) is of particular importance, where SMBH accretion and global star formation reach their peak activity, and galaxy mergers occur much more frequently than at lower redshifts. However, this high-redshift regime is poorly explored because of strict observational requirements such as angular resolution limits. There are only few unambiguously confirmed dual quasars below ~10 kpc at z>1.5. Recently, a large sample of sub-arcsecond dual and lensed quasars was discovered with the Gaia mission given its high angular resolution and astrometric accuracy. But distinguishing a dual quasar from a lensed quasar at high redshift is notoriously difficult with only optical images and spectra. Here we propose a survey program to obtain NIRCam four-band IR images of ~200 sub-arcsecond dual/lensed quasar candidates at z>1.5 selected using Gaia and novel astrometric techniques. The proposed targets are well distributed across the whole sky, suitable for the survey program. These four-band (F115W, F200W, F277W, and F356W) exposures will reveal faint tidal features and test the lensing hypothesis with the IR detection/non-detection of the lens galaxy. This program will produce an unprecedentedly large sample of kpc-scale dual quasars at high-redshift, a regime poorly explored in past studies, enable critical statistical constraints on this population, and deliver important targets for follow-up observations.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4212
Program Title: Unveiling the Most Distant Lensed Arc at z~10

Principal Investigator: Bradley, Larry

PI Institution: Space Telescope Science Institute

JWST was designed to study distant galaxies in the early universe. It has already discovered many, but most are too faint and small to be studied in detail. To understand early galaxies, we must understand the small star clusters (r < 100 pc) within. Gravitational lensing has delivered a few precious highly-magnified galaxies out to z = 6 that reveal small star clusters in the early universe with Hubble and now JWST. Here we propose the first detailed 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 2.5" long, revealing structures as small as r ~ 25 pc in Hubble imaging. We propose JWST NIRCam imaging to measure the colors of these star clusters for the first time, yielding age and mass estimates, while resolving still smaller star clusters with radii < 10 pc. We also propose NIRSpec G395H high-resolution R~3000 spectroscopy in spatially resolved segments of the galaxy with MSA slitlets covering the length of the arc. For the first time, we will resolve the [OII] doublet in a galaxy during reionization, yielding its gas density in multiple locations. We will resolve and measure line widths, revealing outflows that may have enabled early galaxies to reionize the universe. We expect to detect [OIII] 4363Å enabling a direct metallicity measurement when combined with [OIII] 5007Å that may also be detected in this proposal cycle depending on the redshift we measure. These data will also deliver ancillary science on many more high-redshift galaxies magnified by the exceptional lensing cluster SPT0615-57.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4217
Program Title: Probing Early Dust Formation in the Universe via Stripped-Envelope Supernovae

Principal Investigator: Shahbandeh, Melissa

PI Institution: The Johns Hopkins University

Details of dust formation in the early Universe are unknown. While AGB stars are considered to be primary dust producers, the first dust in the local Universe may have formed before AGB stars had time to make it. Core-collapse supernovae (CCSNe) are expected to play an important role in dust production since their current formation rate predominates all other types of supernovae. To date, the community has been fixated on dust formation in CCSNe with intact hydrogen-rich envelopes. However, stripped-envelope supernovae (SESNe) come from the death of massive, shorter-lived stars, and are therefore one of the earliest possible sources of early Universe cosmic dust. We request 16.58 hr of non-disruptive ToO time to obtain an NIR+MIR spectral time-series of one SESN at four key epochs between ~70-300 days past-maximum luminosity to investigate: 1) the formation of CO at ~70 days past-maximum, 2) the formation of SiO precipitated by CO cooling (or rapid adiabatic cooling) at ~100 days, 3) the condensation of SiO to dust at ~200 days, 4) the growth of dust and obtaining its temperature at ~300 days, and 5) constraining the ejecta mass. The third and fourth epochs will allow us to determine the location of the dust and understand its origin, whether in-situ, in the circumstellar medium (CSM), or pre-existing in a molecular cloud. Following a SESN all the way from the formation of dust precursors CO and SiO through the dust formation phases will provide unprecedented insight into the deaths of a range of massive stars and how they might contribute to the total dust budget of the ISM.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4225
Program Title: First spatially resolved characterization of the warm molecular torus in the Circinus galaxy

Principal Investigator: Izumi, Takuma

PI Institution: National Astronomical Observatory of Japan (NAOJ)

The unified scheme of active galactic nuclei (AGN) postulates that the central engine is surrounded by an optically and geometrically thick torus. One of the most promising models to explain the origin of the torus, after accounting for the MIR polar dust elongation, is the radiation-driven fountain model, in which AGN-driven outflows are the key process to form the structure. While strong supportive evidence for this model has been obtained by recent ALMA observations, little is known about the geometrically thick volume of the torus as cold gas and dust is predominantly reside in the mid-plane of the disk. Here we propose MIRI/MRS observations over the full wavelength coverage to detect multiple rotational H2 lines. Our hydrodynamic + radiative transfer simulations indeed reveal that these lines trace the geometrically thick volume. Thanks to the high resolution of MRS (~4-6 pc), we can for the first time map the torus-scale (~30 pc) at these warm molecular lines. We will investigate spatial distribution of the warm gas, which directly constrains the torus shape. The molecular gas temperature and mass will be directly measured by making spatially resolved rotation diagrams, which will also be used to investigate if there is Compton-thick material in the geometrically thick volume. Warm molecular outflows and backflows will be searched based on the resolved dynamics. We will also make a visual extinction map by using the accurately constrained silicate absorption feature. Combined with high resolution multiwavelength data, our JWST observations will finally provide the first spatially resolved, complete understanding of the multiphase AGN torus.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4227
Program Title: Chemistry and Clouds of a Temperate Jupiter

Principal Investigator: Claringbold, Alastair

PI Institution: The University of Warwick

We propose to measure the first transmission spectrum of a temperate extrasolar gas giant (Teq=360 K) in order to understand the chemistry and cloud formation active in atmospheres at habitable temperatures. Using NIRSpec Prism to measure the abundances of methane, ammonia, and water in the atmosphere of TOI-1899b, we can probe the chemical diversity of the gas giant population by sampling an as-yet unobserved part of the exoplanet atmosphere parameter space. In this temperature range we can directly measure the C/N/O ratios, and hence constrain the formation and migration history of the planet. By measuring the level of muting of spectral features, we can study the cloud and haze formation processes at work in atmospheres at habitable temperatures, taking advantage of TOI-1899's similarity in gravity and instellation to terrestrial planets that will be characterized with JWST. By testing for muting of spectral features, which can only be due to clouds or hazes in TOI-1899b, we will inform the studies of temperate terrestrial planets where flat spectra can be caused by multiple degenerate processes.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4233
Program Title: A complete census of the rare, extreme and red: a NIRCam-selected extragalactic community survey with JWST/NIRSpec

Principal Investigator: de Graaff, Anna

PI Institution: Max Planck Institute for Astronomy

The first long-wavelength images of extragalactic deep fields with JWST/NIRCam have yielded myriad interesting sources. Newly discovered objects are reported to show extremely red colors. High-redshift galaxies appear more numerous, brighter, and more massive than anticipated, possibly in tension with the current standard cosmological model. Follow-up spectroscopy is critical to understand the physical properties of these sources and their course of evolution. However, bright objects are extremely rare: collecting a statistical sample demands a wide-area spectroscopic program. We propose spectroscopic follow-up with the NIRSpec MSA of bright F444W sources selected from two deep fields imaged in Cycle 1 (CEERS and PRIMER), covering 18 pointings over 250 sq arcmin to obtain ~100 spectra of the most rare objects and a 4 micron flux-limited sample (1200) spanning 2<z<7. Modest exposures of 48 min in the PRISM and G395M modes will reveal the stellar continua and nebular line emission for bright sources (F444W<26). We will (1) constrain the redshifts and masses of bright z>7 objects, (2) uncover the nature of extremely red sources, and (3) map the star formation histories of galaxies at z>2. Our survey will hold immense legacy value, providing medium-resolution spectroscopy for an additional 3800 targeted sources, enabling population studies of the z>5 interstellar medium. Executing a wide spectroscopic program early in the lifetime of JWST will open up a wealth of new questions and candidates in popular extragalactic fields for further follow-up observations. We are committed to deliver high-level data products on a rapid timescale to maximize community use of these data.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4244
Program Title: Are Luminous Red Novae major factories of cosmic dust?

Principal Investigator: Karambelkar, Viraj

PI Institution: California Institute of Technology

Despite their vital importance to several astrophysical processes, the major sources of dust grains in the interstellar medium (ISM) are still not fully understood. In this proposal, we aim to investigate a previously unexplored but potentially important source of cosmic dust - extragalactic Luminous Red Novae (LRNe). LRNe are energetic outbursts representing the final stages of common envelope evolution (CEE), which results in either a stellar merger or the ejection of the CE. Extragalactic LRNe are prolific sites of dust production, evidenced by their rapid reddening and long lasting (>1000 day) infrared (IR) lightcurves. Their volumetric rate is high enough (~80% of the core-collapse supernova rate) to make their dust contribution comparable to known major dust sources (AGBs, RSGs and SNe). However, dust masses have not been measured for any extragalactic LRN to date. Here, we propose to utilize the unprecedented mid-IR sensitivity of JWST to obtain the first dust mass measurements in a variety of LRNe. During JWST Cycle 2, we aim to observe four extragalactic LRNe that span a wide range in luminosities and progenitor masses (4-20 Msun) with the Mid-Infrared Instrument (MIRI). Our observations use a combination of 5-12 um low-resolution spectroscopy and 5-25 um imaging to derive the dust masses produced by these LRNe. These observations will directly test whether LRNe are major factories of cosmic dust. Additionally, our dust mass measurements will probe the total mass ejected in these LRNe and shed light on whether the binaries that produced them merged, or survived by ejecting the CE.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4246
Program Title: Physical Properties of a Possible Galaxy Merger at z=10.2

Principal Investigator: Abdurro'uf, Abdurro'uf

PI Institution: The Johns Hopkins University

JWST was designed to discover and study the first galaxies. And JWST has delivered: more detailed studies of z <= 9 galaxies than most of us dreamed, and more discoveries of z >= 10 galaxies than most expected. But detailed studies of z >= 10 galaxies in the first 500 Myr have remained elusive due to the bright [OIII] emission line redshifting beyond NIRSpec's wavelength range. Emission lines have recently been detected for the first time at z > 10. MACS0647-JD lensed to AB mag 25.1 was discovered in Hubble imaging, revealed to be merging galaxies in JWST NIRCam imaging, and is now confirmed spectroscopically at z = 10.17 with 5 emission lines observed in NIRSpec PRISM data. Here we propose higher resolution spectroscopy spanning 3000Å – 7000Å rest-frame in the first detailed study of a galaxy at z = 10: 1. NIRSpec G395H high-resolution spectroscopy (R ~ 3000) to resolve the [OII] doublet delivering gas density, and measure line widths and thus outflow strengths. Outflows may clear ionized channels allowing Lyman continuum photons to escape and reionize the universe. Other lines will include [OIII] 4363Å, delivering a confident direct metallicity measurement, based on the line flux ratio with [OIII] 5007Å. 2. MIRI MRS spectroscopy to detect Ha and [OIII] 5007Å. In addition to metallicity, [OIII] will help constrain the galaxy's ionizing strength. Ha will deliver the star formation rate as well as the dust extinction when combined with H? from NIRSpec (with Hß likely too faint for detection). Simultaneous MIRI imaging of the other bright lensed image of MACS0647-JD will yield rest-frame optical photometry securing measurements of the stellar mass and age.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4250
Program Title: Characterization of Water Outgassing in Main-Belt Comets 133P/Elst-Pizarro and 358P/PANSTARRS

Principal Investigator: Hsieh, Henry

PI Institution: Planetary Science Institute

Current research on small bodies in the solar system suggests that there is a continuum between comets and asteroids, and that the dynamical properties of a small body are not enough to predict the volatile content of an object. These questions are profound for our models of the origin and distribution and of water, volatiles, and organics in our solar system. We request JWST General Observer time to characterize the volatile content of two main-belt comets (MBCs), which are small bodies with asteroid-like orbits that exhibit comet-like activity, with NIRCam and NIRSpec. With observations of MBCs 133P/Elst-Pizarro and 358P/PANSTARRS that we propose here, we will be able to detect water gas production rates as low as 1e24 molecules/s (5-sigma), exceeding pre-JWST upper limits by almost two orders of magnitude. This capability was demonstrated by JWST/NIRSpec's recent successful detection of water gas production in MBC 238P/Read, which was the first successful spectroscopic detection of volatile sublimation for a MBC ever. NIRCam imaging will also allow us to search for morphology differences between our targets' gas and dust comae, providing insights into ejection mechanisms and distribution of active sites on each object. JWST observations of two more MBCs would triple the number of meaningful direct measurements of outgassing rates around small (km-scale) asteroids, and significantly advance our understanding of the diversity of the MBC population.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4256
Program Title: Dust imaging of low metallicity molecular clouds in NGC 6822 and WLM

Principal Investigator: Leroy, Adam

PI Institution: The Ohio State University

Most of the star-forming molecular gas in low metallicity galaxies is ``CO dark.'' As a result, both the mass of molecular gas and the structure of molecular clouds remain largely unknown at low metallicity. This CO dark material is still mixed with small dust grains, so JWST mid-IR observations offer the best current prospect to observe this gas at high physical resolution and sensitivity. To develop this capability, we propose MIRI imaging of PAH (F770W) and dust continuum (F2100W) emission towards five low metallicity molecular clouds in the Local Group galaxies NGC 6822 and WLM. Both galaxies have resolved 1-2 pc CO cores characterized by ALMA and high quality Jansky VLA imaging of the atomic gas so that the other gas phases are known. They are close enough that JWST achieves 1-3 pc resolution, sharply resolving individual clouds, yet distant enough that our small program can cover most of the known molecular gas mass in each galaxy and span a range of ISM phases. As these are the only two galaxies with this ideal distance and high quality supporting ISM data, we argue that they are the ideal next targets to tackle this longstanding problem. The result will be some of the best ever constraints on the abundance of CO dark molecular gas, resolved measurements of the CO-to-H2 conversion factor, a new, complete view of low metallicity cloud structure, and dramatic improvements in our understanding of how to use the mid-IR to trace this otherwise invisible gas phase.

Proposal Category: GO
Scientific Category: Large Scale Structure of the Universe
ID: 4265
Program Title: Unveiling the interplay between the circumgalactic and interstellar media in a complex protocluster environment at z=4.5

Principal Investigator: Gonzalez Lopez, Jorge

PI Institution: Carnegie Institution of Washington

Understanding the mechanisms that yield the formation of extended Lyman-alpha halos in the environment of massive galaxies and how this process relates to the formation of early structures (z>4) has been challenging. With JWST, we can now access the rest-frame optical regime that traces the ionized gas and stellar components necessary to constrain the feedback processes and galaxy growth in distant galaxies. We propose to obtain sensitive NIRSpec IFU and MOS towards a dense, star-forming galaxy protocluster at z=4.5. The system is signposted by an interacting massive, infrared-luminous galaxy pair at the center, as seen in sensitive ALMA high-res [CII] imaging, and shows extended Ly-a emission as evidenced by VLT/MUSE. The Ly-a profile and spatial distribution show a spatial gradient and three spectral peaks, signaling either high escape fractions through scattering or in-situ photoionization by extended star formation. Ten bright LAEs plus 10+ other sources are found in this structure. The proposed observations will allow us to test different galaxy formation scenarios. We will use the sensitive NIRSpec IFU H-alpha imaging to map the distribution of unobscured star formation through the system, enabling us to (i) determine the physical mechanisms that yield the extended Lyman-a emission and (ii) test the nature of the [CII] "tail" structure. The proposed NIRSpec MOS, along with publicly available NIRCam imaging, will yield a full characterization of the confirmed protoclusters members, accessing critical emission lines (H-alpha, [NII], [OIII], H-beta), enabling us to determine the stellar population properties, hardness/ionization states, and presence of AGN.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4278
Program Title: Tracing molecular gas in nearby metal-poor systems: the keys to unlocking star-formation in the early universe

Principal Investigator: Mingozzi, Matilde

PI Institution: Space Telescope Science Institute

Molecular gas and star formation (SF) are among the main drivers of galaxy evolution and it is uniquely important to investigate them in the pristine primeval systems of the high-z Universe. SF is expected to take place in the cold molecular phase of the gas, mainly constituted by molecular Hydrogen, that unfortunately cannot be directly traced. Alternative methods, like the use of CO, are limited in metal-poor environments, where the reduced dust shielding and high ionization radiation create the so called CO-dark gas. Most importantly, the cold gas phase is inaccessible in the high-z Universe with the current facilities. Here we propose an efficient MIRI MRS program of six nearby metal-poor objects, considered high-z analogs and spanning a range of galaxy properties. Moreover, each is complemented by a unique set of multi-wavelength data (UV, optical and submm). Our aim is to investigate in an alternative way their total molecular reservoir. Specifically, we will measure their warm molecular gas through multiple mid-IR H2 rotational lines, which will be revealed for the first time in low-metallicity gas by harnessing the sensitivity of MIRI. The conversion of the warm-to-cold molecular gas through their detailed modeling will then give us access to the total molecular gas content. Overall, the MIRI MRS spectra for our high-z analogs in combination with the UV-optical-submm coverage will shed light on the interstellar medium conditions and mechanisms in metal-poor extreme environments of the early systems.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4287
Program Title: Deep Spectroscopy of the First Ionized Bubbles: New Insight into the Beginning of Reionization

Principal Investigator: Mason, Charlotte

PI Institution: University of Copenhagen, Niels Bohr Institute

The detection of Lyman-alpha (Lya) in two z~9 galaxies, separated by just 3.6 pMpc, challenges our understanding of Reionization. These are the only known galaxies detected with Lya emission above z>8 and the region around them is likely overdense at z~9. It is has been suggested that they both reside within one of the Universe's first large ionized bubbles, allowing Lya to propagate without significant attenuation by intergalactic neutral hydrogen. However, given our current understanding of reionization and early star formation, such large bubbles are not predicted to exist at z~9. Here we propose to take a significant step in our understanding of the beginning of reionization by performing deep NIRSpec spectroscopy in the region around these galaxies, with the goal of verifying whether the entire large region is ionized. We propose to target 20 UV-faint (m<28.5) galaxies selected from NIRCam imaging and obtain deep rest-frame UV to optical spectra with NIRSpec/MSA. This will spectroscopically confirm z~9 galaxies in this unique region via [OIII]5007 and test the existence of a large ionized bubble, previously impossible before JWST. These observations will enable us to: (1) confirm or rule out the existence of a large (>1-3.6 pMpc) ionized bubble; (2) spectroscopically confirm the candidate z~9 overdensity and map the distribution of galaxies in 3D; (3) infer the ionizing properties of these galaxies, allowing us to understand how such a bubble formed at such early times. This will provide a critical step for understanding the first stages of reionization, with significant implications for our understanding of early (z>9-15) star formation and structure formation.

Proposal Category: GO
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4290
Program Title: Dust Settling and Grain Evolution across the Nearby Population of Edge-on Protoplanetary Disks

Principal Investigator: Menard, Francois

PI Institution: Institut de Planetologie et d'Astrophysique de Grenoble

Young, edge-on circumstellar disks are uniquely valuable laboratories for planet formation studies. With the central star occulted from direct view, the disk is clearly seen as a central dust lane flanked by reflected light from its upper and lower surfaces. The detailed morphology and chromaticity of these nebulae provides crucial information on disk vertical structure and the properties of its constituent dust grains. Spectral energy distributions and very limited groundbased imaging have shown that edge-on protoplanetary disks continue to be dominated by scattered light even out to wavelengths of 20 microns. JWST imaging of these targets therefore offers the unique opportunity to probe the disk interior between the optical scattered light surface seen with HST and the cold midplane emission seen by ALMA. We propose broad-band NIRCam and MIRI imaging of thirteen edge-on protoplanetary disks spanning a range of central star properties and evolutionary states. The targets are the most nearby objects of their class and thus should be vertically resolved by JWST even at wavelengths >= 7 microns. The images will reveal the wavelength evolution of both the dust lane thickness and the strength of forward scattering, which when interpreted by model fitting will allow us to derive the grainsize as a function of height in the disk and thus the extent of dust vertical settling. This project will empirically quantify for the first time how the dust size increases toward the disk midplane (a necessary condition to efficiently form planetesimals) across a broad disk sample, leaving a legacy of fundamental importance for our understanding of protoplanetary disk evolution.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4297
Program Title: The Novel MIR Abundance Diagnostic Ne23

Principal Investigator: Rogers, Noah

PI Institution: University of Minnesota - Twin Cities

Gas-phase abundances act as powerful tracers of star formation and galactic evolutionary mechanisms. Many prior surveys have relied on strong-line abundance diagnostics, which relate the emission of intense optical lines to the O/H abundance in a nebula. However, these diagnostics have been shown to have large variation and discrepancies when calibrated on empirical or model abundances. The application of different diagnostics produces variations in the shape of the mass-metallicity relation (MZR) at high-O/H, which limits our understanding of galaxy evolution in these highly enriched environments. One alternative is to utilize the IR fine-structure lines, which are insensitive to the electron temperature and reddening, and which accurately probe gas-phase abundances/ionization conditions. Up to this point, aperture effects and low sensitivity of prior telescopes have limited the use of fine-structure lines in chemical abundance surveys. JWST's MIRI/MRS and its IFU capabilities address both issues, allowing for the most direct comparison of space-based MIR and ground-based optical observations of emission line sources. Within MIRI/MRS's Channel 3 are the Ne fine-structure lines, powerful tracers of chemical enrichment from high-mass stars and the ionization structure of the gas. We propose to measure a novel MIR abundance diagnostic, Ne23, in bright, extragalactic H II regions to evaluate the evolution of O/H as a function of Ne23. Once calibrated, the Ne23 diagnostic can be used to accurately infer O/H in a variety of sources over JWST's lifetime, including highly-obscured sources and high-O/H galaxies that will constrain the shape of the MZR.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4318
Program Title: Is there Evidence of alpha-Enhancement in Massive Quiescent Galaxies at z > 3?

Principal Investigator: Antwi-Danso, Jacqueline

PI Institution: Texas A & M University

We propose NIRSpec MOS spectroscopy of three massive quiescent galaxies at 3< z< 5. We have confirmed their quiescent nature and redshifts via the detection of Balmer absorption lines in deep Keck/MOSFIRE spectroscopy. Our robust sample selection and analysis reveals that two them are uncomfortably massive (log M/M_sun>11), placing them in tension with predictions from LCDM. The missing piece in resolving this tension is a direct observational constraint on their formation timescales and hence stellar mass assembly histories via fossil records imprinted in their stellar populations (i.e. their [alpha/Fe] ratios). The largest factor limiting progress on this front is the lack of high SNR spectroscopic data with continuous wavelength coverage (1.6-5.3 microns) that includes these key features. This is a Herculean task to attempt from the ground, where atmospheric absorption and emission make continuum observations far more challenging, thereby requiring 50+ hours on the most sensitive ground-based spectrographs to make marginally constraining measurements of elemental ratios. In this proposal, we demonstrate that we achieve the requisite SNR for all our candidates with only 8 hours of JWST/NIRSpec time enabling us to constrain [alpha/Fe] to within 0.12 dex. This will allow us to trace stellar population properties as close to their formation epoch as possible and make practical recommendations for stellar population synthesis codes and cosmological simulations, which will address this tension with theory. Our modest proposal is a proof of concept that this transformative science can only be done at these early epochs with JWST and will motivate future, deeper observations.

Proposal Category: GO
Scientific Category: Solar System Astronomy
ID: 4320
Program Title: Seeking New Clues to the Habitability and Plume Activity of the Ocean World Enceladus using JWST-NIRSpec

Principal Investigator: Glein, Christopher

PI Institution: Southwest Research Institute

We propose to make the first measurements of Enceladus's leading hemisphere with JWST-NIRSpec. These data are needed to test results from Cassini, to put them in greater context, and to support a path between the Cassini era of Enceladus exploration and the next stage of spacecraft exploration. Enceladus has dazzled the science community and the public alike, and is among the highest-priority targets in the solar system as affirmed by the recently released Decadal Survey. Yet, important questions remain pertaining to the habitability of its ocean and its plume activity, despite Cassini's in-depth investigations and JWST's previous fleeting glimpse of the trailing hemisphere. We aim to address the following questions: Are ocean-derived materials relatively abundant on Enceladus's surface? Are carbon-bearing compounds relatively abundant on Enceladus's surface? Are strong oxidants relatively abundant on Enceladus's surface? Do Enceladus's gas plume and torus exhibit variability? Sensitive searches for key signatures of indicator molecules (carbonate salts, ammonia, CO2, CH-organics, hydrogen peroxide, and water vapor in the range 1.66-5.1 μm) that strike at the heart of these questions will be performed using NIRSpec's integral field unit with G235H and G395M gratings. Much longer exposures, driven by the need to detect CO2, will provide a substantial boost in SNR, which is one of several advancements over the previous GTO observation of Enceladus. By providing access to required spectral regions that are opaque or compromised from the ground, JWST will enable the next breakthrough in our understanding of Enceladus, which otherwise may not happen for at least 20 years.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4332
Program Title: A JWST IFU deep study of gas, dust, and PAHs in a prototypical externally illuminated protoplanetary disk

Principal Investigator: Vicente, Silvia

PI Institution: Institute of Astrophysics and Space Sciences (IA)

What is the thermo-chemical structure of a proplyd Photodissociation Region (PDR)? What is the composition, and hence reservoir, in dust, gas and PAHs in a typical EUV+FUV externally illuminated disk? How the external irradiation affects the process of planet formation in these disks? And how their properties differ from those of disks found in more quiescent environments, such as Taurus-Auriga? In order to address these questions we propose to conduct a JWST deep observational study of an externally illuminated protoplanetary disk (proplyd) using the IFU modes of NIRSpec and MIRI-MRS. The JWST IFU observations will spatially resolve, for the first time, the disk, neutral cocoon and ionization front simultaneously over the 0.9 - 28.5 micron spectral range, providing key line, continuum and PAHs diagnostics that trace the physical conditions, chemical composition and abundances under the effect of external FUV-radiation. It is the FUV radiation that changes the thermal structure and chemical composition of the disk and sets the mass-loss rate through photoevaporation. By comparing our results to those of proto-planetary disks (TTauris) found in nearby low-mass star forming regions and targeted by several JWST GTO and GO programs (e.g. Taurus-Auriga, Lupus) one can start to assess the real effects of a FUV-dominant environment on protoplanetary disk evolution and planet formation. Earth’s atmosphere and proplyd faintness in the mid-IR makes them almost out of reach sources for mid-IR spectroscopy from the ground. And hence, the James Webb Space Telescope (JWST) is currently the only observatory able to perform the proposed observations and study.

Proposal Category: GO
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4339
Program Title: NIRSpec IFU spectroscopy of the first active binary intermediate-mass black hole and its host galaxy

Principal Investigator: Chilingarian, Igor

PI Institution: Smithsonian Institution Astrophysical Observatory

The origin and evolution of supermassive black holes (SMBHs) in galaxy centers remain critical open questions in modern astrophysics. SMBHs grow from yet unidentified BH seeds by accreting gas in active galactic nucleus (AGN) phases or via coalescences during galaxy mergers. Low-mass BH seeds (100s MSun) should leave behind a population of intermediate-mass BHs (IMBHs), which hence are the key to unlock SMBH origins. SMBH binaries form at the pre-coalescence stage and then become the sources of gravitational waves, which may ultimately be detected at cosmological distances by the LISA space mission. We present the first 10:1 mass ratio (10^6/10^5 MSun) active sub-pc-separated IMBH binary, J1631+24 (z=0.0433; 190Mpc) detected via double-peaked broad optical hydrogen lines separated in velocity by 300 km/s in a compact low-mass elliptical galaxy with morphology suggestive of a past merger. The two-component shape and the velocity separation have persisted for 18+ years, as confirmed by ground-based optical spectra. This prototype system proves that hierarchical growth of SMBHs extends to the low-mass regime, although most of its characteristics remain poorly constrained. We propose to collect deep R=2700 NIRSpec IFU spectra for J1631+24 to (i) measure the internal kinematics and stellar population of its host galaxy and search for signatures of a dry minor merger which led to the formation of a binary IMBH; (ii) decompose broad Paschen and Brackett hydrogen lines, where the components should be better separable vs Balmer lines; (iii) map the AGN-driven outflow detected from ground-based spectra; (iv) search for high-ionisation NIR coronal lines predicted by IMBH models.

Proposal Category: GO
Scientific Category: Stellar Physics and Stellar Types
ID: 4343
Program Title: Hunting for IMBHs in the Omega Centauri Globular Cluster

Principal Investigator: Kargaltsev, Oleg

PI Institution: George Washington University

We propose to use the outstanding IR sensitivity and superb angular resolution of JWST to search for emission from IMBH(s) in the most massive Galactic globular cluster (GC), omega Cen. The state-of-the-art ADAF models of low-rate accretion from the ambient medium predict that the spectral flux of an IMBH peaks in IR, while most of the previous searches fro IMBHs in GCs were conducted in X-rays and radio, where IMBHs can be much fainter. Omega Cen is one of the best candidates to host IMBH(s), while also being nearby and having a relatively low central stellar density. Therefore, JWST should be able to resolve even very faint sources in the core of the cluster. Observing in four bands (evenly distrubuted between 2 and 15 micron) and leveraging the existing extraordinary amount of HST data on Omega Cen (including very deep WFC3/IR observations), we will be able to detect IMBH candidates using their distinct IR-NIR colors and a lack of optical counterparts. The data from this program willalso be useful for evaluating the dust content in the globular clusters and for cross-calibration between JWST and Spitzer.

Proposal Category: AR
Scientific Category: Supermassive Black Holes and Active Galaxies
ID: 4357
Program Title: Interpreting JWST surveys with spatially-resolved mock line emission spectra from cosmological hyper-refinement simulations

Principal Investigator: Angles-Alcazar, Daniel

PI Institution: University of Connecticut

The unprecedented infrared sensitivity and spatial resolution of the James Webb Space Telescope (JWST) is revolutionizing the study of galaxies and supermassive black holes (SMBHs) in Active Galactic Nuclei (AGN) from the nearby universe to the earliest stages of galaxy formation. However, maximizing the scientific return of JWST observations requires high-resolution, physically predictive models of the co-evolution of galaxies and SMBHs and careful development of realistic mock JWST observables from simulations for direct apples-to-apples comparison to galaxy surveys. We propose to leverage recent advances in (1) cosmological hyper-refinement simulation techniques, (2) SMBH growth and feedback algorithms, and (3) stellar and ISM physics in the FIRE-3 galaxy formation model, along with (4) state-of-the-art chemistry and 3D line radiative transfer solvers to produce synthetic spectral Integral Field Unit (IFU) data cubes with unprecedented information content. This will enable detailed interpretation of NIRSpec IFU and MIRI MRS spectral cubes for a large suite of emission line tracers from the mid-infrared to rest-frame UV for surveys of galaxies and quasars from the nearby to the distant universe. We will directly connect emission line tracers with the intrinsic physical conditions of gas, test standard reduction pipelines to infer physical properties from observed IFU data, and create a public data repository of synthetic spectral cubes.

Proposal Category: GO
Scientific Category: Stellar Populations and the Interstellar Medium
ID: 4358
Program Title: iCe astrocHemistry at the EdgE of a staR-formIng clOud (CHEERIO): Cha I

Principal Investigator: Smith, Zak

PI Institution: Open University

CHEERIO is a small-scale JWST programme exploiting the NIRCam-WFSS instrument to generate ice spectra (with complete 2-5 micron spectral coverage) of 2 cloud edge regions in the Chameleon I molecular cloud. The enhanced sensitivity of JWST is uniquely suited to probing the edges of molecular clouds, allowing us to address the puzzling question of how interstellar ice mantles first form in these tenuous transition regions between the dense and diffuse interstellar medium. Many questions remain about the true conditions for the appearance of interstellar ice. With the observation strategy forseen in this proposal, we will detect the main constituents of interstellar ices (H2O, CO, CO2 and CH3OH), extracting their abundance and relative compositions as a function of extinction (Av) - the "blocking" by background starlight by ever denser gas and dust. These observations will provide fierce discriminators to benchmark predictions of ice molecular abundances from astrochemical models. Interstellar molecular clouds assemble via a journey exploring successively, and dynamically, different physical conditions. We predict the ices observed depend on this "pathway", and wil test our astrochemical understanding with these obserations.

Proposal Category: GO
Scientific Category: Galaxies
ID: 4368
Program Title: Completing the SMACS 0723 NIRISS WFSS EROs

Principal Investigator: Noirot, Gael

PI Institution: St. Mary's University

We propose to observe SMACS 0723 with NIRISS WFSS in the F150W filter to complete the Early Release Observations (EROs) of the field. The current NIRISS WFSS EROs are limited to the F115W and F200W only, missing the F150W middle filter. The proposed F150W observations will enable a wealth of science (currently not achievable with the limited F115W and F200W coverage) for the z=0.39 cluster galaxies and for background sources, including the first detailed spatially-resolved NIRISS spectroscopic study of an ex- ceptional, highly-magnified cluster at cosmic noon. The proposed observations will ensure the long lasting legacy value of the NIRISS EROs of Webb’s First Deep Field, and we there- fore waive any proprietary time for a direct access of this data by the community.

Proposal Category: AR
Scientific Category: Galaxies
ID: 4369
Program Title: A New-Generation of Synthetic Stellar Population Spectral Models Containing Stellar Binaries

Principal Investigator: Andrews, Jeff

PI Institution: University of Florida

The spectra of distant galaxies contain unique information about the star formation rate and history of the Universe at high redshift. JWST affords new opportunities to observe galaxies at high redshift as never before. Yet, our ability to uncover details about the history of the Universe are only as good as the spectral models they are compared against. The previous generation of stellar population models treat stellar binaries in only an approximate way, if at all. However, stellar mergers generate anomalously massive stars well after a starburst event, mass transfer strips the envelope off stars producing copious UV ionizing photons, and accreting compact objects producing luminous X-ray binaries. Here we propose to use the next-generation binary population synthesis code, POSYDON, to create a new generation of synthetic spectral models. POSYDON self-consistently evolves the structure of both stars, including stellar rotation, simultaneously with the orbital evolution. We propose to couple these models with detailed stellar atmospheric spectral models for both H-rich and He-rich stars, allowing us to produce a new generation of spectral models for any arbitrary star formation history and metallicity. Finally, we propose to produce a library of spectral models for integration into widely used galaxy modeling codes such as bagpipes, CIGALE, and Prospector.

Proposal Category: SNAP
Scientific Category: Exoplanets and Exoplanet Formation
ID: 4403
Program Title: The MIRI survey for Exoplanets Orbiting White-dwarfs (MEOW)

Principal Investigator: Limbach, Mary Anne

PI Institution: University of Michigan

We propose the MIRI survey for Exoplanets Orbiting White-dwarfs (MEOW), an ambitious endeavor aimed at detecting and characterizing the elusive population of exoplanets that orbit white dwarfs. Utilizing MIRI broadband imaging and a powerful combination of infrared excess and direct imaging techniques, the MEOW survey will be capable of detecting white dwarf exoplanets at all separations, from the Roche limit to hundreds of AU. With a sensitivity that extends to extremely cold temperatures, the MEOW survey can detect exoplanets as small as Saturn for the nearest systems, and planets with temperatures as low as 175 K, equivalent to a 2 Jupiter mass at 3 Gyr, out to a distance of 16 pc. We expect to detect 6 +/- 2 exoplanets around white dwarfs from our sample, roughly doubling the number of currently known planets around white dwarfs and enabling the first precise constraints on the occurrence rates of gas giants orbiting white dwarfs. These observations will represent an important step towards understanding the fate of planetary systems after stellar death. The MEOW Survey is well suited for the JWST Survey Program: The proposed detection methods are most effective for nearby systems, and therefore our target list includes the 72 isolated WDs within 16 pc. The sample is uniformly distributed in RA and DEC, which will ease scheduling. The total charged time per target is only 91 minutes, and the observations produce a relatively low data-volume of 1.1GB/target.