ARIZONA SPACE INSTITUTE SYMPOSIUM

May 8th
Venue: ENR2, Room 107

Flash Talk Abstracts

Michelle Coe

A Brief Overview of the UArizona NASA Space Grant Undergraduate Internship Program

Nox is a 12U CubeSat mission designed to map the all-sky EUV and FUV background. The EUV and FUV emission from the hot and warm-hot circumgalactic and intergalactic medium (CGM, IGM) is extremely faint. Therefore, a precise knowledge of the sky background level is essential to detect such faint features. Uncertainty in the background level can lead to several orders of magnitude differences in the required exposure time to reach a target sensitivity. Nox will create a foundational baseline for all future UV missions that seek to detect faint diffuse objects in the sky. Nox will conduct an all-sky spectroscopic survey in the entire EUV and FUV wavelength bands, from 90 nm to 240 nm, with a spectral resolution, R > 25, within a one-year on-orbit mission lifetime. This range covers important airglow lines in low-Earth-orbit, which are also critical for future missions to estimate in-band or out-of-band scattered light from bright airglow lines. An all-sky survey with a 12U CubeSat payload is made possible with two spectroscopic channels, each optimized to detect low-surface brightness faint EUV and FUV sky with high etendue. Nox will advance the Technical Readiness Level of multiple key technologies (UV detector, coating, and grating) for the future large IR/O/UV mission, where the Astro2020 Decadal recommends the mission. Nox proposal was developed with support from the University of Arizona Space Institute and proposed to Astrophysics Research and Analysis Announcement of Opportunity in December 2021.

Aman Chandra

Inflatable Membrane Antennas for Small Satellites

Small satellites such as nano-satellites or CubeSats have seen increased interest as low-cost platforms to access space and are being considered for more challenging mission objectives. However, they are by limited low data downlink rates, low available volume, and mass for high power communication systems. High gain antennas (HGA) have emerged as a critical technology to demonstrate high-speed transmission from small satellites. Conventional HGA technologies are complex in deployment and not scalable beyond a meter in size. Such systems do not efficiently package into available payload volumes on small sats.Further, the complexity of the deployment mechanism introduces multiple points of potential failure. FreeFall Aerospace has been developing inflatable spherical antenna technology for small satellites. These systems are comprised of membrane spheres with a partially reflective surface inflated pneumatically from sizes ranging from half to 3 meters. They provided a highly scalable and efficient stowage means of packaging a large reflector surface into a Cubesat payload form factor. This approach is unique in its ability to provide the missing link in creating high gain and high bandwidth telecom systems for CubeSats. In partnership with the University of Arizona, FreeFall Aerospace has packaged and integrated a 1.5 U inflatable antenna system on a 6U CubeSat mission named CATSAT. CATSAT will be the first technology demonstration of a 50 Mbps link using an inflatable membrane antenna from Low Earth Orbit and has been selected as a part of the NASA Elana 43 launch later this year. In the present work, we describe the development and integration of flight qualification testing of the inflatable antenna system.

Stephen Fleming

History of Space Exploration in Tucson

Tucson has been focused on space since the establishment of Steward Observatory over 100 years ago. We have a rich history of involvement in ground-based astronomy, military orbital surveillance, crewed exploration missions, and dozens of robotic space probes. Now Tucson is engaged in a new wave of space exploration and development with the private sector. This talk will give a quick overview of the University of Arizona's activities and what to expect in the coming years.

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Erika Hamden
Eos, Daughter of Hyperion: a FUV Spectrograph for Observing Galactic Molecular Clouds

We present the science case and rough design for Eos, a mission to be proposed to the 2025 NASA SMEX call. Eos is based on the well-reviewed Hyperion Mission concept, which was submitted in 2021, but not selected. In this flash talk, we will briefly describe the science objectives of Eos and provide details on our path to proposing in 2025.

Kevin Burke
City of Tucson Office of Economic Initiatives

A representative of the City of Tucson Office of Economic Initiatives will provide an overview of the City's economic development goals, share recent success stories, and solicit opportunities to collaborate in the creation of quality jobs and capital investment in our community.

Daniel Marrone
SALTUS, a NASA Probe Mission Concept

The Single Aperture Large Telescope for Universe Studies is a NASA Probe mission concept that leverages a cooled 20-meter inflatable aperture to transform our view of the cool universe. SALTUS is designed to trace the formation and evolution of planetary systems, including the conditions for life, study the formation of galaxies and the growth of metals over cosmic time, and understand the nature of black holes. The SALTUS focal plane is fed by actively and passively cooled 45K optics and houses three instruments cooled by a closed-cycle refrigerator. These include a 30-240micron R=300 spectrometer, focal plane arrays of coherent receivers for 4 bands between 500 GHz and 5.3 THz, and a VLBI receiver to extend the Earth-based Event Horizon Telescope to between 4 and 40x its current resolution. In the five-year lifetime of the mission, 70% of observing time will be available to guest observers, and guaranteed time surveys will produce important public legacy data products.

Alfred McEwen and the Prometheus team
Prometheus: A New Frontiers 5 Mission to Io

Jupiter's moon Io, the world with the greatest tidal flexing, volcanic and tectonic activity, and mass-loss in our solar system, begs for dedicated exploration. Missions such as Juno, JUICE, and Europa Clipper, along with Earth-based telescopes such as JWST and ALMA, will acquire important Io observations over the next 15 years. However, a mission designed for Io science is needed for key advances, to contribute to understanding the early evolution of terrestrial planets, tidally heated exoplanets, and ocean worlds, and magnetospheric physics across the galaxy. The NASA Discovery-class Io Volcano Observer Phase A study demonstrated how ten carefully designed close Io flybys could determine the melt distribution in Io's interior--confirming or refuting the purported magma ocean, determine Io's lithospheric structure, determine where and how Io is losing heat, and determine Io's volatile loss processes and rates. Such encounters would also measure Io's rate of orbital migration, key to determining the stability of the Laplace resonance that heats Europa and Ganymede as well as Io. The science payload included a magnetometer, plasma instrument, narrow- and wide-angle cameras, thermal mapper, and neutral mass spectrometer. There will be an opportunity in 2023 to propose an Io mission in NASA's New Frontiers program, so how might that differ from a Discovery-class mission? An Io orbiter to provide the best geophysical measurements would be very challenging deep inside Jupiter's gravity well and high radiation zone. However, the IVO concept could be augmented with a radiation design to support more than ten encounters and use of Ka-band downlink telemetry to improve the data return capability and gravity science. There are

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many other science instruments that would be valuable additions. Small spacecraft might be released to explore close to Io's surface. International collaborations will be especially important for instruments and spacecraft subsystems.

Mihailo Martinovic

WINS: Waves, Instabilities & Noise Spectrometer for Earth's Ionosphere

A significant advancement for improving our understanding of the physical processes in the Earth's ionosphere has been provided by the introduction of SmallSats---specifically our ability to launch small probes able to perform both in situ and remote sensing measurements in large numbers. To accomplish the high-priority NASA objective of describing the energy transfer throughout the ionosphere mediated by particles and waves, mapping the characteristic plasma conditions in 3-dimensional space, over longitude, latitude, and altitude is necessary. This task has become achievable if the diagnostic equipment is affordable and small in size. Accurate measurements of the plasma density and temperature using electric field fluctuation sensors are routinely done in the solar wind via Quasi-Thermal Noise (QTN) spectroscopy. In this project, with a highly experienced team in field sensor instrumentation in both the ionosphere and the solar wind, and a long record of implementing QTN methods, we will redesign solar wind instrumentation for the ionospheric environment. With significant simplifications of the instruments used on flagship and explorer class missions, while still keeping crucial architectural advantages such as potential to use dipole antenna configuration, we will be able to provide a sensor that can be installed on a CubeSat. Waves, Instabilities & Noise Spectrometer (WINS) instrument will measure plasma parameters and waves as accurately as the well-established solar wind payloads. The maturation of the instrument TRL from 3 to 5 will make this instrument feasible for Heliophysics Low-Cost Access to Space (H-LCAS) projects in the future, as well as for commercial opportunities. Launching on a similar timeline as Geospace Dynamics Constellation (GDC) mission, it will provide results complementary to the ones from Atmospheric Electrodynamics probe for THERmal plasma (AETHER) suite, and aid in resolving potential observational issues early in the mission.

Daniel Apai

Nautilus Space Observatory: A Large Diameter, Ultralight Space Telescope Constellation

Thorough, population-level understanding of habitable and inhabited planets requires systematic studies of large samples of planets. However, the very slow growth of the light-collecting area of space telescopes and their very high cost remain severely limiting factors for exoplanet and biosignature studies. I will introduce the Nautilus Space Observatory concept that is designed to spectroscopically characterize the atmospheres of 1,000 exo-earth candidates. Nautilus is enabled by the revolution in the space launch industry and by a novel optical technology developed at UArizona: Multi-order diffractive engineered material (MODE) lenses. MODE lenses provide ultralight and easier-to-fabricate alternatives to primary mirrors and, thus, enable a new paradigm for very large space telescopes. I will show our active UArizona-led technology development program, our latest MODE lens prototypes, supporting facilities, and progress on design, fabrication, alignment, and testing methods. I will describe the Nautilus Space Observatory and its science scope, and the exciting scientific opportunities this mission will enable.

Aaron Tohuvavohu

A Future of Abundant + Accessible Space Telescopes

Astronomy is on the cusp of a paradigm shift on numerous fronts, with the rapid development of new possibilities for instrumentation, discovery, and access. I will discuss a possible future of space telescope design, development, production, and operation, and efforts by a group of romantics at the University of Toronto and around the world to

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democratize access to orbital-class astronomical data, technological gaps that exist, and open-source instrumentation projects to address these gaps. The next five decades of space-based astronomy have the potential to be significantly brighter, more creative, and diverse than the last five, and we must meet this opportunity with new eyes and a new appetite for discovery.

Carlos Vargas

Aspera SmallSat Mission Update

For over half a century, observational astrophysics has been eager to successfully detect and map the most massive baryonic component of galaxies: warm-hot phase gas in the circumgalactic medium (CGM). Despite its importance to galaxy evolution, this phase of gas is entirely unmapped in the nearby universe. The *Aspera* Mission will provide the first volume-filled emission maps of the warm-hot component of the CGM in nearby galaxies. The *Aspera* mission is designed to target the O VI emission line doublet from highly ionized oxygen, located at 1032 & 1038 Å, rest frame. *Aspera* combines a simple spectroscopic optical design using advances in highly reflective FUV-coated optics with an advanced UV MCP detector to optimize throughput and sensitivity. *Aspera* will build multiple days of exposure time on each individual target to ensure spectroscopic detection of O VI emission and produce 2D morphological maps and direct measurements of physical conditions such as kinematics. The *Aspera* mission was selected for funding in the inaugural 2020 NASA Astrophysics Pioneers Program ($20M) in January of 2021, and is currently concluding its design phase with a projected launch in 2025. This brief talk will provide an update of the mission's recent progress.

Jekan Thanga

Cislunar Development in Support of Space Exploration

The exploration and utilization of space over the last 66 years have had a transformative impact on humanity. In those few decades, robotic missions have explored every major planetary body in the solar system and several small bodies, including asteroids and comets. These missions have been primarily funded by the taxpayer ignited by the superpower competition of the Cold War, followed by transitioning multi-national science agendas. The taxpayer alone cannot sustain renewed interest and support for space exploration, mainly due to ever-changing national priorities and terrestrial threats to human civilization. There is a critical need for space exploration to achieve economic self-sustainability and provide new solution pathways to dire challenges facing humanity. The SpaceTRExLaboratory, in its 10th year of existence, has been exploring the potential opportunities and challenges of Cislunar development to boost and economically sustain space exploration. Through the efficient utilization of space resources, missions have the potential to be simpler from an engineering point of view. In addition, they could achieve increased robustness, attain whole new capabilities in terms of range and propulsion, and science data quality, and could cost a fraction of the present mission costs. Significantly, this paradigm shift could strengthen next-generation exploration missions by enabling them to reach farther into the solar system's edge and to our interstellar neighbors and intercept and explorefast-movinginterstellar objects. This is akin to previous waves of terrestrial exploration missions that have transformed from one-shot exercises into sustained campaigns logistically supported by utilizing local resources. Development of space logistics and space infrastructure development is the key to advancing better communication, enabling spacecraft refueling, repair, and continual instrument upgrades that can sustain and make future space exploration missions more competitive. SpaceTREx has been supporting efforts to advance Cislunar development by evaluating robotic systems of system-end solutions toward lunar base and facility construction, spacecraft refueling depots, and space-based space domain awareness monitoring facilities. These efforts have been complemented with fundamental research in docking and modular

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spacecraft, RF, Laser and light-based communication, space infrastructure construction, and swarm design, coordination, and control. Building and maintaining major science and research/development facilities plays a core strength of the University of Arizona. Herein lies the opportunity to advance such capabilities into Cislunar space.

Maggie Kautz

GMagAO-X: A First Light Coronagraphic Adaptive Optics System for the GMT

GMagAO-X is a visible to NIR extreme adaptive optics (ExAO) system that will be used at first light for the Giant Magellan Telescope (GMT). GMagAO-X is designed to deliver diffraction-limited performance at visible and NIR wavelengths (6 to 10 mas) and extreme contrasts on the order of 10-7. The primary science case of GMagAO-X will be the characterization of mature, and potentially habitable, exoplanets in reflected light. GMagAO-X employs a woofer-tweeter system and includes segment phasing control. The tweeter is a 21,000-actuator segmented deformable mirror (DM), composed of seven individual 3,000 actuator DMs. This new ExAO framework of seven DMs working in parallel to produce a 21,000 actuator DM significantly surpasses any current or near future actuator count for a monolithic DM architecture. Bootstrapping, phasing, and high order sensing are enabled by a multi-stage wavefront sensing system. GMT's unprecedented 25.4 m aperture composed of seven segments brings a new challenge of co-phasing massive mirrors to 1/100th of a wavelength. The primary mirror segments of the GMT are separated by large >30 cm gaps so there will be fluctuations in optical path length (piston) across the pupil due to vibration of the segments, atmospheric conditions, etc. We have developed the High Contrast Adaptive-optics Testbed (HCAT) to test new wavefront sensing and control approaches for GMT and GMagAO-X, such as the holographic dispersed fringe sensor (HDFS), and the new ExAO parallel DM concept for correcting aberrations across a segmented pupil. The CoDR for GMagAO-X was held in September 2021 and a preliminary design review is planned for late 2023. In this talk we will discuss the science cases and requirements for the overall architecture of GMagAO-X, as well as the current efforts to prototype the novel hardware components and new wavefront sensing & control concepts for GMagAO-X on HCAT.

Maxwell Rizzo

Revisiting the FUSE Data Archive - Finding O VI Emission

A significant majority of the galactic baryonic matter exists in the form of diffuse gas, known as the circumgalactic medium (CGM). The Far-UV O VI emission lines (1031.93, 1037.62 Å), corresponding to 6-times ionized Oxygen provide a crucial, but observationally challenging signal of warm-hot gas around a temperature of 10^5 - 10^6 K. Simulations of star forming galaxies indicate warm-hot gas contributes more mass than stars. This project revisited the entirety of the NASA FUSE (Far Ultraviolet Spectroscopic Explorer, 1999-2007) data archive, searching for more detections of extragalactic O VI signal to 3σ. A high-performance data pipeline was created to look for this signal using a combination of computational methods, and manual observation. We expect to increase the number of O VI detections, which will inform the target selection for the NASA Aspera mission, a SmallSat spectroscopic telescope to be launched in 2025.

Mira Milas

APEX Aerospace Medicine and Surgery at University of Arizona... & Beyond

The University of Arizona College of Medicine, Phoenix, in partnership with Banner Health and SpaceX, is the site of the Aerospace Medicine and Surgery (APEX) Fellowship. Centered in Phoenix, AZ, and administered with collaborating surgeons and physicians nationally, the APEX Fellowship will prepare physicians to work in the commercial aerospace medical field and provide austere surgical and critical care support. This is a unique opportunity and represents the first

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fellowship training program in the U.S. that goes beyond primary care medical oversight of astronauts, teaching aerospace surgery and procedural skills for aerospace missions.

John Kidd, Sanford Selznick, and Carl Hergenrother
Mission Engineering Support with Ascending Node Technologies and Spaceline®

Ascending Node Technologies is a Tucson-based small business producing tools from lessons learned on the OSIRIS-REx mission. We provide several services and technologies to assist all stages of a mission from pre-proposal support through operations and data product archiving. Spaceline is our flagship product which provides an ecosystem that enables engineers, scientists, and managers across a team to better collaborate on their mission with a web-based 3D interactive visualization. Spaceline leverages this robust data management system and powerful analytical capabilities to easily render what your spacecraft either saw in the past, is seeing currently, or is predicted to observe in the future. Spaceline is the tool we wish we had on OSIRIS-REx during mission conception and operations planning. Additionally, our team has a long history of designing mission concepts and conducting the analysis necessary to demonstrate their feasibility. Use our experience with developing Concept of Operations (ConOps) for a variety of different mission types to demonstrate to proposal reviewers that your mission will successfully fulfill your science objectives. With over five decades of collective experience designing scalable and robust ground data systems to support missions ranging from orbiting Mars to visiting previously unexplored asteroids, we can build science operations centers to support your mission success. Whether it's flight software, a ground data system to communicate with your spacecraft, or integration with a mission archival service, Ascending Node Technologies has experience with software engineering at any level in the space industry.

Kai Staats
A Space Analog for the Moon & Mars at Biosphere 2

For the past two and a half years, a team of volunteers, consultants, and staff lead by UA Director of Research for SAM at Biosphere 2, Kai Staats, has engaged in the design and construction of the world's highest fidelity otherworld habitat analog. SAM is built around the 1987 Test Module prototype for Biosphere 2, with an expanded living space that now includes a workshop and crew quarters with sleeping pods, common space, kitchen, and full bath. SAM is unique among the many habitat analogs in the world in that it is hermetically sealed and pressurized, with an operational airlock and sealed hatches. One to four crew will live inside for a minimum of one week to a few months at a time, with a life support system that includes temperature control, water recycling, carbon dioxide scrubbing, and bioregeneration (plant-based air cleaning) through the application of hydroponics and algae. The first team arrives to SAM April 26th for a full day of training, and initiates their six day, five-night mission April 27th. The second team enters on May 9th, following the Analog Astronaut Conference hosted by Biosphere 2. This presentation will provide a photo tour of the construction of SAM and a preview of the real-world science that SAM will engage in to help our species become interplanetary.

Tyler Robinson
Solar System Observations for Exoplanet Analogs

The 2020 Decadal Survey on Astronomy and Astrophysics recommended an exoplanet direct imaging telescope as its highest priority for a large-scale, space-based mission and highlighted the synergies between solar system studies and exoplanet science. Unlike previous exoplanet-themed missions, prime targets for characterization with the Decadal's recommended mission (dubbed the Habitable Worlds Observatory, HWO) would be warm/cool planets orbiting Sun-like hosts. Given impending planning and design exercises for HWO, whole-disk observations of solar system worlds across a

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range of relevant wavelengths and phase angles are extremely valuable and are best obtained with interplanetary spacecraft. This presentation will motivate observations of solar system worlds as crucial analogs for future HWO data and will highlight how such observations can be easily added to interplanetary missions for an interdisciplinary astrophysics connection.

Ruben Dominguez

A Thermal Vacuum Chamber: Provides for Thermal Cycling of Space-based Satellites, Balloon Payloads and their Components, and Control Systems

The Applied Research Building's (ARB) thermal vacuum chamber has two requirements. First is for balloon payloads, and the second is for space-based instruments. In the first requirement, for balloon payloads, the thermal vacuum chamber will simulate the thermal conditions and vacuum pressure as the balloon payload ascends to an elevation of 120,000ft. During this ascent, the temperature will go from ground level, 0C to 20C, to -10C at an elevation of 120,000ft. At the same time the vacuum pressure will start at 760torr, at ground level, to 5torr at 120,000ft. A typical balloon payload will ascend to 120,00ft in 2 to 3 hours. The ARB thermal vacuum chamber will have vacuum pumps that can be controlled to simulate the ascension vacuum pressures. A liquid nitrogen shroud system will control the chamber temperatures as the balloon payload ascends to 120,000ft. In the second requirement the thermal vacuum chamber will simulate thermal conditions for space-based satellites. The vacuum pressures will be taken to around 1x10-6 torr, and the temperature of the chamber shrouds will be lowered to around 80K.

Karl Harshman

Mission Operations Center

A mission operations center is where a space/balloon mission is operated from. The operations consist of commanding the spacecraft/balloon and instruments on board. It is also where the data coming from the spacecraft/balloon arrives to be distributed to participating parties. The University of Arizona has been involved in many missions where the science operations were provided but up to now has never provided the Mission Operations. This talk will provide information as to how we got here and where this is hopefully going.

Frederic Zenhausern

Space Drug Discovery – Planetary Gases-As-Drugs

Medical gas therapy (MGT) using biological or noble gases with therapeutic benefits has been limited to inaccurate and possibly unsafe inhalation. Our team is taking a new approach optimizing nanomaterials formulation for enwrapping everlasting gas bubbles into small marbles which can persist positive or negative pressure up to 10 atmospheres containing a variety of gases. These gas marbles are suitable for pharmaceutics and galenical preparation for facilitating administration into a pill or suppository, ultimately. Planetary atmospheres are evolving offering unexploited sources for possibly discovering light isotopes (e.g., volatiles on Mars) or gas mixtures that might provide some future therapeutic benefits. Other contributions may also come from gases seeping out from a planet's interior. As climate change impacts the composition of the Earth atmosphere, with its vast capacity, it could also become the newest frontier for the discovery of future gas therapeutics. The atmospheric composition of thousands of exo-planets might also contribute to the discovery of such gases-as-drugs with potential benefits for mankind.

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Erik Asphaug (University of Arizona) and Paul Sava (Colorado School of Mines)
Remote Sensing Seismology by Laser Doppler Vibrometry

We are advancing a remote sensing seismometer (RSS) for space missions [1]. The primary application is to characterize the mechanical properties and possibly image the interiors of small airless bodies (comets, asteroids, small moons) using seismic wavefields observed from ~1 km distance [2], wherever the spacecraft-mounted instrument is pointed. RSS uses laser Doppler vibrometers (LDVs) to enable seismology in the amplitude range ~1 um to 1 mm, at frequencies ~0.1-100 Hz, exploiting natural and/or artificial seismic sources. LDVs are robust instruments with no mechanical components. RSS operates alongside the other remote sensing payload onboard the main spacecraft; no landers are required, with their cost, complexity and risk, and their severe power, life and data limitations. RSS measures vibrations directly, using mechanically coupled objects such as cliffs and embedded boulders, thus avoiding the data ambiguity associated with lander-surface coupling. Our prototype is based around a commodity instrument; tests have been performed for seismic frequency and amplitude, ground rugosity and reflectivity, and to overcome speckle noise [3]. [1] Sava & Asphaug, “Seismology on small planetary bodies by orbital laser Doppler vibrometry,” Adv. Space Research (2019). [2] Sava & Asphaug, “Interferometric Seismic Imaging of Asteroid 99942 Apophis,” LPI Contribution, Apophis T-7 Years: Knowledge Opportunities for the Science of Planetary Defense, 2681 (2022). [3] Courville & Sava, "Speckle noise attenuation in orbital laser vibrometer seismology," Acta Astronautica (2020).

Daniel Diaz
Laser-based Diagnostics for Space Exploration: Isotopic, Atomic, and Molecular Spectroscopy

Qualitative and quantitative chemical analyses of extraterrestrial materials are essential for achieving the science- and commercial-oriented goals of space exploration. Among many analytical techniques, those based on laser and optical technologies have demonstrated to be suitable for space exploration. This presentation discusses the fundamentals and applications of laser-induced breakdown spectroscopy (LIBS) and LIBS-based techniques for chemical characterization of complex and heterogeneous geomaterials, as well as the characterization of chemical processes with Raman spectroscopy. LIBS-based techniques can perform in situ, rapid, stand-off analysis of solids, liquids, gases, aerosols, and plasmas with minor or no sample preparation in various atmospheres and pressures. They are considered semidestructive and calibration is required for quantitative results. Isotopic, atomic, and molecular information can be retrieved from a LIBS measurement. Related advantages are associated to Raman spectroscopy, a vibrational spectroscopy technique that can provide information regarding chemical and physical structure. Our research includes the chemical characterization and mapping of soils, ores, complex ore mixtures, heavy metals, precious metals, and rare earth elements.

Joe DuBois, Jessica Rousset, and Danny Jacobs
ASU Interplanetary Laboratory Mission Review

ASU has developed a cubesat and space flight hardware laboratory. This Laboratory contains the capital equipment necessary to develop spaceflight hardware including fabrication and environmental testing and is available to both ASU and external partners. This discussion will review the Lab's capabilities, project management approach, recent Lightcube mission, in-process missions, and future directions.

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Walter Harris

The Hydrogen Emission Lineshape Interferometric Explorer (HELIX): Mapping the Doppler Structure of Exospheric Hydrogen with Line Resolved Interference Spectroscopy.

The transition from the topside ionosphere and the exosphere is an important region for interactions that exchange mass, momentum, and energy between the Earth's upper atmosphere and the interplanetary medium. Atomic hydrogen plays a key role in this transition at all levels from its photochemical source in the mesosphere to its eventual escape in the exosphere. Understanding its distribution and how it responds to external factors is therefore important for 1) understanding the mechanisms that drive the evolution planetary atmospheres, 2) providing benchmarks for photochemical processes and the evolution of hydrogen-containing species (e.g., CH4 & H2O), and 3) the study of the plasmasphere. HELIX will explore the vertical distribution, transport flux, thermal, and non-thermal properties of Hydrogen as it expands outward into the exosphere through measurement of the intensity and lineshape of H Ly-a and H Ly-b emissions. The HELIX science instrument is a dual channel reflective spatial heterodyne spectrometer (RSHS). RSHS is a novel spectroscopic technique that provides both high sensitivity and high spectral resolving power in a SmallSat compatible format. HELIX will repetitively sample the hydrogen column density, lineshape, and response to solar activity at a range of altitudes above the terrestrial mesosphere from low Earth orbit over a 12-month mission.