Arizona Space Institute Symposium

Wednesday, March 20, 2022| 8:30am - 1:00pm
ENR2, Room S107

Flash Talk Abstracts

Haeun Chung
Nox: 12U CubeSat Mission for Characterizing All-Sky FUV Background

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.

Jekan Thangavelautham
Advancing Small Spacecraft Technologies for Deep Space Exploration

The SpaceTREx Laboratory seeks to advance agile, rapid response small spacecraft technologies to explore the four corners of the solar system. Our principal targets include Near-Earth Asteroids (NEAs), main-belt asteroids, outer solar system moons, Kuiper Belt Objects (KBOs), and incoming interstellar objects. Most of these targets stretch current small spacecraft beyond their limits in terms of propulsion/delta-v, communication, and mission-life. To enable these missions, fundamental advances are needed in miniaturization, propulsion, communications, and attitude control. Our laboratory is working on whole new systems solutions tackling these challenges through a three-prong strategy of developing (1) Next-generation, extensible, and transformative modular spacecraft that extends the life and range to reach outer solar system targets. (2) Machine-learning-based automated design and control of landers, rovers, hoppers, and flying vehicles to access off-world extreme environments. (3) Use spacecraft swarms to perform tours through rapid, low-cost flybys, impactors, and sample returns. These units can cooperate through formation-flight or physically aggregate and disperse to perform a range of tasks that exploit parallelism, including rapid search, multipoint observation, and continuous temporal observations. These cooperative behaviors enable whole new capabilities not possible with a single, large monolithic spacecraft. In parallel, we are developing (a) On-orbit Docking Enabled Simulation Facility (ODESI), (b) Spacecraft Workings and On-orbit Robotics using Drones (SWORD) Facility, and (c) Low-gravity Terrain Utilization and Simulation (LOTUS) Facility to mature the technology before demonstration missions. We plan to cohesively integrate these capabilities to produce breakthrough space technologies that play to our institutional strengths in space and planetary exploration.

Arizona Space Institute Symposium

Wednesday, March 20, 2022| 8:30am - 1:00pm
ENR2, Room S107

Flash Talk Abstracts

Dathon Golish
CatSat: a student-designed cubesat mission

CatSat is a student-designed cubesat mission scheduled for launch this year on a Firefly Black Alpha launch vehicle. The CatSat mission is a collaboration between the University of Arizona, Freefall Aerospace, and Rincon Research Corporation. CatSat has three primary goals. The first is a technological demonstration of a new inflatable antenna technology. CatSat will carry a 0.5 meter inflatable, partially-metallized antenna that will deploy after CatSat reaches a stable orbit. Successful downlink with the inflatable antenna would demonstrate up to a 50 Mbps downlink from low earth orbit. CatSat's second goal is a scientific investigation using High Frequency (HF) radio waves from ground-based ham radio stations transmitting simultaneously from many known locations. CatSat will receive these signals from across the world. An on-board software defined radio will collect and downlink these signals. Then they can be analyzed to map spatial and temporal variations in Earth's ionosphere. Finally, CatSat has been designed, is being tested, and will be operated primarily by students. CatSat is an opportunity for the next generation of space scientists and engineers to get involved in space flight early in their education. CatSat includes graduate and undergraduate students from Steward Observatory, Aerospace and Mechanical Engineering, Electrical and Computer Engineering, and Systems and Industrial Engineering, as well as staff support from the Lunar and Planetary Laboratory.

Dante Lauretta
Development of a Sustainable CubeSat Program between the University of Arizona and Kenya Space Agency

UA has invested substantial resources to create a hands-on spacecraft hardware development program centered around student teams that design, build, and operate CubeSat missions. The inaugural program is the CatSat1 spacecraft, a 6U CubeSat led by students from UA's Lunar and Planetary Laboratory and supported by other departments including aerospace and mechanical engineering, astronomy, computer science, and systems and industrial engineering.
The Kenya Space Agency (KSA) seeks to use local engineering capacity to develop a sustainable capacity-building program. KSA realizes the potential of space science and technology to address its developmental challenges. It is investing in building capacity in space technology and its related applications to maximize the benefits that accrue from its utilization and to spur their socio-economic development. Due to limited expertise in Space Technology and its related disciplines in developing countries, KSA has identified a need to establish partnerships with space-faring countries.
KSA is providing current funding to support its Research Chair in Nanosatellite Development to the University of Nairobi (UN). It is also providing financial support to build and operate satellite ground stations at the UN main campus and in Mombasa. It has demonstrated its commitment to providing financial support for capacity building in spacecraft engneering and inspiring STEM enrollment. We plan to expand upon this commitment through the development of a joint UA-UN spaceflight-capacity building program.

Arizona Space Institute Symposium

Wednesday, March 20, 2022| 8:30am - 1:00pm
ENR2, Room S107

Flash Talk Abstracts

Reed Spurling

Near Space Club: Student-Led Stratospheric Ballooning at the University of Arizona

Near Space Club is a student-led high-altitude ballooning club at the University of Arizona. We launch helium balloons carrying experiments, technology demonstrations, and other projects to the stratosphere, reaching altitudes of 30 kilometers and above. We provide our members with opportunities to engage in STEM activities, including coding, electronic circuit design, atmospheric sciences, and biological sciences. We offer access to the near-space environment as a service to members of the University of Arizona community. Website: nearspace.arizona.edu

Roberto Silva Espinoza

Chilean Space Collaboration Program

The Chilean Space program, is focused in research and development projects in collaboration with national and international Universities, also is building in Chile a facility to integrate space missións in a sustainable model to become Chile a Pole of Scientific and technology development for the region. Setting up this program allows us to implement social value space projects in areas of academy, industrial, governmental and civil society.
The program is centered in the human talent development throw a three stages of long terms project, at first to create national capabilities in earth and space observation, and monitoring the space related science elements; as a second stage, is to generate a SATCOM program to add social value in the region extending access to information era and reducing the digital and technology gap; and as a therth step, to create multinational projects for launching and global position systems.
From the gobernametal framework we are implementing a new space institutionality, builded in three pillars, these are national facilities, the governance model and the space programs.
So in this context we are in the first step implementing the National Satellite System (SNSat) project, it is going to build in Chile a network of three ground stations, a national laboratory for satellite development and integration, and put in orbit 7 science microsatellites and three earth observation mini satellites. Also, implement a scholarship program for national schools in social lagging.
The SNSat space program is built in a collaboration model to participate in the microsatellites AIT projects and other areas to data science, geospace information analysis, software development, and payload manufacturing and integration.
Finally, through this program Universities under some collaboration agreements can generate projects in specific research and development, engineering and scientific academic exchanges, satellite operations or other areas of mutual interest adding the social impact of the projects as a significant objective.

Arizona Space Institute Symposium

Wednesday, March 20, 2022| 8:30am - 1:00pm
ENR2, Room S107

Flash Talk Abstracts

Ewan Douglas
Enabling Big Science from Small Telescopes in Space

I will briefly summarize current infrastructure development and research work to enable science from SmallSats happening in the UA Space Astrophysics Lab, including development of small telescopes for high-contrast imaging of extrasolar asteroid belts and quantum key distribution, commissioning of SmallSat/CubeSat hardware test facilities, and construction of the CubeSat command station at Biosphere 2.

Christian Viellet
The Large Binocular Telescope: a one of a kind platform for space science and technology exploration

An international partnership between Europe (Germany and Italy) and the US (Arizona and a consortium of four Universities in OH, IN, VA and MN), the Large Binocular Telescope Observatory is currently the largest optical telescope in the world, with two 8.4-m mirrors offering the resolving power of a 23-m telescope and the photon-gathering power of an 11.7-m diameter telescope. Active primary and adaptive secondary mirrors with state of the art detectors make it an ideal facility for space exploration from the vicinity of the Earth to the outskirts of the Universe: imaging geosynchronous satellites, looking at an old rocket stage flying in the Earth-Moon system, exploring a quasi-satellite of the Earth which is likely a piece of the Moon ejected by an impactor, observing volcanoes of a satellite of Jupiter, studying the zodiacal light or the planets orbiting other suns, or peering into far-away galaxies amplified by gravitational lensing. Through collaborations with the LBT partners and UofA colleagues at Steward Observatory, the Lunar and Planetary Laboratory, and the College of Optical Sciences, LBT is also an ideal platform for technology developments. Monitoring with an extreme precision the structure of the telescope (to be used on the Extremely Large Telescopes to come), building a novel device to observe at once the full visible and near-infrared spectrum of faint asteroids, developing and using on-sky a new way to feed an AO-corrected beam into a mono-mode fiber, or building extreme-AO instruments to better observe exoplanets are some of the ongoing LBT developments.

Arizona Space Institute Symposium

Wednesday, March 20, 2022| 8:30am - 1:00pm
ENR2, Room S107

Flash Talk Abstracts

Sergey Shkarayev

Development of planetary science and technology for caves and lave tubes explorations through investigations of analog environments on Earth

The development of planetary science and technology can be achieved through an investigations of analog feature environments on Earth. Based on this approach, the overarching goal of the project is the development of autonomous system for the exploration of complex lava tubes and caves. This project is expected to result in new science and technological capabilities to enable future planetary exploration.
The system for the exploration of caves and lava tubes includes a train of drones, ground station and a path planning and object avoidance algorithm. While many common air vehicle control algorithms require some sort of GNSS communication to maintain position. Through optical sensor fusion, a simultaneous Localization and Mapping (SLAM) algorithm will be employed to facilitate mapping and navigation of the complex environment.
This system will be mated to a flight controller and a computing module. An integrated sensor unit contains a standard image sensor, a binocular image sensor, and a Lidar Time of Flight module.
The autonomy of the system will be handled by the computing module. It has a direct link to the flight controller and will be able to control the motions of the aircraft as required. The system will run the PX4 firmware. This will also allow for a robust simulation environment to be deployed. Using a software in the loop (SITL) based on our platform, a physics engine can be employed with environmentally realistic conditions. These conditions can be generated from LIDAR scans of testing environments. These environments will be useful in the testing of the algorithms as test can be conducted with no risk to hardware.

Winslow Burlson

Just, Equitable, Diverse, and Inclusive (JEDI) Aquanautics: Democratizing Innovation in the Networked Blue Economy

JEDI Aquanautics will fuse the world's most powerful experiential supercomputer, the NSF Holodeck with the transformative capabilities of Ocean Space HabitatSM to create a world-class sociotechnical convergence catalyst—the JEDI Aquanautics Platform. Through integrated convergence research and open-access cyberlearning we will engage a national and international community in transforming "underwater tents" into smart and connected aquanautics infrastructure, tightly integrating Networked Blue Economy (NBE) applications (marine archaeology, biopharmaceutical prospecting, ecological preservation, aquaculture, and planetary exploration, among these) in partnership with diverse communities. We will launch an international JEDI Inventioneering initiative, fostering open-access passion-based convergence research, education, and innovation to inspire and train the next generation of lifelong learners and innovators—significantly increasing human access to, and understanding of, ocean environments and sustainable resource utilization. To ensure that we engage and inspire JEDI exploration, discovery, and innovation throughout the NBE, we will launch an international JEDI Aquanautics Network Improvement Community (NIC), employing NSF INCLUDES methodologies. The overarching project vision is to lay the foundations of a vibrant JEDI Aquanautics ecosystem across academia, industry, government, public and private organizations, diverse multi-stakeholder communities and end-users. JEDI Aquanautics will deliver profound and transformative benefits to American society and pioneer a JEDI global NBE.

Arizona Space Institute Symposium

Wednesday, March 20, 2022| 8:30am - 1:00pm
ENR2, Room S107

Flash Talk Abstracts

Alfred McEwen
The Io Volcano Observer (IVO)

IVO was selected for a Phase A study for Discovery in 2020. The Phase A study was given many compliments and the mission was deemed selectable, but NASA chose to select 2 Venus missions that completed second Phase A studies. We expect to re-propose a very similar mission in the next Discovery opportunity, with AO release expected in 2023. We can arrive at Jupiter from any launch date leading to the same basic Jupiter tour, with 10 close encounters with Io. All instrument providers are available to re-propose. Given that all 5 Discovery missions completing Phase A studies in 2015 now have approved missions, the prospects for IVO are excellent. One possibility is that NASA will delay the next Discovery AO, releasing it after the New Frontiers 5 AO. Since Io is a candidate destination for NF-5, we would in this case proceed with an enhanced mission proposal. JHU-APL will build the spacecraft and manage the mission, with science operations at UArizona. The flash talk will provide an overview of the IVO science.

Daniella DellaGiustina
OSIRIS-APEX: An OSIRIS-REx Extended Mission to Apophis

The Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) mission characterized and collected a sample from asteroid (101955) Bennu. After the OSIRIS-REx Sample Return Capsule is released to Earth's surface in 2023, the spacecraft (S/C) will divert into a solar orbit. On this trajectory, the S/C will approach Earth alongside asteroid (99942) Apophis in 2029, enabling a second mission with the same unique capabilities: OSIRIS–Apophis Explorer (APEX).

On April 13, 2029, the 340-m-diameter Apophis flies within ~32,000 km of Earth's surface, <1/10th the lunar distance. Apophis will be the largest object to approach Earth this closely in recorded history and will captivate the world. This rare planetary encounter will alter Apophis' orbit, subject it to tidal forces that change its spin state and may seismically disturb its surface.

APEX will distantly observe Apophis during its close encounter and capture its evolution in real-time, revealing the consequences of a near-Earth object undergoing tidal disturbance by a major planet. However, chronicling the tidal encounter is only the beginning of APEX's journey with Apophis. Having already challenged our fundamental understanding of "carbonaceous" asteroids during its exploration of Bennu, the S/C instrument suite will provide first-of-its-kind data of a "stony" asteroid—advancing knowledge of these objects and their connection to meteorites.

Near the mission's end, APEX will perform Regolith Excavation by S/C Thrusters, a technique demonstrated at Bennu. Observations during and after excavation will provide insight into the material properties of stony asteroids. Furthermore, Apophis' material and structure have critical implications for planetary defense.

Arizona Space Institute Symposium

Wednesday, March 20, 2022| 8:30am - 1:00pm
ENR2, Room S107

Flash Talk Abstracts

Daniel Apai

Nautilus: A Thousand Earths – An Atmospheric Biosignature Survey with a Novel Space Telescope

NASA's Kepler mission has revealed that habitable zone Earth-sized extrasolar planets are common in the Galaxy. One of the frontiers of modern astrophysics is the exploration of such temperate Earth-sized planets with the goal of understanding their diversity and what fraction of them are truly Earth-like. Although known in increasing numbers, Earth-sized planets remain extremely challenging to observe and characterize — thus, these science goals continue to drive technology development and mission concepts.

In this talk I will review our work and results on a novel space observatory concept that aims to observationally characterize one thousand earth-sized, habitable zone planets and probe their atmospheric compositions for potential biosignatures. The Nautilus Space Observatory utilizes an optical design radically different from that of current space telescopes: The use of large-diameter, diffractive optical elements – developed at UA's James C. Wyant College of Optical Sciences – allows Nautilus to collect much more light than possible with current and planned space observatories. In this talk I will review the science goals and the novel technology that underpins the Nautilus Observatory concept, and highlight ongoing work at different UA departments, including optical design, fabrication, and testing, our next steps in the technology maturation process, and upcoming observations with our prototype telescopes.