



SCIENCE with the
HUBBLE and
JAMES WEBB

SPACE TELESCOPES

11–15 July 2022

VI

*Entering a golden age
for UV – Optical – IR
space astronomy*



Science with the Hubble and James Webb Space Telescopes VI
Entering a golden age for UV – Optical - IR space astronomy

Welcome

11-15 July 2022, Stockholm

Welcome honored guests,

We are entering a new golden age for astronomy. A wealth of multiwavelength, and now multi-messenger, astrophysical observatories in space and on the ground, are currently operating or being planned. These observatories will have fantastic synergies and together advance our collective understanding of the Universe.

Hubble, the ever-versatile observatory, a result of a long-lasting collaboration between NASA and ESA, continues to provide unmatched UV-visible capabilities. In April 2022, we celebrated its 32 splendid years of scientific contributions to all branches of astronomy, from detailed observations of the Solar System and characterization of exoplanet atmospheres to the exploration of the distant Universe. Despite its age, Hubble is still going strong, and we anticipate many more scientific breakthroughs as we expect the observatory to be scientifically productive well beyond 2025.

The James Webb Space Telescope is now orbiting L2 and entering science operations after its spectacular Ariane 5 launch last December and the intense past months of commissioning the observatory and its science instruments. Webb's unique combination of sensitivity and spatial resolution at near- and mid-infrared wavelengths will revolutionize our view of the universe. The Webb project is an international collaboration between NASA, ESA, and CSA. As part of its contribution to the project, ESA and its member states have provided the NIRSpec instrument, part of the MIRI instrument, the Ariane 5 launcher, and staff to support science operations at STScI.

We can't wait to have these two highly complementary observatories operate together in synergy. They will push the boundaries of knowledge on the backdrop of a rapidly evolving astronomical landscape in space. Gaia will soon have completed its nominal high precision astrometric and photometric census of the Milky Way. TESS has discovered multitudes of exoplanet candidates around the nearest stars triggering a cascade of follow-up observations, some of which are being observed by CHEOPS, and JWST will then do the spectroscopic follow-up. We are looking forward to the launch of the Euclid and its quest to derive the geometry of the universe. On the ground, ALMA is delivering exciting results and the European ELT is expected to see first light in late 2027, providing follow-up to the first cycles of JWST observations. The second half of the decade will be further enriched by a suite of major new space missions: Roman will probe the expansion of the universe in the near-infrared, followed by PLATO and ARIEL detecting and characterizing exoplanets, and ATHENA and LISA probing the high energy universe.

Science with the Hubble and James Webb Space Telescopes VI

Entering a golden age for UV – Optical - IR space astronomy

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Science with the Hubble and James Webb Space Telescopes VI
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Science with the Hubble and James Webb Space Telescopes VI

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Agenda

(Times are in CET)

11-15 July 2022, Stockholm

Monday, July 11th

Session 1:

Chair: Paule Sonnentrucker

- 09:30 Registration / Coffee
- 10:30 Conference Opening & Welcome: Göran Östlin (Stockholm)
- 10:40 Welcome: Markus Kissler-Patig (ESA)
- 10:50 Welcome: Nancy Levenson (STScI)
- 11:00 Adam Riess: Surprises from the Expansion of the Universe
- 11:30 Hakon Dahle: Time Delays in Cluster Lenses as An Independent Avenue for Measuring H_0
- 11:50 Daniel Schaerer: Insight on The Sources of Cosmic Reionization: From HST Towards JWST
- 12:10 Rachana Bhatawdekar: Studying the Epoch of Reionization Combining JWST With the Power of Gravitational Lensing
- 12:40 Lunch

Session 2:

Chair: Matthew Hayes

- 14:00 Dan Coe: Discovering the First Galaxies with Gravitational Lensing
- 14:20 Brian Welch: The light of Earendel: A Massive Star at $z = 6.2$
- 14:50 Guillaume Mahler: The Next Generation of Extraordinary Cluster Lenses for JWST - Dark Matter Distribution & High- z Universe
- 15:10 Coffee

Session 3:

Chair: Markus Kissler-Patig

- 15:40 Göran Östlin: The Legacy of The Lyman Alpha Reference Sample in The JWST Era
- 16:10 Lorenz Roth: A Decade of HST Searches for Plumes on Jupiter Moon Europa & Prospects For JWST
- 16:40 Panel discussion: HST
- 17:30 Close
- 18:00 Welcome reception / networking

Tuesday, July 12th

Session 4:

Chair: Angela Adamo

- 10:00 Coffee available
- 10:30 Dan Stark: Spectroscopy of Metal Poor Galaxies in the Reionization Era
- 11:00 Svea Hernandez: Uncovering the Fueling Star Formation History Through Cosmic Time: M83 As a Local Probe of CO-Dark Gas
- 11:20 Marika Giuliatti: Illuminating the Dark Side of Cosmic Star Formation at $z > 3$
- 11:40 Kalliopi Dasyra: Observable Pressure Gradients Can Show the Dynamical Fate of Molecular Clouds In Outflows
- 12:00 Tara Fetherolf: The MOSDEF Survey: Probing Resolved Stellar Populations At $z \sim 2$ Using A New Bayesian-Defined Morphology Metric
- 12:20 Andy Bunker: Spectroscopy with the JWST Advanced Deep Extragalactic Survey (JADES) – the NIRSspec/NIRCAM GTO Galaxy Evolution
- 12:40 Lunch

Session 5:

Chair: Jennifer Wisemann

- 14:00 Danielle Berg: Bridging Galaxy Evolution Across Cosmic Time with The CLASSY Survey
- 14:30 Arjan Bik: Super Star Cluster Feedback in Nearby Luminous Blue Compact Galaxies: HST And VLT In Concert

- 14:50 Martha Boyer: Finally Solving Thermally-Pulsing AGB Stars with HST And JWST
- 15:10 Poster presentations
- 15:30 Coffee

Session 6:

- 16:30-17:30 **JWST FIRST SCIENCE RELEASE**
- 18:30 Public Event at the Nobel Museum feat. Adam Riess & Daniela Calzetti

Wednesday, July 13th

Session 7:

Chair: Matthew Hayes

- 09:00 Coffee available
- 09:30 JWST Keynote – Roberto Maiolino: NIRSpec
- 10:00 Angela Adamo: Star Cluster Formation and Feedback in The Local Universe: Setting the Stage for JWST Observations of Local Star-Forming Galaxies
- 10:30 Linda Smith: HST Observations of Very Massive Stars in Young Super Star Clusters
- 10:50 Elena Sabbi: Time-Domain Study of The Young Massive Cluster Westerlund 2 With HST
- 11:10 Guido De Marchi: New Light on Star Formation in Massive Clusters
- 11:30 Short break

Session 8:

Chair: Daniela Calzetti

- 11:45 JWST Keynote – Pierre-Olivier Lagage: MIRI
- 12:15 Heidi Hammel: Solar System Science With JWST
- 12:45 Close
- 18:00 Conference dinner at Vasa Museum

Thursday, July 14th

Session 9:

Chair: Chris Evans

- 10:00 Coffee available
- 10:30 Julia Roman-Duval: ULLYSES Harnesses the Spectroscopic Powers of Hubble: Overview and Initial Results of This Stellar Program and Application to Astrophysics of The Interstellar Medium
- 11:00 Elena Sacchi: Unlocking IR Stellar Populations in The Local Volume: The Power of Combining HST and JWST
- 11:20 Matteo Correnti: Constraining Globular Cluster Properties Using IR Photometry: New Breakthroughs and Future Prospects
- 11:40 Anna Francesca Pala: Synergies Between HST & Gaia: A Test for Current Models of Binary Evolution
- 12:00 Poster presentations
- 12:30 Lunch

Session 10:

Chair: Giovanna Tinetti

- 14:00 JWST Keynote – Martha Boyer: NIRCам
- 14:30 JWST Keynote – David Lafrenière: NIRISS
- 15:00 David Wilson: Measurements of The Ultraviolet Spectral Characteristics of Low-Mass Exoplanetary Systems (Mega-MUSCLES)
- 15:20 Coffee

Session 11:

Chair: Chris Evans

- 15:50 Fabio Favata: Future ESA program & Voyage 2050
- 16:20 Panel discussion: JWST / HST+JWST synergies
- 17:20 Close

Friday, July 15th

Session 12:

Chair: Giovanna Tinetti

- 10:00 Coffee available
- 10:30 Pat Irwin: New insights into Uranus and Neptune
- 11:00 Angelos Tsiaras: Water Vapor Detection on The Habitable-Zone Planet K2-18b
- 11:30 Nicholas Ballering: Observing Ices in Protoplanetary Disks with JWST
- 11:50 Elisabeth Matthews: Direct Detection of Exoplanets with JWST
- 12:20 Markus Kissler-Patig: Conference wrap-up & future perspectives
- 12:45 Close

Science with the Hubble and James Webb Space Telescopes VI
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Title and Abstracts

11-15 July 2022, Stockholm

Session 1

Surprises from the Expansion of the Universe

Adam Riess

Space Telescope Science Institute (STScI/JHU)

The Hubble constant remains one of the most important parameters in the cosmological model, setting the size and age scales of the Universe. Present uncertainties in the cosmological model including the nature of dark energy, the properties of neutrinos and the scale of departures from flat geometry can be constrained by measurements of the Hubble constant made to higher precision than was possible with the first generations of Hubble Telescope instruments. A streamlined distance ladder constructed from infrared observations of Cepheids and type Ia supernovae with ruthless attention paid to systematics now provide 1.4% precision and offer the means to do much better. By steadily improving the precision and accuracy of the Hubble constant, we now see evidence for 5 sigma deviations from the standard model, referred to as Lambda CDM, and thus the exciting chance, if true, of discovering new fundamental physics such as exotic dark energy, a new relativistic particle, or a small curvature to name a few possibilities. I will review recent and expected progress, most recently based on measurements by the SHOES Team from the Hubble Space Telescope and Gaia EDR3.

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Time Delays in Cluster Lenses as An Independent Avenue for Measuring H₀.

Håkon Dahle

Institute of Theoretical Astrophysics, University of Oslo

The “Hubble tension” between local distance ladder and CMB-based determinations of the Hubble constant strongly motivates the development of additional methods that are not affected by the same systematic effects as either the distance ladder or CMB modelling. Refsdal's method, based on measuring Time delays between multiple, strongly gravitationally lensed images of distant quasars, offers such a promising alternative. At present, the reported H₀ constraints derived from a small subset of the 200 quasars known to be lensed by individual galaxies seem to be rapidly approaching the level of uncertainty of the distance ladder and the CMB. In the next decade, LSST should provide a several orders of magnitude increase in the number of measured time delays for galaxy-lensed quasars and supernovae. However, there will remain significant systematic uncertain ties connected to the

assumed model of the lensing mass distribution, e.g., associated with plausible radial variations of the mass-to-light ratio of the baryonic component. In addition to the 200 galaxy-lensed quasars, four quasars are currently known to be lensed by galaxy clusters. Several new time delay measurements will be presented for two of these cluster lenses and it will be demonstrated how the associated H α measurements differ from galaxy lenses in both their statistical and systematic uncertainties. It will be discussed how HST and JWST can provide data which are crucial to account for the larger complexity of the mass distribution of cluster lenses, relative to galaxy lenses.

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Insight On the Sources of Cosmic Reionization - From HST Towards The JWST.

Daniel Schaerer
Geneva Observatory and University

HST observations, including UV spectroscopy with COS and rest-UV imaging with the WFC3, combined with ground-based spectroscopy have provided essential discoveries of Lyman continuum (LyC) emitting galaxies both at low ($z \sim 0.3$) and high redshift ($z \sim 2-3$). After decade-long searches, we have now small samples of galaxies showing clear signs of escaping LyC radiation, as required to explain cosmic reionization by galaxies, as most commonly accepted. Our group (Izotov et al. 2016, 2018) has identified eleven $z \sim 0.3-0.4$ compact star-forming galaxies selected for strong emission lines and a high [OIII]/[OII] ratio. HST has shown that they are all confirmed Lyman continuum emitters with escape fractions ranging from 2 to 72% and a strong production of LyC photons. From all their measurable properties they are excellent analogs for the sources of cosmic reionization.

For the low- z sample we have assembled a wide range of spectral diagnostics, including the Lyman-alpha line, UV absorption and emission lines (e.g., SiII, CIII]1909), MgII, and optical lines with HST and VLT. ALMA observations are ongoing. We will present a comprehensive analysis of these Lyman continuum emitters, new low- z COS observations, and the high- z galaxies identified by other studies. The low- z sample allows us not only to measure the LyC escape fraction, but also to constrain their stellar populations, ionizing radiation field, dust properties (extinction and attenuation law), and to establish the presence of a porous ISM geometry, which explains the LyC escape. Finally, we will show how the observations and state-of-the-art spectral modeling of UV and optical absorption and emission lines allow us to establish different methods to indirectly measure Lyman continuum escape. These key to interpret upcoming observations of galaxies in the epoch of reionization with the JWST.

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Studying The Epoch of Reionization Combining JWST With the Power of Gravitational Lensing

Rachana Bhatawdekar
European Space Agency (ESA/ESTEC)

The epoch of reionization when the Universe transformed from a neutral state to an ionized state in an important phase change in the history of our Universe. But what were the first luminous sources responsible for this phase change and when exactly did they form? These are some of the major unanswered questions in extragalactic astronomy. The last twelve years since the installation of the Wide Field Camera 3 on the Hubble Space Telescope (HST) have seen the frontier of galaxy evolution studies pushed well into the epoch of reionization (EoR) and we are about to enter another period of revolution in this field with the recently launched James Webb Space Telescope (JWST). In this talk, I will address the motivation behind studying the faint galaxies in the EoR, discuss how we have studied them with the current facilities before the launch of JWST and the subsequent results that we have had in this area, particularly with the Hubble Frontier Fields program in which HST observed six massive clusters of galaxies as gravitational lenses to find the faintest and earliest galaxies in the Universe, $\sim 10-100$ times

fainter than any previously studied. Being a part of JWST GTO and ERS teams, I will further discuss the exciting science that we will soon be doing with JWST, in particular by combining JWST with the power of gravitational lensing.

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Session 2

Discovering the First Galaxies with Gravitational Lensing

Dan Coe

Space Telescope Science Institute (STSCI)

We stand on the verge of completing our cosmic history. With Hubble and Spitzer, we have seen galaxies 97% of the way back to the Big Bang at $z \sim 11$ (400 Myr). And with JWST, we aim to detect the first galaxies. Gravitational lensing by galaxy clusters has enabled efficient discovery of such distant galaxies, including brightly magnified images amenable to more detailed study. Building on the successes of CLASH and the Frontier Fields, I led a new HST Treasury program called RELICS that observed 41 strong lensing clusters. We discovered over 300 high-redshift candidates in the first billion years at $z \sim 6 - 10$, including the brightest known $z \sim 6$ candidates, the longest lensed $z \sim 6$ arc (15"), and the most distant lensed arc known at $z \sim 10$. I will present these candidates along with results from follow-up observations with HST, Spitzer, ALMA, and other telescopes. I will also discuss JWST GTO, ERS, and GO plans and prospects to study these galaxies in more detail and to discover new lensed galaxies at even higher redshifts ($z > 11$). At $z > 11$, the discovery efficiency gains from lensing will be even more pronounced if luminosity function faint end slopes are steeper than $\alpha \sim -2$, as suggested by current models and observational extrapolations. Based on these extrapolations, I predict that gravitational lensing will be the key to discovering the first galaxies with JWST. I will present new work to simulate proposed JWST observations, develop analysis tools, and provide all of these to the public.

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The Light of Earendel: A Massive Star at $Z = 6.2$

Brian Welch

John's Hopkins University (JHU)

Gravitational lensing provides a powerful tool to study distant galaxies, magnifying them to reveal small scale features that would be unresolved otherwise. Observations of galaxy clusters with the Hubble Space Telescope have used lensing to great effect, measuring high redshift galaxies at scales of tens of parsecs, as well as revealing individual stars at $z \sim 1$. I will present new results that further push the limits of what is possible with HST, including observations of a lensed star at $z \sim 6$. The star is magnified by a factor of thousands, and its observed flux is consistent with being a massive star ($M > 50 M_{\odot}$). The galaxy in which this star resides also contains multiple star clusters with radii < 10 parsecs, the smallest yet observed at $z > 6$. I will conclude with a discussion of future prospects, including James Webb Space Telescope observations due to begin in August 2022.

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The Next Generation of Extraordinary Cluster Lenses for JWST - Dark Matter Distribution & High-z Universe

Guillaume Mahler
Durham University

Recently awarded HST program (C27 - "Focusing the Next Generation of Extraordinary Cluster Lenses for JWST" PI: G. Mahler) already delivered its first observations of three spectacular strong lensing clusters. With Einstein Radii $50'' < R_E < 60''$ these clusters rival the Frontier Fields clusters in terms of lensing efficiency, making them excellent sightlines for future studies. Those clusters were discovered and ranked as the best strong lensing candidates from the visual inspection of ground-based follow-up observations of the ~ 1000 massive clusters observed by the South Pole Telescope. Thanks to the HST resolution we will precisely calibrate these strong lensing clusters and therefore enable numerous science goals (e.g., High-resolution measurement of the dark and luminous matter, constraints on the galaxy halo/sub-halo mass ratio and sub-halos mass function, measurements of the spatially-resolved properties for giant arcs, detection of magnified high-redshift galaxies probing the intrinsically fainter ones, cosmological parameter estimates, etc...) In this presentation, I will focus on two topics:

1. Detailed mass distribution of the clusters and their constraints on structure formation and the constraints of the dark matter distribution and its connection to its sub-halos mass fraction. Despite being extraordinary lenses, these clusters are not the most massive; our analysis of lensing strength with the 75 strong lensing clusters observed with HST indicates that the slope of the cluster mass is a better indicator of lensing strength than total mass.
2. The magnified high-z universe. Indeed, such spectacular lenses are the largest window onto the faint end of the luminosity function. These clusters open a new, yet untapped opportunity for discovery in the JWST era.

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Session 3:

The Legacy of The Lyman Alpha Reference Sample in The JWST Era

Göran Östlin
Stockholm University, Department of Astronomy

The Lyman alpha (Ly α) line of hydrogen is the intrinsically strongest emission line of photoionized nebulae. With a rest wavelength of 1216 Ångström it is also accessible in the optical and near-IR even for highly redshifted objects, extending into the pre-reionization era. The Ly α line has therefore been utilized, with quite some success, to find and range galaxies in the distant universe. However, Ly α is a resonant line and become optically thick at tiny column densities of neutral hydrogen, a species that star forming galaxies tend to be abundant with. Hence, Ly α photons tend to resonantly scatter in the ISM, and what fraction that eventually reaches the observer will depend on the physics of the ISM (geometry, dust content, kinematics) in a complicated fashion that is hard to constrain observationally, especially at high-z. If this process could be better quantified, we may extend the use of Ly α to probe the star formation rate, the physics of the late stages of reionization, and understand the selection biases in using Ly α to map large scale structure, among other things. This was the motivation behind the Lyman Alpha Reference Sample (LARS) and its extension which now contain some 45 galaxies imaged with HST in Ly α , H α , H β as well as UV/optical continuum and for which far UV spectroscopy has been obtained with COS. I will present some of the main results of LARS, such as the preference for Ly α to be emitted in scattering halos significantly larger than the continuum, and the role played by a porous outflowing neutral ISM. LARS is unique

compared to high-z samples, in the spatial resolution on which the physics regulating Ly α transport can be studied. In the JWST era, LARS will remain important for investigating the release of Ly α photons through the ISM into the CGM of pre-reionization epoch Ly α emitters.

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A Decade of HST Searches for Plumes on Jupiter Moon Europa - Prospects For JWST

Lorenz Roth
KTH Royal Institute of Technology

Jupiter's moon Europa might harbor life in its vast water ocean below the thick ice crust. This subsurface habitat could potentially be investigated at locations of active outgassing, giving the question whether Europa is geologically active a crucial importance. In the hunt for active outgassing or plumes, the Hubble Space Telescope has observed Europa during over 200 HST orbits over the last 8 years. A detection of localized hydrogen and oxygen atomic emission by our team in 2012 provided first evidence of water vapor plumes. However, similar localized emission signals have not been detected in a long series of follow-up HST spectral observations. Instead, HST filter images of Europa transiting Jupiter were reported to contain significant absorption patches, interpreted as additional evidence for plume activity. A recent reanalysis yet suggests that the features in the transit images might be random statistical outliers and should not serve as plume evidence. Hence, even after numerous attempts and many hours of HST observations, we still do not understand Europa's plume activity. I will review all HST observations in the hunt for Europa's plumes and give an outlook on how an approved JWST GTO program might help to solve the riddle.

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Session 4:

Spectroscopy of Metal Poor Galaxies in the Reionization Era

Dan Stark
University Of Arizona

Over the last five years, we have obtained our first glimpse of the spectral properties of reionization era galaxies, providing a preview of science that will become commonplace in the JWST era. Deep spectroscopy with ground-based telescopes has revealed intense emission lines in the UV (CIII], CIV, OIII]), radically different from what is typical at lower redshifts. The spectra indicate early galaxies have much harder ionizing spectra and different gas conditions from what is common at lower redshifts. The powering mechanism of these lines remains unclear, with the interpretation stunted by shortcomings in our understanding of low metallicity stellar populations. Recent work with HST/COS in the local universe has provided a way forward, characterizing the UV spectra that are common in metal poor galaxies. In my talk, I will first review the state of our knowledge of reionization-era galaxy spectra, before describing what ongoing HST/COS programs are revealing about spectra of metal poor galaxies. I will highlight shortcomings in existing stellar population models at low metallicity and discuss what these programs are revealing about early star forming galaxies.

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Uncovering The Fueling Star Formation History Through Cosmic Time: M83 As a Local Probe of CO-Dark Gas

Svea Hernandez
Space Telescope Science Institute (STSCI)

Molecular gas is a critical ingredient in the recipe of star formation (SF) in galaxies. To fully understand the processes that govern SF, it is essential to accurately measure, map and characterize the distribution of H₂ in star-forming environments. Since H₂ is a weak rotational emitter, the molecular gas content in galaxies is typically inferred using indirect tracers. The CO (1-0) transition has been widely used as H₂ tracer for decades. However, CO provides a partial census of the total H₂ mass, particularly in regions with large quantities of CO-dark gas. Our recent HST/FUV spectroscopic study suggested, for the first time, that S+ might be tracing large amounts of CO-dark gas in the core of M83. We will be exploiting the unprecedented capabilities of JWST in the MIR, using the MIRI/MRS, to perform a spatially-resolved study of the warm H₂ gas in the heart of this face-on spiral galaxy. The combination of the FUV capabilities of HST with the MIR sensitivity of JWST will allow us to confirm if S+ does indeed trace CO-dark gas in such environments with intense SF. To understand the fueling SF history through cosmic time, it is imperative that we test and develop tools to accurately estimate molecular gas mass directly probing the H₂ reservoirs. JWST, with its unrivaled resolution and sensitivity will allow us to do exactly that.

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Illuminating The Dark Side of Cosmic Star Formation at $z > 3$

Marika Giulietti

Scuola Internazionale Superiore di Studi Avanzati (SISSA)

How galaxies transformed their gas into stars as a function of cosmic time? Answering this question requires the reconstruction of the cosmic star formation rate density (SFRD) to the highest possible redshifts. While this quantity has been well constrained up to redshift ~ 3 , its evolution at earlier epochs is limited by the lack of an unbiased census of all types of star-forming galaxies at high redshift ($z > 3$). This talk will present a new approach to find dust-obscured star-forming galaxies which relies on their emission in the radio band. This method led to the selection of a sample of about 500 objects in the COSMOS field missed in previous optical and near infrared surveys. I will present the analysis of about half of this sample: we found 22 candidate galaxies at very high redshift and estimated that these heavily obscured galaxies might provide a substantial contribution to the SFRD at $z > 4.5$, up to the 40% of the previously known estimates based on UV-luminous objects. I will also emphasize the crucial role of the James Webb Space Telescope in shedding light on the nature of this elusive population.

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Observable Pressure Gradients Can Show the Dynamical Fate of Molecular Clouds in Outflows

Kalliopi Dasyra

National and Kapodistrian University of Athens

We present internal and external pressure measurements of molecular gas clouds in the black-hole jet driven outflows of the galaxy IC5063. The pressure gradients indicate that both compression of some clouds and evaporation of other clouds, which could potentially translate into both enhancement and suppression of star formation, are simultaneously happening along the jet passage. The external pressure of the clouds was measured from ionized gas [SII] and [NII] emission in Very Large Telescope MUSE data, whereas the internal pressure from CO and HCO+ emission in Atacama Large Millimeter Array data. Radiative-transfer modelling of these data provided the temperature and density of the gas needed for the pressure gradient calculations, and revealed the mechanisms that can lead to these gradients: mechanical heating and cosmic rays. Observations with the MIRI instrument on board the Webb will enable us to map the pressure of the warm H₂ in the immediate vicinity of dense molecular clouds and find the preferred mechanism of the jet-ISM interaction based on the gas excitation.

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The MOSDEF Survey: Probing Resolved Stellar Populations At $Z \sim 2$ Using A New Bayesian-Defined Morphology Metric

Tara Fetherolf

University of California, Riverside

Studying the resolved structure of high-redshift galaxies can give insight into the evolution of galactic properties, such as the amount and distribution of stars and interstellar dust. We investigate how the distribution of dust changes as galaxies increase in stellar mass during redshift $z \sim 2$, when stellar mass accretion was rapidly progressing. Stellar population maps are resolved images of galaxies used to measure the distribution of stars and

the interstellar dust obscuring their light, giving hints about how galaxies grew. We use the moderate-resolution spectra from the MOSFIRE Deep Evolution Field (MOSDEF) survey combined with CANDELS/3D-HST high-resolution photometry to unveil the obscuring effects of dust on small spatial scales, enabling proper measurements of the stars inside these distant galaxies. We create resolved stellar population and dust maps from the resolved HST images for ~ 300 star-forming MOSDEF galaxies. In order to study the dust distribution across our large sample of galaxies, we require quantification of the geometry in individual galaxies. Many existing morphology metrics that have been used to quantify structures focus on detecting regions of high brightness, which follows the unobscured star-formation. We introduce a new, more general metric that is sensitive to any deviations from the average—referred to as a measure of “patchiness.” The patchiness metric can be used to directly probe the physical properties of galaxies, opposed to exclusively measuring the light distribution in images. We showcase the patchiness metric by using it alongside two established measures, the Gini coefficient and second-order moment of light, in order to interpret the geometry of dust obscuration in our large sample of galaxies. Our results reveal how the dustiness within galaxies changes as galaxies grow, transitioning from mostly uniform coverage to a two-component model with regions of higher obscuration. This work is expected to be submitted for publication in early 2020. Future JWST observations using NIRCcam high-resolution imaging and NIRSspec resolved spectroscopy will enable the construction of high-resolution stellar population, dust, and emission line maps for galaxies out to $z \sim 6$, which will further address the question of how galaxies assemble and evolve across cosmic time.

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Spectroscopy with the JWST Advanced Deep Extragalactic Survey (JADES) – the NIRSspec/NIRCAM GTO galaxy evolution project

Andy Bunker
University of Oxford

I describe the JWST Advanced Deep Extragalactic Survey (JADES), a joint program of the JWST/NIRCam and NIRSspec instrument science teams involving 950 hours of observation. We will target two well-studied fields with excellent supporting data: GOODS-North and South, including the Ultra Deep Field. The science goal of JADES is to chart galaxy evolution at $z > 2$, and potentially out to $z > 10$, using the rest-frame optical and near-IR through observations from 1-5 microns. NIRSspec spectroscopy will measure secure spectroscopic redshifts of the photometrically-selected population, and emission lines can constrain the dust extinction, star formation rates, metallicity, chemical abundances, ionization and excitation mechanism in high redshift galaxies. Potentially we can search for signatures of Population III stars such as HeII. We can address the contribution of star-forming galaxies at $z > 7$ to reionization by determining the faint end slope of the luminosity function and investigating the escape fraction of ionizing photons.

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Session 5:

Bridging Galaxy Evolution Across Cosmic Time with the CLASSY Survey

Danielle Berg
The University of Texas at Austin

Rest-frame far-ultraviolet (FUV) spectra are fundamental to our understanding of star-forming galaxies, providing a unique window on massive stellar populations, chemical evolution, feedback processes, and reionization. JWST

will soon usher in a new era, pushing the FUV spectroscopic frontier past $z=10$. The success of these future endeavors hinges on a comprehensive understanding of the massive star populations and interstellar medium (ISM) gas conditions that power the observed FUV spectral features. I will present the COS Legacy Archive Spectroscopic Survey (CLASSY) Treasury as a powerful and promising solution. The CLASSY atlas is the first high-quality, high-resolution FUV spectral catalog of star-forming galaxies at $z\sim 0$. The spectra contain a suite of emission and absorption lines that characterize the massive stellar populations that populate metal-poor galaxies, the physical properties of large-scale outflows that regulate star formation, and the chemical abundance patterns of the gas and stars. While the CLASSY sample is consistent with the $z\sim 0$ mass-metallicity relationship, it is offset to higher star-formation rates by roughly 2 dex, similar to $z\sim 2$ galaxies. This unique set of properties makes the CLASSY atlas the benchmark training set for star-forming galaxies across cosmic time.

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Super star cluster feedback in nearby luminous Blue Compact Galaxies: HST and VLT in concert

Arjan Bik
Stockholm University

Blue Compact Galaxies are nearby strongly star-forming dwarf galaxies. They host dozens of super star clusters and are considered to be analogues of high redshift star forming galaxies. These galaxies give us the unique laboratories to study the effect of feedback from super star clusters on the interstellar medium (ISM), determine the conditions under which they become Lyman continuum leakers and help probing the role that high-redshift dwarf galaxies play in the re-ionization of the universe. We present deep optical integral field spectroscopy with VLT-MUSE and HST UV and optical imaging of a small sample of nearby blue compact dwarf galaxies. The MUSE datasets enable a detailed study of the ISM from the optical emission lines and reveal that the galaxies are embedded in extended halos of ionized gas. The HST imaging reveals the location, ages and masses of the many super star clusters in the galaxies allowing us to relate the cluster properties to the ISM. We find that the ISM is highly ionized and that the super star clusters are responsible for creating ionization channels extending all the way to the edges of the halo, possibly facilitating the escape of Lyman Continuum photons. We also find evidence for chemical enrichment of the ISM by Wolf-Rayet stars in the super star clusters. In particular we find evidence for supernovae induced feedback in the shape of super bubbles and galactic scale outflows.

The integral field spectrographs on board of JWST (NIRSPEC IFU and MIRI/MRS) will allow the study of these type of galaxies at much higher redshift. We use the MUSE observations of nearby starburst galaxies as input to simulate how these galaxies would look like when observed with MIRI/MRS at redshift 6-7 and study what ISM properties and spatially resolved kinematics we can still recover with deep MRS observations.

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Finally Solving Thermally-Pulsing Asymptotic Giant Branch Stars with HST and JWST

Martha Boyer
Space Telescope Science Institute (STSCI)

Thermally-pulsing Asymptotic Giant Branch (TP-AGB) stars dominate the IR flux in star-forming galaxies (up to 70%). This dominance has a significant impact on derived/model-dependent galaxy properties like the star-formation rate and stellar mass, yet the stellar models that these measurements depend on are not able to reproduce TP-AGB observed properties. IR data are essential for studying these evolved stars. HST's medium-band IR filters are uniquely suited for TP-AGB observations and have enabled the first TP-AGB calibration observations in distant galaxies. This capability significantly broadens the metallicity and age baselines for model calibrations, making

them far more broadly applicable than what has been provided by the typically-used Magellanic Clouds. I will present new results using these HST filters to identify TP-AGB stars in M31 (Boyer et al. 2019, ApJ, 879, 109). We find a dramatic and unpredicted drop in carbon dredge-up efficiency at high metallicity, having strong implications for TP-AGB evolution in massive, metal-rich galaxies. I will also discuss how this observing strategy can be mimicked with JWST, which improves the situation even further given its improved sensitivity and resolution in the IR. Together with improvements in modeling, the superior capabilities of these two Great Observatories can, finally, solve many of the long-standing TP-AGB star problems that have plagued extragalactic astronomy for decades.

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Session 6:

JWST First Science Release

Session 7:

JWST Keynote: Roberto Maiolino - NIRSpec

Star Cluster Formation and Feedback in The Local Universe: Setting the Stage for JWST Observations of Local Star-Forming Galaxies

Angela Adamo
Stockholm University

Star clusters are considered key tracers of star formation conditions, as well as units of stellar feedback within their host galaxies. They sit at the intermediate scales of the star formation cycle of galaxies and can therefore unlock the intricate regulator interplay between star formation and feedback that drives to galaxy evolution. In recent years, HST observations from the FUV to the NIR of local galaxies have enable us to study star cluster populations across a wide range of galaxy environments. In my contribution I will combine results for the Hubble treasury program Legacy extragalactic UV survey (LEGUS) which has observed a large spectrum of dwarf and spiral galaxies, together with results from the Hubble imaging probes of extreme environments and clusters (HiPEEC) survey, which has enabled to study star cluster populations in interacting starburst galaxies. I will discuss how star clusters properties such as mass distributions, maximum mass, dissolution time scales, formation efficiency are closely linked to the global physical properties of their host galaxies. I will show how important events for galaxy evolution, such as mergers or increased gas fraction change the properties of the stellar clusters formed during these enhanced star formation events. I will then focus on the evaluation of star cluster stellar feedback (derived from the analyses of HST and MUSE datasets) on the host interstellar medium, using as a study-case the grand-design spiral galaxy M83. The large number of HII regions detected from the MUSE mosaic, combined with star cluster physical properties derived from the HST dataset enable us to evaluate: 1. The timescale for HII region expansion across the different environment of the disk of the galaxy; 2. the role that cluster feedback has in shaping the dissolution of stellar nurseries. 3. The escape fraction of ionizing photons from HII regions. I will conclude by presenting the goals of JWST Feedback in Extragalactic Star Clusters (JWST-FEAST, #1783) program and discussing how near and mid-IR observations of local galaxies, like M83, will help us to probe the earliest phases of star cluster formation and feedback.

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HST Observations of Very Massive Stars in Young Super Star Clusters

Linda Smith
Space Telescope Science Institute

Super Star Clusters (SSCs) represent the most massive subset of young star clusters ($> 10^5 M_{\odot}$) and are only found locally in galaxy mergers, starburst dwarf galaxies and the centers of galaxies. These GC-like clusters form under high pressure conditions that are similar to those in star-forming galaxies at the peak of cosmic star formation. In this talk, I will discuss HST FUV spectroscopy of local examples of SSCs that reveal the presence of very massive stars (VMS, masses $> 100 M_{\odot}$) at ages of < 2 Myr. I will present recent STIS observations of SSC A in the low metallicity ($Z = 0.003$) Green Pea analog Mrk 71 and show that VMS are present, as characterized by

strong N V, O V, C IV and He II emission features. I will compare these observations to the few other nearby galaxies hosting SSCs with VMS populations, and the latest simple stellar population models accounting for VMS, as a prelude to JWST rest-frame FUV spectroscopy of proto-GCs in young, high redshift galaxies, which may have VMS present.

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Time-Domain Study of The Young Massive Cluster Westerlund 2 With HST

Elena Sabbi
Space Telescope Science Institute

Young massive clusters, like Westerlund 2, are bright regions of intense star formation, that can be observed at several tens of Mpc from us in starburst and interacting galaxies. In the Milky Way and in the Local Group young massive clusters are rare. Yet the few examples that can be resolved into stars are of prime interest for studying the formation and evolution of stars in environments that resemble the extreme conditions found in the early universe. The excellent sensitivity and spatial resolution of the Wide Field Camera 3 on the Hubble Space Telescope, allowed us to carry the first time-domain study of the pre-main sequence population in one of these systems. Our analysis shows that more than 1/3 of Westerlund 2 pre-main sequence stars between 0.1 and 5 Mo are variable. From the analysis of the light curves, we found that less than 12% of the variable pre-main sequence stars have already cleared their inner disks, while in almost 70% of the cases the light curves show clear evidence of active accretion. In this talk we will show the effect of stellar feedback on the various populations of pre-main sequence stars, its impact on the evolution of circumstellar disks, and discuss the implication for the formation of planetary systems. Finally, we will discuss how JWST studies of young massive clusters in the Local Group will allow us to determine the timescale for the evolution of circumstellar disks as a function of stellar mass and metallicity.

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New Light on Star Formation in Massive Clusters

Guido De Marchi
European Space Agency (ESA)

Hubble observations of massive young clusters in the Magellanic Clouds and Milky Way have revolutionized our understanding of low-mass star formation in these environments, revealing almost 50,000 new pre-main sequence (PMS) stars. These objects are still undergoing active mass accretion, as witnessed by excess emission in the H α band. Detailed knowledge of the extinction law in these fields, which we derive directly from UV, optical, and near-IR HST observations, allows us to accurately obtain stellar physical parameters (temperature, luminosity, age, mass and mass accretion rate) for all of them. This is presently the largest and most homogeneous sample of PMS objects, on which we are conducting the first comprehensive and systematic study of the PMS phase: by spanning a wide range of masses (0.5-4 Msun), metallicities (0.1-1 Zsun) and ages (0.5-30 Myr), we probe a parameter space covering the bulk of all stars that form in the Universe. We will discuss how star formation has proceeded in these regions over multiple recent bursts and how the accretion process depends on the physical properties of the individual stars and of the environment. We have discovered a strong dependence of the mass accretion rate on metallicity: mass accretion rates for stars of the same mass and age are systematically higher in the Magellanic Clouds than in the Milky Way and are expected to have been equally high at redshift $z \sim 2$, when star formation in the Universe was at its peak. We will also show a surprising anti-correlation just discovered between the variability and intensity of the H α excess, which in turn suggests a discrete and clumpy nature for the accretion process. To close, we will illustrate how we plan to confirm these results spectroscopically and to extend them to lower

mass objects and to more extinguished environments through already planned observations with NIRSpec and NIRCам onboard the James Webb Space Telescope. Our measurements will provide, for the first time, quantitative information on the nature, excitation, and kinematics of the infalling gas in these dense, low-metallicity environments, shedding new light also on star formation in the early Universe.

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Session 8:

JWST Keynote: Pierre-Olivier Lagage: MIRI

Solar System Science With JWST

Heidi Hammel
AURA

JWST will be a powerful tool for observations within our own Solar System. The high sensitivity and mid-infrared spectroscopic capability complement in situ planetary missions, and expand our knowledge for those objects without current missions. Roughly 7% of Cycle 1 time will be used for imaging and spectroscopy of objects ranging from near-Earth asteroids to beyond the Kuiper Belt. Key targets include dozens of Kuiper Belt objects including Pluto, the distant Ice Giants Uranus and Neptune (see also Pat Irwin's talk), active moons Europa and Enceladus, Jupiter's Great Red Spot, Saturn's moon Titan, and much more. This overview talk will review GTO, ERS, and GO Solar System programs, and highlight expected science results during the first year of JWST observations.

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Session 9:

ULLYSES Harnesses the Spectroscopic Powers of Hubble - Overview and Initial Results of This Stellar Program and Application to Astrophysics of The Interstellar Medium

Julia-Roman Duval
Space Telescope Science Institute (STSCI)

The Hubble Space Telescope's Ultraviolet Legacy Library of Young Stars as Essential Standards (ULLYSES) is a Directorates Discretionary program of approximately 1,000 orbits - the largest ever executed with HST - that will produce an ultraviolet spectroscopic library of young high- and low-mass stars in the local universe. The program is composed of two distinct components: approximately 500 orbits are dedicated to UV-optical-NIR spectroscopy of young, low mass accreting (T Tauri) stars in 8 star-forming regions in the Milky Way, while another 500 orbits focus on UV spectroscopy of massive stars in the Magellanic Clouds, NGC 3109, and Sextans A. The 230+ ULLYSES targets uniformly sample the fundamental astrophysical parameter space for each mass regime: metallicity, spectral type and luminosity class for massive stars; mass and accretion rate for T Tauri stars. As of June 2022, ULLYSES is about 75% complete and has had 4 data releases. In this talk, I will provide an overview of the goals, design, status, and initial results of ULLYSES. In addition, I will show how UV medium-resolution spectroscopy toward massive stars, such as the ULLYSES observations, can reveal how the abundance and composition of interstellar dust varies within and between galaxies, and provide the local calibrations of dust depletions effects that are necessary to track the chemical enrichment of the universe over cosmic time.

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Unlocking IR Stellar Populations in The Local Volume: The Power of Combining HST And JWST

Elena Sacchi
Leibniz-institut Für Astrophysik Potsdam (AIP)

Star formation (SF) studies beyond the Local Group have been pushed to their limits in the past few years. Thanks to the spatial resolution and sensitivity of HST, we can resolve single stars in galaxies up to 15-18 Mpc, with the caveat of observing only the brightest stellar evolutionary features (i.e., the upper main sequence, the Helium-burning phase of massive stars, the asymptotic giant branch, and the red giant branch). This means that the time resolution in a star formation history derivation can reach only a few Gyr (1-2, depending on the galaxy metallicity) in look-back time. In this context, I will discuss the innovative impact of JWST on this kind of studies: its increased sensitivity and longer wavelength baseline will allow us to reach lower-mass stars, thus, older stellar features (e.g., the red clump and the horizontal branch) beyond the confines of the Local Group, and possibly in the whole local Volume. The synergy of UV, optical, and new IR observations will be particularly interesting to study the SF activity in a regime where dust obscuration is minimized, allowing to, e.g., unveil the population of thermally pulsing asymptotic giant branch and carbon stars, very rich in many star-forming galaxies in the local Universe, but so far poorly understood due to the limitations of optical studies in constraining these challenging phases. This will give us precious insight that in turn will constrain the stellar evolution models in these bands, allowing us to unlock even more precise age and metallicity derivations.

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Constraining Globular Clusters Properties Using IR Photometry: New Breakthroughs and Future Prospects

Matteo Correnti
Space Telescope Science Institute (STSCI)

Globular Clusters (GCs) in the Milky Way are the primary laboratories for establishing the ages of the oldest stellar populations and for measuring the color-magnitude relation of stars. The gold standard for these studies have involved high-precision visible light investigations with the Hubble Space Telescope (HST). However, the shape of the color-magnitude relation in the visible bandpass offers little leverage to disentangle the effects of distance, reddening, and metallicity, and these uncertainties impact our derived age measurements for GCs.

Recently, a new feature has been observed in several HST WFC3-IR color-magnitude diagrams (CMDs) of nearby GCs. At low stellar masses, the stellar main sequence in an infrared (IR) CMD exhibits a sharp "kink" (due to opacity effects in M dwarfs), such that lower mass and cooler dwarfs become bluer in the F110WF160W color baseline and not redder. This inversion of the color-magnitude relation offers the possibility to fit GC properties using IR imaging, and to reduce their uncertainties.

In this context, I will present the results obtained from the analysis of archival and new HST WFC3-IR observations of a sample of GCs (Correnti et al. 16, 18, Libralato et al. in preparation). Our studies allowed us to estimate the best-fit GC parameters, in terms of age, metallicity, distance, and reddening, quantify the correlations among them and derive their individual uncertainties. Our overall results show that observing the near-IR main sequence kink offers an alternative venue to push the absolute age of GCs to sub-Gyr statistical accuracy.

Finally, I will discuss how our results provide a fundamental tool to help test stellar models for low-mass stars and how the next generation space IR telescopes (i.e., JWST, WFIRST) can greatly enhance the scientific outcome of the different projects related to this field of research.

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Synergies Between HST and Gaia: A Test for the Current Models of Binary Evolution

Anna Francesca Pala
European Space Agency ESA/ESAC

In the last 20 years, the study of compact binaries has led to two major breakthroughs in astrophysics: the discovery of dark energy and the first direct detection of gravitational waves. Although binaries are crucial to probe the properties of the Universe and to test fundamental physical theories, such as General Relativity, our understanding of their evolution is still far from complete.

Accreting white dwarfs, binaries in which a white dwarf accretes from a main sequence star or a degenerate companion, are ideal laboratories in which to test the models of binary evolution as they are numerous, relatively bright, and both stellar components are structurally simple.

Over the last 30 years, HST has proven to be essential for the study of accreting white dwarfs, delivering ultraviolet observations for hundreds of them. In this talk, I will review how these observations have led to an increasing understanding of the properties of all types of compact binaries, including those containing black holes and neutron stars, as well as the progenitors of Type Ia Supernovae (SNe Ia).

I will also discuss how the synergy with the recent astrometry from the Gaia space mission allow us to accurately constraints the mechanisms of orbital angular momentum loss and the evolution of the most compact accreting white dwarfs, which not only link to SNe Ia, but will also be used to calibrate the LISA space mission for future gravitational wave source discoveries.

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JWST Keynote: Martha Boyer - NIRCam

JWST Keynote: David Lafrenière- NIRISS

Measurements of the Ultraviolet Spectral Characteristics of Low-Mass Exoplanetary Systems (Mega-MUSCLES)

David Wilson
University Of Colorado at Boulder

M dwarf stars have emerged as ideal targets for exoplanet observations. Their small radii aid planetary discovery, their close-in habitable zones allow short observing campaigns, and their red spectra provide opportunities for transit spectroscopy with JWST. The potential of M dwarfs has been underlined by the discovery of remarkable systems such as the seven Earth-sized planets orbiting TRAPPIST-1 and the habitable-zone planet around the closest star to the Sun.

Accurately assessing the surface conditions of planets around M dwarfs requires a firm understanding of how M dwarfs differ from the Sun, beyond just their smaller size and mass. Of particular importance are the time-variable, high-energy ultraviolet and x-ray regions of the M dwarf spectral energy distribution (SED), which can influence the chemistry and lifetime of exoplanet atmospheres, as well as their surface radiation environments. Ideally, ultraviolet and x-ray observations should be obtained for any star with exoplanets of interest. Unfortunately, those wavebands are extremely faint for most M dwarfs, requiring too large an investment of telescope time to obtain data at most stars.

The Measurements of the Ultraviolet Spectral Characteristics of Low-mass Exoplanetary Systems (Mega-MUSCLES) Treasury project, together with the precursor MUSCLES project, aims to produce full SEDs of a representative sample of M dwarfs, covering a wide range of stellar mass, age, and planetary system architecture. We are obtaining x-ray and ultraviolet data for 13 stars using the Hubble, Chandra and XMM space telescopes, along with ground-based data in the optical and state-of-the-art DEM modelling to fill in the unobservable extreme ultraviolet regions. Our completed SEDs will be available as a community resource, with the aim that a close MUSCLES analogue should exist for most M dwarfs of interest.

In this presentation I will overview the Mega-MUSCLES project, describing our choice of targets, observation strategy and SED production methodology. I will also discuss notable targets such as the TRAPPIST-1 host star, comparing our observations with previous data and model predictions. Finally, I will discuss the applications of the Mega-MUSCLES data for future observations with JWST.

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Session 11:

Fabio Favata: Future ESA program & Voyage 2050

Session 12:

New insights into Uranus and Neptune

Pat Irwin
University of Oxford

Observation programs on the Hubble Space Telescope over the last 31 years, such as those using STIS and WFC, including OPAL (Outer Planets Atmospheres Legacy), have transformed our understanding of the atmospheres of Uranus and Neptune, the 'Ice Giants'. In this talk, I will review some of the HST observations made of the Ice Giants over years before going on to present a recent re-analysis of visible and near-infrared reflectance observations that provides an intriguing new insight into the vertical haze structure of these planets that can explain both the color difference between these two planets and also what makes dark spots dark (e.g., Voyager-2's Great Dark Spot). I will then look forward to how we anticipate JWST observations will further advance our understanding of these cold, hazy, blue worlds.

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Water Vapor Detection on the Habitable-Zone Planet K2-18b

Angelos Tsaras:
INAF - Osservatorio Astrofisico di Arcetri

Today, more than 5000 exoplanets have been detected, with super-Earths being the most common in our galaxy. We still know very little about these planets, with their basic parameters such as radius and mass – when available – suggesting a great variety among them. However, the density alone does not reveal the chemical composition and climate of these planets, nor casts light into their formation history. To answer these questions, we need to observe their atmospheres, and, so far, the WFC3 camera on-board the Hubble Space Telescope has been the most powerful instrument to perform infrared transit spectroscopy of exoplanets.

In this talk, I will present the first detection of a molecular signature from the atmosphere of a habitable-zone planet. HST transit observations of K2-18b, an eight Earth-mass planet orbiting an M2.5 red dwarf, have revealed a strong signature of water vapor, providing the first opportunity to study the nature of a temperate planetary body beyond the mass-radius relationship. However, the current data are still very limited, proving only the existence of the atmosphere and the presence of water vapor. These results make K2-18b one of the prime targets for future characterization studies, and JWST observations are already part of the first GO cycle. Such observations will help us reveal the presence of additional molecules, like methane, understand the thermal structure of the atmosphere, and, ultimately, assess the potential habitability of this planet.

Moreover, I will discuss the process followed to develop an automatic analysis pipeline for exoplanet observations with WFC3, and the lessons learnt from working with HST. Today, we are entering the era of big data in the exoplanet characterization field, and it is the moment to make use of the HST experience and develop a scalable approach for future observation planning and data processing. This is vital now as JWST has started its breakthrough observations, and ESAs M4 mission, Ariel, has been adopted and it will provide observations for up to 1000 exoplanets starting from 2029.

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Observing Ices in Protoplanetary Disks with JWST

Nicholas Ballering
University of Virginia

Ices play an important role in protoplanetary disks by facilitating grain growth and planetesimal formation, while ices sequestered in planetesimals may subsequently deliver bio-critical volatiles to potentially-habitable planets. Comparing disk ice abundances with cometary values will reveal whether the chemical inventory of our solar system is unique or common. Measuring disk ices can also reveal to degree to which the molecular abundances of planetary systems are inherited from their proto stellar environment or reset by disk processes. Various ice species (e.g., H₂O, CO, CO₂, CH₃OH, NH₃, CH₄) can be identified via absorption features in the near- and mid-IR. JWST--due to its sensitivity and spectral resolution at these wavelengths--is poised to significantly advance observational studies of protoplanetary disk ices. We present simulated JWST observations of disks to assess which ice features can be observed under various disk conditions and what can be learned about protoplanetary disks and planet formation from such observations. We first use a radiative transfer simulation to derive the temperature and radiation field throughout the disk for a specified dust and gas distribution. We then use a time-dependent gas-grain chemical model to simulate the distribution and abundances of ices within the disk. Finally, we use laboratory-measured optical constants of the dominant ice species plus radiative transfer modeling to simulate observations of the disk with JWST.

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Direct Detection of Exoplanets with JWST

Elisabeth Matthews
University Of Geneva

JWST provides a unique opportunity to collect high-spatial-resolution, coronagraphic observations of nearby stars in the mid-infrared. This opens new parameter spaces to search for exoplanets, and allows opportunities for the characterization of known planets over their full luminous range. I will highlight some of the exoplanet imaging science we can expect during JWST Cycle 1. In particular, I will discuss direct imaging Early Release Science program, which includes detailed characterization of two sub-stellar companions across several JWST instruments and modes. I will also describe my GO program which aims to collect the first images of a cold extra-solar Jupiter analog.

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Markus Kissler-Patig: Conference Wrap-Up & Future Perspectives

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Science with the Hubble and James Webb Space Telescopes VI
Entering a golden age for UV – Optical - IR space astronomy

Poster Titles & Lead Authors

11-15 July 2022, Stockholm

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2. High Redshift Star Formation Processes at An Unmatched Spatial Resolution Thanks To HST/JWST Observations of Lensed Galaxies - Adélaïde Claeysens
3. Twenty Years of Hubble's Advanced Camera for Surveys: Performance Update and Webb Synergies - Norman Grogin
4. METAL-Z – Measuring Dust Depletion in The Low Metallicity Environments - Aleksandra Hamanowicz
5. The Archive of COS Spectra and Their Application for High-Z & Reionization Studies - Matthew Hayes
6. Preparing For JWST With HST/COS Spectroscopy of Pox 186: A Local Analogue of $z > 6$ Galaxies - Nimisha Kumari
7. Exploring The High-Z Universe With JADES: JWST Advanced Deep Extragalactic Survey - Nimisha Kumari
8. 21cm HI Imaging of High-Redshift Analog Galaxies - Alexandra Le Reste
9. Brown Dwarf Dating Using Members of Open Clusters From 2-700 Myr - Elena Manjavacas
10. Informed Systematic Method to Identify Variable Mid and Late-T Dwarfs - Elena Manjavacas
11. The European JWST Archive and Associated Tools - Anthony Marston
12. Late-Time Type Iin Supernovae Investigations with Webb: Dust Formation and Pre-Existing Circumstellar Material - Anthony Marston
13. Matching Complicated Point Spread Functions from HST And JWST From the Far-UV To the Mid-IR - Jens Melinder
14. Astronomy In The 2020s With the Cosmic Origins Spectrograph - Rachel Plesha
15. Young Massive Clusters in Intensely Star-Forming Galaxies with HST And NIR AO On Ground- Based Telescopes - Zara Randriamanakoto
16. The Lyman Alpha Properties of Green Peas - Armin Rasekh
17. On The Origin and Evolution of Lyman Alpha Halos: No Change with Redshift and Evidence for Compound Emission Sources - Axel Runnholm
18. The Star Cluster Population of NGC 5253 - Jenna Ryon
19. The CLUES Survey: Young Star Clusters Studied with Hubble FUV Spectroscopy - Mattia Sirressi
20. Studying Extragalactic Star Clusters with Panchromatic Photometry - Chris Usher
21. A Glance into The Past – The Power of *Hubble*, *MUSE* And *Webb* to Unveil the Formation History of Young Star Cluster - Peter Zeidler