PRESENTER ABSTRACTS

Brandon Chalifoux
Assistant Professor, Wyant College of Optical Sciences

Flex Modules: A Path to High Resolution X-Ray Telescope Optics via Final Step Figuring

Grazing-incidence X-ray telescope mirror assemblies that are accurate enough for sub-arcsecond half-power diameter image quality, yet thin enough for square meters of effective area, will be critical for future flagship-class X-ray astronomy missions. Segmented mirrors are attractive because the small mirror substrates are more easily figured and handled than full shell optics, but severe deformations from coating, assembly, and alignment remain significant challenges for sub-arcsecond imaging quality. To overcome these challenges, we introduce Flex Modules, which are epoxy-free all-glass mirror assemblies in which the mirror segments are simultaneously figured and aligned after coating and assembly. While their primary application is for X-ray optics, we envision the Flex Module approach could enable ultralightweight optical systems in UV/VIS/IR bands as well. To fabricate Flex Modules, the mirror segments (Flex Segments) are first each precisely etched out of a monolithic glass substrate to form a flexure-supported optical sub-aperture. The Flex Segments are then ultrafast laser-welded to the Flex Module via glass spacers. Finally, the Flex Segments are aligned and figured using Ultrafast Laser Stress Figuring (ULSF), a non-contact figuring process that generates permanent and predictable stress within the mirror substrate. I will present our latest flat Flex Module prototype, and I will show that the Flex Module fabrication process meets surface roughness and figure stability requirements for future high resolution X-ray optics. The Flex Module approach may break through the decades-long sub-arcsecond resolution barrier for astronomical X-ray optics, and may enable ultralightweight optical systems at longer wavelengths.

Haeun Chung
Assistant Research Professor, Steward Observatory

GlowSat: A 6U CubeSat Mission Concept for Far-Ultraviolet Airglow Survey and Technology Advancement

GlowSat is a 6U CubeSat mission concept designed to advance far-ultraviolet (FUV) space technology and to perform the first dedicated survey of FUV airglow lines between 101 nm and 141 nm in low Earth orbit (LEO). FUV airglow emissions form the dominant background noise for FUV

observations and can severely limit the detection of faint astrophysical signals. In particular, the extremely faint extreme ultraviolet (EUV) and FUV emissions from the hot and warm-hot circumgalactic and intergalactic media (CGM and IGM) — potentially below 33 LU (1E-20 erg/s/cm^2/arcsec^2 at 150 nm) — necessitate precise characterization of this background. Without such measurements, scattering from bright airglow lines may overlap with the science signal, introducing significant noise. GlowSat aims to establish a foundational baseline for all future FUV missions by systematically mapping the intensity of the strongest hydrogen and other airglow lines over a broad range of Sun–Earth–spacecraft geometries and line-of-sight directions. By correlating airglow intensity with the observer's geometry and attitude, the mission will deliver the first comprehensive dataset quantifying these variations and their impact on space-based FUV observations. The mission's innovative design centers on a compact, high-sensitivity 2U FUV spectrograph payload, featuring an 80 mm × 20 mm cylindrical off-axis mirror, a reflective slit, a collimator, a flat grating, a spherical focusing optic, and a CMOS detector. Leveraging advanced technologies such as a high-groove-density Silicon-based e-beam lithography grating and a commercial CMOS sensor with a scintillator coating, GlowSat achieves high performance with minimal mass, volume, and power consumption. Additionally, by advancing key technologies like humidity-resistant UV coatings and low-scattering gratings, GlowSat not only meets its science objectives but also paves the way for future large-aperture IR/O/UV space missions.

Christopher Corbally & Margaret Boone Rappaport

Staff Astronomer, Adjunct Astronomer, Vatican Observatory, Department of Astronomy

Options for Governance and Regulation of Satellite and Other Space Debris

With greater use of cislunar space, there is added debris from rocket boosters, satellites, and space stations. Collisions between any of these would create fragments of various sizes, in large quantity, at significant velocities. All pose a danger to spacefaring. Governance of cislunar debris mitigation represents a difficult set of issues because of possible financial obligations, imposed standards, rules for handling waste, equipment specifications, and protocols if there are accidents. Existing capacities for rescue and recovery are also limited, and the inter-organizational protocols are not yet fully developed, although the Artemis Accords have established the need. Since 2023, ESA has provided a governance model in its debris mitigation policy - for ESA space missions. NASA has worked on similar policies. When the ISS is decommissioned around 2030, the transfer of its responsibilities to commercial stations will occur. Coordination could be even more complex, to include nation-state programs, commercial businesses, and orbital stations. Organizations like the Space Generation Advisory Council, a US 501(c)3, are helping to outline economic, legal, and political challenges. Beginning in 2024, a US satellite launched into Earth orbit is required by the US Federal Communications Commission to be removed within five years of its mission end. It can be removed by being pushed down to burn up in the Earth's atmosphere or pushed up into a "graveyard orbit". Innovations in technology are essential to achieve the removal of spent satellites. Removing the myriads of tiny fragments from cislunar space is a challenge of a different order. Who will take the lead internationally? What set of incentives and dis-incentives can bolster policies and be realistically administered? What types of technological innovations are most needed? A new Cosmopolitanism beckons in order to agree to the imposition of membership dues or fees, or taxes.

Jason Corliss

R&D Engineer, Lunar and Planetary Laboratory, Department of Astronomy

The Spatial Heterodyne Interferometric Molecular Cloud Observer (SHIMCO): A Suborbital Mission Scheduled for Launch in 2027

SHIMCO is an upcoming sounding rocket mission funded by NASA's Astrophysics Research and Analysis Program (APRA), with launch targeted for June 2027 from White Sands, New Mexico. The mission is designed to investigate the physical conditions within molecular cloud star-forming regions by capturing ultra-high resolution ($R > 150,000$) spectra of molecular hydrogen emissions in the vacuum ultraviolet (VUV) near 160 nm. Central to SHIMCO's payload is an all-reflective spatial heterodyne spectrometer (ARSHS), paired with a photon-counting electron-multiplying CCD (EMCCD) detector. This presentation provides a mission overview, highlighting current development status and the scientific objectives shaping the design and optimization of SHIMCO's instrumentation, software, and hardware.

Fabio Curti

Associate Professor, Departments of Systems & Industrial Engineering

Space-Based Detection of Resident Space Objects Using Star Sensors

The growing population of Resident Space Objects (RSOs), including satellites and space debris, poses significant challenges to space situational awareness and surveillance. Current RSO catalogs are primarily built and updated through ground-based radar and optical measurements, which are limited by factors such as distance and the inability to provide continuous monitoring of space. This work proposes the use of star sensors as an innovative solution for detecting RSOs, capitalizing on their widespread presence on orbiting platforms. Unlike ground-based systems, space-based observations are unaffected by atmospheric distortions or weather conditions, allowing for continuous, distortion-free monitoring from various observer-to-target distances. The study focuses on a feasibility analysis of employing star sensors in conjunction with dedicated algorithms running onboard spacecraft to detect and catalog RSOs. This approach minimizes the impact on the platform, enabling any satellite equipped with a star sensor to function as a space surveillance node. The algorithm produces a pre-processed object database, which can be further analyzed on the ground. The performance of the algorithms is assessed using both real and simulated images, demonstrating advancements in RSO tracking and contributing to improved space situational awareness.

Andrew Gardner

R&D Software Engineer IV, Arizona Space Institute, Lunar and Planetary Laboratory, Department of Astronomy

Multi-Mission Operations Center

ASI's Multi-Mission Operations Center builds on the University of Arizona's decades of space mission operations experience. We partner with instrument and spacecraft teams to provide world-class mission operations and data management services to Pioneer-class missions. We will provide updates on our first partner's development and launch.

Justin Hyatt

Senior Research Associate at UA and CEO of Paramium Technologies, Steward Observatory

Getting data down to earth - new ground station technology

There were 28,318 active satellites in orbit at the end of 2024 . There are not enough earth stations to receive the data collected by the satellites we currently have. Launch costs have dropped by 25x in the last decade and will fall again as SpaceX's Starship comes online. Experts predict that there will be over 100,000 satellites by 2030. Paramium Technologies, a UofA spinoff company is mass-producing a network of ground antennas to relieve this data bottleneck. They use robotic manufacturing and other innovations to mass produce antennas. Paramium is building a self-serve Ground Station as a Service (GSaaS) platform to alleviate the shortage. Satellite companies can use Paramium's antenna network to download data from their satellites. Paramium's secret to mass producing enough antennas for global coverage is their new, patent-protected antenna design called the Magnum, based on principles of origami. Paramium has also built a web-based platform where satellite operators can book time to use the Magnum antenna network. It will be as easy as scheduling a meeting on Zoom. Satellite operators can apply now for early access to the Magnum network. Dr. Justin Hyatt, a Senior Research Associate at Steward Observatory is also one of the founders of Paramium Technologies. He will present on the underlying technologies that allow for this standardized global communication network.

Aafaque Khan

Doctoral Candidate, Future Investigator on NASA FINESST, Steward Observatory

Big Science with Small Satellites: Uncovering the Cosmic Collision Between Milky Way and Large Magellanic Cloud with Aspera Extended Mission and Beyond

Aspera is a NASA Astrophysics Pioneers mission designed to explore diffuse OVI emission from the warm-hot circumgalactic medium (CGM) of nearby galaxies. The payload features two identical long-slit spectrographs optimized to detect and map the OVI emission line at a rest-frame wavelength of 1032 Å. Currently, in the implementation phase, Aspera is targeting a 2026 launch. Its baseline mission will focus on observing up to ten selected galaxies during the first year of operations. Beyond that, Aspera's high sensitivity, wide 1-degree slit field of view, and unique 1030–1040 Å bandpass enable it to pursue additional groundbreaking observations. This talk explores a potential extended mission concept for Aspera, aimed at mapping OVI emission around the Large and Small Magellanic Clouds (LMC/SMC) and the Milky Way (MW). Observations of background quasars have revealed multiphase gas trailing the LMC, rich in ions like CIV, SIV, and OVI. The origin of this gas is still debated—it could represent the LMC's original circumgalactic medium (CGM) or result from interactions between LMC-driven outflows and the MW's CGM, influenced by the LMC's supersonic motion through the Galactic halo. A crucial test to differentiate these scenarios is measuring the gas distribution ahead of the LMC, where current observations are sparse. Models predict that a shock interaction would produce a sharp cutoff, while a CGM-dominated origin would lead to a more extended structure. Aspera's sensitivity to warm-hot gas emission makes it well-suited to investigate this region. We outline a strategy in which Aspera performs several targeted pointings along the LMC's direction of motion over the course of a month, sampling the OVI emission radial profile in front of the LMC. These measurements are essential for understanding the LMC-SMC system's evolution and the role of dwarf galaxy interactions in shaping the MW's CGM. Such observations would also serve as a pathfinder for future missions designed to fully map ionized gas structures around the LMC.

Jarron Leisenring

Director of ITL, Assistant Research Professor, Steward Observatory

Capabilities of the Imaging Technology Lab

The Imaging Technology Lab (ITL) is dedicated to advancing scientific and industrial sciences by developing enabling technologies for semiconductor and photonic devices. Originally formed to optimize imaging sensors for backside illumination, ITL has focused on improving quantum efficiency and wavelength coverage to meet the demanding requirements of astronomy instrumentation, planetary science missions, and Earth-observing satellites. Those processing requirements have developed into capabilities that can be applied to a wide variety of applications. With over 25 years of experience, ITL's core capabilities include wet etching, thin film deposition, packaging, metrology, and sensor characterization to optimize the performance of backside illuminated sensors. Over 4,000 sensors and other systems have been delivered to the worldwide scientific and industrial imaging communities. They are used in astronomy, Earth observing, semiconductor applications, high energy physics, and for many other applications. ITL is operated by the Steward Observatory at the University of Arizona and is affiliated with the Center for Semiconductor Manufacturing.

Angela Marusiak

Assistant Research Professor, Lunar and Planetary Laboratory

LEMS-A3: Sending seismometers back to the Moon

In 2024, the Lunar Environment Monitoring Station (LEMS) was selected for the Artemis III (A3) Deployed Instruments program. LEMS payload includes a short-period (SP) and broadband (BB) seismometer, built by UA. Over the past year, LEMS has progressed through design reviews and has begun building testing units. Here, we provide on update on our progress over the past year, what we will complete in the coming year, and the science that will be done upon landing in 2027.

Andrea Nelson

ODIN Optical Payload Manager, Wyant College of Optical Sciences

Research from the Laboratory of Space Systems and Optomechanics (LASSO)

The Laboratory of Space Systems and Optomechanics (LASSO) develops technology for space focused on laser interferometry and optomechanical sensors for applications in accelerometry, gravimetry, inertial sensing, seismology, and high-precision metrology. We introduce four key projects with space-based applications, including an optical truss interferometer (OTI) for the space-based gravitational wave observatory LISA, a triaxial low-frequency accelerometer unit, a newly funded planetary seismology project, and the Optomechanical Distributed instrument for Inertial sensing and Navigation (ODIN) project, a full inertial sensing unit slotted for space flight testing in 2027 under the NASA InVEST (In-Space Validation of Earth Science Technologies) program. The triaxial optomechanical accelerometer consists of three linear fused silica resonators with resonance frequencies below 10 Hz and quality factors close to 500,000, together with a compact picometer quasi-monolithic heterodyne interferometeric readout. Its acceleration noise is around 8 pico-g. The planetary seismology project builds off this triaxial design, setting them up as candidates for highly sensitive units that could journey to and be used for seismic monitoring on other planetary worlds. The ODIN project expands on the triaxial system as well, forming an array of resonators that allows for measurement of both linear and angular accelerations, making it a fully inertial sensing unit with potential applications in future mass change missions or as a high sensitivity low frequency inertial measurement unit (IMU). Goal acceleration sensitivities at 10 mHz are 10^-10 m/s^2/Hz^1/2 for linear and 7×10^-10 rad/s^2/Hz^1/2 for angular acceleration. The ODIN project will be tested alongside the University of Florida's GRATTIS mission and is scheduled for launch in 2027. The OTI is a system developed to aid in the ground testing of the LISA telescopes and a risk-mitigation plan for flight units to verify the LISA telescopes are stable at the picometer level.

Ricardo Nunes

Researcher Assistant, Mining and Geological Engineering

Lunar Mining: Overcoming Challenges and Evaluating Excavation Strategies

Mining on the Moon is important for future space missions, but it comes with big challenges. The lunar surface has sharp, dusty regolith, extreme temperatures, and low gravity, which make excavation difficult. This presentation looks at different mining methods, such as bucket-wheel excavators, robotic scoopers, enclosed augers, and a dragline system. Understanding these challenges and testing solutions with lunar soil models will help engineers develop better mining systems for future lunar missions.

Rachael Pabst & Ellie Wolcott

Engineer, Lunar Automated Regolith Processing Senior Capstone Project

Scalable In-Situ Water Extraction for Lunar Bases: A Proof-of-Concept System

The construction of a habitable lunar base plays a significant role in the advancement of space exploration. To make this safer and more economical, in-situ resource utilization is one of the best options for obtaining water. This multi-year project explores a solution for water acquisition for a lunar base through utilization of the ice present on the lunar surface. The proposed system is composed of two separate units: a Mobile Excavation Unit (MEU) and a Stationary Extraction Unit (SEU). The MEU uses a bucket elevator to excavate and collect lunar regolith and stores it in a load bed. It utilizes an Arduino-based microcontroller with an on-board Wi-Fi chip to allow for user control on a phone app GUI. The user can control the height of the bucket elevator and load bed via linear actuators and the speed of the wheels and elevator using DC motors. The MEU transports the material to the SEU, depositing the regolith into the heating chamber through a funnel and motorized ball valve. For each SEU cycle, the regolith is heated using drum heaters, and water evaporates into the condensation subsystem. Here, steam passes through a heat exchanger and is condensed into water, dripping into a storage container that can be removed for water collection and later use. This proof-of-concept system can produce half a liter of water per day, but the system could be scaled up to provide more water as needed using a larger processing station or multiple mobile units. This proof-of concept system investigates a simple solution to supply a lunar base with water without having to go through the cost-prohibitive process to ship it from Earth.

Hilliard Paige

Electrical Engineer, Rincon Research Corporation

Evaluation of methods used to downlink and process X-Band data from CatSat

Already eight months into its mission, CatSat has had a significant impact on both the students and the larger community at the University of Arizona. Launched in July of 2024, CatSat is a 6U CubeSat built, tested, and flown by University of Arizona students, faculty, and staff in partnership with FreeFall Aerospace and Rincon Research Corporation. At the heart of CatSat's scientific operations is the 6.1-meter antenna located at the University of Arizona Tech Park. Jointly operated by Rincon Research Corporation and the University of Arizona, this dish has downlinked all X-band microwave scientific data from CatSat and proved to be invaluable asset in downlinking other telemetry when the Command and Control (C2) link was unable to keep up with the telemetry data volume generated by the spacecraft. This talk will discuss and show the efforts for configuring, building, commissioning, and operating the 6.1-meter antenna at tech park to receive, de-doppler, and demodulate CatSat X-band data. This presentation will also show how operators can infer spacecraft pointing and positional error correction by looking at the live signal feed. Finally, data and imagery downlinked through the UATP station will be shown.

Sam Ragland

Adaptive Optics Group Head, Large Binocular Telescope Observatory

Satellite guide star (Sagi-star) Adaptive Optics for the LBT

We propose developing a Satellite Guide Star (Sagi-star) adaptive optics (AO) capability for the Large Binocular Telescope (LBT) to achieve unprecedented angular resolution and sensitivity in visible wavelengths. The upgraded system will utilize natural satellites, such as asteroids, alongside artificial satellite-based laser sources (SLGS), like the one proposed for the Orbiting Configurable Artificial Star (ORCAS) project and other future space assets, as guide stars for the AO systems. This proposed technology development will also enhance AO performance for current natural guide star (NGS) adaptive optics observations and provide essential system robustness for all science instruments. The Sagi-star would enable a wide range of new scientific inquiries, from extragalactic to Solar system scales. The Sagi-star-NGS would facilitate the observation of faint reddened astronomical objects, including young stellar objects (YSOs), in visible wavelengths through wavefront sensing in the near-infrared spectrum, along with improved performance for extreme adaptive optics (XAO) observations in visible wavelengths. The Sagi-star-SLGS would aid in addressing some of the most significant mysteries in cosmology, including the existence and evolution of supermassive black holes and cosmic dark energy. Beyond enabling new scientific exploration, the Sagi-star would transform the LBT into a unique testbed for innovative technology demonstrations, such as integrated optics, photonic lanterns, fiber nulling, Microwave Kinetic Inductance Detectors (MKIDs), compact spectrographs, and more in the era of Extremely Large Telescopes (ELT).

Walter Rahmer

CatSat Command System Lead, Steward Observatory

CatSat: Post-Launch Operations of a Student-built CubeSat

CatSat is a 6U CubeSat designed and built primarily by students at the University of Arizona in partnership with Tucson companies. The primary payloads on the spacecraft are a high frequency (HF) radio for ionospheric research and an inflatable antenna technology demonstration. In the ionosphere, interactions between the atmosphere and space generate free charges, which can absorb, deflect, and reflect radio waves, especially in the HF range. These ionospheric effects are highly volatile, particularly as the at the boundary between day and night. The onboard HF radio is designed to measure the distribution and movement of free charge density in the ionosphere through measurement of HF signals transmitted from the ground. The novel inflatable antenna is designed to demonstrate high bandwidth communication within the stringent size and mass constraints faced by current small spacecraft. By utilizing an inflatable structure, the inflatable antenna is designed to stow into a small, low mass container and deploy with minimal steps. Launched into orbit on July 3rd, 2024, CatSat has now been in orbit for months. The student team operating the spacecraft has progressed through many commissioning activities, navigating numerous obstacles and challenges. Student experience has been key to the mission since its beginning, with numerous students from different departments and class levels participating in all areas and phases of the mission. Many tasks remain to be completed, most notably the deployment of the inflatable antenna, which is expected to occur in the near future.

Andy Ryan

PhD, Research Scientist, Lunar and Planetary Laboratory

EMILIA-3D: Advanced thermal imaging of the lunar surface

The Emission Imager for Lunar Infrared Analysis in 3-Dimensions (EMIILA-3D) is an instrument concept for studying regolith physical properties and thermal conditions on the lunar surface. The payload consists of a thermal imager to measure scene temperature and a stereo pair of visible cameras to create 3D Digital Terrain Models. We will present science objectives, the concept of operations, and future flight opportunities.

Anton Samoylov

PhD. Candidate, Chemical and Environmental Engineering

Multifunctional Nanofiber Reinforcement of Perovskite Solar Cells for Resilience in Space

The current state-of-the-art Earth-sourced solar array blankets lack durability against radiation and thermal effects found in the lunar environment while being heavy to transport into orbit. In efforts to advance alternative solar technologies to meet durability and launch-cost challenges, NASA has seen promising results in the development and early testing of metal halide perovskites. Perovskite solar cells (PSC) currently rival traditional silicon and other third-generation solar cells, becoming increasingly investigated for commercial applications due to their compatibility with scalable processing techniques. However, the poor thermomechanical stability of the perovskite photoabsorbing layer has thus far inhibited the viability of perovskite-based photovoltaics. In our initial studies, we observed that the mechanical stability of perovskite thin films can be increased by an order of magnitude by nanocompositing with polymeric nanofibers using electrospinning. We demonstrate this platform with commodity polymeric nanofibers from the nylon family. My studies comprise of further manipulating and characterizing nanofiber surface chemistry to obtain nanofiber mats with controllable densities of Lewis base functional groups, followed by quantifying the mechanical and residual stress effects of perovskite incorporation into synthesized nanofiber frameworks to correlate nanofiber functional group density and type with mechanical properties of the resulting nanocomposite. The perovskite nanocomposite films made from polymer nanofiber networks possessing modified surface chemistry are also investigated regarding their chemical and optoelectronic properties. We discuss the increase in fracture resistance energy, Gc, in the nanocomposite samples with respect to nanofiber functionalization and material selection. The fiber network reduces the mechanical fragility of the PSCs by increasing their fracture energy several-fold, while maintaining comparable morphology, chemical composition, and device efficiencies to pristine perovskite. Developing understanding of these perovskite composites paves the way for designing mechanically robust perovskite layers for harsh environments such as the Moon.

Hannah Tanquary

Project Systems Engineer, Deputy Project Manager, Steward Observatory

Innovating Under Constraints: Aspera's Path to Launch

Aspera is one of four inaugural projects funded under the 2020 NASA Astrophysics Pioneers program, with a $20M cost cap and a 5-year mission lifecycle. The Pioneers program aims to foster the development of processes and procedures for achieving compelling astrophysics science results at a lower cost using smaller hardware. Aspera will launch via rideshare in 2026 as an ESPA class SmallSat. Aspera is led by principal investigator Dr. Carlos Vargas, Assistant Professor at the UofA Steward Observatory. Aspera’s science goal is to provide the first-ever maps of the vast expanses of highly diffuse gas that surround and connect galaxies, adding to the complex tapestry that is our understanding of galaxy evolution. The design and fabrication of the payload instrument, a UV spectrometer, including all structural elements, electronics, and software is being performed in-house at UArizona. Later this year, the instrument will be integrated with an off-the-shelf spacecraft bus provided by University of Toronto Space Flight Laboratory. This presentation will provide a state-of-the-project as it nears payload completion, with a focus on the challenges involved in developing, integrating, and testing a space-flight-capable instrument under a strict cost cap while incorporating cutting-edge technologies to achieve unprecedented science results.

Victor Tenorio

Professor of Practice, Mining and Geological Engineering

Initiating Lunar Mining Operations for Sustainable Human Presence

As humanity prepares to return to the Moon in the upcoming decade, establishing sustainable mining operations will be a critical task. Initial efforts will focus on the loose, powdery regolith on the lunar surface which can be used to cover inflatable habitats and protect them from solar radiation. While this material is relatively easy to collect at shallow depths, deeper layers present greater challenges due to increased hardness and handling difficulties. Subsequent operations will target the extraction of icy regolith, which contains varying percentages of water, primarily located in the South Pole region. The demand for construction materials for roads, berms, and infrastructure foundations will necessitate a rapid increase in mining production rates. These tasks require specialized equipment designed to operate under the Moon’s harsh conditions. This abstract evaluates a suite of proposed equipment solutions currently available in the market, assessing their capabilities and feasibility for quick implementation in pioneering lunar mining operations. The selected equipment aims to address the unique challenges of lunar mining and support the development of a sustainable human presence on the Moon. Keywords: Lunar mining operations, Sustainable human presence, Moon surface regolith, Icy regolith extraction, South Pole region, Construction materials, Specialized equipment, Harsh lunar conditions, In-situ resource utilization (ISRU), Pioneering lunar operations.

Jekan Thanga

Associate Professor, Space & Terrestial Robotic Laboratory

Advancing SMART Devices Ecosystems to Accelerate Lunar & Martian Surface Exploration and Development

We analyze an ecosystem of surface devices that can enhance this type of cooperation, including the use of mobile control towers, smart sandbags, and distributed computing paradigms. Structures built on a lunar base and their surrounding would consist of modular components that can sense, collect, process, store, and communicate information in a distributed network. These networks can make localized decisions independently and offload routine maintenance responsibilities from astronauts.We further examine the technologies and algorithms available to establish a distributed network within modular base building block components. We analyze sandbags embedded with electronics as a potential candidate for modular building block components. These sandbags demonstrate multi-functionality with different schemes of embedded electronics. Lastly, we examine how this distributed computational infrastructure can cohesively work to both avert disasters and rebound from them.

Andre Wong

Principal Systems Engineer; Deputy Director & Chief Engineer, Imaging Technology Laboratory, Steward Observatory

The Arizona Infrared Detector Laboratory

The Arizona Infrared Detector Laboratory (AIRD) endeavors to further the development and maturation of infrared (IR) imaging technologies and instrumentation for astrophysical, planetary science, and Earth-observing applications. Building on existing capabilities at Steward Observatory, AIRD's mission encompasses three primary tenets: 1) development and characterization of IR detector technologies; 2) deploying IR focal plane arrays in instruments; 3) and training the next generation of IR detector scientists and engineers.   At AIRD, we strive to develop a deep understanding of all aspects of IR detector performance, advance technology development, and enable novel capabilities. Such a knowledge base furthers our capacity to design, build, and deliver IR instruments to meet a broad range of scientific objectives and missions. We further seek to partner with faculty and scientists throughout UA to support existing projects and future mission proposals, isolate and characterize knowledge gaps in modern IR detectors, and identify new technology concepts to pursue.   Over the last year, AIRD has secured lab space capable of supporting spaceflight work, started construction of state-of-the-art cryogenic test dewar for IR detector characterization, and acquired key hardware from the JWST NIRCam program residual at UA. The UASI community stands to benefit from AIRD's new capabilities combined with our expertise, especially those interested applying IR detector technologies to their projects.

Hao Xin

Professor, IEEE Fellow, Electrical and Computer Engineering

Multifunctional Luneburg Lens Enabled Radar for Enhanced Space Domain Awareness

High performance, multifunction and low Size, Weight and Power-Cost (SWaP-C) radar sensors are highly desirable for space and other DoD applications, including in-orbit space object detection, UAV collision avoidance, surveillance, etc. because of their capability of operating in low-light, opposing light, and all-weather conditions, as well as providing precise target velocity information in addition to location. However, the current radar sensors using planar phased array antennas suffer from limited field of view (FOV) and narrow bandwidth. Therefore, to provide full spatial coverage and satisfy all system requirements, multiple radar systems are necessary, leading to significantly increased SWaP-C. These challenges are especially greater for airborne and spaceborne systems. To address these needs, it proposes to develop a Multifunctional Luneburg Lens-enabled Millimeter-Wave Imaging Radar, based on unique hardware and algorithm, including 3D-printed millimeter-wave (mmW) Luneburg lens antennas with panoramic FOV and corresponding radar sensing and imaging techniques. Preliminary design and analysis of a Ka-band sensor has been performed. This radar sensor features the following capabilities. First, it will provide self-contained in-orbit monostatic radar detection of 10-cm size space objects within a 10-km range. Second, it will also be able to function in a bistatic radar mode, utilizing ground-based high power mmW transmitters, such as the Kwajalein Radar facility, to enable longer range and / or smaller object detection. Third, it can be configured to function as an active 3D mmW imager for applications such as Rendezvous and Proximity Operations (RPO).