The Mind the Gap Organizing Committee &
Ultraviolet/Visual Science Interest Group of the Cosmic Origins Program Analysis Group (UVSTIG - COPAG)
invite you to attend joint Splinter Sessions on at the 243 meeting of the AAS in New Orleans
on Tuesday 09 January 2024
Morning Session (09:30 – 11:30) and Afternoon Session (13:30 – 15:30) (currently scheduled) in
room R07 (2nd floor) of the Ernest N. Morial Convention Center

There will be a 10-20 year gap between the end of the Hubble Space Telescope (HST) mission and the beginning of a new flagship mission with ultraviolet spectroscopic capabilities. In the interim, what science should potential small- and modest-sized missions focus on as precursor efforts that advance conceptual and technical readiness and foster core-excellence in early career scientists who will go on to be mainstream uses of future flagship missions.

The sessions are organized around 3 topics:

1) Science goals that define UV spectroscopy and/or spectropolarimetry at various resolving powers and spatial resolution, that might be achievable in the next 10-15 years in preparation for HWO.

2) Current status of UV optical components, detectors and future technology developments

3) Description of missions under implementation that seek to leverage technology states of the art to address high priority science

This meeting is an opportunity for the astronomers interested in UV observations and researchers focused in improving UV observational tools (including detectors, mirror coatings and other new technologies) to gather and discuss science goals, current technical readiness and potential future technology capabilities needed to meet theses science goals.

Virtual Attendance will be available (no AAS registration necessary). See program speakers and abstracts in pdf attachment slides 2 – 5; Convention Center Map, slides 6, 7

NASA COPAG AAS243 activities can be found at https://cor.gsfc.nasa.gov/news/2023/COPAG_Session_at_AAS_Winter.php

Mind the Gap Organizing Committee:

Joy Nichols - Harvard & Smithsonian CfA
Carol Grady - Eureka Scientific
Ted Gull - NASA/GSFC (Emeritus) & STScI
Erika Hamden - University of Arizona
Keri Hoadley - University of Iowa
Al Holm - Retired; STSci Operations
Geraldine Peters - USC
Paul Scowen - GSFC/NASA
Chris Shrader - GSFC NASA
Sarah Tuttle - University of Washington

UVSTIG Leadership Committee:

Stephan McCandliss - Johns Hopkins University
Jason Tumlinson - STScI
Sarah Tuttle - University of Washington
Camden Ertley - SWRI
Derek Buzasi - Florida Gulf Coast University
Kevin France - University of Colorado, Boulder
Allison Youngblood - GSFC
John Hennessy - JPL
Erika Hamden - University of Arizona
Emily Witt - University of Colorado, Boulder
Keri Hoadley - University of Iowa, Iowa City
Shouleh Nikzad - JPL

MindtheGap/UVSTIG	Speaker	Affiliation	Title	Abstract
Session on UV Science - Chair, Douglas Gies				
09:30-09:45	Ted Gull	NASA/GSFC	UV spectroscopy requires an appropriate selection of spectral resolving powers combined with excellent angular resolution.	Resolving visual binaries, selecting individual stars in a crowded field and separating nebular structure from stellar structure are a few examples that have been utilized with the HST/STIS. An example will be provided of Eta Carinae and the Homunculus where spectral resolving powers of 10,000 and 100,000 were used with angular resolution of 0.06" to parse out evolving multiple shells, ejecta clumps from a spatially-resolved, extended colliding wind of a massive binary.
09:45-10:00	Jeff Linsky & Seth Redfield	CU & Wesleyan	Science Objectives of Ultra-high Resolution UV Spectroscopy	Since 1997 the STIS instrument of HST has been the only instrument capable of obtaining UV spectra with a resolution of 100,000, corresponding to 3 km/s. STIS has provided the UV spectra enabling revolutionary studies of the interstellar medium in our Galaxy, but also spectra for studying accretion in pre-main sequence stars and circumstellar phenomena. After HST there are no planned instruments capable of ultra-high resolution UV spectroscopy that could operate in the next 15-25 years. The requirement of high throughput likely rules out cube-sats, but a dedicated mission may only need a 1m aperture telescope. Interstellar studies require this capability because nearly all atoms, ions and molecules are in their ground state in the low density ISM, and nearly all absorption transitions from the ground state are in the UV. High resolution is needed because flows in the ISM are mostly at low speeds, the gas is often filamentary with significant velocity structure, and the thermal Doppler widths are small due to low temperatures. What has been learned so far even with 3 km/s resolution may not reveal important new phenomena. Also, the detection of supra-thermal velocities in the ISM could could change our present models drastically. Our emerging understanding of the gas flows and densities in nearby space are beginning to tell us what changes in the Earth's environment have been and will be driven by the diverse properties of the nearby ISM as the Sun with its terrestrial planets traverses these regions. Passage through supernova shocks, cold dense star forming regions, and even more moderate variations in the ISM could effect the Earth. The same can be said for potentially habitable exoplanets as their host stars traverse hazardous regions of the ISM. This is a new topic at the interface of astrophysics, astrobiology, paleo-climatology, habitability on exoplanets, and conceivably human history.
10:00-10:15	Andrea Dupree	CfA/HarvardSAO	No UV??? What will we miss in stellar astrophysics ???	Loss of ultraviolet capability means loss of a critical piece of astrophysics. As demonstrated during the Great Dimming of Betelgeuse, ultraviolet spectroscopy revealed the massive outward motion and escape of a large part of the stellar atmosphere. Through diagnostics representative of mass motions in the warm outer atmosphere, uv spectra uniquely demonstrate enormous outflowing and escaping plasma. Other 'missing' examples are drawn from from young and old stars in the field and in clusters – including hosts of exoplanets.
10:15-10:30	Geraldine J. Peters & Kenneth G. Gayley	USC & UIowa	New Perspectives on Stellar Evolution on the Upper Main Sequence	For more than a half century the consensus has been that evolutionary tracks for late O-early B stars are simple, but may be modified by rapid stellar rotation. However, it is the consensus now that most OB stars are binary or multiple star systems. There is no consensus on what percentage of OB stars are formed as single objects or wide binaries. But if a high percentage of OB stars are formed as close binaries (with separations < 1-2 AU), they will interact and undergo mass transfer at some point in their evolution. Clarity is needed on the percentage of OB systems formed as close binaries. This talk will address two important quantities that must be determined from observation in order to compute realistic evolutionary tracks for close OB binaries: the amount of mass and angular momentum that is lost to the ISM during mass transfer. Archival IUE SWP HIRES spectra have revealed that a significant amount of mass is lost during the epoch when the gas stream strikes the photosphere of the mass gainer tangentially. We best see this effect near/at phase 0.5 (when the mass gainer is in front) from the appearance of violet-shifted absorption components in the FUV resonance lines of abundant species. But a fine grid of FUV spectra with full phase coverage for systems of intermediate period (about 3-15 d) is needed to map out the mass flow and obtain a good estimate of the systemic mass loss. Angular momentum loss can be estimated from FUV emission lines formed from jets oriented above/below the orbital plane, which have been shown by WUPPE observations to cause a flip of polarization position angle in the UV in β Lyrae. I will show that mass/angular momentum loss in OB interacting binaries can be measured from spectroscopic/polarimetric observations from a future UV spacecraft of intermediate size in the gap years (2030-40) between HST and HWO.

10:30-10:45	Linda Smith (on behalf of the ULLYSES team)	STScI	The ULLYSES UV Spectroscopic Archive for Massive Stars	The Hubble Space Telescope's Ultraviolet (UV) Legacy Library of Young Stars as Essential Standards (ULLYSES) is a Director's Discretionary program of approximately 1,000 orbits - the largest ever executed with HST - that has recently completed a UV spectroscopic library of young high- and low-mass stars in the local universe. This talk focuses on the massive star ULLYSES spectral library, which is composed of UV medium resolution spectra toward over 150 O and B stars in the LMC (0.5 Z_sun) and SMC (0.2 Z_sun). The overall aim is to characterize the winds and photospheres of massive stars as a function of metallicity, spectral type, and luminosity class. The library will also provide the templates necessary for the synthesis of integrated stellar populations at high redshift that are accessible to JWST and the next generation of Extremely Large Telescopes (ELT), and for advancing our understanding of Lyman-continuum escape and the re-ionization of the Universe. Hubble observations of massive stars at < 20% solar metallicity are very costly yet determining how O star mass-loss rates scale with metallicity is essential for understanding stellar feedback in high redshift galaxies at low metallicity. Only the tip of the low metallicity iceberg is accessible to Hubble. It will take the sensitivity and multiplexing capability of HWO to reach the diversity of stars over the range of metallicities typical of cosmic noon in the nearby universe.

Session on UV Tech - Chair, Paul Scowen

10:45-10:55	John Hennessy, Robin Rodriguez & April Jewell	JPL	UV mirror and detector coatings by atomic layer processing	We describe the current status of UV-optimized coatings fabricated with atomic layer deposition (ALD) and atomic layer etching (ALE) approaches . Thin ALD encapsulation layers have proven to be useful in enhancing the environmental stability of protected Al UV mirror coatings fabricated by conventional methods. This encapsulation approach has been implemented for the SPRITE CubeSat and Aspera Pioneers missions. The ALD thin film coating approach can also be utilized in the fabrication of a variety of protected-Al structures, as well as dielectric narrowband mirror structures or dichroic beam splitters. The latter examples leverage more recent demonstrations of ALD processes for metal fluoride materials like LaF3 and CaF2. Multilayer combinations of Al with ALD dielectrics are also useful for UV bandpass filters that can be directly integrated onto back-illuminated Si sensors. Examples of this bandpass filter approach have been delivered to the SPARCS CubeSat mission and are baselined for the MIDEX concept UVEX. Recent optimizations to these ALD/ALE processes and prospects for future gains in performance and scaling will be discussed.
10:55--11:05	April Jewell	JPL	Detectors for UV/Visible Spectroscopy	Here we report on the latest developments in optical coatings methods for preparing silicon detectors with spatially varying response spanning the ultraviolet (UV) and visible wavelength ranges. This innovation is achieved by combining well-established lithographic patterning techniques with optical coating techniques to produce butcher-block style AR coatings, similar to linear variable filters often used in infrared spectroscopy systems. With these patterned AR coatings, a detector's spatial response can be tailored according to the spectral dispersion of the optical system. Thus, high-throughput, wide-wavelength imaging and spectroscopy can be achieved on a single detector.
11:05-11:15	Chaz Shapiro	JPL	UV CMOS detectors for CASTOR and Beyond	The Cosmological Advanced Survey Telescope for Optical and uv Research (CASTOR) is a Canadian space telescope concept planned for launch in 2029. It is a wide field (0.25 deg^2) 1m-aperture telescope with Hubble-like resolution (0.15") extending into the far UV (150-500nm). With R~300–420 grism spectroscopy and an R~2000 UV multi-object spectrograph, CASTOR would help to fill the UV gap in the 2030s. The CASTOR focal plane consists of about 1 Gpx of mosaicked CMOS detectors with UV sensitivity enhanced by 2D-doping and tailored anti-reflective coatings. JPL is partnering with CMOS vendors to develop high-sensitivity UV CMOS detectors suitable for CASTOR and future astrophysics missions that want to benefit from CMOS advantages (relative to CCDs) such as smaller pixels, radiation hardness, low power, shutterless operation, and flexible readout patterns such as guide windows.
11:15-11:30	John Vallerga, Jason McPhate, Anton Tremsin & Oswald Siegmund	UCB/SSL	Ongoing Developments for The Future Space Based Instrumentation	MCP detectors have provided a highly adaptable and robust option for high spatial resolution event counting space based sensors. Their application on instruments has spanned sub-orbital, space shuttle, space station, satellite and cometary/planetary probe missions ranging from small payloads to flagships such as HST. Currently ongoing implementation of MCP detector advancements is already underway in forthcoming selected small missions (MOBIUS, MANTIS, INFUSE, SPRITE, ASPERA). Due to advancements in performance and robustness they are also under consideration in proposals for SMEX, MIDEX and PROBE missions. The recent and pending advancements of MCP's and MCP detector systems will be discussed. In particular the advent of atomic layer deposited MCPs with formats up to 20cm, enhanced lifetime stability, improved quantum efficiency and reduced gamma ray sensitivity and ultra-low background are significant. Event position encoding readouts and electronics have also been advancing with implementation of high spatial resolution (<20µm) large area cross strip readouts (100mm), and pixelated ASIC readouts such as the TimePix. In concert with these, ASIC versions of position processing electronics are in the prototype phase and show considerable promise for enhanced performance with lower power and small footprints. These developments are highly relevant to the goals envisioned in a number of upcoming and conceptual NASA missions.

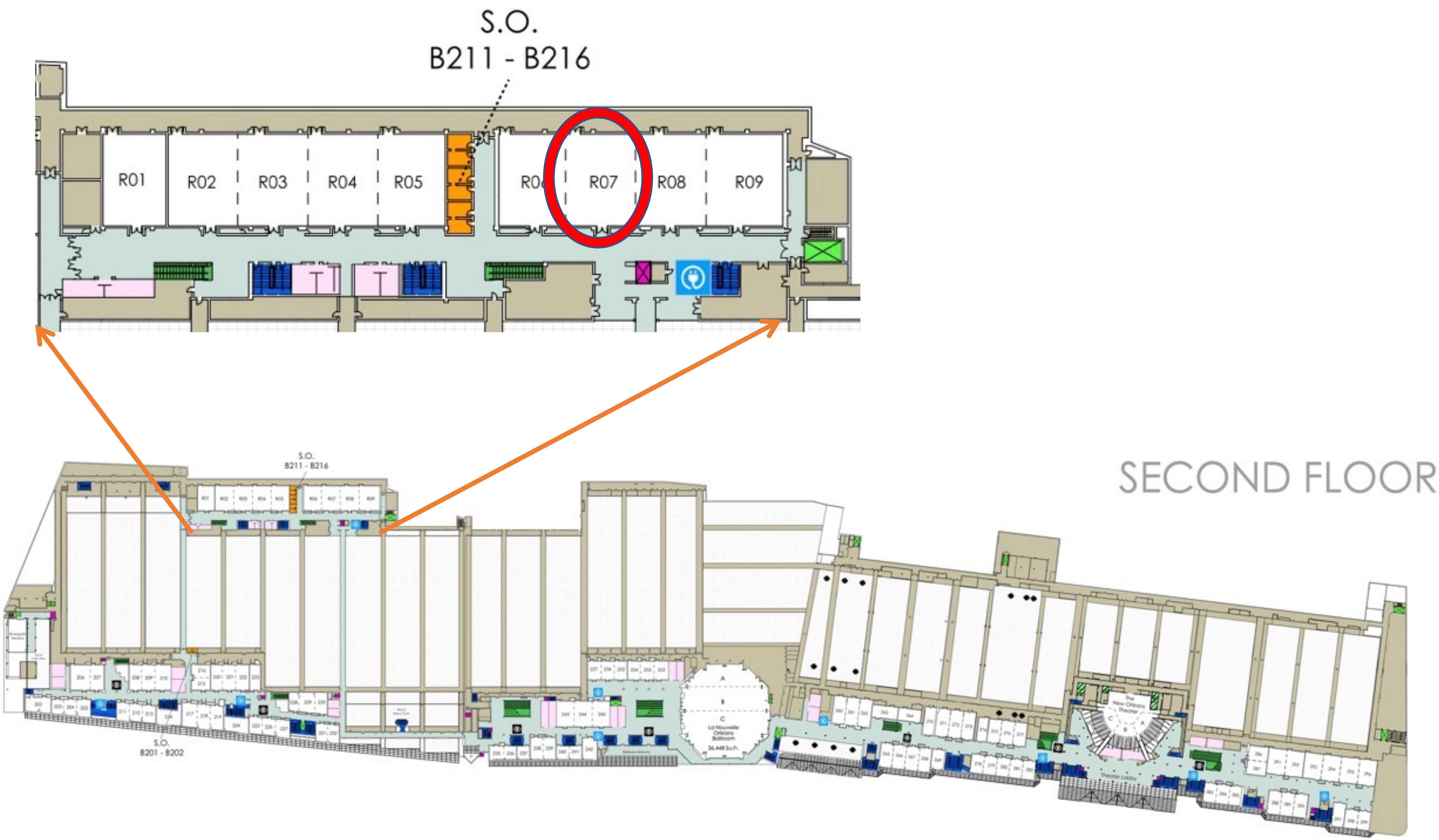
Break for Lunch

13:30-13:40	Keri Hoadly	UIowa	Advances in Diffraction Grating Fabrication for Space-UV Astrophysics	Ultraviolet (UV) spectroscopy has historically suffered from low-performance hardware compared to other wavebands, in part due to the inherent challenges in material properties at UV wavelengths (absorption in common VIS/IR substrates, degradation over time, etc). The biggest limitation to building high-sensitivity, high-resolution UV spectrographs is high-performance UV blazed gratings. Advances must be made to achieve the blazed gratings that will be necessary to enable a high-resolution (R>30,000) UV spectrograph on the Habitable Worlds Observatory (HWO). Here, we'll present on the current state-of-the-art fabrication techniques that shows the potential to make high performance reflection gratings for use in the space UV. We'll speak to advantages, disadvantages, and current challenges to move forward with creating large-format, high efficiency blazed (echelle) gratings. We'll also go through ways we measure the quality of UV gratings in helping to inform grating fabrication recipes.
13:40-13:50	Manuel Quijada	GSFC	Emerging Coating Technologies for Realizing High-Reflectance and Stable Mirror Coatings for Observations in the Far Ultra-violet	Astronomical instrumentation for measurements in the Far Ultra-Violet (FUV, 90-200 nm) typically use aluminum (Al) thin films due to their high reflectance over this wavelength range. However, the native aluminum oxide layer that forms on Al upon exposure to the atmosphere is strongly absorbing in this wavelength range, requiring that the films be protected with a dielectric that inhibits oxidation. The focus of this presentation will be to discuss recent progress made in developing high-reflectance and stable protected aluminum mirrors (based on LiF and AlF_3) by using a plasma-based treatment to protect the Al, as well as, using a chemical passivation process in a Physical Vapor Deposition in combination with using a XeF_2 gas. This presentation will also discuss the paths for each of these technologies for realizing the uniformity requirements of these broad-band Al-based coatings for application in the future flagship mission that NASA will be pursuing such as the Habitable World Observatory (HWO).
13:50-14:00	Sarah Tuttle	UWash	UV Technology White Paper: Getting ready for the Habitable Worlds Observatory	I will present the work of a significant fraction of the UV technology development community, brought together in a recently distributed white paper. We summarize the current state of the art, ongoing and upcoming missions, and propose both hardware development and strategic paths forward to reach the goals of HWO. We focus primarily on the proposed UV spectrograph side of the project, and present the broad range of scientific motivations that argue for a spectrograph with robust sensitivity down to 100nm.

Session on UV Missions - Chair, Stephan McCandliss

14:00-14:10	Kevin France	CU	The Extreme-UV Radiation Environments of Extrasolar Planets: the ESCAPE Small Explorer Mission	The long-term stability of exoplanetary atmospheres depends critically on the extreme-ultraviolet (EUV) photon and high-energy particle fluxes from the host star. The EUV flux also drives the demographics of the short-period planet population and regulates the ability for rocky planets to maintain habitable environments long enough for the emergence of life. In this talk, I will present the Extreme-ultraviolet Stellar Characterization for Atmospheric Physics and Evolution (ESCAPE) mission, selected for Phase A study in the most recent Astrophysics Small Explorer call. ESCAPE employs extreme- and far-ultraviolet spectroscopy (80 - 1650 Angstroms) to characterize the high-energy radiation environment in the habitable zones around nearby stars. ESCAPE provides the first comprehensive study of the stellar EUV and stellar coronal mass ejection (CME) environments that control atmospheric mass-loss and determine the habitability of rocky exoplanets. ESCAPE will survey over 200 stars (including the Tier A and B Habitable Worlds Observatory target list) to measure EUV irradiance, EUV flare rates, and the properties of CMEs. The ESCAPE instrument comprises a grazing incidence telescope feeding multiple diffraction gratings and a photon-counting detector. The science instrument will be assembled and tested in the space hardware facilities at the University of Colorado Boulder's Laboratory for Atmospheric and Space Physics. Data archives will reside at the Mikulski Archive for Space Telescopes (MAST).
14:10-14:20	Alexandre David-Uraz	GSFC/HowardU	Massive star wind variability in the ultraviolet: considerations for optimal mission design	In this presentation, I will briefly discuss some of the forms of variability that are seen in ultraviolet observations of massive stars (such as discrete absorption components) and how they arise from their winds (and the interface with the photosphere). In particular, I will review the important diagnostics as well as the range of timescales involved. Finally, I will discuss how different UV mission designs could help address open questions in high-mass stellar astrophysics and, effectively, bridge the gap.
14:20-14:30	Shouleh Nikzad, Evgenya Shkolnik & TEAM SPARCS	JPL & ASU	Star Planet Activity Research CubeSat (SPARCS)	A planet's atmospheric evolution and chemistry are extremely sensitive to input stellar ultraviolet (UV) radiation, which for low-mass stars (< 0.7 Msun), is known to be both strong and highly variable. The Star-Planet Activity Research CubeSat (SPARCS) is a NASA astrophysics 6U cubesat mission under development that is led by ASU in partnership with NASA's Jet Propulsion Laboratory, Goddard Space Flight Center, other research institutions, and industry. Its purpose is to assess the habitability of the space environment for planets orbiting low-mass stars. SPARCS aims to accomplish this by photometric monitoring of stars in the far-UV and near-UV, measuring the time-dependent spectral slope, intensity, and evolution of low-mass stellar UV radiation. To fit the cubesat format and accomplish its goals, SPARCS is designed with a small 9-inch telescope and enabled by high performance delta-doped sensors. In this presentation, we will briefly discuss SPARCS mission, science motivation, the enabling technologies, its status including the Star Planet Activity Research Camera—SPARCam—the two channel UV camera that was developed at JPL and recently delivered to ASU for integration into the payload.

14:30-14:40	David Ardilla (for Evgenya Shkolnik)	ASU	The Science Drivers and Broad-band Spectroscopic Capabilities of the UV-SCOPE MIDEX Mission Concept	Planetary atmospheres are significantly governed by the host star's ultraviolet (UV) emission through photochemistry and photoevaporation and are best probed by UV spectroscopy where higher atomic and molecular opacities yield bigger signals. UV-SCOPE (Ultraviolet Spectroscopic Characterization Of Planets and their Environments) will be designed to accomplish the broad population-wide studies needed to understand the underlying physical drivers of exoplanet atmospheres and answer today's most pertinent questions in exoplanet science, those needed to be well understood ahead of the Habitable Worlds Observatory. UV-SCOPE will achieve simultaneous wavelength coverage from the far-UV (FUV) to the near-UV (NUV); 1205 - 4000 Å at medium spectral resolution, including the strong and diagnostic Ly-α emission line. The observations will be executed from L2 where, compared to low-Earth-orbit, the UV backgrounds are negligible and uninterrupted long observations are possible. Such a telescopic capability provides a tremendous opportunity for a wide array of planetary and astrophysics research including solar system objects, protoplanetary disks, massive stars, active galactic nuclei, and a range of transient science
14:40-14:50	Paul Scowen	GSFC	POLSTAR	The Polstar SMEX mission has been designed to study the impact of rotation and environment on the evolution of massive stars. These stars are the most important contributors to galactic cosmic evolution, as they live out their entire lives and go supernova while low-mass stars are still forming. Massive stars drive the ecology of star formation through the Baryonic Cycle. A host of theories predict profound, yet different, consequences on stellar evolution for rapid rotation in these stars, so observational constraints are now essential. Polstar will use UV spectropolarimetry to capitalize on tell-tale stellar and wind asphericities induced by rapid rotation, to constrain the internal physics that dictates the evolution of the star and its impact on the Galaxy. Polstar will deliver 0.01% UV spectropolarimetry to provide a new window, a new capability to view the Universe with.
14:50-15:00	Keri Hoadly	UIowa	The Small NASA Optical Ultraviolet Telescope (SNOUT): A SmallSat mission concept to connect extreme UV stellar flare to exoplanetary atmospheres	What is the amount of ionizing energy incident on exoplanet atmospheres from their host stars? What is the relationship between white-light flares and this ionizing energy? These are key questions required to link our current archive of hundreds of stellar whitelight flares to the ionizing radiation released during them, and the ramifications of those flares on the survival of exoplanetary atmospheres, particularly for planets orbiting within the habitable zones of low-mass stars. The Small NASA Optical Ultraviolet Telescope (SNOUT) is a proposed Pioneers mission comprised of two co-pointing telescopes: one optimized for EUV wavelengths (comprised of three separate EUV segments) and one for visible wavelengths. SNOUT is designed to measure the quiescent extreme-UV (EUV) emission for 30 mow-mass stars (0.3 - 1 solar masses), covering a range of ages, in three EUV bandpasses. The combined instrument is housed in an ESPA-Grande spacecraft and will launch into low Earth orbit for a one-year baseline mission.
15:00-15:10	Emily Witt, Brian Fleming, Kevin France, James Green, Briana Indahl, Maitland Bowen, Alex Haughton	CU Boulder	Efficient Spectral Multiplexing for the Habitable Worlds Observatory	The 2020 Decadal Survey has endorsed both an ultraviolet (UV) spectrograph and imager on the Habitable Worlds Observatory (HWO) including the need to achieve sensitivity at 100 nm. In order to achieve spectroscopic imaging in the far ultraviolet (FUV) regime, efficient methods of spectral multiplexing are required. This in turn requires the development and technology readiness level (TRL) advancement of mirror coatings and large-format detectors as well as new optical systems like microshutters and image slicers that permit multi-object or integral field spectroscopy. Low-cost, risk-tolerant suborbital missions have driven the development of these HWO-enabling technologies over the past decade and rapidly advanced them from laboratory demonstrations to TRL 6 and above. One such missions is the INtegral Field Ultraviolet Spectroscopic Experiment (INFUSE), the first FUV integral field spectrograph with access to the >100 nm Lyman UV (91.2 - 121.6 nm). INFUSE incorporates UV-sensitive enhanced lithium fluoride (eLiF) coatings, the largest cross-strip microchannel plate detector ever flown, and an image slicer. Continued partnership with the NASA suborbital program for HWO technology development provides a rapid maturation pathway for these cutting edge advancements.
15:10-15:30	Paul Scowen, Kevin France, Alex David-Uraz, Jeff Linsky, Sarah Tuttle, Keri Hoadley	GSFC, CU, GSFC, CU, UW, UI	Panel Discussion	There will be a 10-20 year gap between the end of the Hubble Space Telescope (HST) mission and the beginning of a new flagship mission with ultraviolet spectroscopic capabilities. In the interim, what science should potential small- and modest-sized missions focus on as precursor efforts that advance conceptual and technical readiness and foster core-excellence in early career scientists who will go on to be mainstream uses of future flagship missions.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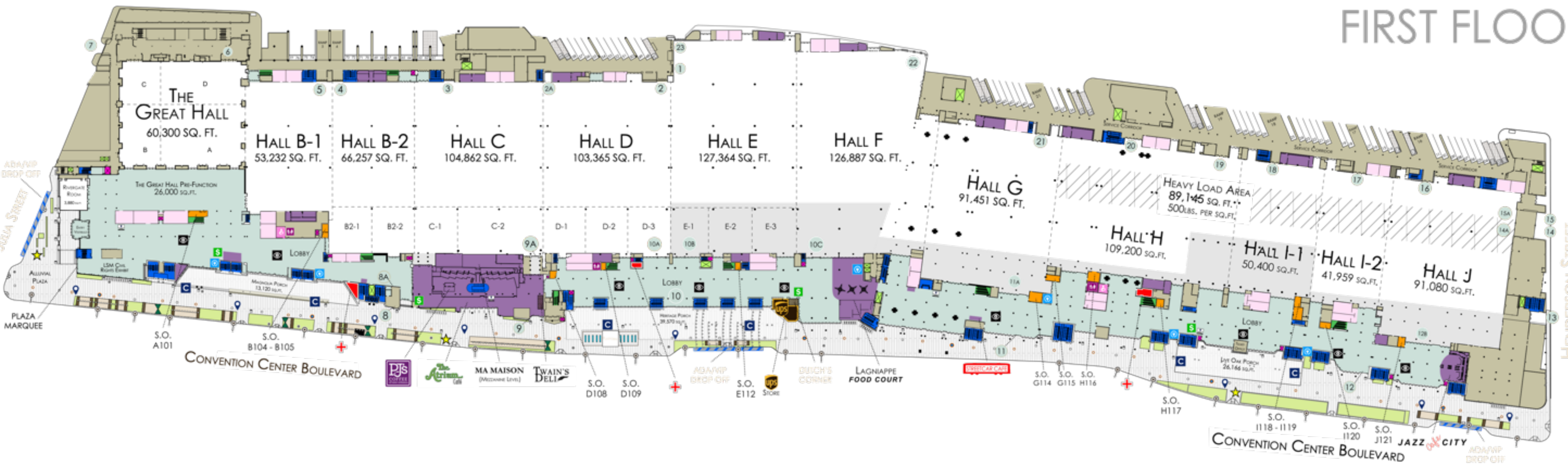

The Great Hall
60,300 SQ. FT.
Hall B-1
53,232 SQ. FT.
Hall B-2
66,257 SQ. FT.
Hall C
104,862 SQ. FT.
Hall D
103,365 SQ. FT.
Hall E
127,364 SQ. FT.
Hall F
126,887 SQ. FT.
Hall G
91,451 SQ. FT.
Heavy Load Area
89,145 SQ. FT.
500lbs. per SQ.FT.
Hall H
109,200 SQ.FT.
Hall I-1
50,400 SQ.FT.
Hall I-2
41,959 SQ.FT.
Hall J
91,080 SQ.FT.
The Great Hall Pre-Function
26,000 SQ.FT.
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B2-2
C-1
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D-1
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D-3
E-1
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Plaza Marquee
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S.O. B104 - B105
Convention Center Boulevard
PJ's Coffee
The Atrium Café
MA MAISON
Twain's Deli
S.O. D108
S.O. D109
S.O. E112
UPS Store
Lagniappe Food Court
Streetcar Café
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S.O. G115
S.O. H116
S.O. H117
S.O. I118 - I119
S.O. I120
S.O. J121
Jazz Café City
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