Arizona/NASA Space Grant

Undergraduate Research Internship Program
Thirtieth Annual Statewide Symposium

ARIZONA

SPACE GRANT
CONSORTIUM

Presentations by Space Grant Interns from:

University of Arizona
Arizona State University
Northern Arizona University
Embry-Riddle Aeronautical University
Central Arizona College
Glendale Community College
Phoenix College
Pima Community College

April 17, 2021
Zoom Virtual Teleconference Meeting

2020-2021 Statewide Arizona/NASA Space Grant Undergraduate Research Internship Symposium
April 17, 2021

Welcome to the 30th annual Statewide Arizona/NASA Space Grant Undergraduate Research Internship Symposium! The Symposium will feature talks from 144 Arizona students, with one student represented “In Title Only”. Talks will last ten minutes each, roughly divided as 7-8 minutes for presentations and 2-3 minutes for questions. Four parallel topical sessions will run throughout the day.

For the second time, all in-person symposium events have been converted to virtual events as our nation responds to COVID-19. The Arizona Space Grant Consortium has adjusted symposium plans to ensure the safety and well-being of our participants. This symposium mirrors 2020 as it will be held entirely online using Zoom Telecommunications. View the symposium schedule for Zoom links and passwords to join and listen to each session.

Arizona State University alum, Dr. Robert Pappalardo, is our keynote speaker for the symposium. Dr. Pappalardo will virtually present a talk titled “Journey to Europa”. This talk will review our current knowledge of Europa, the status and objectives of the Europa Clipper mission, and how Europa exploration has affected his career path.

This symposium is made possible through NASA support of the Arizona Space Grant Consortium. The efforts of steering committee members and Space Grant representatives at Arizona State University, Northern Arizona University, Embry-Riddle Aeronautical University, Central Arizona College, Glendale Community College, Phoenix College, Pima Community College, and The University of Arizona are acknowledged. Interns with a variety of academic backgrounds have come together to make the program a success; this symposium is a tribute to their dedication and spirit of inquiry.

This year marks the 31st anniversary of NASA’s National Space Grant College and Fellowship Program. Across the nation, NASA Space Grant Consortia has had, and continues to have, an extraordinary impact on students in all 50 states, D.C. and Puerto Rico. To learn more about what Space Grant is doing across the nation, visit https://national.spacegrant.org/.

The Arizona NASA Space Grant internship program would not be possible without the efforts of many university faculty, private sector, and other federal research faculty researchers/mentors, who give selflessly of their time and energy to provide leading-edge research experiences to enrich the education of Arizona’s Space Grant scholars. We thank them all for their past, present and future support.

Timothy Swindle, Director
Arizona Space Grant Consortium, UA

Michelle Coe, Manager
Arizona Space Grant Consortium, UA

Thomas G. Sharp, Associate Director
ASU/NASA Space Grant

Desiree D. Crawl, Program Manager
ASU/NASA Space Grant

<table>
<tr><td colspan="5">Saturday, April 17, 2021, Zoom Virtual Teleconference Meeting
8:30-9:30 a.m. WELCOME & KEYNOTE SPEAKER:
*Zoom Link and Password removed for website use

Welcome: Dr. Timothy Swindle (Director) & Dr. Thomas Sharp (ASU Associate Director), Arizona Space Grant Consortium
Keynote Speaker: Dr. Robert Pappalardo, Europa Clipper Mission Project Scientist</td></tr>
<tr><td>Zoom Link</td><td colspan="4" rowspan="2">*Zoom links and passwords removed for website use</td></tr>
<tr><td>Password</td></tr>
<tr><td>TIME
(MST)</td>
<td>Moderators:
Maitrayee Bose, ASU
Desiree Crawl, ASU
Joseph Foy, ASU
Timothy Swindle, UArizona

Session A
TOPICS IN MATH, PHYSICS & CHEMISTRY

(9:40 AM – 12:10 PM)

Session E
ASCEND

(12:10 PM – 1:40 PM)

Session H
PLANETARY SCIENCE

(1:50 PM – 3:20 PM)</td>
<td>Moderators:
Anne Boettcher, ERAU
Michelle Coe, UArizona
Chandra Holifield Collins, USDA

Session B
EARTH & ENVIRONMENTAL ENGINEERING

(9:40 AM – 3:00 PM)

Session F
EDUCATION & PUBLIC OUTREACH

(3:00 PM – 3:20 PM)</td>
<td>Moderators:
Christopher Edwards, NAU
Rolf Jansen, ASU
Tom Sharp, ASU
Yancy Shirley, UArizona

Session C
ASTRONOMY & SPACE PHYSICS

(9:40 AM – 3:20 PM)</td>
<td>Moderators:
Elliott Bryner, ERAU
Paloma Davidson, NAU
Ron Madler, ERAU
Ernest Villicana, Phoenix College

Session D
AERONAUTICS

(9:40 AM – 11:10 AM)

Session G
EXPLORATION SYSTEMS ENGINEERING: BIOLOGICAL, MATERIALS, OPTICAL, AND ELECTRICAL

(11:10 AM – 12:40 PM)

Session I
AEROSPACE TECHNOLOGY

(12:40 PM – 3:10 PM)</td></tr>
</table>

9:40-9:50	[A-1] *Eric Babcock* *Dawson Brindle* New Methods for the Iteration and Visualization of Mandelbrot and Julia Sets	[B-1] *Justin Baez* Can Changes in Hot Spring Composition Reflect Decadal-Scale Deformation of the Yellowstone Caldera?	[C-1] *Krister Barclay* The Characterization of EZ CMa	[D-1] *David Aksenfeld* *Robert Belz-Templeman* Experimental Investigation of Active Vortex Generators
9:50-10:00	[A-2] Cont… *Eric Babcock* *Dawson Brindle* New Methods for the Iteration and Visualization of Mandelbrot and Julia Sets	[B-2] *Terese Maxine Cruz* Urban Biodiversity Life Rafts: A Way to Conserve our Pollinators	[C-2] *Delondrae Carter* Image Simulations for Testing the Fidelity of SKYSURF Background Measurement Algorithms	[D-2] *Maria Babcock* *Thorne Wolfenbarger* Stall Hysteresis – Why the reattachment angle is less than the separation stall angle
10:00-10:10	[A-3] *Lovenia Libby* Theory and simulation investigation of eutectic phase behavior on Pluto	[B-3] *Samantha Johnson* Potential Road Impacts on Gila Monsters in an Urbanizing Environment	[C-3] *Harrison Bradley* HCN Mapping of the Taurus Molecular Cloud	[D-3] *Sebastian Castillo-Sotelo* Optimizing Autorotating Sensor Probe Design for Space Exploration
10:10-10:20	[A-4] *Quinn White* Superfluidity of Neutron Star Matter	[B-4] *George Klett* *Victor Mandala* Analysis of Space-based Riometer Measurement data for characterization of Radio Propagation Disturbance in the Ionosphere	[C-4] *Aaron Goldtooth* A Deep Look at the Nature of Black Holes: Using Tidal Disruption Events to See the Unseeable	[D-4] *Alek Cotnoir* Low Frequency Unsteadiness in Laminar Separation Bubbles
10:20-10:30	[A-5] *Rebecca Martin* Target Detection Using Algorithmic Matter	[B-5] *Hayley Limes* Phenology Data to Aid Pollinator Restoration	[C-5] *Mohit Doshi* Exoplanet Classification using Data Mining	[D-5] *David Madden* Validating a New CFD Algorithm by Finding the Drag Coefficient of a Sphere
10:30-10:40	[A-6] *Ryan Evans* Artificial Cilia Creation for Advanced Sensor Devices	[B-6] *Richard Pepel* The Contribution of Plants and Pollution to Tucson's Urban Ozone Problem	[C-6] *Clarissa Pavao* The First Magnetar in a Binary System?	[D-6] *Sierra McConnell* CIS Aviation-ISAC
10:40-10:50	[A-7] *Christopher Ramirez* Purification of the P66 Outer Membrane Protein of the Bacterium Borrelia burgdorferi	[B-7] *Jonathan Romero* Bioremediation of Insensitive Munitions Compounds	[C-7] *Colter Richardson* Taperings and Analytic Continuations of Supernova Gravitational Waves with Memory	[D-7] *Addison Plummer* Characterization of a Hypersonic Wind Tunnel Nozzle
10:50-11:00	[A-8] *Emily Luffey* Properties of Chromatin Extracted by Salt Fractionation from a Cancerous and Non-cancerous Esophageal Cell Line	[B-8] *Lauren Thompson* The Influence of Conservation Structures on Rangeland Vegetation Patterns	[C-8] *Hope Wetzstein* Laboratory Analysis of olivine-carbonate mixtures as observed on Mars	[D-8] *Maddie Schiffler* *Reed Spurling* Suborbital Uncrewed Aerial Vehicles for Earth Surveillance and Mars Exploration

11:00-11:10	[A-9] *Elena Boyd* Nonlinear Laser Pulse Compression with a Multipass Cell	[B-9] *Erin Alexander* Mapping Hot Spring Geochemistry in Yellowstone	[C-9] *Logan Horner* *Hayden West* EagleSat Team: Determining Particle Energy Using CMOS Sensors	[D-9] Cont… *Maddie Schiffler* *Reed Spurling* Suborbital Uncrewed Aerial Vehicles for Earth Surveillance and Mars Exploration
11:10-11:20	[A-10] *Liam Nolan* Majority of the Faint (μJy) Radio Source Population Appears Powered by Star Formation, not AGN	[B-10] *Jacob Cain* Using Remote Sensing to Determine Vegetation Change and Impacts to Communities	[C-10] *Aidan DeBrae* MW-Andromeda Dark Matter Halo Velocity Dispersion Profiles	[G-1] *Gerardo Figueroa* Ex Vivo Analysis of Multi-Sensory Device for Bone Strain Monitoring
11:20-11:30	[A-11] *Emily Strawn* H-beta Analysis of eta Carinae Radial Velocity during Recent Periastron Passages	[B-11] *Sierra Generette* Nevada Offsite Management	[C-11] *Dymetris Ramirez* Evaluation of Supernovae Astrophysical Parameters by Using Machine Learning on Laser Interferometric Data	[G-2] *Joshua Wu* Minimizing Local Electromagnetic Interference Using Adaptive Filters
11:30-11:50	**BREAK**			
11:50-12:00	[A-12] *Thomas Redford* Identification of Thiol Function Groups in GRA 95229 and Murchison	[B-12] *Erin Kaplan* Identifying unique emplacement characteristics of O'Leary Peak: a volcanic dome in the San Francisco Volcanic Field	[C-12] *Jessica Berkheimer* SKYSURF: Measuring the Brightness of the Sky	[G-3] *Josh Smith* Measuring Antenna Patterns for Ground Station
12:00-12:10	[A-13] *Jack Schulte* Heterogeneous Supernova Production of Ti and Cr Isotopes	[B-13] *Melissa Parkhurst* Instance Segmentation for Biogeography	[C-13] *Sean Dougall* Characterizing the Images of Black Hole Shadows	[G-4] *Alexis Hocken* Photocurable nanocomposites for customizable cartilage replacements
12:10-12:20	[E-1] *Meghann Boland* *Tory Galat* *Benito Rincon Ramirez* *Samuel Jimenez* *Jacqueline Do* Phoenix College: Video Streaming and DNA Studies	[B-14] *Tyler Routt* Soil hydraulic properties three years after the Frye Fire on Mount Graham, Arizona	[C-14] *Parker Landon* Controlling the Unseen: GIG Undergraduate Optical Research	[G-5] *Santana Solomon* Mars In-Situ Resource Utilization for Health Applications
12:20-12:30	[E-2] Cont… *Richard Ricketts* *Maxx Mudd* *Drew Corona* *Sandra Montero* *Karla Chao* Phoenix College: Video Streaming and DNA Studies	[B-15] *Samantha Winstin-Seitz* Numerical simulation of Laramide flat-slab subduction	[C-15] *Jacob Magnusson* Assessing the Performance of the JWST/NIRCam Image Simulator PhoSim-NIRCam	[G-6] *Ryan Stratton* Direct Air Capture Using Moisture Swing Chemistry

12:30-12:40	[E-3] *Quynn Bell* *Pablo De La Fuente* *Michelle Burr* Project Helix	[B-16] *Edward Apraku* Multi-drug Resistance of Pseudomonas aeruginosa Under Microgravity Growth Conditions	[C-16] *Brad Ratto* Gravitational Wave Calibration Error for Supernovae Core Collapse	[G-7] *Zoe Horvath* An Introduction to Systems Engineering: Building a Monochromator Mount
12:40-12:50	[E-4] *Nicolas Blanchard* *Kevin May* *Daniel McConville* UArizona ASCEND: Profiling High-Altitude Radiation with a General Data Logger	[B-17] *Caitlin Brogan* Off the Hook: Assessing the Vulnerability of Inland Subsistence Fisheries to Climate Change	[C-17] *Kadin Worthen* Investigating the Planet Detection Limit in Debris Disk Images from the Gemini Planet Imager	[I-1] *Benjamin Black* Rocket Development Lab Team: The Effects of Equivalence Ratio during shutdown of a rocket engine on hardware longevity
12:50-1:00	[E-5] *Gehrig Dixon* *Gerard Dsouza* *Arturo Luse* *Kevin Segovia* *Calida Mills* A Measurement of the Concentration of Greenhouse Gases as Altitude Increases	[B-18] *Caitlin Encinas* Assessing the Role of the Winds in the Biogeochemical Cycling and Carbon Budget of the Southern Ocean	[C-18] *Alex Blanche* Characterizing High [OIII]/[OII] and High [OIII] Galaxies to Further LyC Study	[I-2] *Macallan Boyle* Rocket Development Lab Team: Thermal Management Analysis of Water-Cooled Rocket Engine
1:00-1:10	[E-6] *Erik Harang* EagleSat Team: Design and Refinement of 3U CubeSat Structure	[B-19] *Hari Krishnan* Investigation of Electron Parameters and Association with Structures using Quasi-thermal noise Spectroscopy (QTN)	[C-19] *Isabela Huckabee* Characterizing the Atmospheres of Low Surface Gravity M-dwarfs	[I-3] *Zoe Brand* Rocket Development Lab Team: Cooling Channel Geometry Analysis for a Regeneratively Cooled Rocket Engine
1:10-1:20	[E-7] *Zachary Howe* *Nicodemus Phaklides* Study of Thermal Heat Transfer Within a High-Altitude Balloon Payload	[B-20] *Alexa Rosenthal* Rare Earth Metal Recovery from Waste Stream Using Algae	[C-20] *Oddisey Knox* Predictions for the Observable Autocorrelations of Accreting Black Holes from the Trinity Theoretical Model	[I-4] *Katherine Rocha* EagleSat Team: On-board Computer Subsystem
1:20-1:30	[E-8] *Dylan Hutchins* *Andrea Maya* *Ricardo Ontiveros* Glendale Community College (GCC) ASCEND Team	[B-21] *Catherine Weibel* More Effectively Selective Species Have Greater Protein Structural Disorder	[C-21] *Noa Nishizawa* Identification of Switchback Intervals in Parker Space Probe Data	[I-5] *Joshua Crest* Pico Balloon Platform for Atmospheric Exploration
1:30-1:40	[E-9] *Lorenzo Kearns* *Andre Simmons* EagleSat Team: Development and Implementation of a Self-Contained Harness for In-House Integration, Verification, and Testing of CubeSat Electric Power Systems	[B-22] *Brooke Carruthers* Developing a model system using Azotobacter vinelandii to investigate the evolution of nitrogen fixation	[C-22] *Nicole Kerrison* Measuring Galactic Wind Frequency and Strength as a Function of Environment	[I-6] *Cole Errico* Designing and Exploring the Structure of Launch Vehicles to Create Optimal Theoretical and Small-Scale Experimental Models

1:40-1:50	**BREAK**			
1:50-2:00	[H-1] *Anthony Kiefer* USGS Science Center - Solar System Exhibit Captions	**BREAK**		
2:00-2:10	[H-2] *Natalie Shultz* Calibration of Images from the OSIRIS-REx Camera Suite	[B-23] *Abigail Kahler* Modeling to Make a Difference - Hydrologic Analysis for Improved Decision Support	[C-23] *Adrienne Vescio* Investigating the Relationship Between Exoplanet Occurrence & Host Star Metallicity	[I-7] *Agustin Jimenez* *Jacob Padilla* CatSat Groundstation Command and Control
2:10-2:20	[H-3] *Isabella Bryant* Magnetic Anomalies in the South Polar Region of the Moon	[B-24] *Karen Perkins* Using GIS to Quantify Effects of Land Cover Change on Movement Patterns of Tiger Rattlesnakes (Crotalus tigris) in an Urbanizing Environment	[C-24] *Andrea Daly* The long-period orbit of the dust-producing Wolf-Rayet binary WR 125	[I-8] *Marcus Kaiser* *Parker Landon* Julia 1.2 Ephemeris and Gravitational Modeling Development
2:20-2:30	[H-4] *Victoria Froh* Exploring Carbon-bearing Matter in an Antarctic Micrometeorite	[B-25] *Paige Thompson* Can We Predict Germination Success in Seed Pellets Using Seed Traits?	[C-25] *Skylar Kemper* Improving the Detection of Core-Collapse Supernova Through Experimentation	[I-9] *Kevin May* Simulation and Evaluation of a Mechanical Hopping Mechanism for Robotic Small Body Surface Exploration
2:30-2:40	[H-5] *Meronda Walker* Supporting the Climate Change Department	[B-26] *Christian Polo* Electrolytic Application of Load-Managing Photovoltaic System	[C-26] *Yuka Lin* Low Frequency Prototype of Laser Interferometer Suspensions for Gravitational Wave Detection	[I-10] *Matthew Robinaugh* Spacecraft Attitude Control Implementation and Development
2:40-2:50	[H-6] *Morgan Cryder* Variability of Martian Wrinkle Ridges	[B-27] *Rodney Staggers Jr* Aquatic Data Analysis from Deployable, Autonomous Boat	[C-27] *Julian Mena* SPHEREx: The Future of Satellite Astronomy	[I-11] *Ci'mone Rogers* Measurements of the Sky
2:50-3:00	[H-7] *Grace Hathaway* Increasing CO Gas Detections in Protoplanetary Disks	[B-28] *Galen Dennis* Biogas Production from Microalgae following Freeze-Heat Pretreatment	[C-28] *Cameron Piotti* Narrow-band Filter Photometry Calibration for the Lowell 20"	[I-12] *Amber Scarbrough* Heuristic Optimization Applied to Orbital Transfers Between Low-Planetary Orbits and Distant Retrograde Orbits
3:00-3:10	[H-8] *Xeynab Mouti* Investigating the Origin of Fine-Grained Rims in Mighei-like Carbonaceous Chondrites	[F-1] *Stone Woodham* Communication and Exploration	[C-29] *Liam David* Energy Balance at Interplanetary Shocks: In-situ Measurement of the Fraction in Energetic Protons with ACE and Wind	[I-13] *Carly VeNard* A Study of the Deflection of 99942 Apophis from Earth

3:10-3:20	[H-9] *Shaye Fordring* Trends In Mineralogy and Grain Size Distribution Across Paleolake Basins on Mars	[F-2] *Stephanie Martinez* The Impact and Importance of Science Writing	[C-30] *Cole Roberson* The Origins of Supermassive Black Holes	
3:20	**CLOSING & NETWORKING** ***Zoom Link and password removed for website use** Join us for closing remarks and the opportunity to use Zoom breakout rooms to get to know other presenters, mentors, and guests! Breakout rooms will allow guests to use the “self-select” feature; please have the latest version of Zoom downloaded.			

Program Schedule

Session A:
Topics in Math, Physics, and Chemistry

Moderators:
Maitrayee Bose, ASU, School of Earth and Space Exploration
Desiree Crawl, ASU, School of Earth and Space Exploration
Joseph Foy, ASU, Barrett Honors College
Timothy Swindle, UArizona, Lunar and Planetary Laboratory

[A-1-2] **New Methods for the Iteration and Visualization of Mandelbrot and Julia Sets**, Eric Babcock, (Junior, Software Engineering, Embry-Riddle Aeronautical University). Mentors: Lara Ismert and Mitch Hamidi, Mathematics, Embry-Riddle Aeronautical University.

[A-1-2] **New Methods for the Iteration and Visualization of Mandelbrot and Julia Sets**, Dawson Brindle, (Sophomore, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentors: Lara Ismert and Mitch Hamidi, Mathematics, Embry-Riddle Aeronautical University.

[A-3] **Theory and simulation investigation of eutectic phase behavior on Pluto**, Lovenia Libby, (Junior, Bioinformatics, Northern Arizona University). Mentor: Gerrick Lindberg, Department of Chemistry and Biochemistry, Northern Arizona University.

[A-4] **Superfluidity of Neutron Star Matter**, Quinn White, (Senior, Physics & Mathematics, Arizona State University). Mentor: Kevin Schmidt, Physics, Arizona State University.

[A-5] **Target Detection Using Algorithmic Matter**, Rebecca Martin, (Senior, Computer Systems Engineering & Mathematics, Arizona State University). Mentor: Andrea Richa, School of Computing, Informatics, and Decision Systems Engineering, Arizona State University.

[A-6] **Artificial Cilia Creation for Advanced Sensor Devices**, Ryan Evans, (Senior, Chemistry, Northern Arizona University). Mentor: Stephanie Hurst, Chemistry & Biochemistry, Northern Arizona University.

[A-7] **Purification of the P66 Outer Membrane Protein of the Bacterium Borrelia burgdorferi**, Christopher Ramirez, (Senior, Biophysics, Arizona State University). Mentor: Debra Hansen, Biodesign, Arizona State University.

[A-8] **Properties of Chromatin Extracted by Salt Fractionation from a Cancerous and Non-cancerous Esophageal Cell Line**, Emily Luffey, (Senior, Biophysics, Arizona State University). Mentor: Robert Ros, Physics, Arizona State University.

[A-9] **Nonlinear Laser Pulse Compression with a Multipass Cell**, Elena Boyd, (Junior, Physics, Arizona State University). Mentor: Samuel Teitelbaum, Physics, Arizona State University.

[A-10] **Majority of the Faint (μJy) Radio Source Population Appears Powered by Star Formation, not AGN**, Liam Nolan, (Junior, Earth and Space Exploration & Physics, Arizona State University). Mentor: Rolf Jansen, School of Earth and Space Exploration, Arizona State University.

[A-11] **H-beta Analysis of eta Carinae Radial Velocity during Recent Periastron Passages**, Emily Strawn, (Junior, Astronomy, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Department of Physics, Embry-Riddle Aeronautical University.

[A-12] **Identification of Thiol Function Groups in GRA 95229 and Murchison**, Thomas Redford, (Junior, Mathematics & Physics, Arizona State University). Mentor: Maitrayee Bose, School of Earth and Space Exploration, Arizona State University.

[A-13] **Heterogeneous Supernova Production of Ti and Cr Isotopes**, Jack Schulte, (Senior, Physics, Arizona State University). Mentor: Maitrayee Bose, School of Earth and Space Exploration, Arizona State University.

Program Schedule

Session B:
Earth and Environmental Engineering

Moderators:
Anne Boettcher, ERAU, Undergraduate Research Institute Director
Michelle Coe, UArizona, Lunar and Planetary Laboratory
Chandra Holifield Collins, USDA, Southwest Watershed Research Center

[B-1] **Can Changes in Hot Spring Composition Reflect Decadal-Scale Deformation of the Yellowstone Caldera?** Justin Baez, (Junior, Geological Sciences, Arizona State University). Mentor: Everett Shock, School of Earth and Space Exploration, Arizona State University.

[B-2] **Urban Biodiversity Life Rafts: A Way to Conserve our Pollinators**, Terese Maxine Cruz, (Sophomore, Biosystems Engineering, University of Arizona). Mentor: Kathleen Prudic, Natural Resources and the Environment, University of Arizona.

[B-3] **Potential Road Impacts on Gila Monsters in an Urbanizing Environment**, Samantha Johnson, (Senior, Veterinary Science & Wildlife Conservation and Management, University of Arizona). Mentor: Matt Goode, School of Natural Resources and the Environment, University of Arizona.

[B-4] **Analysis of Space-based Riometer Measurement data for characterization of Radio Propagation Disturbance in the Ionosphere**, George Klett, (Senior, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University.

[B-4] **Analysis of Space-based Riometer Measurement data for characterization of Radio Propagation Disturbance in the Ionosphere**, Victor Mandala, (Junior, Electrical Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical, Computer, & Software Engineering, Embry-Riddle Aeronautical University.

[B-5] **Phenology Data to Aid Pollinator Restoration**, Hayley Limes, (Junior, Environmental Science, University of Arizona). Mentor: Erin Posthumus, School of Natural Resources and the Environment, USA National Phenology Network.

[B-6] **The Contribution of Plants and Pollution to Tucson's Urban Ozone Problem**, Richard Pepel, (Senior, Chemical Engineering, University of Arizona). Mentor: Eric Betterton, Department of Hydrology and Atmospheric Sciences, University of Arizona.

[B-7] **Bioremediation of Insensitive Munitions Compounds**, Jonathan Romero, (Senior, Environmental Engineering, University of Arizona). Mentor: Reyes Sierra, Department of Chemical and Environmental Engineering, University of Arizona.

[B-8] **The Influence of Conservation Structures on Rangeland Vegetation Patterns**, Lauren Thompson, (Senior, Ecology and Evolutionary Biology, University of Arizona). Mentor: Mary Nichols, Southwest Watershed Research Center, U.S. Department of Agriculture - Agricultural Research Service.

[B-9] **Mapping Hot Spring Geochemistry in Yellowstone**, Erin Alexander, (Junior, Earth and Space Exploration, Arizona State University). Mentor: Everett Shock, School of Earth and Space Exploration, Arizona State University.

[B-10] **Using Remote Sensing to Determine Vegetation Change and Impacts to Communities**, Jacob Cain, (Junior, Computer Science, Northern Arizona University). Mentor: Dianne Mcdonnell, Engineering, Northern Arizona University.

[B-11] **Nevada Offsite Management**, Sierra Generette, (Senior, Environmental Studies, North Carolina Agricultural & Technical State University). Mentor: Ken Kreie, Department of Energy: Legacy Management.

[B-12] **Identifying unique emplacement characteristics of O'Leary Peak: a volcanic dome in the San Francisco Volcanic Field**, Erin Kaplan, (Post-Baccalaureate, Geology, Northern Arizona University). Mentor: Nancy Riggs, Geology, Northern Arizona University.

[B-13] **Instance Segmentation for Biogeography**, Melissa Parkhurst, (Senior, Astrobiology, Arizona State University). Mentor: Jnaneshwar Das, Distributed Robotic Exploration and Mapping Systems Laboratory, Arizona State University.

[B-14] **Soil hydraulic properties three years after the Frye Fire on Mount Graham, Arizona**, Tyler Routt, (Senior, Natural Resources, University of Arizona). Mentor: Jason Williams, USDA Southwest Watershed Research Center.

[B-15] **Numerical simulation of Laramide flat-slab subduction**, Samantha Winstin-Seitz, (Junior, Environmental Science, Northern Arizona University). Mentor: Thomas Hoisch, Geology, Northern Arizona University.

[B-16] **Multi-drug Resistance of Pseudomonas aeruginosa Under Microgravity Growth Conditions**, Edward Apraku, (Senior, Civil and Environmental Engineering, Arizona State University). Mentor: Otakuye Conroy-Ben, School of Sustainable Engineering and the Built Environment, Arizona State University.

[B-17] **Off the Hook: Assessing the Vulnerability of Inland Subsistence Fisheries to Climate Change**, Caitlin Brogan, (Senior, Environmental and Sustainability Studies, Northern Arizona University). Mentor: Denielle Perry, School of Earth and Sustainability, Northern Arizona University.

[B-18] **Assessing the Role of the Winds in the Biogeochemical Cycling and Carbon Budget of the Southern Ocean**, Caitlin Encinas, (Senior, Ecology and Evolutionary Biology, University of Arizona). Mentors: Joellen Russell and Paul Goodman, Geosciences, University of Arizona.

[B-19] **Investigation of Electron Parameters and Association with Structures using Quasi-thermal noise Spectroscopy (QTN)**, Hari Krishnan, (Senior, Statistics, University of Arizona). Mentor: Mihailo Martinović, Lunar and Planetary Laboratory, University of Arizona.

[B-20] **Rare Earth Metal Recovery from Waste Stream Using Algae**, Alexa Rosenthal, (Junior, Environmental Engineering, Northern Arizona University). Mentor: Fethiye Ozis, Civil and Environmental Engineering, Northern Arizona University.

[B-21] **More Effectively Selective Species Have Greater Protein Structural Disorder**, Catherine Weibel, (Senior, Physics & Mathematics, University of Arizona). Mentor: Joanna Masel, Ecology and Evolutionary Biology, University of Arizona.

[B-22] **Developing a model system using Azotobacter vinelandii to investigate the evolution of nitrogen fixation**, Brooke Carruthers, (Sophomore, Molecular and Cellular Biology, University of Arizona). Mentor: Betül Kaçar, Molecular and Cellular Biology & Astronomy, University of Arizona.

[B-23] **Modeling to Make a Difference - Hydrologic Analysis for Improved Decision Support**, Abigail Kahler, (Junior, Environmental Hydrology, University of Arizona). Mentor: Ty P.A. Ferre, Hydrology and Atmospheric Sciences, University of Arizona.

[B-24] **Using GIS to Quantify Effects of Land Cover Change on Movement Patterns of Tiger Rattlesnakes (Crotalus tigris) in an Urbanizing Environment**, Karen Perkins, (Junior, Biosystems Engineering, University of Arizona). Mentor: Matt Goode, School of Natural Resources and the Environment, University of Arizona.

[B-25] **Can We Predict Germination Success in Seed Pellets Using Seed Traits?** Paige Thompson, (Junior, Environmental Science, Northern Arizona University). Mentor: Rachel Mitchell, Earth Sustainability, Northern Arizona University.

[B-26] **Electrolytic Application of Load-Managing Photovoltaic System**, Christian Polo, (Junior, Electrical Engineering, Arizona State University). Mentor: Meng Tao, School of Electrical, Computer, and Energy Engineering, Arizona State University.

[B-27] **Aquatic Data Analysis from Deployable, Autonomous Boat**, Rodney Staggers Jr, (Senior, Mechanical Engineering, Arizona State University). Mentor: Jnaneshwar Das, School of Earth and Space Exploration, Arizona State University.

[B-28] **Biogas Production from Microalgae following Freeze-Heat Pretreatment**, Galen Dennis, (Senior, Chemistry, Northern Arizona University). Mentor: Terry Baxter, Environmental and Civil Engineering Department, Northern Arizona University.

Program Schedule

Session C:
Astronomy and Space Physics

Moderators:
Christopher Edwards, NAU, Astronomy and Planetary Science
Rolf Jansen, ASU, School of Earth and Space Exploration
Tom Sharp, ASU, School of Earth and Space Exploration
Yancy Shirley, UArizona, Astronomy and Steward Observatory

[C-1] **The Characterization of EZ CMa**, Krister Barclay, (Junior, Astronomy, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Physics and Astronomy, Embry-Riddle Aeronautical University.

[C-2] **Image Simulations for Testing the Fidelity of SKYSURF Background Measurement Algorithms**, Delondrae Carter, (Senior, Astrophysics, Arizona State University). Mentor: Rogier Windhorst, School of Earth and Space Exploration, Arizona State University.

[C-3] **HCN Mapping of the Taurus Molecular Cloud**, Harrison Bradley, (Junior, Astronomy, University of Arizona). Mentor: Yancy Shirley, Steward Observatory, University of Arizona.

[C-4] **A Deep Look at the Nature of Black Holes: Using Tidal Disruption Events to See the Unseeable**, Aaron Goldtooth, (Senior, Mathematics, Physics, & Astronomy, University of Arizona). Mentor: Ann Zabludoff, Astronomy, University of Arizona.

[C-5] **Exoplanet Classification using Data Mining**, Mohit Doshi, (Senior, Computer Science, Arizona State University). Mentor: Huan Liu, School of Computing, Informatics and Decision Systems Engineering, Arizona State University.

[C-6] **The First Magnetar in a Binary System?** Clarissa Pavao, (Sophomore, Space Physics, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Department of Physics and Astronomy, Embry-Riddle Aeronautical University.

[C-7] **Taperings and Analytic Continuations of Supernova Gravitational Waves with Memory**, Colter Richardson, (Senior, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Department of Physics and Astronomy, Embry-Riddle Aeronautical University.

[C-8] **Laboratory Analysis of olivine-carbonate mixtures as observed on Mars**, Hope Wetzstein, (Junior, Physics & Astronomy, Northern Arizona University). Mentor: Mark Salvatore, Astronomy & Planetary Science, Northern Arizona University.

[C-9] **EagleSat Team: Determining Particle Energy Using CMOS Sensors**, Logan Horner, (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University.

[C-9] **EagleSat Team: Determining Particle Energy Using CMOS Sensors**, Hayden West, (Sophomore, Space Physics, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University.

[C-10] **MW-Andromeda Dark Matter Halo Velocity Dispersion Profiles**, Aidan DeBrae, (Junior, Physics & Astronomy, University of Arizona). Mentor: Peter Behroozi, Astronomy, University of Arizona.

[C-11] **Evaluation of Supernovae Astrophysical Parameters by Using Machine Learning on Laser Interferometric Data**, Dymetris Ramirez, (Sophomore, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Physics Department, Embry-Riddle Aeronautical University.

[C-12] **SKYSURF: Measuring the Brightness of the Sky**, Jessica Berkheimer, (Senior, Astrophysics, Arizona State University). Mentor: Rogier Windhorst, School of Earth and Space Exploration, Arizona State University.

[C-13] **Characterizing the Images of Black Hole Shadows**, Sean Dougall, (Senior, Astronomy & Physics, University of Arizona). Mentor: Dimitrios Psaltis, Astronomy, University of Arizona.

[C-14] **Controlling the Unseen: GIG Undergraduate Optical Research**, Parker Landon, (Junior, Computer Engineering & Space Physics, Embry-Riddle Aeronautical University). Mentor: Gretarsson Andri, Physics & Astronomy, Embry-Riddle Aeronautical University.

[C-15] **Assessing the Performance of the JWST/NIRCam Image Simulator PhoSim-NIRCam**, Jacob Magnusson, (Junior, Astronomy & Statistics and Data Science, University of Arizona). Mentors: Eiichi Egami and Kevin Hainline, Steward Observatory, University of Arizona.

[C-16] **Gravitational Wave Calibration Error for Supernovae Core Collapse**, Brad Ratto, (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Department of Physics and Astronomy, Embry-Riddle Aeronautical University.

[C-17] **Investigating the Planet Detection Limit in Debris Disk Images from the Gemini Planet Imager**, Kadin Worthen, (Senior, Physics, Arizona State University). Mentor: Jennifer Patience, School of Earth and Space Exploration, Arizona State University.

[C-18] **Characterizing High [OIII]/[OII] and High [OIII] Galaxies to Further LyC Study**, Alex Blanche, (Sophomore, Astrophysics, Arizona State University). Mentor: Brent Smith, School of Earth and Space Exploration, Arizona State University.

[C-19] **Charcterizing the Atmospheres of Low Surface Gravity M-dwarfs**, Isabela Huckabee, (Sophomore, Astrophysics, Arizona State University). Mentor: Michael Line, School of Earth and Space Exploration, Arizona State University.

[C-20] **Predictions for the Observable Autocorrelations of Accreting Black Holes from the Trinity Theoretical Model**, Oddisey Knox, (Junior, Astronomy, University of Arizona). Mentor: Peter Behroozi, Astronomy, University of Arizona.

[C-21] **Identification of Switchback Intervals in Parker Space Probe Data**, Noa Nishizawa, (Junior, Optical Sciences & Engineering, University of Arizona). Mentor: Kristopher Klein, Lunar and Planetary Laboratory, University of Arizona.

[C-22] **Measuring Galactic Wind Frequency and Strength as a Function of Environment**, Nicole Kerrison, (Junior, Astronomy, University of Arizona). Mentor: Ann Zabludoff, Department of Astronomy and Steward Observatory, University of Arizona.

[C-23] **Investigating the Relationship Between Exoplanet Occurrence & Host Star Metallicity**, Adrienne Vescio, (Senior, Astrophysics & Physics, Arizona State University). Mentor: Patrick Young, School of Earth and Space Exploration, Arizona State University.

[C-24] **The long-period orbit of the dust-producing Wolf-Rayet binary WR 125**, Andrea Daly, (Junior, Astronomy, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Department of Physics, Embry-Riddle Aeronautical University.

[C-25] **Improving the Detection of Core-Collapse Supernova Through Experimentation**, Skylar Kemper, (Junior, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Arts and Sciences, Embry-Riddle Aeronautical University.

[C-26] **Low Frequency Prototype of Laser Interferometer Suspensions for Gravitational Wave Detection**, Yuka Lin, (Junior, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Physics & Astronomy, Embry-Riddle Aeronautical University.

[C-27] **SPHEREx: The Future of Satellite Astronomy**, Julian Mena, (Junior, Astrophysics, Arizona State University). Mentor: Philip Mauskopf, School of Earth and Space Exploration, Arizona State University.

[C-28] **Narrow-band Filter Photometry Calibration for the Lowell 20''**, Cameron Piotti, (Senior, Astronomy & Physics, Northern Arizona University). Mentor: Gerard van Belle, Lowell Observatory.

[C-29] **Energy Balance at Interplanetary Shocks: In-situ Measurement of the Fraction in Energetic Protons with ACE and Wind**, Liam David, (Junior, Physics, Astronomy, & Applied Mathematics, University of Arizona). Mentor: Federico Fraschetti, Lunar and Planetary Laboratory, University of Arizona / Visiting Scientist, Harvard & Smithsonian Center for Astrophysics.

[C-30] **The Origins of Supermassive Black Holes**, Cole Roberson, (Senior, Physics & Astronomy, Northern Arizona University). Mentor: Robert Barrows, Astronomy, University of Colorado Boulder.

Program Schedule

Session D:
Aeronautics

Moderators:
Elliott Bryner, ERAU, Department of Mechanical Engineering
Paloma Davidson, NAU, Department of Astronomy and Planetary Science
Ron Madler, ERAU, Aerospace and Mechanical Engineering
Ernest Villicana, Phoenix College, Engineering

[D-1] **Experimental Investigation of Active Vortex Generators**, David Aksenfeld, (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Lance Traub, Aerospace Engineering, Embry-Riddle Aeronautical University.

[D-1] **Experimental Investigation of Active Vortex Generators**, Robert Belz-Templeman, (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Lance Traub, Aerospace Engineering, Embry-Riddle Aeronautical University.

[D-2] **Stall Hysteresis – Why the reattachment angle is less than the separation stall angle**, Maria Babcock, (Sophomore, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Mark Sensmeier, Aerospace Engineering, Embry-Riddle Aeronautical University.

[D-2] **Stall Hysteresis – Why the reattachment angle is less than the separation stall angle**, Thorne Wolfenbarger, (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Mark Sensmeier, Aerospace Engineering, Embry-Riddle Aeronautical University.

[D-3] **Optimizing Autorotating Sensor Probe Design for Space Exploration**, Sebastian Castillo-Sotelo, (Junior, Aerospace Engineering, Arizona State University). Mentor: Jnaneshwar Das, School of Earth and Space Exploration, Arizona State University.

[D-4] **Low Frequency Unsteadiness in Laminar Separation Bubbles**, Alek Cotnoir, (Junior, Aerospace Engineering, University of Arizona). Mentor: Jesse Little, Aerospace & Mechanical Engineering, University of Arizona.

[D-5] **Validating a New CFD Algorithm by Finding the Drag Coefficient of a Sphere**, David Madden, (Senior, Aerospace Engineering, Arizona State University). Mentor: Mohamed Kasbaoui, School for Engineering of Matter, Transport and Energy, Arizona State University.

[D-6] **CIS Aviation-ISAC**, Sierra McConnell, (Junior, Cyber Intelligence and Security, Embry-Riddle Aeronautical University). Mentor: Krishna Sampigthaya, School of Cyber Intellegence and Security, Embry-Riddle Aeronautical University.

[D-7] **Characterization of a Hypersonic Wind Tunnel Nozzle**, Addison Plummer, (Junior, Aerospace Engineering, University of Arizona). Mentor: Jesse Little, Aerospace & Mechanical Engineering, University of Arizona.

[D-8-9] **Suborbital Uncrewed Aerial Vehicles for Earth Surveillance and Mars Exploration**, Maddie Schiffler, (Senior, Aerospace Engineering, University of Arizona). Mentor: Sergey Shkarayev, Aerospace & Mechanical Engineering, University of Arizona.

[D-8-9] **Suborbital Uncrewed Aerial Vehicles for Earth Surveillance and Mars Exploration**, Reed Spurling, (Sophomore, Aerospace Engineering, University of Arizona). Mentor: Sergey Shkarayev, Aerospace & Mechanical Engineering, University of Arizona.

Program Schedule

Session E:
ASCEND (Aerospace STEM Challenges to Educate New Discoverers!)

Moderators:
Maitrayee Bose, ASU, School of Earth and Space Exploration
Desiree Crawl, ASU, School of Earth and Space Exploration
Joseph Foy, ASU, Barrett Honors College
Timothy Swindle, UArizona, Lunar and Planetary Laboratory

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Meghann Boland, (Sophomore, Aerospace Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Jacqueline Do, (Sophomore, Electrical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Tory Galat, (Sophomore, Biomedical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Samuel Jimenez, (Sophomore, Aerospace Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Benito Rincon Ramirez, (Sophomore, Mechanical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Karla Chao, (Sophomore, Aerospace Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Drew Corona, (Sophomore, Computer Science, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Sandra Montero, (Sophomore, Chemical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Maxx Mudd, (Junior, Computer Science, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-1-2] **Phoenix College: Video Streaming and DNA Studies**, Richard Ricketts, (Sophomore, Applied Mathematics, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College.

[E-3] **Project Helix**, Quynn Bell, (Sophomore, Mechanical Engineering, Pima Community College). Mentor: AnnMarie Condes, Chemistry, Pima Community College.

[E-3] **Project Helix**, Michelle Burr, (Junior, Cellular and Molecular Biology, Pima Community College). Mentor: AnnMarie Condes, Chemistry, Pima Community College.

[E-3] **Project Helix**, Pablo De La Fuente, (Senior, Mechanical Engineering, Pima Community College). Mentor: AnnMarie Condes, Chemistry, Pima Community College.

[E-4] **UArizona ASCEND: Profiling High-Altitude Radiation with a General Data Logger**, Nicolas Blanchard, (Sophomore, Electrical and Computer Engineering, University of Arizona). Mentor: Michelle Coe, Lunar and Planetary Laboratory, University of Arizona.

[E-4] **UArizona ASCEND: Profiling High-Altitude Radiation with a General Data Logger**, Kevin May, (Sophomore, Aerospace Engineering, University of Arizona). Mentor: Michelle Coe, Lunar and Planetary Laboratory, University of Arizona.

[E-4] **UArizona ASCEND: Profiling High-Altitude Radiation with a General Data Logger**, Daniel McConville, (Junior, Materials Science and Engineering, University of Arizona). Mentor: Michelle Coe, Lunar and Planetary Laboratory, University of Arizona.

[E-5] **A Measurement of the Concentration of Greenhouse Gases as Altitude Increases**, Gehrig Dixon, (High School Senior going into Electrical Engineering, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College.

[E-5] **A Measurement of the Concentration of Greenhouse Gases as Altitude Increases**, Gerard Dsouza, (Sophomore, Electrical Engineering, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College.

[E-5] **The Concentration of Gasses as Altitude Changes**, Arturo Luse, (Sophomore, Computer Science, Central Arizona College). Mentor: Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College.

[E-5] **A Measurement of the Concentration of Greenhouse Gases as Altitude Increases**, Calida Mills, (Sophomore, Computer Science, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College.

[E-5] **A Measurement of the Concentration of Greenhouse Gases as Altitude Increases**, Kevin Segovia, (Sophomore, Computer Science, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College.

[E-6] **EagleSat Team: Design and Refinement of 3U CubeSat Structure**, Erik Harang, (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical, Computer & Software Engineering, Embry-Riddle Aeronautical University.

[E-7] **Study of Thermal Heat Transfer Within a High-Altitude Balloon Payload**, Zachary Howe, (Junior, Aeronautical Sciences, Embry-Riddle Aeronautical University). Mentor: Douglas Isenberg, Mechanical Engineering, Embry-Riddle Aeronautical University.

[E-7] **Study of Thermal Heat Transfer Within a High-Altitude Balloon Payload**, Nicodemus Phaklides, (Junior, Electrical Engineering, Embry-Riddle Aeronautical University). Mentor: Douglas Isenberg, Mechanical Engineering, Embry-Riddle Aeronautical University.

[E-8] **Glendale Community College (GCC) ASCEND Team**, Dylan Hutchins, (Sophomore, Electrical Engineering, Glendale Community College). Mentor: Timothy Frank, Engineering, Glendale Community College.

[E-8] **Glendale Community College (GCC) ASCEND Team**, Andrea Maya, (Junior, Environmental Engineering, Glendale Community College). Mentor: Timothy Frank, Engineering, Glendale Community College.

[E-8] **Glendale Community College (GCC) ASCEND Team**, Ricardo Ontiveros, (Junior, Electrical Engineering, Glendale Community College). Mentor: Timothy Frank, Engineering, Glendale Community College.

[E-9] **EagleSat Team: Development and Implementation of a Self-Contained Harness for In-House Integration, Verification, and Testing of CubeSat Electric Power Systems**, Lorenzo Kearns, (Junior, Computer Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, College of Engineering, Embry-Riddle Aeronautical University.

[E-9] **EagleSat Team: Development and Implementation of a Self-Contained Harness for In-House Integration, Verification, and Validation Testing of CubeSat Electric Power Systems**, Andre Simmons, (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University.

Session F:
Education and Public Outreach

Moderators:
Anne Boettcher, ERAU, Undergraduate Research Institute Director
Michelle Coe, UArizona, Lunar and Planetary Laboratory
Chandra Holifield Collins, USDA, Southwest Watershed Research Center

[F-1] **Communication and Exploration**, Stone Woodham, (Senior, Earth and Space Exploration & Communication, Arizona State University). Mentor: Mansour Javidan, Thunderbird School of Global Management, Arizona State University.

[F-2] **The Impact and Importance of Science Writing**, Stephanie Martinez, (Sophomore, Physics & Astrophysics, Northern Arizona University). Mentor: Chris Etling, Managing Editor, Arizona Daily Sun.

Program Schedule

Session G:
Exploration Systems Engineering

Moderators:
Elliott Bryner, ERAU, Department of Mechanical Engineering
Paloma Davidson, NAU, Department of Astronomy and Planetary Science
Ron Madler, ERAU, Aerospace and Mechanical Engineering
Ernest Villicana, Phoenix College, Engineering

[G-1] **Ex Vivo Analysis of Multi-Sensory Device for Bone Strain Monitoring**, Gerardo Figueroa, (Senior, Biomedical Engineering, University of Arizona). Mentor: John Szivek, Department of Orthopaedic Surgery, University of Arizona.

[G-2] **Minimizing Local Electromagnetic Interference Using Adaptive Filters**, Joshua Wu, (Junior, Electrical and Computer Engineering, University of Arizona). Mentor: John Wallace, Rincon Research Corporation.

[G-3] **Measuring Antenna Patterns for Ground Station**, Josh Smith, (Senior, Aerospace Engineering, University of Arizona). Mentor: Mike Parker, Rincon Research Corporation.

[G-4] **Photocurable nanocomposites for customizable cartilage replacements**, Alexis Hocken, (Senior, Chemical Engineering, Arizona State University). Mentor: Matthew Green, Chemical Engineering, School for Engineering of Matter, Transport, and Energy, Arizona State University.

[G-5] **Mars In-Situ Resource Utilization for Health Applications**, Santana Solomon, (Junior, Medical Studies, Arizona State University). Mentor: Sara Walker, School of Earth and Space Exploration, Arizona State University.

[G-6] **Direct Air Capture Using Moisture Swing Chemistry**, Ryan Stratton, (Senior, Mechanical Engineering, Northern Arizona University). Mentor: Jenifer Wade, Mechanical Engineering, Northern Arizona University.

[G-7] **An Introduction to Systems Engineering: Building a Monochromator Mount**, Zoe Horvath, (Junior, Earth and Space Exploration & Physics, Arizona State University). Mentor: Paul Scowen, School of Earth and Space Exploration, Arizona State University.

[G-In Title Only] **Mediated Liver Regeneration**, Andrea Borsenik, (Junior, Biomedical Sciences, Arizona State University). Mentor: Douglas Lake, School of Life Sciences, Arizona State University.

Program Schedule

Session H:
Planetary Science

Moderators:
Maitrayee Bose, ASU, School of Earth and Space Exploration
Desiree Crawl, ASU, School of Earth and Space Exploration
Joseph Foy, ASU, Barrett Honors College
Timothy Swindle, UArizona, Lunar and Planetary Laboratory

[H-1] **USGS Science Center - Solar System Exhibit Captions**, Anthony Kiefer, (Junior, Environmental Science, Northern Arizona University). Mentor: Greg Vaughan, U.S. Geological Survey Research Geologist, Northern Arizona University.

[H-2] **Calibration of Images from the OSIRIS-REx Camera Suite**, Natalie Shultz, (Senior, Optical Engineering, University of Arizona). Mentor: Dathon Golish, Lunar and Planetary Laboratory, University of Arizona.

[H-3] **Magnetic Anomalies in the South Polar Region of the Moon**, Isabella Bryant, (Junior, Mathematics, University of Arizona). Mentor: Lon Hood, Lunar and Planetary Laboratory, University of Arizona.

[H-4] **Exploring Carbon-bearing Matter in an Antarctic Micrometeorite**, Victoria Froh, (Senior, Chemistry & Earth and Space Exploration, Arizona State University). Mentor: Maitrayee Bose, School of Earth and Space Exploration, Arizona State University.

[H-5] **Supporting the Climate Change Department**, Meronda Walker, (Sophomore, Environmental Science, Northern Arizona University). Mentor: Niccolette Cooley, Institute for Tribal Environmental Professionals, Northern Arizona University.

[H-6] **Variability of Martian Wrinkle Ridges**, Morgan Cryder, (Sophomore, Geoscience, University of Arizona). Mentor: Jeff Andrews-Hanna, Lunar and Planetary Laboratory, University of Arizona.

[H-7] **Increasing CO Gas Detections in Protoplanetary Disks**, Grace Hathaway, (Senior, Physics & Astronomy, University of Arizona). Mentor: Kamber Schwarz, Lunar and Planetary Laboratory, University of Arizona.

[H-8] **Investigating the Origin of Fine-Grained Rims in Mighei-like Carbonaceous Chondrites**, Xeynab Mouti, (Junior, Microbiology, Arizona State University). Mentor: Devin Schrader, Center for Meteorite Studies, Arizona State University.

[H-9] **Trends In Mineralogy and Grain Size Distribution Across Paleolake Basins on Mars**, Shaye Fordring, (Sophomore, Chemistry, Northern Arizona University). Mentor: Jennifer Buz, Planetary Sciences, Northern Arizona University.

Program Schedule

Session I:
Aerospace Technology

Moderators:
Elliott Bryner, ERAU, Department of Mechanical Engineering
Paloma Davidson, NAU, Department of Astronomy and Planetary Science
Ron Madler, ERAU, Aerospace and Mechanical Engineering
Ernest Villicana, Phoenix College, Engineering

[I-1] **Rocket Development Lab Team: The Effects of Equivalence Ratio during shutdown of a rocket engine on hardware longevity**, Benjamin Black, (Junior, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Elliott Bryner, College of Engineering, Embry-Riddle Aeronautical University.

[I-2] **Rocket Development Lab Team: Thermal Management Analysis of Water-Cooled Rocket Engine**, Macallan Boyle, (Sophomore, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Elliott Bryner, College of Engineering, Embry-Riddle Aeronautical University.

[I-3] **Rocket Development Lab Team: Cooling Channel Geometry Analysis for a Regeneratively Cooled Rocket Engine**, Zoe Brand, (Sophomore, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Elliott Bryner, Mechanical Engineering, Embry-Riddle Aeronautical University.

[I-4] **EagleSat Team: On-board Computer Subsystem**, Katherine Rocha, (Junior, Computer Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical, Computer, & Software Engineering, Embry-Riddle Aeronautical University.

[I-5] **Pico Balloon Platform for Atmospheric Exploration**, Joshua Crest, (Senior, Mechanical Engineering, University of Arizona). Mentor: Jekan Thangavelautham, Department of Aerospace and Mechanical Engineering, University of Arizona.

[I-6] **Designing and Exploring the Structure of Launch Vehicles to Create Optimal Theoretical and Small-Scale Experimental Models**, Cole Errico, (Sophomore, Aerospace Engineering, Arizona State University). Mentor: Timothy Takahashi, School for Engineering of Matter, Transport and Energy, Arizona State University.

[I-7] **CatSat Groundstation Command and Control**, Agustin Jimenez, (Senior, Aerospace Engineering, University of Arizona). Mentor: Christopher Walker, Department of Astronomy and Steward Observatory, University of Arizona.

[I-7] **CatSat Groundstation Command and Control**, Jacob Padilla, (Senior, Electrical and Computer Engineering, University of Arizona). Mentor: Christopher Walker, Department of Astronomy and Steward Observatory, University of Arizona.

[I-8] **Julia 1.2 Ephemeris and Gravitational Modeling Development**, Marcus Kaiser, (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Kaela Martin, Aerospace Engineering, Embry-Riddle Aeronautical University.

[I-8] **Julia 1.2 Ephemeris and Gravitational Modeling Development**, Parker Landon, (Junior, Computer Engineering & Space Physics, Embry-Riddle Aeronautical University). Mentor: Kaela Martin, Aerospace Engineering, Embry-Riddle Aeronautical University.

[I-9] **Simulation and Evaluation of a Mechanical Hopping Mechanism for Robotic Small Body Surface Exploration**, Kevin May, (Sophomore, Aerospace Engineering, University of Arizona). Mentor: Jekan Thangavelautham, Aerospace & Mechanical Engineering, University of Arizona.

[I-10] **Spacecraft Attitude Control Implementation and Development**, Matthew Robinaugh, (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Bradley Wall, Aerospace Engineering, Embry-Riddle Aeronautical University.

[I-11] **Measurements of the Sky,** Ci'mone Rogers, (Junior, Information Security, Arizona State University). Mentor: Tim Carlton, School of Earth and Space Exploration, Arizona State University.

[I-12] **Heuristic Optimization Applied to Orbital Transfers Between Low-Planetary Orbits and Distant Retrograde Orbits**, Amber Scarbrough, (Senior, Software Engineering, Embry-Riddle Aeronautical University). Mentor: Davide Conte, Aerospace Engineering, Embry-Riddle Aeronautical University.

[I-13] **A Study of the Deflection of 99942 Apophis from Earth**, Carly VeNard, (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Davide Conte, Aerospace Engineering, Embry-Riddle Aeronautical University.

2020-21 Arizona/NASA Space Grant Undergraduate Research Intern & ASCEND Team Abstracts

Aksenfeld, David (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Lance Traub, Aerospace Engineering, Embry-Riddle Aeronautical University. [D-1]

EXPERIMENTAL INVESTIGATION OF ACTIVE VORTEX GENERATORS

Vortex generators and active flow control improve wing performance across many metrics. The purpose of this project is to investigate the ability of an active vortex generator to combine the benefits of active flow control and standard vortex generators. A wind tunnel test model is designed to investigate the effect of a rotating vortex-generating disk (VGD) which protrudes through the upper surface of a wing. A NACA 0016 airfoil with a 6-inch chord is used with the VGD at 15% chord from the leading edge. Measurements are taken at a Reynolds number of 150,000. Data will be collected from static pressure taps on the top surface of the model and from a 6-component load cell. Tests will vary frequency and geometry of VGDs. This research will create opportunities to expand research on types of active flow control involving vortex generators and have future implementation in aircraft design.

Alexander, Erin (Junior, Earth and Space Exploration, Arizona State University). Mentor: Everett Shock, School of Earth and Space Exploration, Arizona State University. [B-9]

MAPPING HOT SPRING GEOCHEMISTRY IN YELLOWSTONE

Patterns uncovered by mapping the geochemistry of a hydrothermal system in Yellowstone through time and space reveal a dynamic region where hot spring chemistry is linked to both the deep hydrothermal system and the surface meteoric system. Spatial analysis through mapping displays a chloride gradient across the region, interpreted to be hydrothermal fluid input. Temporal analysis shows changing sulfate concentrations, interpreted as variations in volcanic gas input. Local topography adds a layer of complexity, bringing in surficial meteoric fluid that mixes with deep magmatic input in this area, resulting in the diversity of hot springs seen today. Combining interpretations of major ion concentrations allow for inferences of water rock reaction, magmatic gas input, and dilute meteoric water addition, revealing a geochemical gradient where meteoric and deep waters mix.

Apraku, Edward (Senior, Civil and Environmental Engineering, Arizona State University). Mentor: Otakuye Conroy-Ben, School of Sustainable Engineering and the Built Environment, Arizona State University. [B-16]

MULTI-DRUG RESISTANCE OF PSEUDOMONAS AERUGINOSA UNDER MICROGRAVITY GROWTH CONDITIONS

The effects of spaceflight on microbial growth are critical to the success of future NASA missions and astronaut health. Research has shown that gram-negative bacteria acquire increased resistance to antibiotics during spaceflight conditions through their proton (H+) blocking chemical efflux proteins. These efflux proteins allow for broad-spectrum resistance and increased acid stress responses. Such membrane-bound antibiotic-resistance pumps export a wide array of drugs, while concurrently taking up a proton (H+). These efflux pumps are also responsible for elevated antimicrobial resistance in clinical settings. The purpose of this project is to identify the antibiotic resistance of this opportunistic pathogen under low shear microgravity and normal shear conditions. This work will aid NASA in analyzing resistance from microgravity and in future planning of long-term space missions.

Babcock, Eric (Junior, Software Engineering, Embry-Riddle Aeronautical University). Mentors: Lara Ismert and Mitch Hamidi, Mathematics, Embry-Riddle Aeronautical University. [A-1-2]

NEW METHODS FOR THE ITERATION AND VISUALIZATION OF MANDELBROT AND JULIA SETS

For each complex polynomial, one can define an associated Julia set by iterating the given polynomial at a seed and studying the boundedness of the resulting sequence. The most famous example being the Mandelbrot set which arises from special Julia sets where the seed is equal to the complex constant. One can establish a new method for generating the Mandelbrot set by replacing polynomials with matrices, and seeds with vectors. Using this construction, we found a theorem that shows an interesting connection between a complex number's membership in the Mandelbrot set and the boundedness of an associated family of matrices. This new method has been expanded to work on Julia sets as well. With this new method, we hope to decrease the computational complexity of calculating Julia and Mandelbrot sets. By applying linear algebra to these sets, we hope to gain a greater understanding of fractal geometry.

Babcock, Maria (Sophomore, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Mark Sensmeier, Aerospace Engineering, Embry-Riddle Aeronautical University. [D-2]

STALL HYSTERESIS – WHY THE REATTACHMENT ANGLE IS LESS THAN THE SEPARATION STALL ANGLE

Our work involves focusing on the behavior of the "effective body" aerodynamics of stalled airfoils. The effective body is the physical airfoil along with the recirculating wake behind it, dominating the hysteresis loop from catastrophic stall to reattachment. Stall hysteresis is observed when an airfoil's angle of attack is increased beyond the angle for stall and flow does not reattach at the same (separation) angle when lowering the angle of attack again. It is found that, where hysteresis data is available for comparison, the reattachment angle of a given airfoil geometry agrees with the stall/separation angle of the associated effective body to within a fraction of a degree. Our work carries implications that we could predict the angle an airfoil recovers from stall by using the stall angle of the airfoil's effective body. This work can be used to improve airfoil design where hysteretic stall control is mission critical.

Baez, Justin (Junior, Geological Sciences, Arizona State University). Mentor: Everett Shock, School of Earth and Space Exploration, Arizona State University. [B-1]

CAN CHANGES IN HOT SPRING COMPOSITION REFLECT DECADAL-SCALE DEFORMATION OF THE YELLOWSTONE CALDERA?

Vertical displacement measurements dating back to the 1920's have indicated that the large Yellowstone Caldera contained within Yellowstone National Park (YNP), WY. has undergone periods of rapid deformation that operate on a decadal time-scale. Previous studies focused on this characteristic of the Yellowstone Caldera have attempted to correlate the deformation cycles with earthquake activity and the movement of materials in the subsurface, only speculating on its signature within the chemical composition of YNP hot springs. The study at hand investigates this potential relationship by plotting the compositional data collected annually since 1997 as a function of time and observing trends that can be related to the deformation data. Many hot springs within the dataset display compositional adjustments that carry on from year to year and our data analysis is focused on hot spring constituents that are affected by changes in gas input (sulfide, sulfate, pH, etc.), to search for correlations between the deformation activity and hot spring chemical composition.

Barclay, Krister (Junior, Astronomy, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Physics and Astronomy, Embry-Riddle Aeronautical University. [C-1]

THE CHARACTERIZATION OF EZ CMA

Recently, it has been suggested that the variability of the bright WN4 star EZ CMa (WR 6, HD 50896) that has a period of 3.7 d could be attributed to a close binary system with some eccentricity and fast apsidal motion with a period of only ~100 d. Past analyses have attributed this variability to large-scale wind structures from a single star with a rotational period of 3.7 d. We began observations with the CTIO 1.5 m telescope and the high-resolution CHIRON spectrograph to look for radial velocity shifts that could be attributed to the orbital motion. Alternatively, we may find that the variability is attributable to large-scale wind structures.

Bell, Quynn (Sophomore, Mechanical Engineering, Pima Community College). Mentor: AnnMarie Condes, Chemistry, Pima Community College. [E-3]

PROJECT HELIX

The focus of this year's study has been centered around designing a fully 3D printed payload shell capable of carrying four samples of Culex pipen for ionizing radiation research as well as custom designed PCB's with surface mounted electronics able to read altitude, pressure, humidity, temperature, acceleration, rotational data, light intensity, and radiation; both gamma and beta radiation. On board we have a number of sensors including a BME280, one MPU6050, two variants of the TMP36, one DS1307, one HC-SR04, and one Geiger Counter. With the data recorded by the MPU6050, a 3-axis gyroscope, our team will be able to recreate a 3D simulation of the entire flight with accurate acceleration and rotational data. The HC-SR04 module, an ultrasonic distance sensor, will be used to measure the speed of sound throughout the flight, but our team is primarily focused on the changes in the upper atmosphere. Once the data is retrieved, we will create graphs of the speed of sound versus altitude and temperature in order to get a better understanding of how these measurements compare. The Geiger Counter is custom built and involves its own integrated circuit prototyping board capable of outputting over 400V DC and measuring gamma and beta radiation. The data collected from this module will be primarily used for studying the effects of ionizing radiation on Culex pipens. By knowing the amount of ionizing radiation introduced to the species of mosquitoes, it will be easier to determine the amount of damage that has affected the DNA. The study will also use other techniques to observe the damage to the DNA such as PCR, Comet Assay, and Immunostaining with DNA damage markers.

Belz-Templeman, Robert (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Lance Traub, Aerospace Engineering, Embry-Riddle Aeronautical University. [D-1]

EXPERIMENTAL INVESTIGATION OF ACTIVE VORTEX GENERATORS

Vortex generators and active flow control improve wing performance across many metrics. The purpose of this project is to investigate the ability of an active vortex generator to combine the benefits of active flow control and standard vortex generators. A wind tunnel test model is designed to investigate the effect of a rotating vortex-generating disk (VGD) which protrudes through the upper surface of a wing. A NACA 0016 airfoil with a 6-inch chord is used with the VGD at 15% chord from the leading edge. Measurements are taken at a Reynolds number of 150,000. Data will be collected from static pressure taps on the top surface of the model and from a 6-component load cell. Tests will vary frequency and geometry of VGDs. This research will create opportunities to expand research on types of active flow control involving vortex generators and have future implementation in aircraft design.

Berkheimer, Jessica (Senior, Astrophysics, Arizona State University). Mentor: Rogier Windhorst, School of Earth and Space Exploration, Arizona State University. [C-12]

SKYSURF: MEASURING THE BRIGHTNESS OF THE SKY

SKYSURF is the largest Hubble Space Telescope (HST) archive program to date. By fully characterizing the sky's brightness, it will leverage HST's imaging capabilities to survey faint objects, from Solar System bodies to other galaxies. Hubble's excellent sensitivity makes it an ideal candidate to study these objects, but we must understand the foreground light precisely (in terms of its brightness, color, and time-dependence) to accurately characterize these objects. SKYSURF's measurements of the sky brightness, along with a comprehensive study of faint background galaxies, will result in a better understanding of the sources of foreground and background light. The research presented here involves collecting and downloading data from the HST archive and visually inspecting images. By conducting an in-depth comparison of results using data from multiple calibration procedures, we will ensure steps in the calibration are not affecting the sky measurements.

Black, Benjamin (Junior, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Elliott Bryner, College of Engineering, Embry-Riddle Aeronautical University. [I-1]

ROCKET DEVELOPMENT LAB TEAM: THE EFFECTS OF EQUIVALENCE RATIO DURING SHUTDOWN OF A ROCKET ENGINE ON HARDWARE LONGEVITY

During the shutdown or purge period after firing of a rocket engine it is critical to understand what equivalence ratios are desirable and implement a shutdown sequence so that the hardware is subjected to the lowest thermal and mechanical loading. Furthermore, it is essential that hazards to the test technicians caused by this method be minimized. The initial study was conducted into combustion mechanics, to understand how the reactants would ideally behave at varying equivalence ratios and in both pre-mixed and diffusion flame combustion. Using this foundation an analytical model for a Propane-Oxygen flame was created and tested using a scale combustion chamber and a pre-mixed gaseous flame. Finally, the pressure and exhaust gas temperature data will be used to create a solution to be implemented for further full-scale testing on a 250lbf thrust Ethanol-LOX rocket engine.

Blanchard, Nicolas (Sophomore, Electrical and Computer Engineering, University of Arizona). Mentor: Michelle Coe, Lunar and Planetary Laboratory, University of Arizona. [E-4]

UARIZONA ASCEND: PROFILING HIGH-ALTITUDE RADIATION WITH A GENERAL DATA LOGGER

CubeSats have been a rapidly growing technology over the last decade due to their diminutive total mass to orbit while maintaining spacecraft performance. However, smaller electronics are more susceptible to the high-energy radiation present in orbit, so lightweight radiation shielding is a growing area of research to extend the lifetime of CubeSats. This project serves to analyze the viability of high-altitude ballooning as a testbed for radiation shielding materials as a safe alternative to radiation source experimentation on the ground. Within the bounds of a standard 1U CubeSat, the UArizona ASCEND payload housed a geiger counter and atmospheric profiling system to identify the amount of ionizing radiation present in Earth's atmosphere up to approximately 100,000 feet to determine whether testing radiation shielding materials in this environment is reasonable for research purposes.

Blanche, Alex (Sophomore, Astrophysics, Arizona State University). Mentor: Brent Smith, n/a, Arizona State University. [C-18]

CHARACTERIZING HIGH [OIII]/[OII] AND HIGH [OIII] GALAXIES TO FURTHER LYC STUDY

This project aims to modify the scope of two published papers, Smith et al. 2018 and Smith et al. 2020, by focusing on high [OIII] and high [OIII]/[OII] ratio galaxies in the GOODS North, South, and COSMOS fields and their characteristics. This project's purpose outside of the context of Space Grant is to contribute to Lyman Continuum (LyC) emission study and these galaxies' possible contributions to the epoch of cosmic reionization. Out of 1103 spectra categorized, there are 48 strong candidates for high [OII] and high [OIII] galaxies, some of which include measured line flux. More spectra from other surveys need to be gathered in order to observe the wavelengths where LyC emissions can be found and begin to categorize these galaxies beyond the current state of the project.

Boland, Meghann (Sophomore, Aerospace Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College's goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Borsenik, Andrea (Junior, Biomedical Sciences, Arizona State University). Mentor: Douglas Lake, School of Life Sciences, Arizona State University. [G-In Title Only]

MEDIATED LIVER REGENERATION

Current treatment for liver cirrhosis is restricted to treating the symptoms of the disease. However, there is a large body of research pertaining to serotonin and other chemicals being used in mediated liver regeneration as a treatment for the root cause of liver cancer and cirrhosis. Last year, a meta-analysis of the literature on the current research was conducted to build a model of the biological mechanisms behind serotonin-mediated liver regeneration.

Then a schematic model was made highlighting the key factors, including serotonin, that play a role in liver regeneration. The goal of this research is to create a mathematical model of how serotonin plays into liver regeneration and cancer to demonstrate the therapeutic threshold of serotonin and other chemicals with similar attributes. Ultimately, the hope is the model can be verified in a laboratory setting and then generalized for clinical use.

Boyd, Elena (Junior, Physics, Arizona State University). Mentor: Samuel Teitelbaum, Physics, Arizona State University. [A-9]

NONLINEAR LASER PULSE COMPRESSION WITH A MULTIPASS CELL

The CXFEL team is designing a compact ultrafast x-ray source in order to perform research on condensed matter systems using Inverse Compton scattering, which ejects high-energy photons by scattering laser light against an electron beam. In the Compact X-ray Light Source design, the peak power of the laser needs to be increased in order to keep laser intensity constant with a larger beam spot size. Since peak power is approximately equal to the pulse energy divided by the FWHM of the pulse duration, the pulse needs to be compressed by a factor of approximately 1/25. I used MATLAB to simulate this nonlinear compression. Up to this point, nonlinear pulse compression has only been performed on 18 mJ pulses, and for the CXLS a 500 mJ pulse was needed. These calculations required use of the numerical parameters of the laser: input pulse energy & duration, beam diameter, & wavelength.

Boyle, Macallan (Sophomore, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Elliott Bryner, College of Engineering, Embry-Riddle Aeronautical University. [I-2]

ROCKET DEVELOPMENT LAB TEAM: THERMAL MANAGEMENT ANALYSIS OF WATER-COOLED ROCKET ENGINE

The objective of this research is to investigate and model the thermal management of a water-cooling jacket on a liquid rocket engine using energy balance and heat transfer correlations in advection fluid flow networks. The water-cooling jacket flows water around the engine geometries for the purpose of transferring away heat using conduction. Within the water-cooling jacket, the models create an advection fluid flow network that describes the heat transfer from the combustion chamber, throat, and nozzle to the flowing water. An advection network model describes the transfer of a fluid and its properties through a system. Thus, fluid properties can be characterized using this model as it flows around the engine geometries and these findings can be used to describe different fluid types and how they would behave.

Bradley, Harrison (Junior, Astronomy, University of Arizona). Mentor: Yancy Shirley, Steward Observatory, University of Arizona. [C-3]

HCN MAPPING OF THE TAURUS MOLECULAR CLOUD

The Taurus Molecular Cloud (TMC) is one of the nearest star forming regions of dust and gas in our galaxy. Molecular clouds are characterized by turbulent hierarchical filamentary structure and no single molecular tracer probes all densities and scales in these clouds. The TMC has been previously mapped in the low-density tracer carbon monoxide and high-density tracer ammonia. We map the spectral signature of the 1-0 rotational transition of hydrogen cyanide, an intermediate-density gas tracer, towards several filaments in the TMC. Observations were made by on-the-fly mapping with the Arizona Radio Observatory (ARO) 12 Meter Telescope on Kitt Peak. Our observations bridge the gap in density traced by prior carbon monoxide and ammonia observations. We analyze the centroid position and shape of the spectral lines to constrain the kinematics of the intermediate density gas.

Brand, Zoe (Sophomore, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Elliott Bryner, Mechanical Engineering, Embry-Riddle Aeronautical University. [I-3]

ROCKET DEVELOPMENT LAB TEAM: COOLING CHANNEL GEOMETRY ANALYSIS FOR A REGENERATIVELY COOLED ROCKET ENGINE

The variation of cooling channel geometries is based on complex heat transfer analysis for a regeneratively cooled rocket engine. The knowledge of cooling channel geometries is required to continue the development of regeneratively cooled rocket engines at Embry-Riddle. To assist in future projects, a mathematical model has been created to analyze inputs of predictive designs to identify the constraints that will need to be met to have optimal rocket engine cooling. The mathematical model generates different channel geometries by varying aspect ratios based on specifications inputted by the user. To test the validity of the model, an experiment will be conducted to find the convection coefficient of a liquid through a heated simple geometry cooling channel test stand.

Brindle, Dawson (Sophomore, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentors: Lara Ismert and Mitch Hamidi, Mathematics, Embry-Riddle Aeronautical University. [A-1-2]

NEW METHODS FOR THE ITERATION AND VISUALIZATION OF MANDELBROT AND JULIA SETS

For each complex polynomial, one can define an associated Julia set by iterating the given polynomial at a seed and studying the boundedness of the resulting sequence. The most famous example being the Mandelbrot set which arises from special Julia sets defined by iterating complex polynomials where the seed is equal to the complex constant. One can establish a new method for generating the Mandelbrot set by replacing polynomials with matrices, and seeds with vectors. Using this construction, we found a theorem that shows an interesting connection between a complex number's membership in the Mandelbrot set and the boundedness of an associated family of matrices. This new method has been expanded to work on Julia sets as well. With this new method, we hope to decrease the computational complexity of calculating Julia and Mandelbrot sets. By applying linear algebra to these sets, we hope to gain a greater understanding of fractal geometry.

Brogan, Caitlin (Senior, Environmental and Sustainability Studies, Northern Arizona University). Mentor: Denielle Perry, School of Earth and Sustainability, Northern Arizona University. [B-17]

OFF THE HOOK: ASSESSING THE VULNERABILITY OF INLAND SUBSISTENCE FISHERIES TO CLIMATE CHANGE

Inland fisheries in the United States serve as a critical subsistence food source, especially to communities with a cultural connection to fishes and/or that are experiencing depressed economic activity. Climate change is projected to affect inland fisheries, potentially threatening food security brought by subsistence fishing activities. Through geospatial analysis that takes into consideration socio-economic, hydrologic, climate, land use, and creel survey data, this study aims to first identify fisheries and associated communities of subsistence fishers that are projected to be negatively impacted by climate change. Subsequent analyses of extant water resource management policies will be conducted to determine whether current management practices are sufficient to confer resilience in the fisheries or whether additional policies need to be applied to sustain these critical food sources. This study will ultimately provide a unique national dataset identifying the location of subsistence fisheries and a set of adaptive management recommendations for select fisheries.

Bryant, Isabella (Junior, Mathematics, University of Arizona). Mentor: Lon Hood, Lunar and Planetary Laboratory, University of Arizona. [H-3]

MAGNETIC ANOMALIES IN THE SOUTH POLAR REGION OF THE MOON

Unlike the Earth, the Moon lacks a global magnetic field. Instead, it has weaker localized crustal magnetic anomalies, likely caused by ejecta from a collision of an iron-rich asteroid with the Moon’s surface. By using an equivalent source dipole (ESD) technique, we constructed stereographic maps of these fields in the south polar region. This technique more accurately shows the size and shape of the magnetic anomalies in this area. These maps can assist in the exploration and analysis of the south polar region of the Moon. We used data collected from the Kaguya/SELENE orbiter in 2009. By mapping this data, we were able to select the orbits with the least amount of interference from the solar wind. We then took this data and modeled it at a constant 30-kilometer altitude via a simulated mesh of dipoles at 15 km beneath the Moon’s surface, and mapped the results.

Burr, Michelle (Junior, Cellular and Molecular Biology, Pima Community College). Mentor: AnnMarie Condes, Chemistry, Pima Community College. [E-3]

PROJECT HELIX

The focus of this year's study has been centered around designing a fully 3D printed payload shell capable of carrying four samples of Culex pipen for ionizing radiation research as well as custom designed PCB's with surface mounted electronics able to read altitude, pressure, humidity, temperature, acceleration, rotational data, light intensity, and radiation; both gamma and beta radiation. On board we have a number of sensors including a BME280, one MPU6050, two variants of the TMP36, one DS1307, one HC-SR04, and one Geiger Counter. With the data recorded by the MPU6050, a 3-axis gyroscope, our team will be able to recreate a 3D simulation of the entire flight with accurate acceleration and rotational data. The HC-SR04 module, an ultrasonic distance sensor, will be used to measure the speed of sound throughout the flight, but our team is primarily focused on the changes in the upper atmosphere. Once the data is retrieved, we will create graphs of the speed of sound versus altitude and temperature in order to get a better understanding of how these measurements compare. The Geiger Counter is custom built and involves its own integrated circuit prototyping board capable of outputting over 400V DC and measuring gamma and beta radiation. The data collected from this module will be primarily used for studying the effects of ionizing radiation on Culex pipens. By knowing the amount of ionizing radiation introduced to the species of mosquitoes, it will be easier to determine the amount of damage that has affected the DNA. The study will also use other techniques to observe the damage to the DNA such as PCR, Comet Assay, and Immunostaining with DNA damage markers.

Cain, Jacob (Junior, Computer Science, Northern Arizona University). Mentor: Dianne Mcdonnell, Engineering, Northern Arizona University. [B-10]

USING REMOTE SENSING TO DETERMINE VEGETATION CHANGE AND IMPACTS TO COMMUNITIES

Hurricanes cause disastrous impacts to communities, destroying vegetation and setting erosion, landslides, and flooding into motion. Remote Sensing and Geographical Information Systems (RS/GIS) are used to map out where water accumulates, and how vegetation changes. NASA's Landsat 8 Satellite has an Enhanced Thematic Mapper Plus (ETM+) sensor, which captures an array of images in visible and invisible bands. Red and Near-Infrared (NIR) bands are used to calculate Normalized Difference Vegetation Index (NDVI), which measures the greenness of an area. Comparing NDVI before and after a hurricane shows the effect of the storm on the health of the vegetation, which in turn shows areas of potential impacts. A Digital Elevation Model (DEM) map of heights is used to calculate sinks where flow accumulates and flooding may occur. Flow Accumulation and NDVI data in conjunction show which areas are most at risk. Communities can use this data to plan and mitigate risk.

Carruthers, Brooke (Sophomore, Molecular and Cellular Biology, University of Arizona). Mentor: Betül Kaçar, Molecular and Cellular Biology & Astronomy, University of Arizona. [B-22]

DEVELOPING A MODEL SYSTEM USING AZOTOBACTER VINELANDII TO INVESTIGATE THE EVOLUTION OF NITROGEN FIXATION

Earth's geologic record preserves much of the history of life, but interpretation often relies on properties of modern biology that may not resemble ancient biological states. The experimental reconstruction of inferred ancestral enzymes provides a way to directly test traits of ancient biology. We used this approach to investigate ancestral nitrogenases, enzymes that have supported biological productivity for billions of years by making nitrogen available to life through the process of biological nitrogen fixation. We developed and optimized an automated growth protocol for the nitrogen-fixing model bacterium, Azotobacter vinelandii. This protocol enables the assessment of nitrogen fixation in wild-type and engineered bacterial strains carrying ancestral nitrogenases. Our protocol can be used to investigate the physiological impact of ancestral and other modified nitrogenases in modern host microbes. These investigations can inform our understanding of early nitrogen fixation as well as the search for biosignatures relating to nitrogen on other extraterrestrial bodies.

Carter, Delondrae (Senior, Astrophysics, Arizona State University). Mentor: Rogier Windhorst, School of Earth and Space Exploration, Arizona State University. [C-2]

IMAGE SIMULATIONS FOR TESTING THE FIDELITY OF SKYSURF BACKGROUND MEASUREMENT ALGORITHMS

Several sky background measurement algorithms have been developed to determine the background levels of images in the SKYSURF database. To test the fidelity of these sky background measurement algorithms, images with known sky background and noise levels were necessary to determine quantitatively how far a sky background measurement algorithm strays from the true value. For this purpose, I developed an algorithm that could create simulated images for filter F125W of the WFC3 IR instrument on the Hubble Space Telescope (HST). These simulated images include stars, galaxies, cosmic rays, and gradients. Sky measurements performed on these images reveal that the sky measurement algorithms developed for SKYSURF are incredibly precise, with some algorithms reporting sky values within <0.3% of the known values.

Castillo-Sotelo, Sebastian (Junior, Aerospace Engineering, Arizona State University). Mentor: Jnaneshwar Das, School of Earth and Space Exploration, Arizona State University. [D-3]

OPTIMIZING AUTOROTATING SENSOR PROBE DESIGN FOR SPACE EXPLORATION

When preparing for space exploration missions to other planets, it is an important objective to collect data about the planet so that it can be analyzed and learn as much as we can from it. It is desirable to develop technology that can collect surface data of planets like Mars as inexpensive and accurately as possible. Our project revolves around a sensor probe called the Marspod, which is designed to be dropped in the atmosphere of other planets and land safely on the planet's surface using rotor blades like those of a helicopter to slowly descend. A model for the Marspod was designed and assembled so that drop tests could be performed. Additionally, a Newtonian model of the Marspod was developed that could describe its aerodynamic behavior while it's in flight. The drop tests have shown that the Marspod is capable of spinning its rotor blades and slowing its descent.

Chao, Karla (Sophomore, Aerospace Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College’s goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Corona, Drew (Sophomore, Computer Science, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

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Cotnoir, Alek (Junior, Aerospace Engineering, University of Arizona). Mentor: Jesse Little, Aerospace & Mechanical Engineering, University of Arizona. [D-4]

LOW FREQUENCY UNSTEADINESS IN LAMINAR SEPARATION BUBBLES

Laminar separation bubbles (LSBs) form in wall bounded flows when subjected to a strong adverse pressure gradient and are common in many areas of aerodynamics. In various flow regimes spanning subsonic to hypersonic, LSBs have shown low frequency unsteadiness referred to as bubble 'breathing'. As a canonical case for incompressible flow, a wing is mounted over a flat plate, projecting an adverse pressure gradient onto the plate, forming an LSB. Pressure, constant temperature anemometry (CTA), and particle image velocimetry (PIV) data are used to analyze the LSB. Long duration CTA measurements at low sampling rates are recorded to investigate the low frequency unsteadiness. Periodic forcing is also applied to investigate sensitivity of the process to disturbances. Results of this work will be used to inform studies of low frequency unsteadiness for high-speed flows and develop methods to combat its adverse effects.

Crest, Joshua (Senior, Mechanical Engineering, University of Arizona). Mentor: Jekan Thangavelautham, Department of Aerospace and Mechanical Engineering, University of Arizona. [I-5]

PICO BALLOON PLATFORM FOR ATMOSPHERIC EXPLORATION

NASA has expressed interest in revisiting Venus to perform life detection experiments. Venus's thick atmosphere, high surface temperatures, and sulfuric acid clouds present unique challenges that make exploration costs high. A pico-balloon platform has been developed for atmospheric exploration. The prototype pico-balloon was constructed using an SBS-13 balloon envelope with helium lifting gas and was equipped with a solar powered APRS and WSPR tracker that relays position and atmospheric conditions. Preliminary flights have flown for upwards of two weeks, have achieved speeds up to 289 MPH, and have nearly circumnavigated the earth. Swarms of pico-balloons could be launched on earth to provide in situ measurements of the jet stream. The platform could be further expanded to form constellations around Venus that will act as an in situ long-duration detector, scanning and identifying the regions that have the highest potential to harness life.

Cruz, Terese Maxine (Sophomore, Biosystems Engineering, University of Arizona). Mentor: Kathleen Prudic, Natural Resources and the Environment, University of Arizona. [B-2]

URBAN BIODIVERSITY LIFE RAFTS: A WAY TO CONSERVE OUR POLLINATORS

Insect pollinators (primarily bee and butterfly species) are vital to plant reproduction, nutrient cycling, and offer benefits to human societal well-being and enjoyment. In general, pollinator biodiversity has been decreasing over time globally due to factors such as agricultural intensification, urbanization, climate change, and other anthropological activities. The purpose of our study is to investigate the potential ability of the University of Arizona to serve as a pollinator "biodiversity hotspot" in an urban landscape. We used community science data from two sources, iNaturalist and the USA National Phenology Network, to analyze the relative presence, diversity, and change over time of pollinators on the university campus compared with the surrounding urban area. The results from this study will help us better understand pollinator activity, employ conservation methods, and potentially increase their frequency on campus through thoughtful management and restoration practices including a digital pollinator field guide.

Cryder, Morgan (Sophomore, Geoscience, University of Arizona). Mentor: Jeff Andrews-Hanna, Lunar and Planetary Laboratory, University of Arizona. [H-6]

VARIABILITY OF MARTIAN WRINKLE RIDGES

Wrinkle ridges are compressional tectonic structures that are observed in large numbers on the volcanic surfaces of Mars. These structures provide a record of global contraction and cooling. Previous studies have used topographic profiles to constrain the underlying geometry of faults and the associated strain. However, the variability within an individual ridge and between different ridges has not been addressed, and may shed light on the ridges' formation. We analyzed large numbers of topographic profiles of wrinkle ridges in Solis and Lunae plana using a K-means classification algorithm. We acquired information on vergence direction, width, and height. We also classified the ridges into three types: symmetric, asymmetric, or double. We found that some ridges exhibit extreme variability in the profiles, while others demonstrate consistency. Our results indicate that some details of the ridges' structures (e.g., the geometry of thrusts and backthrusts at shallow depths) vary widely within and between ridges.

Daly, Andrea (Junior, Astronomy, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Department of Physics, Embry-Riddle Aeronautical University. [C-24]

THE LONG-PERIOD ORBIT OF THE DUST-PRODUCING WOLF-RAYET BINARY WR 125

Recently the binary system WR 125 began a dust creation episode seen with an infrared outburst. This is the first time since 1991 that this type of activity has been observed for WR 125, leading to the first determination of a period: 28.1 years. We began collecting spectra of WR 125 to constrain the orbit, on the assumption that this system will produce dust near periastron, similarly to WR 140. We present the infrared light curves showing the similarities between the 1990s dust event and the current dust event, as well as the first measured radial velocities for the system to begin constraining the orbit.

David, Liam (Junior, Physics, Astronomy, & Applied Mathematics, University of Arizona). Mentor: Federico Fraschetti, Lunar and Planetary Laboratory, University of Arizona / Visiting Scientist, Harvard & Smithsonian Center for Astrophysics. [C-29]

ENERGY BALANCE AT INTERPLANETARY SHOCKS: IN-SITU MEASUREMENT OF THE FRACTION IN ENERGETIC PROTONS WITH ACE AND WIND

Shock waves in the solar wind between the Earth and Sun can generate significant fluxes of high-energy charged particles. We obtained interplanetary plasma parameters, including the density, temperature, and magnetic field, for a sample of shocks observed by the ACE and Wind spacecraft at 1AU. Using the conservation of energy, momentum, and mass across the shock surface, and assuming that proton fluxes are isotropic, we find that high-energy protons can drain about 15-35% of the total plasma energy, in agreement with previous observational findings. The proton energy fraction is insensitive to the shock speed and the inclination of the local magnetic field, thereby generalizing recent numerical simulations.

De La Fuente, Pablo (Senior, Mechanical Engineering, Pima Community College). Mentor: AnnMarie Condes, Chemistry, Pima Community College. [E-3]

PROJECT HELIX

The focus of this year's study has been centered around designing a fully 3D printed payload shell capable of carrying four samples of Culex pipen for ionizing radiation research as well as custom designed PCB's with surface mounted electronics able to read altitude, pressure, humidity, temperature, acceleration, rotational data, light intensity, and radiation; both gamma and beta radiation. On board we have a number of sensors including a BME280, one MPU6050, two variants of the TMP36, one DS1307, one HC-SR04, and one Geiger Counter. With the data recorded by the MPU6050, a 3-axis gyroscope, our team will be able to recreate a 3D simulation of the entire flight with accurate acceleration and rotational data. The HC-SR04 module, an ultrasonic distance sensor, will be used to measure the speed of sound throughout the flight, but our team is primarily focused on the changes in the upper atmosphere. Once the data is retrieved, we will create graphs of the speed of sound versus altitude and temperature in order to get a better understanding of how these measurements compare. The Geiger Counter is custom built and involves its own integrated circuit prototyping board capable of outputting over 400V DC and measuring gamma and beta radiation. The data collected from this module will be primarily used for studying the effects of ionizing radiation on Culex pipens. By knowing the amount of ionizing radiation introduced to the species of mosquitoes, it will be easier to determine the amount of damage that has affected the DNA. The study will also use other techniques to observe the damage to the DNA such as PCR, Comet Assay, and Immunostaining with DNA damage markers.

DeBrae, Aidan (Junior, Physics & Astronomy, University of Arizona). Mentor: Peter Behroozi, Astronomy, University of Arizona. [C-10]

MW-ANDROMEDA DARK MATTER HALO VELOCITY DISPERSION PROFILES

Dark matter remains undetected because it only interacts via gravity and does not absorb or emit light. The density structure resulting from the gravity of dark matter produces dark matter halos around galaxies. The intent of this experiment is to analyze the dark matter halo system of the Milky Way (MW) and its closest neighboring galaxy, Andromeda (M31). Our objective is to compare the velocity dispersion profile of the MW dark matter halo to the velocity dispersion profile of the MW-M31 dark matter halo system. Understanding the velocity dispersion profile of the MW-M31 system can help develop predictions for the direct detection experiments which aim to measure the effects of the dark matter. The analysis is conducted in a simulated universe, where we assess halos to find those that are similar to the MW and MW-M31 system.

Dennis, Galen (Senior, Chemistry, Northern Arizona University). Mentor: Terry Baxter, Environmental and Civil Engineering Department, Northern Arizona University. [B-28]

BIOGAS PRODUCTION FROM MICROALGAE FOLLOWING FREEZE-HEAT PRETREATMENT

Developing systems that can efficiently recycle biological products is an important step for enabling space travel over long distances. Carbon dioxide is a combustion product that can be recycled through fixation by algae then breakdown and recovery by anaerobic digestion. This experiment examined how anaerobic conversion of algae biomass to methane is affected by hot and cold pretreatment at levels that might be available to a ship in space. An anaerobic digester was fed algae after pretreatment at varying temperatures. The bio-gas production and composition were measured and compared to a control fed only untreated biomass. It was found that heat pretreatment significantly increased bio-gas production, while freeze treatment only slightly increased efficiency. These results show that pretreating algae biomass prior to anaerobic digestion can improve its efficiency. Future work can explore how combining both hot and cold treatments in different ways can maximize conversion efficiency.

Dixon, Gehrig (High School Senior going into Electrical Engineering, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College. [E-5]

A MEASUREMENT OF THE CONCENTRATION OF GREENHOUSE GASES AS ALTITUDE INCREASES

An increase in the concentration of greenhouse gases in the atmosphere has the effect of increasing the atmosphere's ability to trap heat. The hypothesis is that there will be a higher concentration of the lighter gases compared to the heavier ones at higher altitudes, as heavier gases tend to sink compared to lighter ones. This payload is designed to collect data on the concentration of greenhouse gases, such as carbon dioxide, carbon monoxide, nitrous oxide, methane, and water vapor, in parts per million (ppm) at various altitudes using gas and altitude sensors. The payload walls are made of insulating material. Some sensors are placed in grooves along the outside of the enclosure. The inside of the enclosure is sealed to keep the microcontroller and the batteries safe. The data collected will be analyzed using Excel to determine if the hypothesis is supported.

Do, Jacqueline (Sophomore, Electrical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College's goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Doshi, Mohit (Senior, Computer Science, Arizona State University). Mentor: Huan Liu, School of Computing, Informatics and Decision Systems Engineering, Arizona State University. [C-5]

EXOPLANET CLASSIFICATION USING DATA MINING

The purpose of this project is to study and understand existing Exoplanet discovery and classification methods and analyze the extensive archives of exoplanet datasets from various missions and space agencies to generate insights as well as classify the exoplanets on their potential for displaying signs of life. Exoplanets are planets which orbit a star outside of the solar system. Using Data Mining and Machine Learning Techniques, the Caltech Exoplanet Archive's approximately 26000 exoplanets were studied and each exoplanet's features were analyzed to build a suitable feature set. This data was fed to a classifier that picked key features and ground truth data to make an informed choice on the probability that an exoplanet is habitable. With the use of various Python libraries and evaluating different models, a K-Nearest-Neighbors Classifier was built and trained on the dataset in addition to a Deep Learning classification model.

Dougall, Sean (Senior, Astronomy & Physics, University of Arizona). Mentor: Dimitrios Psaltis, Astronomy, University of Arizona. [C-13]

CHARACTERIZING THE IMAGES OF BLACK HOLE SHADOWS

Black hole images show bright rings of emission surrounding deep brightness depressions, the black hole shadows. The shadows have sizes and shapes that are determined entirely by the theory of gravity. The bright emission rings, however, vary in size depending on the properties of the plasma that surrounds the black hole. Testing Einstein's theory of General Relativity with black hole images requires us to be able to both measure the size of the bright emission ring and to infer the respective size of the target black hole's shadow. In this project, we use image-domain feature extraction techniques to analyze and characterize the images of black holes in a large suite of numerical simulations and, in particular, measure the sizes and widths of the bright emission rings. Our results provide strong support to using the emission rings as proxies in determining the size of the black hole shadows and testing Einstein's theories.

Dsouza, Gerard (Sophomore, Electrical Engineering, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College. [E-5]

A MEASUREMENT OF THE CONCENTRATION OF GREENHOUSE GASES AS ALTITUDE INCREASES

With the increased concentrations of greenhouse gasses in the atmosphere, the effect is the augmentation of our atmosphere's ability to trap heat. This payload determines the concentration of greenhouse gasses at various altitudes using gas and altitude sensors. We will be collecting data in parts per million (ppm) of gasses such as Carbon Dioxide, Carbon Monoxide, Ethane, Methane, and Water Vapor. The sensors collecting the data are placed in grooves along the outside of the payload made of insulating board material. The inside of the board will be sealed while it ascends to keep the microcontroller and the batteries safe. As the payload ascends, the team hypothesizes that there will be a higher concentration of the lighter gasses compared to the heavier gasses. The team infers this based on the knowledge that heavier gasses tend to sink compared to lighter gasses.

Encinas, Caitlin (Senior, Ecology and Evolutionary Biology, University of Arizona). Mentors: Joellen Russell and Paul Goodman, Geosciences, University of Arizona. [B-18]

ASSESSING THE ROLE OF THE WINDS IN THE BIOGEOCHEMICAL CYCLING AND CARBON BUDGET OF THE SOUTHERN OCEAN

The Southern Ocean absorbs anthropogenic carbon and heat and is a vital component in sustaining ocean biogeochemistry. Climate change has the potential to alter the biogeochemistry of the Southern Ocean. Warming, the poleward shift of the surface winds, and sea ice reduction can lead to biogeochemical feedbacks including nutrient trapping. Research shows that winds regulate the carbon dioxide exchange between the ocean and the atmosphere. Numerical simulations are used to estimate how impacts of wind-stress and biogeochemical changes in the Southern Ocean affect the carbon flux there. Previous research shows that climate change will impact nutrient circulation and could put oceanic systems at risk. We will use estimations and assimilations to assess Southern Ocean biological productivity and carbon flux alterations associated with wind, climate, and biogeochemistry changes.

Errico, Cole (Sophomore, Aerospace Engineering, Arizona State University). Mentor: Timothy Takahashi, School for Engineering of Matter, Transport and Energy, Arizona State University. [I-6]

DESIGNING AND EXPLORING THE STRUCTURE OF LAUNCH VEHICLES TO CREATE OPTIMAL THEORETICAL AND SMALL-SCALE EXPERIMENTAL MODELS

This research project focuses on structural and performance analysis used to design and optimize a theoretical launch vehicle through the Arizona State University (ASU)/NASA Space Grant program. Multiple programs and codes, in conjunction with one another, come together to produce an overall design model. Using this model, further additions and modifications can be made to add components to the structure, scale up or down the size of the vehicle, or test how viable a certain design is with a simulated launch. These programs are useful for any engineer who needs to either test the feasibility of a design they have created or create one for various aerospace purposes. It can be exported to a computer-aided design (CAD) program to be manufactured for small-scale experiments. These methods have been applied to a potential launch vehicle model similar in scale and structure to those used in modern aerospace.

Evans, Ryan (Senior, Chemistry, Northern Arizona University). Mentor: Stephanie Hurst, Chemistry & Biochemistry, Northern Arizona University. [A-6]

ARTIFICIAL CILIA CREATION FOR ADVANCED SENSOR DEVICES

The scope of my project is to create 3-D printed smart materials through infusion of various metallic nanoparticles. This infusion will provide an accurate model of the articulate movement of cilia. When introduced inside light curable polymers these smart materials activate in the presence of a magnetic field. The combination of nanoparticles into printable resin allows for two main advantages: controlled dispersion and narrowing down individual cilia hairs' response to light and magnetic fields. The findings in this study allows for the pursuit and production of advanced sensory systems; that will be instrumental in future endeavors in space. The successfully synthesized smart materials were able to retain the characteristics of both magnetic and optically active nanoparticles.

Figueroa, Gerardo (Senior, Biomedical Engineering, University of Arizona). Mentor: John Szivek, Department of Orthopaedic Surgery, University of Arizona. [G-1]

EX VIVO ANALYSIS OF MULTI-SENSORY DEVICE FOR BONE STRAIN MONITORING

Bone mass and bone healing are regulated by activity that produces bone strain. Changes in environments with altered gravity affect bone strain, which in turn affects bone remodeling. To better understand this relationship, we need a method of obtaining accurate, direct in vivo measurements. Calcium phosphate ceramic (CPC) coatings have successfully bonded in vivo bone strain sensors through biological bone-bonding within 3 weeks. In this study, we used a cyanoacrylate adhesive and a CPC coating on sensors creating a combinatorial attachment system, to obtain continuous bone strain measurements beginning immediately after sensor implantation. In vivo data collection showed peak femoral strains of approximately 400 microstrain. At 3 weeks, ex vivo analysis showed incomplete bonding between CPC particles and the bone surface. This may be a result of various factors such as sensor motion in vivo or potentially an inflammatory response. Additional experiments will evaluate new gauge stabilizing approaches.

Fordring, Shaye (Sophomore, Chemistry, Northern Arizona University). Mentor: Jennifer Buz, Planetary Sciences, Northern Arizona University. [H-9]

TRENDS IN MINERALOGY AND GRAIN SIZE DISTRIBUTION ACROSS PALEOLAKE BASINS ON MARS

Modern basins on Mars show significant material diversity, and many hosted ancient lakes. Because of this, Martian basins are of interest for planetary geology, climate modeling and astrobiology. Through our research we aim to characterize the fundamental material properties/trends of paleolake basins. To achieve this, we use remote sensing spectroscopy (VNIR/IR) where possible. Our study focuses on Terby crater, where findings are compared to trends observed in other Martian basins and paleolake basins on Earth. Findings suggest phyllosilicates – clays, olivine and smectites predominate in fan deposits, while materials like carbonates, a component of the ubiquitous Martian dust, are found throughout the basin. Additional research pertaining to differences between craters unlocks further clues of early Martian climates and advances knowledge of Mars' past habitability.

Froh, Victoria (Senior, Chemistry & Earth and Space Exploration, Arizona State University). Mentor: Maitrayee Bose, School of Earth and Space Exploration, Arizona State University. [H-4]

EXPLORING CARBON-BEARING MATTER IN AN ANTARCTIC MICROMETEORITE

TAM 19B-7 is the largest, unmelted fine-grained micrometeorite found to date. It has carbonaceous chondritic origins, but the oxygen isotope composition does not match any known parent bodies. Therefore, TAM 19B-7 has the possibility of coming from a new asteroid parent body that has not been previously represented here on Earth in meteorite or micrometeorite samples. Additionally, carbon-bearing matter and isotopic composition has been extensively characterized in meteorites, but this work has not been done yet for micrometeorites. Here, we seek to constrain the carbon isotopic composition of TAM19B-7 using the NanoSIMS 50L instrument. The bulk δ13C for TAM19B-7 was found to be 3 +/- 8‰, and four anomalous spots were identified with δ13C values of 12.9‰, 16.8‰, 32.7‰, and -27.1‰. The bulk and anomalous 13C enrichments are novel for micrometeorites, and may be due to the presence of carbonates or carbonaceous materials.

Galat, Tory (Sophomore, Biomedical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. The mechanical team aims not only to house and hold all internal components but also to protect them from the cold atmosphere and the fall back to the ground. A space blanket covered by a layer of wax paper is used to insulate the payload and prevent any potential unwanted conductance between components. An interior structure in the shape of a cube holds the components on the outside, and within the cube holds the battery along with the camera. A 6-inch dome sits at the bottom of the payload and acts as the lid and allows for a wide view for the camera. The exterior and interior are vital to keeping the components safe and secure.

Generette, Sierra (Senior, Environmental Studies, North Carolina Agricultural & Technical State University). Mentor: Ken Kreie, Department of Energy: Legacy Management. [B-11]

NEVADA OFFSITE MANAGEMENT

Legacy Management (LM) is the Department of Energy’s steward of many closed environmental sites in the United States. LM is responsible for performing long term surveillance and maintenance at these sites to protect the environment and public health. Within the LM sites are the Nevada Offsites (NVOS), where underground nuclear tests and experiments were performed outside the boundaries of the Nevada National Security Site. The NVOS program manages nine sites in five states that are managed under a variety of obligations and agreements. In order to maintain site institutional knowledge, this project will develop Site Management logs which will include historical information that captures decisions, recommendations, and obligations made for each of the NVOS sites from 2006 to present. This will ensure that Legacy Management is keeping track of management decisions for each of the NVOS for years to come.

Goldtooth, Aaron (Senior, Mathematics, Physics, & Astronomy, University of Arizona). Mentor: Ann Zabludoff, Astronomy, University of Arizona. [C-4]

A DEEP LOOK AT THE NATURE OF BLACK HOLES: USING TIDAL DISRUPTION EVENTS TO SEE THE UNSEEABLE

Data from NASA mission archives will be used to produce a large dataset of X-ray data for identifying potential tidal disruption events. The data will include deep, multi-epoch X-ray spectra from XMM-Newton, Chandra and Swift telescopes. Additionally, UV spectra will also be collected from Swift observations. This spectra data will then be reduced and analyzed uniformly with improved calibrations, background subtraction, and interloping source removal, ultimately fitting them with our new slim disk accretion model for TDEs. Primary objectives will be: (1) to build up and maintain the spectral dataset with hopes for eventual open use and (2) to gain experience in reducing X-ray spectra data as well as fitting that with the accretion model.

Harang, Erik (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical, Computer & Software Engineering, Embry-Riddle Aeronautical University. [E-6]

EagleSat Team: Design and Refinement of 3U CubeSat Structure

The structures team of EagleSat 2 has been refining and making changes to a 3U CubeSat structure, with emphasis on both manufacturability and ease of integration. Building upon past experiences and looking at the present state-of-the-art in industry, the team created a structure that can fully support EagleSat 2's mission profile. Additionally, the team is designing structural elements to support all the payload subsystems, including a bracket to secure the platinum radiation moderators employed in the cosmic ray experiment. This presentation will highlight the design processes and milestones along the road to the current design and will conclude with a snapshot of the current and projected states of the structures team.

Hathaway, Grace (Senior, Physics & Astronomy, University of Arizona). Mentor: Kamber Schwarz, Lunar and Planetary Laboratory, University of Arizona. [H-7]

Increasing CO Gas Detections in Protoplanetary Disks

One of the most important gas mass tracers used for analyzing the properties of protoplanetary disks is carbon monoxide (CO). Previous ALMA radio telescope surveys of disks in star-forming regions had short integration time which led to molecular line non-detections, particularly in disks around less luminous protostars and with lower dust masses. By revisiting these archival disks surveys, we hoped to increase the number of CO detections by exploiting the Keplerian velocity structure of protoplanetary disks. Using CASA software and the Python package GoFish, we stacked the spectra of the isotopologues 13CO and C18O to increase the signal to noise of our data. Using this improved data, we've reanalyzed previous trends to deepen our understanding of the characteristics of protoplanetary disks.

Hocken, Alexis (Senior, Chemical Engineering, Arizona State University). Mentor: Matthew Green, Chemical Engineering, School for Engineering of Matter, Transport, and Energy, Arizona State University. [G-4]

Photocurable nanocomposites for customizable cartilage replacements

The properties of photocurable nanocomposites can be tailored to mimic those of various tissues and/or cartilage, allowing the bio-inspired synthetic materials to replace them. Ultimately, the long-term goal of this project is to 3D print the replacements so they can be tailored to fit individual patients. Therefore, it is critical that the thermal, mechanical, and rheological properties of the nanocomposites be more acutely understood to better predict the behavior of the replacements. In a previous study, it was found that addition of non-functionalized and inert silica nanoparticles increased the ultimate stress that the structure could withstand. In this new investigation, a similar study will be performed, however this time with functionalized silica nanoparticles. Functionalized nanoparticles will likely contribute to a more robust material compared to composites with nonfunctionalized additives. Characterizing the properties of photocurable nanocomposites will give better insight into the applicability of this material as cartilage replacements.

Horner, Logan (Junior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University. [C-9]

EagleSat Team: Determining Particle Energy Using CMOS Sensors

Generally, particle and nuclear physicists use a combination of a scintillator and photomultiplier tube to detect subatomic particles' energies. However, the scintillator is unable to relay an incident direction of the particle. We are attempting to remedy this by using an array of complementary metal oxide semiconductor (CMOS) sensors to track the incident direction of particles interacting with the cameras. Since we have an incident direction, the focus of this work is to relate the pixel intensity of particle interaction on the camera to the energy of the particle itself.

This would mainly be accomplished with the assistance of the Bethe-Bloch equation which relates the incident particle energy to the pixel intensity. This technique is to be further developed for use on Embry-Riddle Aeronautical University's cube sat Eaglesat 2, to determine cosmic ray direction, magnitude, and flux in an International Space Station orbit.

Horvath, Zoe (Junior, Earth and Space Exploration & Physics, Arizona State University). Mentor: Paul Scowen, School of Earth and Space Exploration, Arizona State University. [G-7]

AN INTRODUCTION TO SYSTEMS ENGINEERING: BUILDING A MONOCHROMATOR MOUNT

The goal of this research project is the successful creation of a support structure for the monochromator, light source, and vacuum pump assembly to the test chamber for the Star-Planet Activity Research Cube-Sat (SPARCS). The monochromator assembly is integral to the test chamber's ability to test the performance of the SPARCS optical system, so it is crucial that it is properly supported as to not compromise the optical path. From establishing necessary requirements derived from the system's science goals, to the complete conception and review of a mount design, and finally to the machining and physical assembly of the support system, this research project encompasses the start-to-finish development of a mount to support the monochromator assembly. Once the mount is built, it will be integrated into the chamber during assembly and continue to be evaluated on the basis of its support and the integrity of the optical path.

Howe, Zachary (Junior, Aeronautical Sciences, Embry-Riddle Aeronautical University). Mentor: Douglas Isenberg, Mechanical Engineering, Embry-Riddle Aeronautical University. [E-7]

STUDY OF THERMAL HEAT TRANSFER WITHIN A HIGH-ALTITUDE BALLOON PAYLOAD

In the design of high-altitude balloon payloads, it is critical to ensure that experiments are safe from the extreme range of temperatures experienced. Payloads require insulation and/or a heating solution to protect them from the cold thermal environment but also require the ability to dissipate heat during touchdown and recovery. The created payload will study this heat transfer via 26 thermistors uniformly distributed in and around the craft. These will also be placed near temperature critical components such as the battery and microcontroller. Thermal control is implemented through a heating element and a controllable vent servo. Additionally, solar panels are mounted externally to use in tandem with a gyroscope, magnetometer, and GPS to determine position and attitude. The payload is also designed to record video of the entire flight via a GoPro. This payload will be incredibly important to provide a sturdy, safe, and modular foundation for future experiments.

Huckabee, Isabela (Sophomore, Astrophysics, Arizona State University). Mentor: Michael Line, School of Earth and Space Exploration, Arizona State University. [C-19]

CHARACTERIZING THE ATMOSPHERES OF LOW SURFACE GRAVITY M-DWARFS

The objective of this study is to model the atmospheres of low surface gravity M-dwarfs. This will aid in investigating observed trends of these stars unexplained by models thus far. A growing collection of observed low gravity M-dwarfs (Faherty et al.,2016; Patience et al., 2012) have appeared brighter in the infrared than typical M-dwarfs and they hypothesize this may be from a high altitude cloud layer. Our code simulates a 1-D M-dwarf atmosphere and determines the effective temperature, surface gravity, and atmospheric bulk chemical properties. We incorporate radiative transfer, equations of state, and convection to determine the model star's spectra, thermal structure, and molecular/elemental mixing ratios. We plan to fit spectral data for cloudy, low gravity M-dwarfs and address brightness trends in these objects. The results will help gain a better understanding of the processes in low surface gravity M-dwarfs and therefore the potentially habitable exoplanets orbiting them.

Hutchins, Dylan (Sophomore, Electrical Engineering, Glendale Community College). Mentor: Timothy Frank, Engineering, Glendale Community College. [E-8]

GLENDALE COMMUNITY COLLEGE (GCC) ASCEND TEAM

The focus of GCC's ASCEND team was to work together to create three separate payloads. While the team members were not able to work directly with each other due to social distancing requirements, they communicated through a virtual environment. An Arduino Uno was used to collect data from sensors that measure temperature, pressure, acceleration, and battery voltage. It was also used to control a RunCam2 video camera to capture images of the balloon throughout the flight. With the aid of our ASCEND mentor, Dr. Frank, the team members soldered together circuit boards and built enclosures out of foamboard to house the three individual payloads, which were constrained to be under 1-lb so that the total weight of all of GCC's payloads was under 3-lbs. After the flight, the sensor data was downloaded into Excel and graphed to view the changes in the atmospheric conditions throughout the entire flight.

Jimenez, Samuel (Sophomore, Aerospace Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College's goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Jimenez, Agustin (Senior, Aerospace Engineering, University of Arizona). Mentor: Christopher Walker, Department of Astronomy and Steward Observatory, University of Arizona. [I-7]

CATSAT GROUNDSTATION COMMAND AND CONTROL

In preparation for the launch of the CatSat, communication between the satellite's core components to the ground station must be firmly established. CatSat is a CubeSat project using components provided by GOMSpace and Rincon Research Corporation. Our initial step towards establishing communication between these is to develop the ground station software to be compatible with the FlatSat to ensure functionality with the components that will be used in the CubeSat once it is completely assembled. So far, we have set up the GOMSpace flight computer to downlink packets to the ground station, and we have established communication from the AstroSDR flight computer to the GOMSpace flight computer. Our next step is to set up the camera to transfer files to the AstroSDR, which can relay them to the GOMSpace computer, and downlink them to the ground station. This provides us a route in which to send images back to the ground station.

Johnson, Samantha (Senior, Veterinary Science & Wildlife Conservation and Management, University of Arizona). Mentor: Matt Goode, School of Natural Resources and the Environment, University of Arizona. [B-3]

POTENTIAL ROAD IMPACTS ON GILA MONSTERS IN AN URBANIZING ENVIRONMENT

Since 2002, we have conducted surveys on an approximately 50-km road network in an urbanizing environment near Tucson, in the foothills of the Tortolita Mountains. The focus of this research is to examine the potential impacts of roads on the Gila Monster (Heloderma suspectum), a protected species throughout its range. We analyzed spatial data from radio-tracked animals, and from individuals found during road cruising surveys. Preliminary results indicate that Gila Monsters experience low rates of road mortality, suggesting that they are proficient at avoiding roads, choosing to remain within habitat patches, and minimally interact with roads. Kernel density analyses indicate that Gila Monsters are less likely to be detected in the vicinity of culverts after initial capture, which may be due to avoidance of negative stimuli associated with being captured. We suggest that Gila Monsters may change their behavior in response to human contact.

Kahler, Abigail (Junior, Environmental Hydrology, University of Arizona). Mentor: Ty P.A. Ferre, Hydrology and Atmospheric Sciences, University of Arizona. [B-23]

MODELING TO MAKE A DIFFERENCE - HYDROLOGIC ANALYSIS FOR IMPROVED DECISION SUPPORT

Hydrologic models are used to predict the effects of proposed water uses, but are uncertain because they lack sufficient subsurface data. The tools that are used to describe this uncertainty do not fully consider the risk to decision makers. This work follows a different approach, using an ensemble of models, jointly, to explicitly evaluate the greatest risk to each stakeholder. These ensembles describe the uncertainty and also intentionally include models that 'advocate' for decision makers. Specifically, this project developed an iterative approach that searches for best-fit models in addition to plausible models that would lead to outcomes of concern. The goal is to show how this system could lead to improved scientifically-based water resources decisions under uncertainty. This method's success depends on stakeholder engagement, and future work will include developing an interface to illustrate the benefit of these ensembles and encourage collaboration.

Kaiser, Marcus (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Kaela Martin, Aerospace Engineering, Embry-Riddle Aeronautical University. [I-8]

JULIA 1.2 EPHEMERIS AND GRAVITATIONAL MODELING DEVELOPMENT

Julia is a new programming language designed for numerical computing combining simplicity and the ease of dynamic languages with the speed of compiled languages. Julia version 1.0 was released in August of 2018, marking the first stable version of the language. An ephemeris and constant reader, capable of retrieving data for major and small bodies, does not yet exist in Julia. With user inputs, this tool stores information from NASA databases, then outputs the specific information about a body. Julia 1.2 has allowed for many improvements which include decreasing the code's runtime and new gravitational field modeling. To model the gravitational fields of major and minor bodies, the code uses both moments of inertia, polyhedral models, and spherical harmonics. The knowledge of celestial bodies and their gravitational models within one program will help continue the advancement of astrodynamics and space trajectory optimization.

Kaplan, Erin (Post-Baccalaureate, Geology, Northern Arizona University). Mentor: Nancy Riggs, Geology, Northern Arizona University. [B-12]

IDENTIFYING UNIQUE EMPLACEMENT CHARACTERISTICS OF O'LEARY PEAK: A VOLCANIC DOME IN THE SAN FRANCISCO VOLCANIC FIELD

O'Leary Peak, located 35 km northeast of Flagstaff, Arizona, in the San Francisco Volcanic Field, is an obsidian rhyolite dome volcano that exhibits uncharacteristic eruption patterns. Features that make O'Leary Peak unique are the much older sedimentary rock units that appear approximately 700 m above the pre-eruption ground level, a breccia containing clasts of volcanic rock from an earlier, unknown, eruption, and convolute banding in the obsidian flow. Methods used to understand these diverse features were field work, sample collection, and thin-section analysis. Thin sections confirm that the sedimentary rocks are sandstone and limestone that match rock units in northern Arizona. The volcanic rocks have varying degrees of glass in the groundmass and contain minerals commonly associated with a rhyolitic lava. Devitrification of the glassy groundmass suggests variable rates of cooling in the flow. Future research will investigate flow banding to understand more about the emplacement of the dome.

Kearns, Lorenzo (Junior, Computer Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, College of Engineering, Embry-Riddle Aeronautical University. [E-9]

EAGLESAT TEAM: DEVELOPMENT AND IMPLEMENTATION OF A SELF-CONTAINED HARNESS FOR IN-HOUSE INTEGRATION, VERIFICATION, AND TESTING OF CUBESAT ELECTRIC POWER SYSTEMS

The Electric Power System (EPS) and Fabrication Teams at EagleSat have been working on methods for safe and effective battery testing. The teams' ultimate goal is to perform certification testing that verifies the battery's integrity, capacity, and safety for mission operations. Given hardware restrictions, a test board manages battery charging and discharging operations during the testing procedures. The EPS system integrates into the test board through simulated solar arrays and an I2C serial connection. Over the research period, the team developed various generations of boards, each scaling in complexity and utility. This presentation will cover the battery testing results and present details of the board designs used to safely conduct the tests.

Kemper, Skylar (Junior, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Arts and Sciences, Embry-Riddle Aeronautical University. [C-25]

IMPROVING THE DETECTION OF CORE-COLLAPSE SUPERNOVA THROUGH EXPERIMENTATION

Currently the Laser Interferometer Gravitational Wave Observatory (LIGO) utilizes a Photon Calibrator for hardware injections to test the response of instrumentation, reduce noise and interference, and produce calibration lines of desired frequencies. The Photon Calibrator cannot replicate injections between 500Hz-1500Hz however, limiting research developing an optimal configuration for lowering the noise floor on high frequency events. Implementing an Electro-Optical Modulator (EOM) can transform the signal from electrical current to waveform, allowing for high frequency injections though. The purpose of this research is to develop a functioning configuration for a single-recycled Fabry-Perot Interferometer which is capable of successfully injecting a high frequency signal using an EOM. Developing a system for high frequency injections will benefit research into lowering the noise floor and eventually lead to a greater range of observations for Core-Collapse Supernova and various other high frequency events which are not currently observable.

Kerrison, Nicole (Junior, Astronomy, University of Arizona). Mentor: Ann Zabludoff, Department of Astronomy and Steward Observatory, University of Arizona. [C-22]

MEASURING GALACTIC WIND FREQUENCY AND STRENGTH AS A FUNCTION OF ENVIRONMENT

We examine how galactic inflows and outflows vary among starburst, post-starburst, and quiescent galaxies and with environment, defined by local galaxy density and galaxy cluster mass. The galactic flows are detected and measured via the residual (interstellar) Na D absorption line in stellar continuum-subtracted galaxy spectra. The fraction of significant outflows and typical outflow speed decline from starburst to post-starburst to quiescent galaxies, suggesting changes in the importance of stellar and/or nuclear feedback over time.

Kiefer, Anthony (Junior, Environmental Science, Northern Arizona University). Mentor: Greg Vaughan, n/a, Northern Arizona University. [H-1]

USGS SCIENCE CENTER - SOLAR SYSTEM EXHIBIT CAPTIONS

The solar system exhibit at the USGS building in Flagstaff consists of hallways lined with high definition prints of actual photos of other worlds from various spacecrafts. My task is to help finish the exhibit with captions for each image. We do not want to print the captions and clutter the exhibit, so these captions will be uploaded to an app that will allow visitors to read along as they walk. Using NASA’s Photojournal website as much as possible, I gathered information about each print. Whenever I couldn’t find an image there, I used Google. The image search tool allows for the upload of picture files, and their algorithms search for similar photos, usually resulting in a match. To make this information friendly to the public, I removed or translated jargon, and summarized the information accompanying each image. I have completed a significant portion of the task, and will do so until the end of the program.

Klett, George (Senior, Mechanical Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University. [B-4]

ANALYSIS OF SPACE-BASED RIOMETER MEASUREMENT DATA FOR CHARACTERIZATION OF RADIO PROPAGATION DISTURBANCE IN THE IONOSPHERE

Relative ionospheric opacity meter (Riometer) measures cosmic radio noise absorption in the D-region of the ionosphere. A riometer quantifies the amount of electromagnetic-wave absorption in the atmosphere, thereby allowing the characterization of the attenuations experienced by long-range radio communications systems where radio signals propagate through the ionosphere. Impacts on radio communications between spacecraft, airplane, etc., and ground stations can be modelled from riometer measurement through theoretical extrapolation techniques.

Riometer was deployed in several cities in the USA and Canada, to monitor the disturbance in the ionosphere due to radiations from solar activities. The goal of this research is to analyze space-based measurement data from riometers deployed over Ottawa to find correlation between solar activities and the observed radio wave attenuation ionosphere. The results and conclusions to be drawn from this analysis will closely represent what is obtained in the ionosphere over many cities in the north- eastern coast of the USA.

Knox, Oddisey (Junior, Astronomy, University of Arizona). Mentor: Peter Behroozi, Astronomy, University of Arizona. [C-20]

PREDICTIONS FOR THE OBSERVABLE AUTOCORRELATIONS OF ACCRETING BLACK HOLES FROM THE TRINITY THEORETICAL MODEL

Supermassive black holes (SMBHs) are present in most galaxies. Moreover, these SMBHs play a role in the evolution and growth of their host galaxies. When actively accreting, SMBHs release tremendous amounts of energy. This energy may regulate the growth of both the host galaxies and the black holes themselves. However, galaxies do not exist in isolation. Some galaxies have few neighbors, while others are found in dense clusters. By observation, the more neighbors a galaxy has, the more massive it and its surrounding galaxies are likely to be. Given a galaxy-SMBH connection, we calculate the clustering signals of SMBHs, determining the likelihood of finding neighbors around SMBHs. In this project, we use the theoretical model Trinity to predict SMBH clustering signals. To examine whether the galaxy-SMBH connection in Trinity is realistic, we compare these results with observed numbers of neighbors surrounding SMBHs. The results will be presented at the symposium.

Krishnan, Hari (Senior, Statistics, University of Arizona). Mentor: Mihailo Martinović, Lunar and Planetary Laboratory, University of Arizona. [B-19]

INVESTIGATION OF ELECTRON PARAMETERS AND ASSOCIATION WITH STRUCTURES USING QUASI-THERMAL NOISE SPECTROSCOPY (QTN)

Quasi-thermal noise Spectroscopy (QTN) is a powerful method that analyzes in situ measurements of space plasma to obtain the electron density, temperature, and non-thermal properties. NASA has compiled a database of almost three decades of data from the Wind spacecraft orbit, near the Earth's bow shock and at first Lagrange (L1) point. Given the databases potential, we have developed a framework that can efficiently process this data set via QTN and produce decades worth of analyzed in situ observations, containing electron density and temperature estimates of space plasma at different points in the trajectory of the WIND Spacecraft over 2.5 solar cycles at 4.4s resolution. The initial results show a high degree of confidence and compare well with other available data sets.

Landon, Parker (Junior, Computer Engineering & Space Physics, Embry-Riddle Aeronautical University). Mentor: Gretarsson Andri, Physics & Astronomy, Embry-Riddle Aeronautical University. [C-14]

CONTROLLING THE UNSEEN: GIG UNDERGRADUATE OPTICAL RESEARCH

Optical research is on the forefront of today's scientific endeavors. Concepts like fiber optic communications, laser weapon defense systems, and this project: laser interferometry, continually influence modern technologies. Interferometry is foundational to much graduate level optics research, and this project is a typical graduate-level endeavor (but with more support from the advisor than is typical at the graduate level). The project aims to develop a 'low-noise laser' by constructing an Amplitude Modulation (AM) servo and Frequency Modulation (FM) servo to control a class 3B laser. Once implemented, both the AM and FM servos will significantly lower the phase and amplitude noise on the laser. The creation of a successful optical control system will provide the foundation for new research opportunities at Embry-Riddle Aeronautical University.

Landon, Parker (Junior, Computer Engineering & Space Physics, Embry-Riddle Aeronautical University). Mentor: Kaela Martin, Aerospace Engineering, Embry-Riddle Aeronautical University. [I-8]

JULIA 1.2 EPHEMERIS AND GRAVITATIONAL MODELING DEVELOPMENT

Julia is a new programming language designed for numerical computing combining simplicity and the ease of dynamic languages with the speed of compiled languages. Julia version 1.0 was released in August of 2018, marking the first stable version of the language. An ephemeris and constant reader, capable of retrieving data for major and small bodies, does not yet exist in Julia. With user inputs, this tool stores information from NASA databases, then outputs the specific information about a body. Julia 1.2 has allowed for many improvements which include decreasing the code's runtime and new gravitational field modeling. To model the gravitational fields of major and minor bodies, the code uses both moments of inertia, polyhedral models, and spherical harmonics. The knowledge of celestial bodies and their gravitational models within one program will help continue the advancement of astrodynamics and space trajectory optimization.

Libby, Lovenia (Junior, Bioinformatics, Northern Arizona University). Mentor: Gerrick Lindberg, Department of Chemistry and Biochemistry, Northern Arizona University. [A-3]

THEORY AND SIMULATION INVESTIGATION OF EUTECTIC PHASE BEHAVIOR ON PLUTO

Recent high-resolution images of Pluto's surface reveal morphological features that suggest the motion of liquids despite all molecules known to predominate there being solid at the relevant temperatures and pressures. We suspect that this liquid is a eutectic system - a chemical mixture that freezes at a temperature lower than the melting points of its constituents. The goal of this project is to develop a framework for computational analysis of eutectic behavior across several relevant binary mixtures, providing insight into molecular mechanics that could not be measured as easily in an experimental setting. If a solution is treated as ideal, then the mixture is straight-forward to model, but such an assumption is only valid when the molecules are similar. To quantify the deviation of mixtures from simple ideal solution behavior, we have automated a pipeline that uses molecular dynamics simulations to predict several features of each pure component and mixture.

Limes, Hayley (Junior, Environmental Science, University of Arizona). Mentor: Erin Posthumus, School of Natural Resources and the Environment, USA National Phenology Network. [B-5]

PHENOLOGY DATA TO AID POLLINATOR RESTORATION

When working to restore pollinators, managers need to select a mix of plant species that support pollinators of concern throughout their periods of activity. The USA National Phenology Network (USA-NPN) seeks to create phenology calendars for managers in the south-central region of America (TX, NM, OK, LA) to summarize flowering and fruiting of key species of plants as well as provide information about species' response to climate change. The goal of this project was to determine the geographic and temporal extent of available phenology data from iNaturalist and the USA-NPN's Nature's Notebook programs. We created priority species lists, summarized data available by site and year, and created data visualizations of start, peak, and end of flowering and fruiting. These data and visualizations will be used to inform future data collection efforts in the region and form the basis for calendars to inform managers working on pollinator restoration.

Lin, Yuka (Junior, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Physics & Astronomy, Embry-Riddle Aeronautical University. [C-26]

LOW FREQUENCY PROTOTYPE OF LASER INTERFEROMETER SUSPENSIONS FOR GRAVITATIONAL WAVE DETECTION

In recent years, the Laser Interferometer Gravitational-Wave Observatory (LIGO) has been developing more advanced ground-based laser interferometers which utilizes complex suspension systems to detect various levels of low frequency gravitational waves (GW's). Our experiment utilizes a torsion pendulum and a laser set up to model a suspension detector which is a steppingstone to understanding LIGO detector responses to low frequency GW's. The first purpose is to experimentally characterize the transfer function of the torsion pendulum with respect to ground vibrations. The second goal is to investigate ways to distinguish low frequency torsion and translations from low frequency gravitational waves. The knowledge that comes out of this experiment will help to distinguish ground noise events from gravitational waves events, which will be a major step in being able to detect them in the low frequency regime.

Luffey, Emily (Senior, Biophysics, Arizona State University). Mentor: Robert Ros, Physics, Arizona State University. [A-8]

PROPERTIES OF CHROMATIN EXTRACTED BY SALT FRACTIONATION FROM A CANCEROUS AND NON-CANCEROUS ESOPHAGEAL CELL LINE

The NIH estimates that approximately 38.4% of humans will be diagnosed with cancer at some point during their lifetimes. While cancer is mostly viewed as a genetic disease characterized by genetic markers and expression of mutant proteins, there is considerable evidence that cancer is more than somatic mutations. The first signature looked for by a pathologist is grossly aberrant cell nuclei. It has been shown that the more abnormal a particular cell nucleus is, the more aggressive a type of cancer is. A major variable in the overall nuclear structure is chromatin compaction and structure. We compared chromatin compaction and structure between a non-cancerous and cancerous esophageal cell line by using a combination of salt fractionation and atomic force microscopy (AFM). We found significant differences in chromatin morphology and anticipate that our results will help gain insight into the mechanisms of phenotypic change in cells from normal to cancerous.

Luse, Arturo (Sophomore, Computer Science, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College. [E-5]

THE CONCENTRATION OF GASSES AS ALTITUDE CHANGES

With the increased concentrations of greenhouse gasses in the atmosphere, the effect is the augmentation of our atmosphere's ability to trap heat. This payload determines the concentration of greenhouse gasses at various altitudes using gas and altitude sensors. We will be collecting data in parts per million (ppm) of gasses such as Carbon Dioxide, Carbon Monoxide, Ethane, Methane, and Water Vapor. The sensors collecting the data are placed in grooves along the outside of the payload made of insulating board material. The inside of the board will be sealed while it ascends, to keep the microcontroller and the batteries safe. As the payload ascends, the team hypothesizes that there will be a higher concentration of the lighter gasses compared to the heavier gasses. The team infers this based on the knowledge that heavier gasses tend to sink compared to lighter gasses.

Madden, David (Senior, Aerospace Engineering, Arizona State University). Mentor: Mohamed Kasbaoui, School for Engineering of Matter, Transport and Energy, Arizona State University. [D-5]

VALIDATING A NEW CFD ALGORITHM BY FINDING THE DRAG COEFFICIENT OF A SPHERE

A novel CFD algorithm called LEAP is currently being developed by the Kasbaoui Research Group (KRG) using the Immersed Boundary Method (IBM) to describe complex geometries. To validate the algorithm, this research project focused on testing the algorithm in three dimensions by simulating a sphere placed in a moving fluid. The simulation results were compared against the experimentally derived Schiller-Naumann Correlation. Over the course of 36 trials, various spatial and temporal resolutions were tested at specific Reynolds numbers between 10 and 300. It was observed that numerical errors decreased with increasing spatial and temporal resolution. This result was expected as increased resolution should give results closer to experimental values. Having shown the accuracy and robustness of this method, KRG will continue to develop this algorithm to eventually explore new geometries such as aircraft engines or air moving through lungs.

Magnusson, Jacob (Junior, Astronomy & Statistics and Data Science, University of Arizona). Mentors: Eiichi Egami and Kevin Hainline, Steward Observatory, University of Arizona. [C-15]

ASSESSING THE PERFORMANCE OF THE JWST/NIRCAM IMAGE SIMULATOR PHOSIM-NIRCAM

The James Webb Space Telescope (JWST) must be properly calibrated to account for distortions in the images it generates before it collects data. The current understanding of Near Infrared Camera (NIRCam) combines lab measurements with a simulator such as Photon Simulator (PhoSim) to produce images. PhoSim provides a novel approach to the simulation through Monte Carlo photon raytracing. We used PhoSim to generate images of individual stars to measure detector zero-point magnitudes for both NIRCam modules, produce complicated galaxy structures, and generate a Large Magellanic Cloud image to measure geometric distortion. PhoSim was less sensitive than expected from laboratory measurements on the NIRCam detector--greater than half a magnitude for the zero-points. More testing of the geometric distortion measurement is needed to quantify the distortion map of the JWST-NIRCam optical system. This will ensure proper calibration of the telescope to account for these distortions before collecting data.

Mandala, Victor (Junior, Electrical Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical, Computer, & Software Engineering, Embry-Riddle Aeronautical University. [B-4]

ANALYSIS OF SPACE-BASED RIOMETER MEASUREMENT DATA FOR CHARACTERIZATION OF RADIO PROPAGATION DISTURBANCE IN THE IONOSPHERE

Relative ionospheric opacity meter (Riometer) measures cosmic radio noise absorption in the D-region of the ionosphere. A riometer quantifies the amount of electromagnetic-wave absorption in the atmosphere, thereby allowing the characterization of the attenuations experienced by long-range radio communications systems where radio signals propagate through the ionosphere. Impacts on radio communications between spacecraft, airplane, etc., and ground stations can be modelled from riometer measurement through theoretical extrapolation techniques. Riometer was deployed in several cities in the USA and Canada, to monitor the disturbance in the ionosphere due to radiations from solar activities. The goal of this research is to analyze space-based measurement data from riometers deployed over Ottawa to find correlation between solar activities and the observed radio wave attenuation ionosphere. The results and conclusions to be drawn from this analysis will closely represent what is obtained in the ionosphere over many cities in the north- eastern coast of the USA.

Martin, Rebecca (Senior, Computer Systems Engineering & Mathematics, Arizona State University). Mentor: Andrea Richa, School of Computing, Informatics, and Decision Systems Engineering, Arizona State University. [A-5]

TARGET DETECTION USING ALGORITHMIC MATTER

Syncells are micro-scale robots with limited computation power and memory that can communicate locally to achieve complex collective tasks. To control these Syncells for a desired outcome, they must each run a simple distributed algorithm. Only capable of local communication, Syncells cannot receive commands from a control center, so their algorithms cannot be centralized. In this work, we created a distributed algorithm that each Syncell can execute so that the system of Syncells can find and converge to a specific target within the environment. The most direct applications of this problem are in medicine, as a safer alternative to invasive surgery or to treat internal bleeding or tumors. We tested and analyzed our algorithm through simulation and visualization in Python. Overall, our algorithm successfully caused the system of particles to converge on a specific target present within the environment.

Martinez, Stephanie (Sophomore, Physics & Astrophysics, Northern Arizona University). Mentor: Chris Etling, Managing Editor, Arizona Daily Sun. [F-2]

THE IMPACT AND IMPORTANCE OF SCIENCE WRITING

Discover the sizable impact of science writing and the important role it plays in both the scientific community and general population. The primary objective of this research is to come to understand some of the latest scientific work and discoveries, to then translate the technical details into a more comprehensive dialect for any general audience. Experimenting with multiple approaches to the subjects, as well as different writing styles, the results conclude that the way scientific work is published and presented to the general public impacts the overall perception of what has been done. Based on delivery style, the same work can have a multitude of understandings and reactions across a generic and broad audience. The way something is perceived can greatly influence how much support a project or discovery can obtain. Join us to further discuss the details of what science writing means and its importance to everyday life.

May, Kevin (Sophomore, Aerospace Engineering, University of Arizona). Mentor: Michelle Coe, Lunar and Planetary Laboratory, University of Arizona. [E-4]

UArizona ASCEND: Profiling High-Altitude Radiation with a General Data Logger

CubeSats have been a rapidly growing technology over the last decade due to their diminutive total mass to orbit while maintaining spacecraft performance. However, smaller electronics are more susceptible to the high-energy radiation present in orbit, so lightweight radiation shielding is a growing area of research to extend the lifetime of CubeSats. This project serves to analyze the viability of high-altitude ballooning as a testbed for radiation shielding materials as a safe alternative to radiation source experimentation on the ground. Within the bounds of a standard 1U CubeSat, the UArizona ASCEND payload housed a Geiger counter and atmospheric profiling system to identify the amount of ionizing radiation present in Earth's atmosphere up to approximately 100,000 feet to determine whether testing radiation shielding materials in this environment is reasonable for research purposes.

May, Kevin (Sophomore, Aerospace Engineering, University of Arizona). Mentor: Jekan Thangavelautham, Aerospace & Mechanical Engineering, University of Arizona. [I-9]

Simulation and Evaluation of a Mechanical Hopping Mechanism for Robotic Small Body Surface Exploration

Swarms of small, mechanical hopping robots such as SphereX (Kalita et al. 2019) are an intriguing method of in-situ surface exploration of small Solar System bodies (SSSBs). Difficulties navigating in an unfamiliar environment and complications due to low gravity are two key challenges in designing these robots. To address these challenges, this study involved developing a simulated environment in Webots (Michel 2004) modeled on small bodies such as Bennu and Deimos to test the navigation of a SphereX robot with realistic obstacles. Additionally, the n-body code pkdgrav (Stadel 2001; Richardson et al. 2000; Schwartz et al. 2012) was used to test how the mechanical foot might interact with asteroid-like regolith in order to optimize the mechanism for given conditions. By demonstrating navigation in an asteroid-like environment and numerically modeling low-gravity surface interactions, a mechanical hopping robot can be evaluated as a method of surface exploration and mapping on SSSBs.

Maya, Andrea (Junior, Environmental Engineering, Glendale Community College). Mentor: Timothy Frank, Engineering, Glendale Community College. [E-8]

Glendale Community College (GCC) ASCEND Team

The focus of GCC's ASCEND team was to work together to create three separate payloads. While the team members were not able to work directly with each other due to social distancing requirements, they communicated through a virtual environment. An Arduino Uno was used to collect data from sensors that measure temperature, pressure, acceleration, and battery voltage. It was also used to control a RunCam2 video camera to capture images of the balloon throughout the flight. With the aid of our ASCEND mentor, Dr. Frank, the team members soldered together circuit boards and built enclosures out of foamboard to house the three individual payloads, which were constrained to be under 1-lb so that the total weight of all of GCC's payloads was under 3-lbs. After the flight, the sensor data was downloaded into Excel and graphed to view the changes in the atmospheric conditions throughout the entire flight.

McConnell, Sierra (Junior, Cyber Intelligence and Security, Embry-Riddle Aeronautical University). Mentor: Krishna Sampigthaya, School of Cyber Intelligence and Security, Embry-Riddle Aeronautical University. [D-6]

CIS Aviation-ISAC

The aviation industry reliance on technology opened avenues for cyber intrusion. To inspire others to fight threats facing aerospace cybersecurity, I worked with a team of Embry-Riddle students to create a virtual cybersecurity competition for Aviation-ISAC. Aviation Information Sharing and Analysis Centers (ISAC) is an international consortium that enhances the sector's ability to prepare and respond to threats. The competition utilizes gamification to teach aviation cybersecurity topics. Starting at airport check-in, competitors must investigate a simulated attack, regain control of critical systems, and identify the attackers. In addition, the simulation covers a wide variety of threats including airport security, critical infrastructure, runway light systems, air traffic control, and aircraft avionic systems. The challenges were designed to practice skills in incident response and enhanced disaster recovery while educating in a variety of topics. This competition allowed the next generation of aviation cybersecurity professionals to train in advanced aviation cybersecurity topics.

McConville, Daniel (Junior, Materials Science and Engineering, University of Arizona). Mentor: Michelle Coe, Lunar and Planetary Laboratory, University of Arizona. [E-4]

UARIZONA ASCEND: PROFILING HIGH-ALTITUDE RADIATION WITH A GENERAL DATA LOGGER

CubeSats have been a rapidly growing technology over the last decade due to their diminutive total mass to orbit while maintaining spacecraft performance. However, smaller electronics are more susceptible to the high-energy radiation present in orbit, so lightweight radiation shielding is a growing area of research to extend the lifetime of CubeSats. This project serves to analyze the viability of high-altitude ballooning as a testbed for radiation shielding materials as a safe alternative to radiation source experimentation on the ground. Within the bounds of a standard 1U CubeSat, the UArizona ASCEND payload housed a Geiger counter and atmospheric profiling system to identify the amount of ionizing radiation present in Earth's atmosphere up to approximately 100,000 feet to determine whether testing radiation shielding materials in this environment is reasonable for research purposes.

Mena, Julian (Junior, Astrophysics, Arizona State University). Mentor: Philip Mauskopf, School of Earth and Space Exploration, Arizona State University. [C-27]

SPHEREX: THE FUTURE OF SATELLITE ASTRONOMY

Space telescopes have been key in the progression of space exploration, and have discovered things that were once considered science fiction. These space telescopes, however, have only been able to look at one small part of the sky at a time, leaving much of the sky unobserved. The SPHEREx Satellite Telescope seeks to solve this issue. SPHEREx will orbit the Earth longitudinally with set movement constraints in order to observe the entire sky. This will be accomplished by writing a routine in Python, which will not only tell the satellite where to look, but will also tell the satellite to avoid objects such as the Moon and Sun; it will even account for the power received from bright planets such as Jupiter, Saturn, and Mars. Current projections predict about 99% sky observance by the satellite telescope. With this increase in observed sky, countless new discoveries are sure to follow.

Mills, Calida (Sophomore, Computer Science, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College. [E-5]

A MEASUREMENT OF THE CONCENTRATION OF GREENHOUSE GASES AS ALTITUDE INCREASES

We will be utilizing this payload to collect data on carbon dioxide, ethanol, and iso-butane to determine the concentration of these gasses at various altitudes in the atmosphere. The intent of this experiment is to conclude whether or not the different molar masses of the gasses determine where it is indicated within the atmosphere. In the creation of our device, we took on a hexagonal prism design to be used as the housing for our internal and external sensors that are used to collect out data. Once the payload is released, we hope to gather the density of the carbon dioxide, ethanol, and iso-butane and take that information to determine how their weights are placed within different altitudes. Prior to beginning this project, we had many thoughts about what type of data we could collect and bring to life by our experiment. Most of our ideas were centered around the environment and the different ways it is being impacted by the use of humans.

Montero, Sandra (Sophomore, Chemical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College's goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Mouti, Xeynab (Junior, Microbiology, Arizona State University). Mentor: Devin Schrader, Center for Meteorite Studies, Arizona State University. [H-8]

INVESTIGATING THE ORIGIN OF FINE-GRAINED RIMS IN MIGHEI-LIKE CARBONACEOUS CHONDRITES

This research investigated the origin of fine-grained rims (FGRs) around chondrules in Mighei-like carbonaceous (CM) chondrites. There are two major hypotheses regarding the origin and formation of FGRs, one proposing a solar nebular origin while the other proposing their formation is due to parent body processes. Six samples were chosen that encompassed a wide range of parent body aqueous and thermal alteration. Measurements were taken to determine the abundance and size of chondrules and FGRs in each sample, as well as to determine if the samples displayed any foliation. These data were analyzed and any correlations, or lack thereof, between the abundance or size of FGRs and heating were discussed. This research puts forth new data and conclusions based on analysis of CM chondrites that record a range of parent body alteration. The study suggests FGRs were formed prior to aqueous alteration and not formed by parent body processes.

Mudd, Maxx (Junior, Computer Science, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College's goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Nishizawa, Noa (Junior, Optical Sciences & Engineering, University of Arizona). Mentor: Kristopher Klein, Lunar and Planetary Laboratory, University of Arizona. [C-21]

IDENTIFICATION OF SWITCHBACK INTERVALS IN PARKER SPACE PROBE DATA

NASA's Parker Space Probe (PSP) looks to trace the flow of energy that heats the solar corona and accelerates the solar wind, trace plasma and magnetic field structures near the Sun, and explore particle acceleration and transportation mechanisms in this environment. PSP magnetic field and thermal particle data shows that the outward stream of charged particles in the Sun's extended atmosphere undergoes abrupt reversals, referred to as magnetic field "switchbacks." In this project, we perform a switchback identification procedure of manual detection, quantification of biases in the detection, and comparison of identified switchbacks with other identification methods. The identified switchback set will challenge theories on switchback formation, distinguishing between magnetic reconnection, shear-driven turbulence, and slow/fast wind interaction as potential sources. Gaining a better understanding of the Sun's atmosphere can have critical impacts on forecasting Earth's space environment.

Nolan, Liam (Junior, Earth and Space Exploration & Physics, Arizona State University). Mentor: Rolf Jansen, School of Earth and Space Exploration, Arizona State University. [A-10]

MAJORITY OF THE FAINT (μJY) RADIO SOURCE POPULATION APPEARS POWERED BY STAR FORMATION, NOT AGN

We present results of an analysis of VLA and VLBA radio-continuum observations, and ancillary UV to Visible images with the Hubble Space Telescope (HST), in the James Webb Space Telescope (JWST) North Ecliptic Pole Time-Domain Field. This new community field for time-domain studies will be observed with JWST/NIRCam and

NIRISS as part of IDS GTO program 1176 (Windhorst). Among the wealth of ancillary data in this field, we use the VLA 3 GHz (Windhorst), VLBA 4.7 GHz (Brisken), and HST 245–725 nm (Jansen) observations in this study. To date, 12 sources in the VLA have been shown via VLBA targeting to be powered primarily by an active galactic nucleus, and we show an additional ~100 sources are sufficiently bright to infer they are primarily powered by star formation. We show radio and visible images for several VLBA-detected sources, a comparison set of other VLA-detected sources, and a quantitative analysis.

Ontiveros, Ricardo (Junior, Electrical Engineering, Glendale Community College). Mentor: Timothy Frank, Engineering, Glendale Community College. [E-8]

GLENDALE COMMUNITY COLLEGE (GCC) ASCEND TEAM

The focus of GCC's ASCEND team was to work together to create three separate payloads. While the team members were not able to work directly with each other due to social distancing requirements, they communicated through a virtual environment. An Arduino Uno was used to collect data from sensors that measure temperature, pressure, acceleration, and battery voltage. It was also used to control a RunCam2 video camera to capture images of the balloon throughout the flight. With the aid of our ASCEND mentor, Dr. Frank, the team members soldered together circuit boards and built enclosures out of foamboard to house the three individual payloads, which were constrained to be under 1-lb so that the total weight of all of GCC's payloads was under 3-lbs. After the flight, the sensor data was downloaded into Excel and graphed to view the changes in the atmospheric conditions throughout the entire flight.

Padilla, Jacob (Senior, Electrical and Computer Engineering, University of Arizona). Mentor: Christopher Walker, Department of Astronomy and Steward Observatory, University of Arizona. [I-7]

CATSAT GROUNDSTATION COMMAND AND CONTROL

Ground station software for a CubeSat is a crucial part of operations. There is always a need to communicate with the CubeSat to make sure everything is running correctly onboard, and data is being sent properly from the CubeSat to the ground station. The goal of this project is to prepare ground station software for in-flight communication that can be utilized by CatSat, a CubeSat project running several different experiments in the Ionosphere. We are using software and hardware provided by GOMSpace, along with hardware supplied by Rincon Research Corporation. The software and hardware need to be modified and assembled to fit the needs of the CatSat project. The ground station software is being developed and tested on a FlatSat to verify functionality with the different components before the CubeSat is completely assembled for flight. The development of the ground station software will be reusable for any future CubeSat projects.

Parkhurst, Melissa (Senior, Astrobiology, Arizona State University). Mentor: Jnaneshwar Das, Distributed Robotic Exploration and Mapping Systems Laboratory, Arizona State University. [B-13]

INSTANCE SEGMENTATION FOR BIOGEOGRAPHY

Hydrothermal vent systems are home to many species. I present a path using neural networks to aid in biogeographical study of these ecosystems. The deep neural network (DNN) Mask R-CNN was used to create a predictive model for identifying six categories of organisms in their natural habitats using instance segmentation. The neural network has been trained on an initial dataset of annotated images taken from the Nautilus 2018 Lo'ihi Seamount expedition by the Alvin submersible at a 2km depth. with the degrees of organism classification being correctly predicted varying among the six categories. The percentage of correct predictions are expected to increase as more images are added to the training dataset. This study shows both the potential of using neural networks to sift through large amounts of data and the limitations of it, which are in part characterized by the parameters of the training dataset.

Pavao, Clarissa (Sophomore, Space Physics, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Department of Physics and Astronomy, Embry-Riddle Aeronautical University. [C-6]

THE FIRST MAGNETAR IN A BINARY SYSTEM?

In March 2016, Swift found a new magnetar candidate designated SGR 0755-2933. Coincident to this target on the sky, we found a Be star: CPD-29 2176. We obtained 33 spectroscopic observations from CTIO and the Chiron spectrograph for this target. These spectra showed that the star has a He II 4686 Å line in absorption, consistent with a spectral type of B0Ve. From measurements of the radial velocity, we find a single-lined orbit which is consistent with the reflex motion from a magnetar companion in a 60-day orbit. Photometric data shows no evidence of orbitally-modulated variability but does show long-term variations similar to Be-X-ray binaries. We are continuing to analyze the spectroscopic observations to investigate possible disk variability related to the orbit or long-term behavior.

Pepel, Richard (Senior, Chemical Engineering, University of Arizona). Mentor: Eric Betterton, Department of Hydrology and Atmospheric Sciences, University of Arizona. [B-6]

THE CONTRIBUTION OF PLANTS AND POLLUTION TO TUCSON'S URBAN OZONE PROBLEM

In 2018, the ozone levels in Tucson, Arizona exceeded national air quality standards for the first time in the city's history. In order to mitigate ozone levels in the future, the most significant ozone precursors must be identified. By continuously measuring the concentrations of volatile organic compounds (VOCs) using Gas Chromatography-Mass Spectroscopy (GC-MS), and comparing these measurements to nitrogen oxide (NOx), the biggest contributors to spikes in ozone production can be determined. Concentration and reactivity values, along with temporal trends in ozone concentration, can provide more valuable insight into the causes of increasing ozone levels. Some significant precursors have been identified, but further data analysis is required to determine whether the ozone exceedances are primarily due to biogenic or anthropogenic sources, and whether ozone levels are VOC-limited or NOx-limited. Once this is known, effective regulations can be proposed, targeting the ozone precursors with the greatest impact on ozone levels.

Perkins, Karen (Junior, Biosystems Engineering, University of Arizona). Mentor: Matt Goode, School of Natural Resources and the Environment, University of Arizona. [B-24]

USING GIS TO QUANTIFY EFFECTS OF LAND COVER CHANGE ON MOVEMENT PATTERNS OF TIGER RATTLESNAKES (CROTALUS TIGRIS) IN AN URBANIZING ENVIRONMENT

Tucson is comprised of a metropolitan area that is expanding at the expense of the surrounding Sonoran Desert. Residential development has resulted in widespread changes to wildlife habitats. Our study site is situated on Tucson's urban fringe, where we documented the response of tiger rattlesnakes (Crotalus tigris) to anthropogenic changes over 20 years. The movement patterns of C. tigris were obtained from intensive radio telemetry data. We used ArcGIS to conduct supervised land cover classifications for high-resolution imagery. Although land cover classifications are still being developed, we have observed C. tigris's space use change in response to increasing development. Challenges in creating land cover data include accurate categorization of cover types, aerial imagery limitations. The resulting data will be used to understand the long-term response of rattlesnakes to urbanization better. Ultimately, we hope our results will lead to more effective management and conservation of rattlesnakes, and urban wildlife, in general.

Phaklides, Nicodemus (Junior, Electrical Engineering, Embry-Riddle Aeronautical University). Mentor: Douglas Isenberg, Mechanical Engineering, Embry-Riddle Aeronautical University. [E-7]

STUDY OF THERMAL HEAT TRANSFER WITHIN A HIGH-ALTITUDE BALLOON PAYLOAD

In the design of high-altitude balloon payloads, it is critical to ensure that experiments are safe from the extreme range of temperatures experienced. Payloads require insulation and/or a heating solution to protect them from the cold thermal environment but also require the ability to dissipate heat during touchdown and recovery. The created payload will study this heat transfer via 26 thermistors uniformly distributed in and around the craft. These will also be placed near temperature critical components such as the battery and microcontroller. Thermal control is implemented through a heating element and a controllable vent servo. Additionally, solar panels are mounted externally to use in tandem with a gyroscope, magnetometer, and GPS to determine position and attitude. The payload is also designed to record video of the entire flight via a GoPro. This payload will be incredibly important to provide a sturdy, safe, and modular foundation for future experiments.

Piotti, Cameron (Senior, Astronomy & Physics, Northern Arizona University). Mentor: Gerard van Belle, Lowell Observatory. [C-28]

NARROW-BAND FILTER PHOTOMETRY CALIBRATION FOR THE LOWELL 20"

The Lowell Titan Monitor 20" telescope has a new filter set that is in need of calibration for it to be used in accurately measuring the absolute flux of stars. We aim to measure vega as it is a known magnitude star and use it as a zero point for our filter calibrations. Knowing how much light we would see from vega through our filters allows us to calibrate our measurements and obtain the transmissivity for each filter. Being able to correctly measure the brightness of stars will allow us to pin down the spectral energy distribution of a star. With these filters properly calibrated, we will also be able to establish other known magnitude stars around the sky for when vega is not present. The calibration of these filters will allow for more efficient measurements of future stars and better matches with a spectral template.

Plummer, Addison (Junior, Aerospace Engineering, University of Arizona). Mentor: Jesse Little, Aerospace & Mechanical Engineering, University of Arizona. [D-7]

CHARACTERIZATION OF A HYPERSONIC WIND TUNNEL NOZZLE

Hypersonic flight offers significant advantages over more traditional flight regimes due to high-speeds and low-observability. These advantages are accompanied by complex flow phenomena that are both uncertain and underexplored. One example is shockwave boundary layer interactions (SBLI) that can reduce performance due to large increases in pressure fluctuations and surface heat flux. Understanding and quantifying the effects of SBLIs are crucial to hypersonic flight development. Prior to detailed experimental SBLI studies, it is essential to establish characteristics of the employed hypersonic wind tunnel. This work seeks to characterize a new Mach 5 nozzle using schlieren imaging and pressure measurements. Results indicate that the nozzle actually produces a Mach 5.3 flow with laminar sidewall boundary layers, approximately 8.8 mm thick. An additional disturbance was identified on the sidewall, which may be due to vortical structures generated by nozzle curvature. Additional studies of this vortical flow are being pursued with supporting computations.

Polo, Christian (Junior, Electrical Engineering, Arizona State University). Mentor: Meng Tao, School of Electrical, Computer, and Energy Engineering, Arizona State University. [B-26]

ELECTROLYTIC APPLICATION OF LOAD-MANAGING PHOTOVOLTAIC SYSTEM

As power demands require that photovoltaic efficiency increase to support the growing energy demand, new solutions for power transfer have been investigated in this project. This research replaces the conventional maximum power point tracker (MPPT) with a load-managing control system, which operates by varying the loads with respect to the irradiance and has been proven to have 99% efficiency with resistive loads. For this project, the system has been designed to work with an electrolytic load application, in replacement of the purely resistive loads, for the sustainable production of hydrogen. Using MATLAB and Simulink, simulations for daily system performance and energy production have been run to test the systems validity and find optimal operating conditions for the system. The simulations have shown the ideal characteristics for a Yingli 290 W solar panel, which will be used in small scale physical tests of the system.

Ramirez, Christopher (Senior, Biophysics, Arizona State University). Mentor: Debra Hansen, Biodesign, Arizona State University. [A-7]

PURIFICATION OF THE P66 OUTER MEMBRANE PROTEIN OF THE BACTERIUM BORRELIA BURGDORFERI

Lyme disease is a common tick-borne illness caused by the Gram-negative bacterium Borrelia burgdorferi. An outer membrane protein of Borrelia burgdorferi, P66, has been suggested as a possible target for Lyme disease treatments. However, a lack of available structural information has hindered attempts to design medications to target the protein.

Therefore, this study attempted to find methods for purifying P66 in quantities that can be used for structural studies. It was found that by using the PelB signal sequence, His-tagged P66 could be directed to the outer membrane of E. coli, as confirmed by anti-His Western blotting. Further attempts to optimize P66 expression in the outer membrane were made, pending verification via Western blotting. The ability to direct P66 to the outer membrane using the PelB signal sequence is a promising first step in determining the overall structure of P66, but further work is needed before large-scale purification is viable.

Ramirez, Dymetris (Sophomore, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Physics Department, Embry-Riddle Aeronautical University. [C-11]

EVALUATION OF SUPERNOVAE ASTROPHYSICAL PARAMETERS BY USING MACHINE LEARNING ON LASER INTERFEROMETRIC DATA

This project serves to develop an algorithm that utilizes machine learning (a combination of python and coherent Wave-Burst which is one of LIGO's current burst detection algorithms) to detect and analyze gravitational waves from core-collapse supernovae. Physical processes will be identified in the explosion that result in unique features in the signal. These features are the g-mode, the standing accession shock instability, the core bounce, and the memory. Creating a trained machine, that can identify if the feature is present in the gravitational wave, will allow for the features to be extracted in a more efficient way. The extracted features can then be studied using a χ^2 fit to analytic toy models, which will estimate the parameters for the event. These derived astrophysical parameters can then serve as a starting point (for future detections) in order to filter through multiple sets of raw data to depict if specific features exist.

Ratto, Brad (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Department of Physics and Astronomy, Embry-Riddle Aeronautical University. [C-16]

GRAVITATIONAL WAVE CALIBRATION ERROR FOR SUPERNOVAE CORE COLLAPSE

The existence of Gravitational Waves (GWs) reveals yet another method in which information is transmitted across the cosmos. To detect such events, equipment known as laser interferometers are used to measure microscopic deformations in space-time caused by transient GWs. However, interferometers introduce distortions in the measured signal in the form of calibration errors. Although the maximum amplitude of these errors is documented, the relationship between the phase and amplitude errors at neighboring frequencies is not well understood. The study has developed a plugin in coherent Wave Burst, a data analysis tool, to be the basis on which the relationship of these errors between neighboring frequencies will be defined. This study aims to quantify the impact of these calibration errors on GWs from core-collapse supernova and establish realistic models for phase and amplitude errors enabling future searches to consider GW candidates that were previously ignored due to the current calibration budgets.

Redford, Thomas (Junior, Mathematics & Physics, Arizona State University). Mentor: Maitrayee Bose, School of Earth and Space Exploration, Arizona State University. [A-12]

IDENTIFICATION OF THIOL FUNCTION GROUPS IN GRA 95229 AND MURCHISON

We study vitally important sulfur-bearing organic molecules found on carbon-rich meteorites. The samples in this study were from Grave Nunataks 95229 (GRA 95229) and the Murchison. On these, we have identified thiol function groups (R-SH) in situ. This was accomplished using X-ray absorption near-edge spectroscopy (XANES) and micro-X-ray fluorescence (µXRF). We have identified several disk-shaped areas within the fine-grained matrix that measures between 20 – 50 µm across with elemental sulfur and thiols present. Thiols have not previously been found on meteorites before--even though they have been theorized to exist--possibly due to them being a rather volatile material that can easily be destroyed through extraction techniques. The existence of thiols on meteorites has important implications to extraterrestrial organics and how life originally started on Earth as well.

Richardson, Colter (Senior, Space Physics, Embry-Riddle Aeronautical University). Mentor: Michele Zanolin, Department of Physics and Astronomy, Embry-Riddle Aeronautical University. [C-7]

TAPERINGS AND ANALYTIC CONTINUATIONS OF SUPERNOVA GRAVITATIONAL WAVES WITH MEMORY

In order to prepare for the next galactic supernova, the LIGO/Virgo/KAGRA collaboration is investigating different defined features of gravitational waves (GW's) from core-collapse supernovae, like the Standing Accession Shock Instability and the oscillations of the protoneutron star, through simulations, but due to the current sensitivities of GW detectors, little work is dedicated to the analysis of the low frequency portions of the signal. In this project we investigate this low frequency emission, or memory. This analysis shows that for future space-based detectors, like aLISA and TianGO, this memory signal is detectable. This work also shows the effect of the truncation of simulated GW signals and how the addition of an artificial tapering reduces the high frequency artifacts in the signals but increases the artifacts at low frequencies. We also recommend the addition of an extension function in order to replicate the long duration signals that continue past most GW taperings.

Ricketts, Richard (Sophomore, Applied Mathematics, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College's goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Rincon Ramirez, Benito (Sophomore, Mechanical Engineering, Phoenix College). Mentor: Ernest Villicana, Engineering, Phoenix College. [E-1-2]

PHOENIX COLLEGE: VIDEO STREAMING AND DNA STUDIES

Phoenix College has been dedicated to creating a payload that allows for the collection of data from the entirety of the flight including the effects of UV-radiation on DNA, telemetry, and atmospheric measurements. Our power system has been optimized by utilizing printed circuit boards and buck boosters to supply regulated power to the components within the payload. Utilizing a carbon fiber housing while reducing the weight of a 3D printed internal structure has allowed for a new DNA-oriented experiment. New mounting technology for our video stabilization system has also been implemented, aiding in Phoenix College's goal of providing a live stream of the flight to the public. This semester features a resigned system for better performance, a web API for automated tracking accuracy, and the consolidation of components for a streamlined video system with a smaller energy footprint.

Roberson, Cole (Senior, Physics & Astronomy, Northern Arizona University). Mentor: Robert Barrows, Astronomy, University of Colorado Boulder. [C-30]

THE ORIGINS OF SUPERMASSIVE BLACK HOLES

We work together to study the evolution of black holes. In this effort we began with analyzing spectra of galactic cores and sought offset x-ray sources. The x-ray sources are strong emissions from black holes merging. The emission lines of the spectra we analyze are incredibly strong; we consider the source to be a Hyper-luminous X-Ray Source (HLX). These HLXs provide fantastic insight to the formations of Supermassive Black Holes found in the cores of galaxies.

Robinaugh, Matthew (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Bradley Wall, Aerospace Engineering, Embry-Riddle Aeronautical University. [I-10]

SPACECRAFT ATTITUDE CONTROL IMPLEMENTATION AND DEVELOPMENT

The primary objective of the Spacecraft Attitude Control Implementation and Development project is to design, code, and implement one dimensional attitude control for a physical model of a satellite. The attitude control will be done using a single reaction wheel that is connected to the physical model which will be allowed to rotate using a turntable, simulating the frictionless space environment. In conjunction with this control mechanism and a microcontroller, the final objective is to be able to create a model satellite capable of efficient pointing at arbitrary locations in 360 degrees about a single axis with a precision of ±0.5°. The secondary objective of the project is to also demonstrate control using a one-dimensional momentum wheel as well as act as a proof of concept and a platform to build upon this research to expand into more complex control laws and multi-dimensional control.

Rocha, Katherine (Junior, Computer Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical, Computer, & Software Engineering, Embry-Riddle Aeronautical University. [I-4]

EAGLESAT TEAM: ON-BOARD COMPUTER SUBSYSTEM

The On-Board Computer subsystem (OBC) of EagleSat 2 balances out the scientific needs with the other subsystems requirements ensuring that the satellite continues operation and still sends scientific data to the ground. The On-Board Computer is a field programmable gate array (FPGA) with triple-mode redundancy. Due to the reduced cost of the FPGA the OBC team now has multiple test boards allowing the work to be more effectively divided for faster implementation of the design. The FPGA will be running a MicroBlaze softcore with the remaining logic elements offloading processing, such as downlink packet creation, reducing the workload for the softcore. The FPGA has enabled the OBC team to design a custom printed circuit board for unique interfacing to the other subsystems. This presentation will discuss the changes to the subsystem design late in the design process, and how this consistently changing approach to design has led to some delays in our work.

Rogers, Ci'mone (Junior, Information Security, Arizona State University). Mentor: Tim Carlton, School of Earth and Space Exploration, Arizona State University. [I-11]

MEASUREMENTS OF THE SKY

We now know of thousands of worlds outside of our solar system, extrasolar planets, that present extreme conditions beyond anything in our solar system. The sky had many things to offer such as measurements. More than 95% of all photons in the HST Archive come from <5 AU. Yet, no precise panchromatic all-sky HST measurement of foregrounds exists. The data will show all the information that were found over a school year period. I will touch upon the key questions, current state of the art observations, challenges in their interpretation, and prospects for future characterization efforts of sky measurements from the James Webb Space Telescope.

Romero, Jonathan (Senior, Environmental Engineering, University of Arizona). Mentor: Reyes Sierra, Department of Chemical and Environmental Engineering, University of Arizona. [B-7]

BIOREMEDIATION OF INSENSITIVE MUNITIONS COMPOUNDS

Conventional explosives are being replaced by insensitive munitions compounds, such as 3-nitro-1,2,4-triazol-5-one (NTO), which are more resistant to unintentional detonation, but more toxic to soils and groundwater in the United States. In this study, the microbial degradation of NTO was studied in batch and continuous-flow experiments. Results from batch assays confirmed that NTO is reduced to 3-amino-1,2,4-triazol-5-one (ATO) under anaerobic conditions. ATO resisted biodegradation under anaerobic conditions but it was fully mineralized in aerobic environments. NTO biodegradation in two sequential anaerobic-aerobic lab-scale bioreactors operated under continuous-flow conditions is currently under investigation. These reactors were packed with soil bioaugmented with a microbial enrichment culture capable of degrading NTO/ATO, respectively. The data obtained indicated that NTO is readily reduced to ATO. However, ATO degradation has not been observed after more than 50 days of operation. Ongoing research aims to optimize the conditions required to promote growth and retention of ATO-degraders in soil.

Rosenthal, Alexa (Junior, Environmental Engineering, Northern Arizona University). Mentor: Fethiye Ozis, Civil and Environmental Engineering, Northern Arizona University. [B-20]

RARE EARTH METAL RECOVERY FROM WASTE STREAM USING ALGAE

Rare earth elements (REE) are used in modern technology, but extraction is costly. Existing research showed algae's absorption capacity for REEs, including lanthanum and scandium. Yttrium is a REE employed by NASA in their yttrium aluminum garnet laser, but has not been previously studied. In this study, Scenedesmus, a genus of green algae, was tested to determine its absorption capacity of yttrium. Aluminum was used as a substitute to yttrium. The algae were dried, mixed with a 100 mL solution with a concentration of 0.5 mg/L $Al3+$ for 48 hours, and tested using HACH method 8012, Aluminon Method. A spectrophotometer was used to determine the equilibrium aluminum concentration. Results indicated that as the mass of algae increased from 0.1g to 4.0g in the 100mL solution, removal of yttrium improved to 81.4%. Recovery of yttrium using algae is a possible and economically viable option.

Routt, Tyler (Senior, Natural Resources, University of Arizona). Mentor: Jason Williams, USDA Southwest Watershed Research Center. [B-14]

SOIL HYDRAULIC PROPERTIES THREE YEARS AFTER THE FRYE FIRE ON MOUNT GRAHAM, ARIZONA

Wildfire activity is expected to increase around the world as the climate warms. Changes in soil hydraulic properties due to fire can persist for many years and can lead to flooding and debris flow events which pose risks to life, infrastructure, and ecological habitats. Infiltration and soil water repellency data were collected from burned and unburned areas within the Frye Fire area on Mount Graham, Arizona to assess persistence of fire impacts on soil hydraulic properties three years post-fire. We predicted that burned areas would exhibit lower infiltration rates and higher repellency than unburned areas; however, the burned areas displayed greater infiltration rates and lower water repellency instead. Litter depth and total soil organic carbon were greater in unburned areas and positively related to repellency persistence and infiltration. This study highlights the complex interactions between wildfire and infiltration processes and provides insight for post-fire risk assessment and monitoring.

Scarbrough, Amber (Senior, Software Engineering, Embry-Riddle Aeronautical University). Mentor: Davide Conte, Aerospace Engineering, Embry-Riddle Aeronautical University. [I-12]

HEURISTIC OPTIMIZATION APPLIED TO ORBITAL TRANSFERS BETWEEN LOW-PLANETARY ORBITS AND DISTANT RETROGRADE ORBITS

Particle Swarm Optimization (PSO) is a heuristic optimization technique inspired by the swarming behavior observed in the motion of bird flocks and schooling fish. This algorithm is used to analyze the motion of a spacecraft in the Circular Restricted Three-Body Problem (CR3BP). Usually, computing orbital transfers in the CR3BP requires computationally expensive numerical methods. However, PSO can shorten the computational time significantly while producing accurate numerical results. In this research, a transfer from Low-Martin Orbit (LMO) to a Mars-Phobos Distant Retrograde Orbit (DRO) is considered. The design parameter to minimize is represented by the total Δv required for the orbital transfer and orbital insertion, as well as Time of Flight (TOF). Numerical results give the trajectories between the desired orbits that require the minimum Δv in the allotted maximum TOF constraint. Such results are then compared with the existing literature to be appropriately validated.

Schiffler, Maddie (Senior, Aerospace Engineering, University of Arizona). Mentor: Sergey Shkarayev, Aerospace & Mechanical Engineering, University of Arizona. [D-8-9]

SUBORBITAL UNCREWED AERIAL VEHICLES FOR EARTH SURVEILLANCE AND MARS EXPLORATION

An autonomous sailplane capable of mimicking the dynamic soaring behavior of albatrosses could enable mapping and climatology on Earth, and investigations of otherwise inaccessible terrains on Mars. We have been working this year to develop, assemble, and test a weather balloon-based system to support experimental flights of a prototype sailplane at altitudes up to 100,000 feet above Earth's surface, where the atmosphere is similar to Mars' atmosphere. Thus far, we have launched this system twice, once without our sailplane—to verify the accuracy of our calculations and the proper functioning of electronics and telemetry systems—and once with the sailplane to test the preparedness of our ground station and balloon release mechanism, both designed and built by us. These launches verified the successful operation of the modified sailplane prototype, balloon release mechanism, and ground station, in preparation for future high-altitude flight tests.

Schulte, Jack (Senior, Physics, Arizona State University). Mentor: Maitrayee Bose, School of Earth and Space Exploration, Arizona State University. [A-13]

HETEROGENEOUS SUPERNOVA PRODUCTION OF TI AND CR ISOTOPES

The titanium and chromium isotope compositions of several different types of supernovae (SNe) are inspected and compared to presolar stardust grains. The stardust grains with smaller enrichments of the rapid neutron capture (r-process) isotope 54Cr are best explained by core-collapse supernova (CCSN) origin, while those with larger enrichments of r-process 50Ti and slow neutron capture (s-process) isotopes 50Cr, and 54Cr are better explained by electron capture supernovae (ECSN) or slow deflagration and fast deflagration type Ia SNe. r-process and s-process isotopes can be produced in the same CCSN, in which case the r-process isotopes are present in shells exterior to the s-process isotopes. The clumps of ejecta with r-process enrichments additionally have greater velocities than those with s-process enrichments, indicating that the r-process and s-process enriched ejecta will become more physically separated and the CCSN ejecta will become more heterogeneous as time passes.

Segovia, Kevin (Sophomore, Computer Science, Central Arizona College). Mentors: Armineh Noravian and John Morris, Science and Engineering Division, Central Arizona College. [E-5]

A MEASUREMENT OF THE CONCENTRATION OF GREENHOUSE GASES AS ALTITUDE INCREASES

An increase in the concentration of greenhouse gases in the atmosphere has the effect of increasing the atmosphere's ability to trap heat. The hypothesis is that there will be a higher concentration of the lighter gases compared to the heavier ones at higher altitudes, as heavier gases tend to sink compared to lighter ones. This payload is designed to collect data on the concentration of greenhouse gases, such as carbon dioxide, carbon monoxide, nitrous oxide, methane, and water vapor, in parts per million (ppm) at various altitudes using gas and altitude sensors. The payload walls are made of insulating material. Some sensors are placed in grooves along the outside of the enclosure. The inside of the enclosure is sealed to keep the microcontroller and the batteries safe. The data collected will be analyzed using Excel to determine if the hypothesis is supported.

Shultz, Natalie (Senior, Optical Engineering, University of Arizona). Mentor: Dathon Golish, Lunar and Planetary Laboratory, University of Arizona. [H-2]

CALIBRATION OF IMAGES FROM THE OSIRIS-REX CAMERA SUITE

The OSIRIS-REx Camera Suite (OCAMS) has been acquiring images of asteroid Bennu since 2018 in preparation for the sample collection that was performed in October 2020. Image calibration removes noise and is important for drawing scientific conclusions from the images. Charge smear is a common source of noise for frame transfer detectors; although the current method of charge smear correction is acceptable, it requires an additional correction factor that takes time to find and has some uncertainty. We tested several techniques to address these factors and ultimately implemented an optimization function that has been shown to increase the accuracy and efficiency of the charge smear correction. The primary benefit of this work is improved calibration of OCAMS images, but it also demonstrates a discrepancy between the theoretical and experimental correction. Further investigation into this discrepancy might improve our understanding of the physical and electronic characteristics that affect the detector’s physical operation.

Simmons, Andre (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University. [E-9]

EAGLESAT TEAM: DEVELOPMENT AND IMPLEMENTATION OF A SELF-CONTAINED HARNESS FOR IN-HOUSE INTEGRATION, VERIFICATION, AND VALIDATION TESTING OF CUBESAT ELECTRIC POWER SYSTEMS

The Electric Power System (EPS) and Fabrication Teams at EagleSat have been working on methods for safe and effective battery testing. The teams' ultimate goal is to perform certification testing that verifies the battery's integrity, capacity, and safety for mission operations. Given hardware restrictions, a test board manages battery charging and discharging operations during the testing procedures. The EPS system integrates into the test board through simulated solar arrays and an I2C serial connection. Over the research period, the team developed various generations of boards, each scaling in complexity and utility. This presentation will cover the battery testing results and present details of the board designs used to safely conduct the tests.

Smith, Josh (Senior, Aerospace Engineering, University of Arizona). Mentor: Mike Parker, Rincon Research Corporation. [G-3]

MEASURING ANTENNA PATTERNS FOR GROUND STATION

The University of Arizona is launching a 6U CubeSat called Cat-Sat in the Spring of 2022. Cat-Sat will be communicating with 6.1-meter dishes that are part of the Arizona Array currently being constructed. My research was aimed to develop software that would control azimuth and elevation scan patterns. This would be useful in measuring the antenna's beam shape and later errors in predicted satellite orbits. The plan was to first use the software on a small scale with a Yagi antenna connected to Azimuth and Elevation rotators driven by a Green Heron RT-21 and then expand to the 6.1-meter dishes. Currently, software exists to move the rotors to the desired position, however, further work is still required to allow the rotors to move as a function of azimuth and elevation scan patterns.

Solomon, Santana (Junior, Medical Studies, Arizona State University). Mentor: Sara Walker, School of Earth and Space Exploration, Arizona State University. [G-5]

MARS IN-SITU RESOURCE UTILIZATION FOR HEALTH APPLICATIONS

This research project seeks to explore the chemical components of macromolecules, vitamins, and minerals necessary for human metabolism and their abundance in various space environments. The purpose of this project is to contribute to research surrounding human health and space travel, especially for the purpose of long-term space voyages. To do this, network expansions will be used to compare the biochemical environments present on other planets to the biochemicals present in our biology to determine if life on earth is viable on other planets. Additionally, the research will seek to explore the environmental conditions that are necessary for a species to acquire the needed chemical compounds of a viable metabolism.

Spurling, Reed (Sophomore, Aerospace Engineering, University of Arizona). Mentor: Sergey Shkarayev, Aerospace & Mechanical Engineering, University of Arizona. [D_8-9]

SUBORBITAL UNCREWED AERIAL VEHICLES FOR EARTH SURVEILLANCE AND MARS EXPLORATION

An autonomous sailplane capable of mimicking the dynamic soaring behavior of albatrosses could enable mapping and climatology on Earth, and investigations of otherwise inaccessible terrains on Mars. We have been working this year to develop, assemble, and test a weather balloon-based system to support experimental flights of a prototype sailplane at altitudes up to 100,000 feet above Earth's surface, where the atmosphere is similar to Mars' atmosphere. Thus far, we have launched this system twice, once without our sailplane—to verify the accuracy of our calculations and the proper functioning of electronics and telemetry systems—and once with the sailplane to test the preparedness of our ground station and balloon release mechanism, both designed and built by us. These launches verified the successful operation of the modified sailplane prototype, balloon release mechanism, and ground station, in preparation for future high-altitude flight tests.

Staggers Jr, Rodney (Senior, Mechanical Engineering, Arizona State University). Mentor: Jnaneshwar Das, School of Earth and Space Exploration, Arizona State University. [B-27]

AQUATIC DATA ANALYSIS FROM DEPLOYABLE, AUTONOMOUS BOAT

The variance of biogeochemical attributes (i.e. pH, temperature gradients, chlorophyll levels) in aquatic settings can be observed through in situ measurements and ex situ analyses over extended periods of time. Currently, a probe is being utilized to assess the properties of the man-made structure called Tempe Town Lake. However, there exists a need to expand the spatial resolution of the lake test sampling to consider dramatic variability. By integrating ROS (Robot Operating System), Arduino, and an altimeter to a sonde winched by an autonomous catamaran-style boat, this project expects to gain insight into the biogeochemistry at various locations and desired depth intervals at Tempe Town Lake. Along with water quality, the scheduled deployments hope to reap additional information in mapping the lake and crafting path-planning avenues for optimal test locations.

Stratton, Ryan (Senior, Mechanical Engineering, Northern Arizona University). Mentor: Jenifer Wade, Mechanical Engineering, Northern Arizona University. [G-6]

DIRECT AIR CAPTURE USING MOISTURE SWING CHEMISTRY

Carbon dioxide, a greenhouse gas is of growing concern as the average temperature of Earth continues to rise and eliminating the emissions of carbon dioxide is not enough to slow the rising temperature. In order to combat this issue, not only does the burning of fossil fuels need to be replaced by renewable energy but the investigation into the removal of carbon dioxide from the atmosphere must also be investigated. This project investigates the ability to remove carbon dioxide from the air by using a passive carbon dioxide collection system. This system uses a chemical phenomenon known as swing state chemistry. This process allows for the use of a brine to go from a rich or saturated carbon dioxide state to a lean state allowing the brine to be reused to collect more carbon dioxide. The goal of this study is to create models of complex geometries for the mathematical approach to explain the mass transfer of carbon dioxide on the shell side of the system. This work was achieved through the use of the computer aided design software Solidworks, as well as GMSH, which allows the parts to be broken down into a partitioned meshes. This is required for solving the flux of carbon dioxide via FEniCS using a finite element modeling approach. Using the geometries created in Solidworks with a packing factor of 0.197 resulted in a mass transfer rate of 2.0 mm/s.

Strawn, Emily (Junior, Astronomy, Embry-Riddle Aeronautical University). Mentor: Noel Richardson, Department of Physics, Embry-Riddle Aeronautical University. [A-11]

H-BETA ANALYSIS OF ETA CARINAE RADIAL VELOCITY DURING RECENT PERIASTRON PASSAGES

We analyzed data from the massive binary star η Carinae taken with the CTIO 1.5 m telescope and CHIRON spectrograph during the recent periastron passages. This is one of the most extreme binaries known in the Milky Way Galaxy. The H-beta emission line variations were examined beginning a short period before and through the entire duration of the 2020 periastron event. We have measured the radial velocity for these orbital phases by fitting the curve and taking a half bisector. This has shown the velocity increasing in intensity then reaching a peak of 75 km/s during periastron before once again slowing. The same analysis was used for the 2014 and 2009 events, which show a smaller maximum velocity. We are investigating the changes in the system across the optical spectrum over the past three cycles.

Thompson, Lauren (Senior, Ecology and Evolutionary Biology, University of Arizona). Mentor: Mary Nichols, Southwest Watershed Research Center, U.S. Department of Agriculture - Agricultural Research Service. [B-8]

THE INFLUENCE OF CONSERVATION STRUCTURES ON RANGELAND VEGETATION PATTERNS

Across the American Southwest there have been regional shifts from grasslands to shrublands. These shifts are exacerbated by climate change; however, vegetation patterns are also affected by earthen berm structures that support ranching by managing runoff and erosion. While there is extensive research regarding these regional landscape changes, the long-term effects of the structures on vegetation patterns have not been quantified. We performed supervised classifications using orthographic imagery taken in June 2016 to quantify the effects of the structures in the uplands and floodplain of the Altar Valley in Southern Arizona. On the upslope side of the structures, 33% of pixels were classified as bare soil versus 52% on the downslope side. There were more shrubs (24%) and grass (42%) on the upslope side versus the downslope side (17% and 31%). These results are relevant for managing arid landscapes where runoff and vegetation are affected by conservation structures.

Thompson, Paige (Junior, Environmental Science, Northern Arizona University). Mentor: Rachel Mitchell, Earth Sustainability, Northern Arizona University. [B-25]

CAN WE PREDICT GERMINATION SUCCESS IN SEED PELLETS USING SEED TRAITS?

Using the species Argemone mexicana and Linum lewisii I examined how seeds encased in seed pellets responded in terms of germination efforts compared to bare seeds. Seed pellets are used as a tool to restore degraded ecosystems. I matched seed characteristics with pellet characteristics to try achieve higher germination rates. Methods included keeping the bare seeds constantly moistened and under the right conditions to encourage germination. The seed pellets were shaped to two sizes, 0.25 inches and 0.5 inches in diameter, with five seeds per pellet. Over the course of five weeks I checked for germination between the two species. Results showed 51.7% germination rate for the Blue Flax and 14.1% for the Mexican Poppy from the bare seeds and the pellets are still in the process of germination.

VeNard, Carly (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Davide Conte, Aerospace Engineering, Embry-Riddle Aeronautical University. [I-13]

A STUDY OF THE DEFLECTION OF 99942 APOPHIS FROM EARTH

99942 Apophis has been a near Earth Asteroid of interest to the scientific community since its discovery. With a heliocentric orbit like that of Earth, the asteroid has several close encounters with our planet in the near future, specifically in 2029, 2036, and 2066. This study utilizes the close Earth approach of Apophis in 2029 to perform a kinematic impact maneuver onto the asteroid to deter its orbit from Earth. This methodology uses a high-velocity projectile impact onto the asteroid to impart an artificial Δv to change the orbit of Apophis. Additionally, a spacecraft will follow the new path of the asteroid to incorporate a gravitational force onto the asteroid and maintain the orbit a safe distance from the Earth. Both maneuvers will dramatically decrease the risk of future impact of Apophis with Earth, as well as test the feasibility to perform deflection maneuvers on similar threats in the future.

Vescio, Adrienne (Senior, Astrophysics & Physics, Arizona State University). Mentor: Patrick Young, School of Earth and Space Exploration, Arizona State University. [C-23]

INVESTIGATING THE RELATIONSHIP BETWEEN EXOPLANET OCCURRENCE & HOST STAR METALLICITY

Over the years since the discovery of exoplanets, research has been performed investigating the correlations between host star and planet characteristics in an effort to better understand the conditions that best promote planetary formation and system longevity. Growing our knowledge in these areas supports efforts to discover planets that are most likely to host life. Here, we discuss a related effort investigating the relationship between host star metallicity and exoplanet frequency as it relates to a visible pattern in abundance ratio. In applicable plots comparing the abundance ratios of fundamental system building blocks, we observe a separation of the stellar population into two distinct groups, which were selected by eye and individually investigated. Through efforts to uncover potential effects of this separation, we find that there is a uniform discrepancy between populations, in which one has, on average, over twice the occurrence of planet-hosting stars.

Walker, Meronda (Sophomore, Environmental Science, Northern Arizona University). Mentor: Niccolette Cooley, Institute for Tribal Environmental Professionals, Northern Arizona University. [H-5]

SUPPORTING THE CLIMATE CHANGE DEPARTMENT

During my internship with ITEP I worked on many projects to support the Tribes and Climate Change Program. I attended the National Tribal & Indigenous Climate Conference (NTICC) and spoke in the Elder and Youth Engagement session. I wrote a short reflection on my experience, which was featured in the December Tribes and Climate Change newsletter. I have attended webinars that focus on climate change such as the Affiliated Tribes of Northwest Indian's Climate Change Summit: Tribal Climate Resiliency, Wildfire Hazard Mitigation webinar, and another called the SCIENCE x Invasive Tree Pests and Pathogens. I supported the program's Climate Change 202: Tribal Hazard Mitigation Planning (THMP) course by attending monthly large group meetings along with compiling hazard mitigation strategies from existing THMPs for hazards wildfire and extreme heat. This internship showed me that climate change consists of more extreme weather conditions, global warming and melting ice.

Weibel, Catherine (Senior, Physics & Mathematics, University of Arizona). Mentor: Joanna Masel, Ecology and Evolutionary Biology, University of Arizona. [B-21]

MORE EFFECTIVELY SELECTIVE SPECIES HAVE GREATER PROTEIN STRUCTURAL DISORDER

Past work in the Masel lab suggests that protein domains become more structurally ordered with age. We ask whether protein structural order also depends on a species' ability to purge deleterious mutations or effectiveness of selection. To quantify individual species' effectiveness of selection, we developed a new metric, Codon Adaptation Index of Species (CAIS), corrected for total genomic GC content and amino acid composition. CAIS is comparable across species and shows the expected relationship that more effectively selective species have smaller body size. We predicted the Intrinsic Structural Disorder (ISD) of protein domains across 118 vertebrate species and estimated the effect of species identity on ISD using a mixed linear model with species as fixed effect and Pfam as random effect. This yields a species-specific disorder metric corrected for protein domain composition. We find that the degree of structural disorder of a given protein domain evolves to be greater when in well-adapted vertebrate species. This suggests a selective tendency for disorder, contrary to all assumptions of disorder's deleteriousness.

West, Hayden (Sophomore, Space Physics, Embry-Riddle Aeronautical University). Mentor: Ahmed Sulyman, Electrical Engineering, Embry-Riddle Aeronautical University. [C-9]

EAGLESAT TEAM: DETERMINING PARTICLE ENERGY USING CMOS SENSORS

Generally, particle and nuclear physicists use a combination of a scintillator and photomultiplier tube to detect subatomic particles' energies. However, the scintillator is unable to relay an incident direction of the particle. We are attempting to remedy this by using an array of complementary metal oxide semiconductor (CMOS) sensors to track the incident direction of particles interacting with the cameras. Since we have an incident direction, the focus of this work is to relate the pixel intensity of particle interaction on the camera to the energy of the particle itself. This would mainly be accomplished with the assistance of the Bethe-Bloch equation which relates the incident particle energy to the pixel intensity. This technique is to be further developed for use on Embry-Riddle Aeronautical University's cube sat Eaglesat 2, to determine cosmic ray direction, magnitude, and flux in an International Space Station orbit.

Wetzstein, Hope (Junior, Physics & Astronomy, Northern Arizona University). Mentor: Mark Salvatore, Astronomy & Planetary Science, Northern Arizona University. [C-8]

LABORATORY ANALYSIS OF OLIVINE-CARBONATE MIXTURES AS OBSERVED ON MARS

Create mixtures of olivine and carbonate grains and measure the mixtures under a variety of different sample, and environmental conditions to generate a new suite of library spectra to be compared to existing and future spectral measurements acquired from Mars. These sample mixtures of olivine and carbonate will be in 10% increments from 0-100. Making a laboratory spectrum with the VNIR and MIR. Recorded cool down temperatures with a FLIR camera to create a new spectra with the MIR. Using the VNIR, changes were only observed once one of the minerals reaches 80% of the mixture. Using the MIR, carbonate effects of the olivine as the mixtures contains more carbonate were observed. Next is to cement these mixtures and rerun these experiments to give us a larger library for direct comparison to olivine-carbonate mixtures as observed on the Martian surface by both the Spirit and Perseverance Mars Rovers.

White, Quinn (Senior, Physics & Mathematics, Arizona State University). Mentor: Kevin Schmidt, Physics, Arizona State University. [A-4]

SUPERFLUIDITY OF NEUTRON STAR MATTER

It is expected that neutrons in the inner crust and outer core of neutron stars form a superfluid. To accurately model these systems, it is necessary to move beyond standard BCS theory, as its lack of nucleon-nucleon correlations leads to an overestimate of the superfluid gap. Here we discuss how quantum Monte Carlo methods can be used to perform more realistic calculations, with prior results from collaborators using auxiliary field Diffusion Monte Carlo

(AFDMC) being shown. We discuss how introducing linear correlations to the trial wave functions used in AFDMC calculations is expected to lead to improved results in the future.

Winstin-Seitz, Samantha (Junior, Environmental Science, Northern Arizona University). Mentor: Thomas Hoisch, Geology, Northern Arizona University. [B-15]

NUMERICAL SIMULATION OF LARAMIDE FLAT-SLAB SUBDUCTION

Subduction has been occurring along the western margin of North America since the Permian period, about 300 million years ago. About 85 million years ago, the angle at which the oceanic plate dove eastward beneath the continent changed from a normal angle (~45°) to nearly horizontal, producing what is referred to as 'flat-slab subduction.' I simulated the thermal evolution of Laramide flat-slab subduction in 2-dimensions using the finite difference modeling program ThermodSubduct, with the goal of explaining geological features known to have developed in southeastern California around the time flat-slab subduction began. I learned to use and assisted in the development of this program in preparation for its release. The simulations incorporated values of thermal diffusivity, thermal conductivity, density, and internal heat production for crust (oceanic and continental) and mantle. Laramide crustal melting and fluid-driven metamorphism in southeastern California were successfully simulated with a high assumed frictional coefficient of 0.2.

Wolfenbarger, Thorne (Senior, Aerospace Engineering, Embry-Riddle Aeronautical University). Mentor: Mark Sensmeier, Aerospace Engineering, Embry-Riddle Aeronautical University. [D-2]

STALL HYSTERESIS – WHY THE REATTACHMENT ANGLE IS LESS THAN THE SEPARATION STALL ANGLE

Our work involves focusing on the behavior of the "effective body" aerodynamics of stalled airfoils. The effective body is the physical airfoil along with the recirculating wake behind it, dominating the hysteresis loop from catastrophic stall to reattachment. Stall hysteresis is observed when an airfoil's angle of attack is increased beyond the angle for stall and flow does not reattach at the same (separation) angle when lowering the angle of attack again. It is found that, where hysteresis data is available for comparison, the reattachment angle of a given airfoil geometry agrees with the stall/separation angle of the associated effective body to within a fraction of a degree. Our work carries implications that we could predict the angle an airfoil recovers from stall by using the stall angle of the airfoil's effective body. This work can be used to improve airfoil design where hysteretic stall control is mission critical.

Woodham, Stone (Senior, Earth and Space Exploration & Communication, Arizona State University). Mentor: Mansour Javidan, Thunderbird School of Global Management, Arizona State University. [F-1]

COMMUNICATION AND EXPLORATION

The International Space Station (ISS) has had crews of multicultural teams cohabiting since 2000. Each team has specific tasks and objectives to complete while in space; however, communication and dynamic challenges arise due to the complex multicultural composition of each crew that goes to space. In order to analyze these challenges and determine the sources of them, participants were interviewed, and thematic analysis was done to determine that initiative, awareness, and a lack of support contribute to those challenges. It was also concluded that there are some individual responses that can contribute to effective teamwork and communication on the ISS.

Worthen, Kadin (Senior, Physics, Arizona State University). Mentor: Jennifer Patience, School of Earth and Space Exploration, Arizona State University. [C-17]

INVESTIGATING THE PLANET DETECTION LIMIT IN DEBRIS DISK IMAGES FROM THE GEMINI PLANET IMAGER

Debris disks are a collection of dust grains and planetesimals in orbit around a star and are thought to be the remnants of planet formation. Directly imaging debris disks and studying their morphologies is valuable for studying the planet formation process. In some stellar systems that have a directly imaged debris disk, there are also directly imaged planets. Debris disk structures like gaps and asymmetries can show the gravitational effects of planets that are below the brightness threshold for being detected via direct imaging. To that end, we investigate a sample of debris disks in Scorpius-Centaurus that were imaged with the Gemini Planet Imager (GPI), which is an adaptive optics system with a coronagraph to block starlight. Using the GPI images, we determine the planet detection limit for these systems, and measure the surface brightness profiles of the disks to determine if any of the disks exhibit asymmetric brightness profiles.

Wu, Joshua (Junior, Electrical and Computer Engineering, University of Arizona). Mentor: John Wallace, Rincon Research Corporation. [G-2]

MINIMIZING LOCAL ELECTROMAGNETIC INTERFERENCE USING ADAPTIVE FILTERS

Within communication systems, there has always been a struggle to minimize Electromagnetic interference (EMI) in order to maintain optimal performance. Rincon Research's AstroSDR is no exception; due to the limited space aboard a CubeSat, close contact with other circuitry causes local EMI in its recordings. In this project, we aim to implement an adaptive filter to separate EMI from received signals in hopes of regaining our signal of interest. We implement several adaptive filter algorithms in Python and find that the Least Mean Squares algorithm outputs signal data perfect for our use case. We expect this filter implementation to produce more Weak Signal Propagation Reporter hits during reception.

2020-2021 Arizona/NASA Space Grant
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