HAWAI'I SPACE GRANT CONSORTIUM NASA

Nā Hua ka'i

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The Voyages

Project Imua: UHCC Four-Campus Enterprise for Small Satellite Development

By: Dr. Joseph Ciotti, Project Manager and Professor of Physics, Astronomy, and Mathematics—Windward Community College

Project Imua (to move forward in Hawaiian) is a joint faculty-student enterprise of four campuses within the University of Hawai'i Community College (UHCC) system (Honolulu, Kapi'olani, Kaua'i and Windward) dedicated to designing, fabricating, and testing small payloads for launch into space. This multi-campus project is funded by a two-year $500,000 grant awarded to the Hawai'i Space Grant Consortium under the NASA Space Grant Competitive Opportunity for Partnerships with Community Colleges and Technical Schools. This grant includes $200,000 in student internships.

Sixteen students are involved in Project Imua's first mission, which is scheduled in August for sub-orbital flight through the RockSat-X program. The Kaua'i campus developed the payload's scientific instrumentation, consisting of an ultraviolet spectrometer for measuring solar irradiance above the atmosphere. Students from the Honolulu campus fabricated the payload's electronic circuitry as well as two engineering experiments—a 9-axis motion tracking device (accelerometer, gyro, and magnetometer) and an array of photosensors for determining the orientation

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Right: Project Imua Payload (PIP).

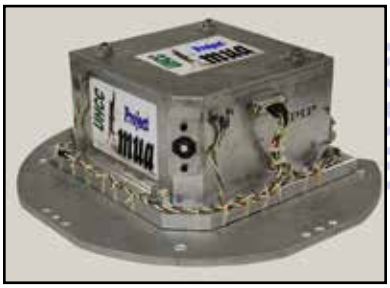
of the sun to the payload. The Kapiʻolani campus designed the print circuit board for the system's power and telemetry. Students from the Windward campus were responsible for integrating all subsystem components together, performing full mission simulation tests and conducting various environmental static tests on the assembled payload. The payload's aluminum mechanical housing, which measures approximately 8" x 8" x 5", was developed jointly by the Kauaʻi and Windward campuses.

Coordinating such a multi-campus/multi-island project presents its own special challenges. Organizationally the program operates under the guidance of a project manager, campus mentors, and several technical consultants. Communication networks among the campuses incorporate Google Hangouts and local telecon sessions as well as Google Drive, emails, and other social media. Face-to-face meetings were also built into the demanding one-year schedule. Students furthermore participated in periodic teleconferences with the RockSat-X coordinators in Colorado. These benchmark review sessions simulate the same procedures required by NASA employees and its sub-contractors, thus providing students with valuable experience in aerospace engineering protocols.

Debora Pei and Nicholas Herrmann integrating PIP at WFF. (photo by: Amber Imai-Hong)

In preparation for its August launch, the assembled payload first was subjected to vibration and pressure tests at UH Mānoa's Hawaiʻi Space Flight Laboratory (HSFL). Later in June seven members of the Project Imua team traveled to NASA Wallops Flight Facility (WFF) in Virginia to conduct additional environmental tests, including spin, vibration, balance, moment of inertia, and skirt deployment. The UHCC students also assisted with the integration of their payload onto the RockSat-X structure carrying the other six experiments from various other universities.

Project Imua's first payload named PIP is scheduled for sub-orbital flight on August 11, 2015 aboard a Terrier Improved Malemute sounding rocket from WFF. Eleven Imua team members are traveling to Wallops to witness this historic launch, which marks the first ever space flight of a payload fully developed by UHCC undergraduates. The flight's sub-orbital trajectory will carry the payload to an altitude of ~100 miles, where the onboard spectrometer will measure the sun's ultraviolet radiation. Data from this experiment will contribute to an understanding of the variations of the sun's UV irradiance. With extremes varying from solar sunspot maximum to solar minimum, the nature of this change is still not well known and may have significant impact on Earth's upper atmosphere (thermosphere and ionosphere) and climate.



Project Imua Payload (PIP).

Upon completion of this two-year project, the lessons learned and partnerships established will provide the UHCC campuses a proven platform for moving forward (imua) in playing a major role in the development and support of HSFL's CubeSat missions slated for launch at the Pacific Missile Range Facility on Kauaʻi. Most importantly, Project Imua offers undergraduate students opportunities to gain practical hands-on STEM skills and experience through the real-world, project-based activities that are associated with the development of satellite payloads. Θ

Imua Integration Session at Windward Community College. (photo by: Helen Rapozo)

Kalanikapu Copp, Dr. Jacob Hudson, and Nicholas Herrmann at WFF during their post-test checkout. (photo by: Amber Imai-Hong)

The View from the Pipeline:
Employment at the NASA Jet Propulsion Laboratory

By: Carolyn Parcheta, NASA Postdoctoral Fellow at JPL, 2005-2006 HSGC Fellow

Left: Carolyn will take VolcanoBot-2 to Kīlauea volcano in Hawai'i in 2015. Right: Carolyn was in the field in May 2014, with VolcanoBot-1, exploring an inactive fissure (crack that erupts magma) on the active Kīlauea volcano. (NASA/JPL -Caltech)

The journey to my current position as a NASA Postdoctoral Fellow (administered by Oak Ridge Associated Universities) at NASA's Jet Propulsion Laboratory (JPL) started 10 years ago, as a young freshman at UH Mānoa. I was eager to get my hands into some research and, after a short stint refereeing intramural volleyball, I looked up which professors needed research assistants in SOEST. I came across Sarah Fagents' ad for a student to do some mapping—namely identifying lava tubes and lava channels on Mars. I excitedly applied and, before I knew it, I was looking at MOC and THEMIS images, documenting any tubes or channels that I found on Olympus Mons. In short, I loved it. I worked on the project for three years with Sarah (and Barb Bruno and Steve Baloga); two semesters as a Hawai'i Space Grant Fellow. This experience introduced me to planetary geology, and enhanced my desire to pursue terrestrial and planetary volcanism as my profession.

After getting a Ph.D. from UH Mānoa specializing in terrestrial physical volcanology with Bruce Houghton, I submitted an application to the highly competitive NASA Postdoctoral program. The pitch? I had just spent 5 years working around and analyzing fissure vents, yet the exact subterranean geometry was unknown (by anyone)… so I suggested that building a robotic device would be the best way to document fissure geometries and finally know what volcanic fissure conduits look like in detail. This would subsequently allow the scientific community to increase the level of conduit complexity in eruption fluid dynamic models, allowing for more realistic geometries (i.e., second or third order) or even fully realistic geometries for fissure eruptions. The postdoctoral program agreed and I came to JPL to pursue this work in February 2014.

Over the past year and a half, I've led the design, development, and deployment of VolcanoBot. It is an American-football-sized robot that has already made 2 descents into the 1969 Mauna Ulu fissure to document it's geometry over a 1-km-long exposure. VolcanoBot uses a near-infrared sensor for determining distances to objects (i.e. the fissure walls) and creating a 3D point cloud from it. The design and development is a collaborative effort with co-advisor Aaron Parness and the extreme environment robotics group here at JPL. This project embodies the merging of science and engineering—the science drives the engineered design of VolcanoBot while the engineering allows us to obtain previously unobtainable data of volcanic systems. Each aspect of the project helps the other, creating a synergistic project (and product) that feels greater than the sum of its parts. Rapid prototyping with frequent mini-tests allows us to quickly hone in on the best design for VolcanoBot while the science and knowledge of the environment help constrain what engineering changes can be made to improve the design. Our next step will involve computational fluid dynamic models with my advisor, Karl Mitchell, to understand the interplay of eruptive magmas and their conduit walls, namely how the flow affects or is effected by the conduit geometry. Currently, our focus is on terrestrial applications, but we are considering how VolcanoBot might behave in lunar lava tubes, Martian fissure vents, or the cracks in ice shells of Europa and Enceladus, and the respective fluid dynamical behaviors of their assumed conduit geometries.

Being a Hawai'i Space Grant Fellow as an undergraduate helped prepare me for this postdoc in a couple ways, which my Ph.D. subsequently reinforced: (1) Essential skills for being a researcher (or an engineer) are independence, thinking critically,

and asking questions (i.e., about the science, where errors may come up, and for help or guidance if you feel stuck. (2) The easiest way to do what you love, or are most interested in, is to get funded. In some regard, the HSGC was my first grant, and because it was successful and enjoyable, I was encouraged and empowered to apply for future funding elsewhere throughout my PhD and leading into my current postdoc. Θ

Hawai'i MarsBot at NASA Competition

By: Steven Ewers and Liem Nguyen, 2014 UH Mānoa Fellows

Steven Ewers and Liem Nguyen with robot on Maunakea.

A collaborative team of Kapi'olani Community College and UH Mānoa STEM students formed in the summer of 2013 on a journey to compete in NASA's 2014 Robotics Mining Competition. This is a university-level robotics competition for students to design and build a 80-kg Martian excavation rover that would be able to collect and deposit at least 10-kg of simulated regolith, BP-1, in a simulated Martian arena. The team's goal was to construct a low cost and efficient mining robot that was lightweight. The competition was held on May 19- 23, 2014 at the Kennedy Space Center in Florida.

The competition process began with the team's registration in late August, 2013. Shortly after, we began the design of the robot as well as outlining educational outreach programs that would benefit K-12 students, a requirement for the competition. Another requirement was a systems engineering report that detailed the design selection of our robot. This report encompassed the whole system of our robot, from the mechanical, electrical, and software to control the robot. Throughout the design and build process, we worked together as a team when tough decisions were needed to be made. In doing so, we were able to meet all deadlines set by NASA. Steven worked on the electrical systems of the robot, while Liem worked on the mechanical subsystems.

We were able to travel to the competition in Florida with HSGC support. At the competition, our team was able to meet and interact with teams from around the country as well as NASA judges and engineers. Once we arrived, we quickly assembled our robot and were able to pass all of the required mechanical and communication checks in order to practice in the regolith arena.

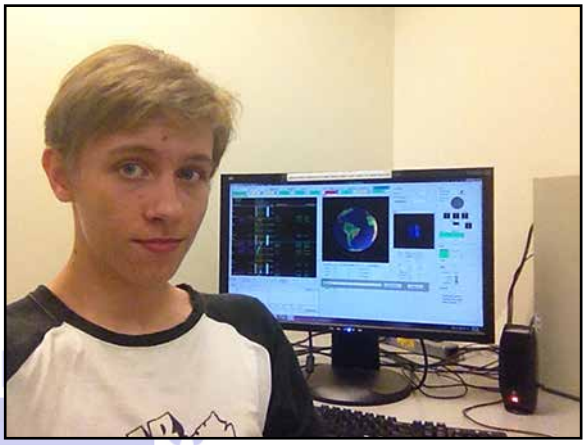
These practices increased our confidence and helped us address any issues that we might face for our official competition rules. During our first competition run, we experienced a mechanical failure in our robot's drivetrain. We quickly addressed this issue and, in our opinion, succeeded in our second and final competition run by collecting and depositing 1.6-kg of BP-1 in ten minutes. By collecting and depositing regolith during the official competition runs, our team was amongst the top 50% of the competing teams, a feat that displayed our engineering collaborative effort and perseverance. We would like to thank the HSGC for supporting our endeavors in this competition. With their help, we were able to represent our state and university at the national level. Mahalo! Θ

Hawai'i Marsbot Team members & Faculty Advisor at Kennedy Space Center. (L to R) Liem Nguyen, Steven Ewers, Dr. Aaron Hanai, Tayler Pave, Logan Tamayo, Rae Zan Belen, Holm Smidt.

Designing Mission Planning Software and Testing Satellite Hardware

By : Erik Wessel, 2014 HSFL Workforce Development Program Intern

Last summer I was lucky enough to work on software to support the Hawai'i Space Flight Laboratory's Hiakasat mission as a HSGC/HSFL workforce development program intern. I wrote software that aids the testing and control of the satellite.

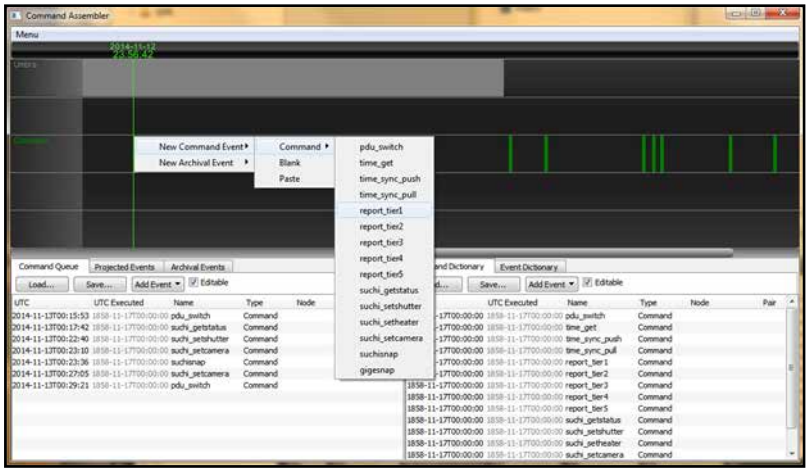


Erik Wessel at work in the POST building at UH Mānoa.

The satellite is composed of diverse pieces of equipment: heaters, radios, scientific sensors and experiments, and so on. A suite of programs on the on-board computer control and monitor these systems. While the satellite is on the ground we can simply run these programs manually and look at their output in real time, but after launch that will no longer be possible. So there has to be a standard way to tell the satellite what we want it to do, and for the satellite to tell us what's actually happening. This is done using "events," which are described via a single line of text in a format called JSON (JavaScript Object Notation), which the computer can understand. Lists of command events can be written in a text file, which can be transmitted to the satellite, and a record of events that have transpired can be transmitted back down to the ground.

One of my primary tasks during the internship was to create a software tool that would let us make and modify these command files, as well as view the archival event logs the satellite sends back. I got to design an application from the ground up using the Qt framework, that could represent all the information contained in the files graphically, in a way that was both comprehensive and clear, and allow all of it to be edited by the user. Designing a user interface may sound banal, but it's actually a process that is both incredibly creative and cerebral. You start out thinking about all the pieces of data that are flowing around the software system, and you figure out which ones need to be communicated to the user and which ones need to be editable. Then, you explore all the possible ways of representing that data, and finally you must make that vision a reality in code. It's a very fun task, because you have a simple, well-defined goal, and a huge array of choices for how to achieve it. It gives you a lot of freedom to think about what the best solution might be and to make and implement design choices.

In addition to writing that program, this internship gave me the opportunity to help test some of the important systems on the satellite. I wrote a test routine that insures the Magtorque rods (a crucial set of electromagnets that control the satellite's orientation by interacting with the Earth's magnetic field) are functioning properly before launch. It's an exciting experience to write code and have it run on an actual spacecraft. I also had a chance to work in the clean room where the satellite was being assembled, helping to test a payload (a digital camera) that would be attached to the satellite.



Screenshot of the Commander Assembler Tool being used to create an event.

This internship has given me experience writing software applications. I've learned how to use the Qt framework to build advanced GUIs, and been able to do hands-on work writing software to control hardware on a real spacecraft. I feel I gained many useful skills during this internship, and I hope I contributed something of value to the Hiakasat project. Θ

My NASA Marshall Space Flight Center Experience

By: David Harris, 2014 HSGC Summer Intern

Left: Life-size replica of Saturn V rocket. Right: David drinking butter beer at the Three Broomsticks Inn on an excursion to Orlando, Florida.

It all began as a class assignment—I was required to create a portfolio that included curriculum vitae, a cover letter, and an elevator pitch. With the portfolio, I was to apply for jobs and show the results of the application process to the professor. Because I was applying just for the sake of this assignment, I did not expect any job offers. To my surprise, two months later, one of the internships I applied for, the Marshall Space Flight Center (MSFC) Space Academy, called me back. They did not call me to interview me, but to tell me they were already willing to offer me a job!

Despite my initial belief that taking a summer off to do an internship would hamper my progress towards my degree, I found that the knowledge gained during my internship would be invaluable to my thesis. My summer internship project (the diffusion of water vapor in a CO_2 scrubber) and my thesis project (diffusion of water in eucalyptus wood) both involved the diffusion of water. Both projects also required a software package that I was struggling to teach myself. Fortunately, the MSFC used this software regularly and were willing to train me in it. Currently, I am still using some of the skills they taught me for my project.

Since my internship was part of the Space Academy, I was involved with a lot more than just my main research project. As an academy member I was able to tour almost the entire MSFC, and be exposed to many other projects. We also had the opportunity to tour other facilities. The Academy field trips took us to Cape Canaveral (Florida), The Goddard Space Flight Center (Maryland), NASA Headquarters (Washington D.C.), the Jet Propulsion Lab and the Armstrong Space Center (both in California). Besides the space centers, we also took field trips just for fun. As a group we went skydiving, white water rafting, and toured museums.

In addition to NASA's valuable training in software programming, I believe that the exposure to many other research projects helped me to determine my future. Before my experience, I did not think it was possible for my knowledge in biotechnology to be applied to space. I was convinced that building green houses on Mars or zero-gravity bioreactors was too impractical in the near future. However, now that I have been exposed to some of the incredible technology that is already out there, I realize that we are closer than I thought to achieving these. The possibility of even creating a space related biotech company does not seem that farfetched.

I also appreciated meeting many people from different colleges and schools. I used to think high-end space research was only for people who had degrees from esteemed institutions, however, I saw that many people doing interesting projects, and in high positions, had degrees from colleges I have never heard about. If you have the drive, and the passion, you can do many remarkable things regardless of your university. Θ

Left: Simulation Lunar Lander at MSFC. Right: Rocket Assembly building at Cape Canaveral.

David skydiving!

UNDERGRADUATE FELLOWSHIPS & TRAINEESHIPS

Fellowships *are awarded to U.S. citizens who are full-time students at the University of Hawai'i campuses at Mānoa and Hilo. Awards are given for space-related research with a mentor and provide a stipend of up to $4,000 per semester to the student. Fellows are also eligible for travel and supply funds. In previous semesters, these funds have been used for activities including observing runs at Mauna Kea telescopes, fieldwork to collect ground-truth information for interpreting satellite data of the Hawaiian Islands and other locations, and travel to meetings to present project results.*

Mānoa Fellows - Fall 2014

Steven Ewers, a senior in Electrical Engineering studied microwave technology for wireless power transmission with Dr. David Garmire of the Department of Electrical Engineering. In his project titled, "Wireless Power Transfer System by Means of Microwaves," Steven focused on designing, running simulation models, and constructing a system utilizing the 2.4 and 5.8GHz frequencies to efficiently transmit power over a range of at least 10 feet.

Kathryn Hu, a senior in Mechanical Engineering, combined her interests in engineering and chemistry to work with mentor Dr. Mehrdad Ghasemi Nejhad of the Department of Mechanical Engineering to improve the efficiency of fuel cells in space applications by utilizing carbon nanotubes. In her project titled, "Gas Diffusion Layers for Proton Exchange Membrane Fuel Cells using Multi-walled Carbon Nanotubes Nanoforests," Kathryn processed carbon nanotubes nanoforests by a chemical vapor deposition process and evaluated their performance in the fuel cells under different operating conditions.

Arvin Niro, a senior in Mechanical Engineering, continued working with mentor Dr. Aaron Hanai of the Kapi'olani Community College Math and Sciences Department on an autonomous rover. Arvin's work included the design and construction of an efficient suspension system for his project, "Design and Development of a Suspension System used in Rough-Terrain Vehicle Control for Vibration Suppression in Planetary Exploration."

Roberto Ramilio Jr., a junior in Kinesiology and Rehabilitation Science, continued to work on "The Estimation of Daytime Sleepiness for Astronauts" with mentor Dr. Hervé Collin of the KCC Math and Sciences Department. By combining qualitative data with his new approach of measuring fluctuations of pupil diameter, Roberto collected quantitative data from student test subjects to establish benchmarks for problematic sleepiness, which could someday be applied to fitness assessments of astronauts on duty.

Bryan Yamashiro, a senior in Physics worked with mentor Dr. Veronica Bindi of the Department of Physics and Astronomy on a high energy physics project, focusing on solar energetic particles. Utilizing data from the Alpha Magnetic Spectrometer installed on the International Space Station, Brian's project, "Study of the Most Harmful Solar Energetic Particle for Shielding Next Human Space Flights," supports NASA's efforts to improve the prediction of large solar storms.

UH Hilo Fellows - Fall 2014

Christina Cauley, a senior in Geology and Anthropology, worked on a project covering "Digital Imagery and Geologic Map of Chegem Caldera, Russia." Using geospatial software for image processing and mapping, Christina registered and re-projected old geologic field maps onto accurate topographic maps based on Space Shuttle–Digital Elevation Model data. She also used the collected field data and new remote sensing data to improve the accuracy of the geologic details. Dr. Ken Hon of the Department of Geology served as mentor.

Casey Jones, a junior in Physics, worked with data from the UH 2.2m telescope on Maunakea of star-forming regions in 20 different galaxies. In his project titled, "Correcting Spectral Data from Extragalactic Star Forming Regions for Atmospheric Dispersion," Casey worked with mentor Dr. Marianne Takamiya of the Department of Physics and Astronomy to code solutions to calculate the atmospheric dispersion corrections for 33,000 spectra, apply the corrections, and rebuild the database.

Robert Ponga, a senior in Astronomy and Physics, worked with mentor Dr. Kathy Cooksey of the Department of Physics and Astronomy to characterize the highly enriched gas surrounding distant galaxies. In his project titled, "Analysis of Strong Triply Ionized Carbon Systems in Galaxy Halos," Robert used a suite of software programs to model spectral data from the Sloan Digital Sky Survey, looking in particular for heavy-element enrichment of the gas.

Mānoa Trainees - Fall 2014

Brian Chan, a junior in Electrical Engineering, continued working on a project titled "Orthorectification of Infrared Images" with mentors Dr. Norbert Schörghofer of the Institute for Astronomy and Dr. Brendan Hermalyn of the Hawai'i Institute of Geophysics and Planetology. This project involved geometric image manipulation and processing of remote sensing infrared data aimed at understanding the microclimates in craters on Maunakea, which may be analogous to craters on Mars.

Lauren Froberg, a senior in Geology and Geophysics, continued working with mentor Dr. Michael Garcia of the Department of Geology and Geophysics on "Submarine Lavas Discovered off Diamond Head—New Honolulu Volcano?" Lauren investigated the mineralogy and trace element chemistry of rocks to help determine if these are from a known or previously unidentified eruption. This work contributed to NASA's goals of characterizing the dynamics of Earth's surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards.

Kihaakeanu Sai, a junior in Sociology, continued working with satellite remote sensing data and learning image processing techniques in his project titled "Geology of Moons of Jupiter and Saturn." This semester he studied radar images in preparation for studying Europa and Titan. Serving as mentor for this work was Dr. Peter Mouginis-Mark of the Hawai'i Institute of Geophysics and Planetology.

Kimberly Teehera, a sophomore in Pre-Psychology, continued her project titled "Lava Tube Microclimates on Mauna Loa" with mentor Dr. Norbert Schörghofer of the Institute for Astronomy. Kimberly gained experience with data analysis techniques as well as with cave science. Studies of these terrestrial ice-filled lava tubes are relevant to the fields of astrobiology and climate of Mars.

Application Deadlines

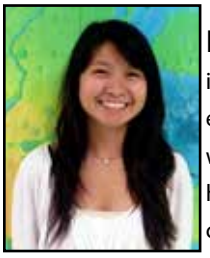
Application deadlines for undergraduate fellowships and traineeships are December 1 for Spring semester and June 15 for Fall semester. Download fillable application forms and get additional information from the HSGC website at: www.spacegrant.hawaii.edu/fellowships.html.

Mānoa Fellows - Spring 2015

James Bynes III, a senior in Electrical Engineering with previous trainee (2012) and fellowship (2013) experience, worked with mentor Dr. Gary Varner of the Department of Physics on a fiber-optic data network for a multi-institution, particle detector mission. In his project titled, "RF Over Optical Fiber Design and Implementation for the ExaVolt Antenna," James focused on the design and implementation of a radio frequency over fiber system to be used for data transmission in a scaled prototype of the ExaVolt balloon-embedded antenna.

Kathryn Hu, a senior in Mechanical Engineering, combined her interests in engineering and chemistry working with mentor Dr. Mehrdad Ghasemi Nejhad of the Department of Mechanical Engineering to improve the efficiency of fuel cells in space applications. In her project titled, "Multi-Walled Carbon Nanotube Nanoforests as Gas Diffusion Layers for Proton Exchange Membrane Fuel Cells," Kathryn grew carbon nanotube nanoforests by a chemical vapor deposition process and evaluated their performance in the fuel cells under different operating conditions.

Logan Magad-Weiss, a junior in Geology and Geophysics, worked with mentor Dr. Ryan Ogliore of the Hawai'i Institute of Geophysics and Planetology on a cosmochemistry project titled, "Development of Sample Mounting for Stardust Interstellar Candidates." Using test analog grains, Logan helped to develop techniques and protocols that could be used to prepare and analyze the oxygen isotopic compositions of dust grains returned by NASA's Stardust Mission.



Kimberly Teehera, a sophomore in Biochemistry (with previous trainee experience in 2014 studying lava tubes) worked with mentor Dr. Norbert Schörghofer of the Institute for Astronomy and co-mentor Myriam Telus of the Hawai'i Institute of Geophysics and Planetology on a project titled "Secondary Minerals in Lava Tubes on Mauna Loa." Kimberly used a variety of analysis techniques to identify minerals and chemical processes from a collection of water and rock samples. Studies of terrestrial ice-filled lava tubes are relevant to the fields of astrobiology and climate of Mars.

Bryan Yamashiro, a senior in Physics continued to work with mentor Dr. Veronica Bindi of the Department of Physics and Astronomy on a high energy physics project, focusing on solar energetic particles. Utilizing data from the Alpha Magnetic Spectrometer installed on the International Space Station, Brian's project, "Study of the Most Harmful Solar Energetic Particle for Shielding Next Human Space Flights," supports NASA's efforts to improve the prediction of large solar storms.

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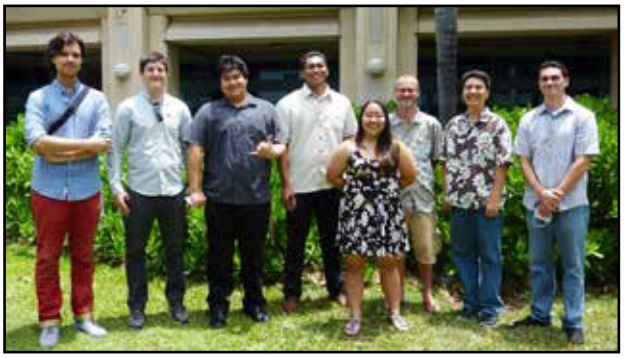
Jasmin Silva, a sophomore in Astronomy and Physics, combined her interests in astronomy, physics, and math to study the gaseous structure surrounding galaxies and its evolution with time. In her project titled, "Understanding Galactic Evolution through Absorption," Jasmin used data from the Sloan Digital Sky Survey to construct and analyze composite absorption-line spectra of the cosmic web. Dr. Kathy Cooksey of the Dept. of Astronomy and Physics served as mentor.

Traineeships *are awarded to U.S. citizens who are full-time students at University of Hawai'i Mānoa and Hilo campuses, Community Colleges, and the University of Guam. Awards provide lab training and practical experience with a mentor in any space-related field of science, technology, engineering or math. Trainees receive a stipend of up to $1,500 per semester and may be eligible for supply funds.*

Mānoa Trainee - Spring 2015

Rachel Chang, a senior in Global Environmental Science, worked on "Investigating Sea-Level Rise and Shoreline Change with Satellites" with mentor Dr. Peter Mouginis-Mark of the Hawai'i Institute of Geophysics and Planetology. Rachel gained experience with coastal geomorphology, tide data, and remote sensing data relevant to shoreline change for areas vulnerable to reshaping and flooding caused by rise in sea levels.

Kapi'olani Community College Trainees - Spring 2015



(L to R) Joshua Faumuina, Matthew Domenichelli, Bryson Racoma, Jackson Poscablo, Erin Hashimoto, Dr. Hervé Collin, Dr. Aaron Hanai, and Po'okela Stillman Reyes. (Not pictured): Vincent Nguyen.

Kaua'i Community College Trainee - Spring 2015

Steven Westerman, a sophomore in Chemistry, worked on a project titled "Operation and Maintenance of Kaua'i Ground Station." Serving as a mentor for this work is Dr. Georgeanne Purvinis of the Electronics Department.

UH Maui Trainee - Spring 2015

Jordan Moore, a sophomore in Electronics and Computer Engineering Technology, worked with his mentor, Dr. Jung Won Park of the Engineering Technology Department, on a project titled "Irradiance Forecasting Capability through Sky Image."

Hawai'i Space Flight Laboratory Torque Rod Trainees-Spring 2015

(L to R) Aaron Nagamine and Grant Takara.

HSFL Sounding Rocket Trainees - Spring 2015

(L to R) Adrianna Saymo, Chase Yasunaga, Christianne Izumigawa, Andrew Nguyen, Tina Li, and Glenn Galvizo.

Project Imua RockSat-X Trainees

Undergraduate Rock-Sat Traineeship Program ***is open to undergraduates at Honolulu, Kapi'olani, Kaua'i, and Windward Community Colleges. The traineeships are part of Project Imua, a joint faculty-student enterprise for fabricating and testing CubeSat satellite payloads.***

After one-year's development of our first payload—named PIP: Project Imua Payload—we have a primary instrument that is a UV spectrometer designed to measure solar radiation especially in the 200-400nm range. Also onboard are an array of photodetectors for determining the orientation of the sun to the UV detector and a miniature IMU that was custom-made from off-the-shelf components. For more, please see our cover story.

Honolulu Community College

(L to R) Helen Rapozo, Matthew Mau, Debora Pei, Dr.Gregory Witteman, and Suraj Mehta.

Kapi'olani Community College

(L to R) Kalaimoana Garcia, Dr. Hervé Collin, Mitch Mikami, Jackson Poscablo, and Dr. Aaron Hanai.

Kaua'i Community College

(L to R) Dr. Georgeanne Purvinis, Amber Mokelke, Erik Rita, Marcus Yamaguchi, Brennen Sprenger, and Nicholas Herrmann.

Windward Community College

(L to R) Cale Mechler, Elena Barbour, Keith Nakamatsu, Madori Rumpungworn, and Kalanikapu Copp.

HAWAII NASA

Our NASA Summer Internship Experience at PMRF

By: Jacob Matutino and Kolby Javinar, 2014 Summer Interns

[Editor's note: The Low Density Supersonic Decelerator project is sponsored by NASA's Space Technology Mission Directorate and is managed by JPL. The project addresses the need for larger parachutes and other kinds of drag devices that can be deployed at supersonic speeds to safely land heavier spacecraft on Mars. Supersonic flight tests of full-scale parachutes and drag devices in Earth's stratosphere are scheduled from the Pacific Missile Range Facility on Kauaʻi, Hawaiʻi. During the 2014 test, a balloon carried the test vehicle to an altitude of 120,000 feet (36,600 meters), where the vehicle was released and its rocket fired to take it to 180,000 feet (54,900 meters)–the top of the stratosphere–where the supersonic tests began on the Supersonic Inflatable Aerodynamic Decelerator (SIAD) and parachutes.]

(L to R) Mentor Shad Combs with Jacob Matutino and Kolby Javinar in front of the test vehicle at PMRF.

(May 19-23, 2014): <Jacob> This was the first week of the internship and I honestly had mixed feelings going into this. I was very excited simply because of the fact that I would be working with NASA! They introduced us to the Low Density Supersonic Decelerator that decelerates a payload as it enters a planet's atmosphere, more specifically Mars. <Kolby> The task we have been given is to create a Launch Day Operations book that will include information on the different parts of the project such as a list of different procedures and checklists that will be crucial information to the launch process.

(June 23-27, 2014): <Kolby> On Saturday, the team will be launching the SIAD and balloon. This will be the first test of the two decelerator technologies and the first test of its kind in over 4 decades when the Viking Project first broke ground. The launch will be the first time NASA does a balloon launch into a rocket launch. <Jacob> This week was an awesome week for everyone on the team and history in general. Meetings were held to finalize 'Go-No Go' decisions with all of the teams and PMRF. All problems were addressed and all parties came to a consensus as to what was acceptable for launch. The launch was a success and the test went wonderfully! [Editor's note: We thank Jacob and Kolby for these journal-excerpts from their nine-week internships.] Θ

K-12 EDUCATION

"A variety of K-12 education projects bring hands-on experiments, tools, and the excitement of space exploration to thousands of participants."

- Arthur Kimura, HSGC Education Specialist

Future Flight Hawaiʻi: 25 Years of Inspiring the Next Generation of Explorers

http://www.higp.hawaii.edu/futureflight/

Left: Rene Kimura and Future Flight students calling for the future. Middle: Father and daughter experimenting with a doodling robot. Right: Excitement and smiles fill the room as students and educators test out their BrushBots.

Future Flight Hawai'i (FFH) hosted its 25th Family Exploration Program on June 6-7, 2015 at UH Mānoa, with a theme of Challenger...the Journey Continues. Over 9,000 students and parents have participated in one or more of the FFH residential and non-residential programs in exploring the Moon, Mars, and Earth. Learning modules included programmable robotics, space biospheres, spinning satellites, molecule modeling, sound, music conductivity, and design a satellite. A new program for younger children, Next Generation, was piloted with modules covering sound, balance, and bubbles.

25th anniversary participants.

Rachel James.

The Kimuras with Governor Ige.

Carissa Nakamura and Riley Fujisaki.

The anniversary event attracted state-wide attention, including visits from Governor David Ige, Rachel James from Congresswoman Tulsi Gabbard's office, and Riley Fujisaki and Carissa Nakamura from Congressman Mark Takai's office. Senators Brian Shatz and Mazie Hirono sent congratulatory letters. Governor Ige presented a proclamation to FFH, a commendation to the Kimuras for their leadership, and he stayed to congratulate the participants and pose for photos. Θ

Astronaut Ellison Onizuka Day of Discovery

http://www.spacegrant.hawaii.edu/OnizukaDay

(L to R) Art Kimura, Rene Kimura, and JAXA Astronaut Koichi Wakata at the 2015 Onizuka Science Day.

The 15th annual Astronaut Ellison Onizuka Science Day held on January 24, 2015 at the University of Hawai'i-Hilo, featured keynote speaker JAXA Astronaut Koichi Wakata who was the commander of the International Space Station in 2014. The day was also filled with 20 workshops, 19 displays, the TMT VEX IQ Robotics tournament, demonstrations of quadcopters, and a wind tube audience participation activity. Sponsored by the Onizuka family, the Astronaut Onizuka Space Center, the University of Hawai'i-Hilo, American Savings Bank, and the Hawai'i Space Grant Consortium, the 600 participants and 200 volunteers joined together in honoring the legacy of Ellison Onizuka and the Challenger crew. Workshops included flight simulator, wayfinding, nature of light, paper circuits, cooking science, extracting DNA, making your own telescope, hardware science, forensic science, satellite remote sensing, renewable energy, Hawaiian herbal medicine, and astronomical objects. Θ

"Onizuka Day was a success! Our students had a great time connecting to the scientific and academic community. We all enjoyed the day and appreciate your efforts."

- Hawai'i Academy of Arts and Sciences

Left: An auditorium filled with fun and wind tubes at Onizuka Day. Right: Action at the VEX IQ tournament.

Astronaut Lacy Veach Day of Discovery

http://www.spacegrant.hawaii.edu/Day-of-Discovery

The 13th annual Astronaut Lacy Veach Day of Discovery, held on October 25, 2014 at Punahou School, featured keynote speaker, Kai Kahele, Hawaiian Airlines Airbus pilot and Hawai'i Air National Guard instructor pilot, who is leading the effort to establish a pilot training program in Hilo. The day also featured an 18 team VEX IQ robotics tournament, industry sponsored displays, and workshops to inspire the next generation of explorers. Workshops included electricity, science magic, cow eye dissection, vacuum bazooka, meat tray rocket cars, squid dissection, food science, engineering fun, bristlebot racers, and string and sticky tape experiments.

The event was sponsored by the Hawaiian Electric Company, Punahou School, the family of Lacy Veach including the Chatlos Foundation, and the Hawai'i Space Grant Consortium. Two hundred volunteers supported the registration, workshops, and displays for the 600 registered students, parents, and teachers. The afternoon assembly included the final VEX IQ matches, the demonstration of the EKSO robotic suit for spinal cord injury, and science demonstrations by Roger Kwok, Leeward Community College, and Rick Jones, University of Hawai'i-West Oahu. Θ

" Thank you VERY much for organizing the VEX IQ at Punahou. We truly appreciate the time and energy spent on behalf of our children. The children enjoyed themselves, and we plan to reflect on what they learned, and how people had to volunteer their time to make events like these happen. Our goal is to have our students appreciate people and (hopefully) to pay it forward by helping others. "

-Mililani Mauka Elementary School VEX IQ team

Left: Pilot Kai Kahele speaking to all the participants. Middle: Volunteer teaches a parent and student about food digestion. Right: Roger Kwok teaching cool science magic tricks to students.

"It was a great event. Very organized and everyone, including exhibitors, were all so friendly. Thanks for letting us be a part of it all. Hope to do it again next year. "

-Computational Thinkers

VEX Robotics

http://www.vexrobotics.com

VEX Robotics is the fastest growing middle and high school robotics program in Hawai'i and around the world, with over 10,000 teams including 200 VEX EDR and VEX IQ teams in Hawai'i. Eight qualifying tournaments were held on Oahu, Maui and the Big Island, with 40 teams qualifying for the Hawai'i State VEX Championship, held at the Kamehameha School, Maui campus. NASA Robotics Alliance coordinator, Mark Leon, was the game announcer. VEX Robotics is sponsored by Hawaiian Electric and NASA, in collaboration with Kamehameha School, and with the support of the Hawai'i Space Grant Consortium, the UH College of Engineering, McKinley High Robotics and Team Hawai'i Robotics (university robotics). Seven Hawai'i teams qualified through the competition for the World VEX Championship in April 2015 in Louisville, Kentucky. Θ

VEX IQ Robotics

http://www.vexrobotics.com/vexiq

HSGC helped facilitate the expansion of the VEX IQ robotics program for elementary and middle school students. Eight qualifying tournaments were held on Maui, the Big Island, and Oahu with a state VEX IQ championship held at Pearlridge Center. Sponsored by the aio Foundation and the Thirty Meter Telescope, VEX IQ provides an exciting, engaging lead-in to robotics through the kit of parts and competition game. Team and skills challenges (both driver and autonomous), and the STEM research project provide relevant opportunities to apply STEM skills to hands-on experiences to design and build a robot to meet competition goals. Eighty-five elementary and junior high school teams competed in one or both qualifying tournaments hosted at Pearl City High School and Island Pacific Academy, with 24 teams advancing to the first Hawai'i State VEX IQ Championship hosted on February 22, 2015 at Pearlridge Center and sponsored by the aio Foundation, Hawai'i Council of Engineering Societies, and Pearlridge Center. Seven teams qualified for the World VEX IQ championship in April 2015 in Louisville, Kentucky. Θ

Above: Huakalani school for girls testing out their robot. Right: Photo mosaic of VEX IQ championship at Pearlridge Center.

Space Science FESTivals

(FEST = Families Exploring Science Together)

Schools in Hawai'i are hosting Future Flight Hawai'i's Space FESTivals. These free programs offered by HSGC feature science demonstrations, information about NASA-supported educational opportunities, and selected hands-on activities for students and parents. These evening, family science programs encourage children and parents to work together, foster home/school partnerships, engage parents and students in thinking and working scientifically, assist parents to encourage an interest in science in their child, and help students to learn through active engagement in educational experiences. Θ

Art and Rene Kimura demonstrating gravity and water and surface tension to Waimalu Elementary School students.

"I just wanted to thank you again for an inspiring night of science fun - today when I spoke to all of our fourth graders who were in attendance last night about how they felt and what they remembered, I heard only positive responses. They remembered ALL the activities you did with them, from the water on the pennies experiment at the beginning, to the vacuum chamber popping and marshmallow puffing and compressing, to what it's like to be an astronaut in space at the end. One of my parents came by this afternoon and commented that it was THE BEST activity he's ever attended... He and his son were so excited that his son wasn't able to go to sleep right away; they kept playing with the cartesian diver and the glasses when they got home... I never cease to be tickled by the joy of science experienced by all."

-Gus Webling Elementary School

"Thank you so much for bringing SpaceFEST to our school. Our students, parents, and teachers had an awesome time and everyone learned so much! We did post blurb and slide show on our school's website."

-Waimalu Elementary School

Pacific Astronomy and Engineering Education Summit

http://www.paes.hawaii-conference.com

As a result of the experiences at the Japan Super Science Fair, and through a grant from the Thirty Meter Telescope, the Hawai'i Space Grant Consortium assisted the 'Imiloa Astronomy Center and the University of Hawai'i-Hilo Conference Center in the 2nd Pan Pacific Astronomy and Engineering Summit in July 2014. Students and teachers from Japan, China, India and Canada along with those from Hawai'i, participated in the five-day experience to share science and technology, which included field trips to star gaze at Onizuka Visitor Center, Maunakea, and the Hawai'i Volcanoes National Park. Keynote and workshop presenters included Dr. Günther Hasinger, Director of the Institute for Astronomy; Dr. James Kauahikaua, USGS Hawaiian Volcano Observatory; Dr. Paul Coleman, Institute for Astronomy; Astrophysicist, Dr. Saeko Hayashi, Subaru Telescope, National Astronomical Observatory of Japan; Associate Professor, Heather Kaluna, Institute for Astronomy /University of Hawai'i NASA Astrobiology Institute; Olivier Lai, Gemini North Observatory; Adaptive Optics Scientist, Dr. Warren Skidmore, Thirty-Meter Telescope; Ian Kitajima, Oceanit, Marketing Director and Leader of the Design Thinking Movement in Hawai'i; and Janesse Brewer, 23.four Degrees, Principal and Public Policy Facilitator. Art and Rene Kimura facilitated a push-button programmable robot challenge. A highlight was the visit by members of the HI-SEAS CREW 2 who had just emerged from their simulated Mars habitat on Mauna Loa. Student teams made science and cultural presentations. HSGC will be contributing support to the 3rd Pacific Astronomy and Engineering Summit, July 2015. Θ

Above: Group photo of students and teachers at the Summit.

Japan Super Science Fair/Ritsumeikan High School

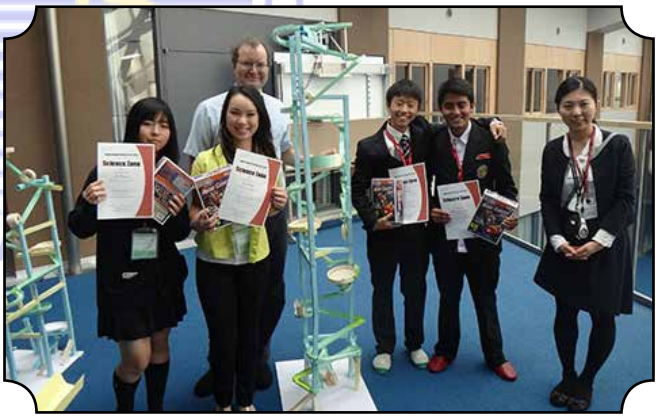
http://www.fkc.ritsumei.ac.jp/fkc/jssf2014/

In November 2014, three Kalani High and one Roosevelt High School students and a teacher from Kalani High School, along with HSGC educational specialists, Art and Rene Kimura, participated as the first Hawai'i Space Grant Consortium team at the Japan Super Science Fair (JSSF), hosted at Ritsumeikan University and High School in Kyoto, Japan. The student team did a research study of Mars topography using data from the Mars Curiosity rover and Mars-orbiting satellites under the mentorship of Ms. Linda Martel, Dr. Jeff Taylor and Dr. Scott Rowland (all at the University of Hawai'i at Mānoa). The students shared their project with a global audience during a science presentation and a poster session. The goal of JSSF is to foster a global perspective on how to work together as scientists and engineers to solve problems. Forty-six schools from nineteen countries participated in this global collaborative event.

(L to R) JSSF student host, Riley Kishaba, Danielle Young, Aaron Segawa, and Liana Young in Japan.

HSGC received a grant from the Thirty Meter Telescope to sponsor a BrushBot Olympics at JSSF, in which the global teams competed in an Olympic style atmosphere. Art and Rene also provided one of the science zones, a team problem-solving opportunity, in which the teams had to apply the engineering design process to make a paper roller coaster. Ritsumeikan High School is one of 200 designated Super Science High Schools and one of five Core Super Science High Schools in Japan. All sessions at JSSF are conducted in English and the host pays for all ground expenses during the week-long program that includes visits to local science and technology industries and historic cultural sites.

Nine students, a teacher, and the former principal of Ritsumeikan High School visited Hawai'i for a week in February 2015. Hosted by Art and Rene Kimura, the students experienced home stay with families from Punahou School, Kalani and Roosevelt High Schools. They toured the UH research facilities on Coconut Island, spent several days at host schools, and attended presentations by UH scientists, Dr. Scott Rowland and Dr. Jeffrey Gillis-Davis and HSGC / HSFL engineer, Ms. Amber Imai-Hong. Θ



JSSF students with paper roller coaster.

Ritsumeikan students visit to Hawai'i.

Ritsumeikan students at a presentation of a digital video globe by Dr. Jeffrey Gillis-Davis at UH Mānoa.

Kauaʻi K-12 Rocketeer Volunteer

By: Stewart Burley, Kauaʻi Liason/HSGC Industry Affiliate

Whooooooosh? Or whoosh? A large model rocket or a small model rocket? Where are we? The baseball field of Kapaʻa High School? The football practice field of Kauaʻi High School? The field behind Daniel K. Inouye Technology Center at Kauaʻi Community College? Or, just off the runway at the Pacific Missile Range Facility (PMRF) at Barking Sands on Kauaʻi?

If there are model rockets being launched on Kauaʻi, I'd like to help. I have extra rocket engines in the A, B, C, D, and E size. Most schools use the A or B. I use an E in the large model rocket built at Windward Community College by Dr Jake Hudson. It's bright red (like my Dodge Hemi) and sports the identifier KGB-7 (like my truck license KGB-6). I watch the small kids' eyes light up when KGB-7 is placed on a single launch rod. Then I ask a young child in the audience to count down and push the launch button. There is a whoooosh as it leaves the launch pad. Twice the engine blew out the after fins and the audience gasps. Later the KGB-7 is shipped back to Jake Hudson for repair.

After everyone has had a chance to launch, I take a couple extra small rockets out of my truck and give them to the real small kids to launch, recover, and to keep. This is one of my hobbies. Other hobbies are underwater robotics and helping students get scholarships and into college.

Over 30 years ago I had a dream about launching satellites out of PMRF. I visited Senator Inouye and told him of my dream and that I needed funds to do it. He told me that he couldn't fund a Navy civilian at PMRF. After I retired in 2004 I tried again and finally started my consulting business called STU, LLC (Strategic Theories Unlimited). Having worked at PMRF since January 1957 and being involved in deep submersibles, range expansion, contract evaluator, strategic plan writer, underwater-, surface- and air-warfare and space projects, I began to assist other commands and companies with documentation in various testing arenas.

Stu and student preparing to launch rocket.

I've had an exciting career and life. I graduated from Frankfurt American High School (inducted into their sports Hall of Fame for basketball), attended University of Maryland in Munich, six years a Guided Missileman in the US Navy, worked for the Navy as a supervisory program manager, obtained three AS degrees from Kauaʻi Community College, involved in three plane crashes (got 6 more to go for my final 9 lives), rode US, Japan and Australian submarines, made one aircraft carrier landing/takeoff in the backseat of a F9 fighter, marketed PMRF and Kauaʻi around the world with the Kauaʻi Economic Development Board, started the Navy RimPac exercises with six countries (it now has 22 countries), President of the Hawaiʻi chapter of Marine Technology Society, President of Hawaiʻi International Test and Evaluation Association overseeing activity in Hawaiʻi and Australia, Kauaʻi AARP president, President of US Navy League–Kauaʻi Chapter, voted Kauaʻi's Outstanding Older American in 2010, and I now mentor underwater robotics and rocketry in at least five schools, volunteer where needed at the Veterans Council and provide ~40 hours a week in volunteer services throughout Kauaʻi. I married a Hawaiian girl from Kekaha, have 3 children, 8 grandchildren and 4 great grandchildren with my home as the family hub.

I am very excited about the HSFL multiple satellite launch out of PMRF (my dream comes to fruition). I'm also excited with the students at Kauaʻi CC as they work with three other UHCC in planning, drafting, building and launching a small satellite out of the NASA Wallops Flight Facility in Virginia. My new assignment this next semester is to help plan, build and launch a model rocket near Waimea High School with a camera carrying payload that orients to magnetic North. The camera then will stream a live video of all the high school students in front of the school waving at the camera. WOW! This is what I live for. A whooooooosh, a pop, the whir of a camera, then waving students, and success. All this done by students – not adults – but future scientists and engineers and leaders of this great County of Kauaʻi, State of Hawaiʻi and the USA. Θ

HONORIES

HSGC/HSFL Celebrate the 25th Anniversary of SOEST

http://www.soest.hawaii.edu

The School of Ocean and Earth Science and Technology (SOEST) was established by the UH Board of Regents in 1988. SOEST brings together academic departments (atmospheric sciences, geology and geophysics, ocean & resources engineering, and oceanography) along with dozens of research institutes, groups, federal cooperative programs, and support facilities of the highest quality in the nation to best meet the challenges in the ocean, earth, planetary and space sciences and technologies.

(L to R) Camilla Bortoluzzi and Amber Imai-Hong (HSFL Engineers), Stu Burley (HSGC Kaua'i Liason/Industry Affiliate), Dr. Luke Flynn (HSGC & HSFL Director), Art Kimura (Future Flight Hawai'i Director)

With its location in Hawai'i, SOEST can provide convenient access to active volcanoes, deep ocean habitats, vibrant coral reef and the most isolated terrestrial ecosystem in the world. SOEST's ~700 faculty and staff are recognized as international leaders in research, innovation, and education on topics as diverse as alternative energy, microbial oceanography, volcanology, cosmochemistry, planetary geology, and climate modeling. SOEST has a fleet of three research vessels, two submersibles, two coastal and deep-ocean cabled observatories, a private island devoted to marine biology, and a space satellite fabrication facility. Hawai'i Space Grant Consortium and Hawai'i Space Flight Laboratory were honored to attend the anniversary banquet in April 2014. Θ


Dr. Hawke

Remembering a Valued Collaborator and Friend B. Ray Hawke (1946—2015) Lunar Geologist

By: Paul D. Spudis (Lunar and Planetary Institute, Houston)
Reprinted with permission from 1/29/15 article at www.airspacemag.com

I was saddened this weekend by the not totally unexpected news that lunar scientist and good friend B. Ray Hawke of the University of Hawai'i has passed away. Colleague and collaborator, I knew B. Ray as long as almost anyone in the business. We were graduate students together, early co-workers and good friends.

Bernard Ray Hawke hailed from Upton, Kentucky, about 60 miles north of my birthplace, Bowling Green, Kentucky. We first met in 1976 as graduate students at Brown University. A returning Vietnam veteran who'd served as an Airborne Ranger, B. Ray was a kindred spirit who helped me deal with the cultural shock as an Arizona State University student who'd exchanged the grand vistas of my adopted Arizona for the claustrophobic confines of Ivy League New England. We became good friends, spending hours at his preferred office—the local coffee shop (the IHOP, which advertised a "bottomless" coffee pot, a descriptor that B. Ray took literally).

During our graduate years, we took to using ironically the honorific "Doctor" when speaking to each other (we were all pre-doctoral candidates), not only between ourselves but also when in the presence of others, a private joke that we continued throughout the years. This led to some amusing situations later, as our students expressed confusion when I would refer to B. Ray—a colleague but also a long-time personal friend—with the formal title of "Dr. Hawke" and he would address me as "Dr. Spudis."

B. Ray's scientific work focused very specifically on the Moon. As a Masters student at the University of Kentucky, he analyzed lunar regolith chemistry and used something called a "mixing model" to determine its geological affinities. In this technique, the composition of a soil is determined and that composition is modeled as a mixture of known components. Although seemingly an academic exercise, this approach could be a very powerful technique to decipher the geological history of the Apollo landing sites. Later, B. Ray and I would apply this same technique to chemical data returned by the orbiting Apollo spacecraft, giving us our first look at regional and global compositions. Combined with information about the geological setting of regions covered from orbit (such as the basin ejecta), such study would help us reconstruct the composition and makeup of the crust of the Moon.

B. Ray's early work dealt with integrating lunar sample information with images and geological mapping, my own field of specialization. He and I spent many hours discussing some of the problems of this effort, and also the issue of overcoming considerable community skepticism about the approach. We worked to convince our colleagues that the future of lunar science lay in the melding of the broad disciplines of sample science and remote sensing—taking results from the study of samples, using it to inform the interpretation of remote sensing data, and then concocting a geological model that explains and encompasses all known facts. Although this approach is now a recognized way to conduct lunar science, careful reading of the early literature will show that most early post-Apollo work was highly sequestered by discipline, with little cross-fertilization of results and insights.

Dr. Hawke on the rim of Kilauea Caldera, Hawaii Volcanoes National Park, 1984.

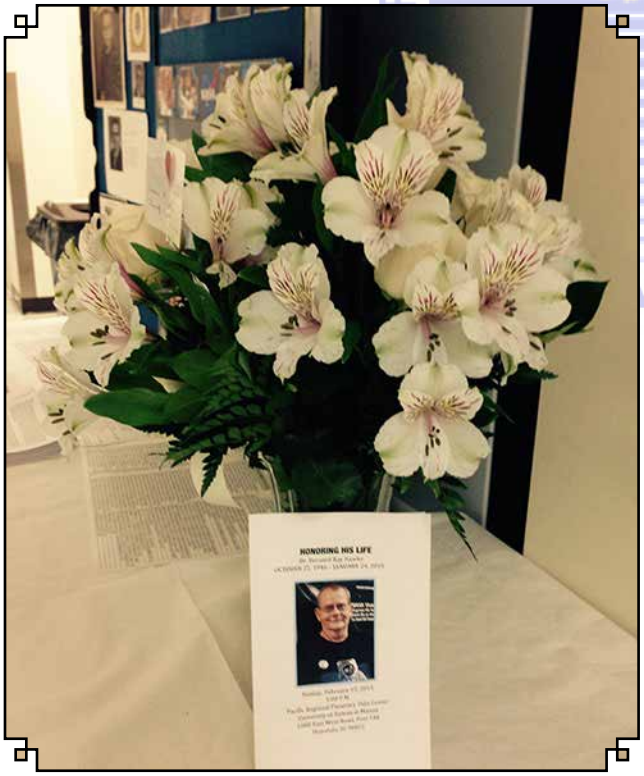
Because B. Ray and I found ourselves working on many of the same scientific problems after graduate school, we formed a partnership that lasted 40 years. One of our earliest efforts was an attempt to use impact basins as large-scale probes of the lunar crust. An early paper (1984) on the Orientale basin was the first to discover that massive blocks of pure anorthosite, an indigenous rock composed almost completely of plagioclase feldspar, make up the inner ring of that basin. In addition, we measured the composition of material thrown out from Orientale using chemical maps based on data from the orbiting Apollo spacecraft. These results indicated that the Orientale basin excavated only the upper portions of the lunar crust; new data from subsequent missions have confirmed these early results.

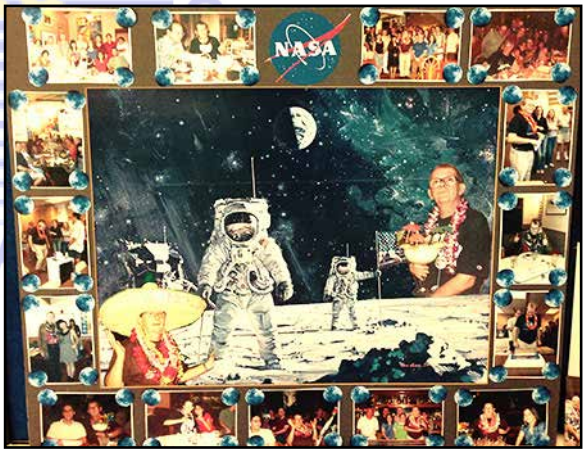
The study of telescopic spectra, involving very precise measurements of color at high resolution of very small spots on the Moon, became B. Ray's specialty. These spectra would be taken of many carefully selected geological targets, a great improvement over the previous approach of targeting mostly by geographic region. He spent many hours at Hawai'i's Mauna Kea Observatory, diligently working to make certain that data for the correct spot on the Moon was being acquired. His spectra were collected to address many scientific problems, including basin rings, dark halo craters, lunar "red spots" (spectrally anomalous regions), impact melt deposits and the ejecta of large craters and basins. B. Ray brought to these studies his extensive background in image analysis and interpretation. He had made geological maps of portions of the Moon, which for the first time could be interpreted in terms of mineral

and chemical content. These studies are critical to our understanding of the complex and protracted geological evolution of the lunar crust.

During his 35 year association with the University of Hawai'i, B. Ray mentored and befriended many students and visiting scientists. I made an extended stay at UH early in 1980, and worked closely with B. Ray on using spectral interpretation to map the Apollo 16 landing site. B. Ray's work habits were unorthodox to say the least, almost 180 degrees out of phase with normal working hours (I had to adjust to starting work at 9:00 pm and working until after breakfast). But for all that, I never saw anyone work so long and so hard when there was a problem to be solved. B. Ray was a great collaborator who very carefully reviewed each word in a paper, assuring that many errors and mistakes were corrected long before submittal. I could always count on a detailed and insightful review from him, even for papers for which he was not an author.

As he passes into the annals of history, the world of lunar science is a bit poorer without B. Ray Hawke. He was a productive scientist, a hard worker, a tireless advocate for lunar activities and a good and faithful friend. His legacy leaves us with a new way of looking at the Moon—an integrated approach involving studies of samples, remote sensing data, and images. His contributions to lunar science include work on impact melts, Apollo 14 site geology, dark halo craters and the extent of ancient volcanism, lunar non-mare volcanism (KREEP and red spots), and geochemical anomalies of the lunar crust—an extensive and impressive amount of work. Thank you and rest easy, Dr. Hawke. Θ





Dr. Hawke joined the small group of planetary geologists at the University of Hawai'i in 1978. That group grew and later became part of the Hawai'i Institute of Geophysics and Planetology. In 1983, he established the Pacific Regional Planetary Data Center, one of NASA's Regional Planetary Image Facilities, and remained Director until his death.

Dr. Hawke's lunar geology interests included impact craters and volcanic deposits. He was a pioneer in advocating the use of the resources associated with pyroclastic deposits by future inhabitants of the Moon. His scientific studies involved active collaborations with colleagues in Hawai'i and around the world, and their success was due to his generosity. He shared his ideas and knowledge and gave his time to help others. A memorial for Dr. B. Ray Hawke was held in the Pacific Regional Planetary Data Center on Sunday, February 15th, 2015.

RockOn! 2014 at Wallops Flight Facility, VA
Diary from UH Maui College Participants

By : Students Dominic Agabin and Derrick Torricer, with faculty advisor Dr. Jung Park,
Engineering Technology, University of Hawai'i Maui College

(L to R) Dr. Jung Park, Dominic Agabin, and Derrick Torricer in front of the payload rocket.

Between June 21—26, Dr. Jung Park, (UHMC faculty), Dominic Agabin, and Derrick Torricer (Juniors in the Engineering Technology program) attended the RockOn 2014 workshop at the Wallops Flight Facility in Virginia. They constructed a research payload, under the guidance of staff at the RockOn workshop, that would be launched with a sounding rocket to collect data on the space environment.

On the first day of the workshop all of the RockOn staff and participants introduced themselves, which helped us to get a glimpse of people from different levels of various fields of study and schools from around the United States.

Working on the research payload was an exciting experience. We were able to learn about and implement sensors we had yet to work with. The payload measured radiation, pressure, temperature, humidity, acceleration, and orientation. In addition, we were also excited about learning more about programming languages, such as C, to incorporate with micro controllers like the Arduino board, which was a central component in controlling the sensors in the research payload. When all the sensors were in place and tested the payload was then complete and ready to be integrated into the rocket with the other participants' research payloads.

The vast amount of testing and precautions taken in order to launch a sounding rocket was intriguing to witness. The rocket sections needed to be bolted in many places and had to be pressurized. In the middle of the construction, the processes were halted due to the inner pressure of the rocket being off by about 0.5 psi. To remedy this, every inch of the rocket's connections was inspected to find the leak. Such careful considerations showed us all how accurate the rocket needed to be to meet specs for its launch. When the rocket was constructed, its structural integrity was then tested by applying weights on various points on the rocket and subjecting it to motions similar to those that the rocket would experience in flight.

Prior to launch day we were allowed to get up close to the rocket. They added another stage to the rocket which increased the rocket's size. Thinking of the levels of science and engineering put into the rocket itself was quite humbling.

On launch day, over a nearby speaker the preparations for the launch could be heard going on behind the scenes. Many variables were being considered. From weather to the evacuation of the boats offshore, many things were being accounted for. Even test rockets were fired to examine the current environment. The launch was originally scheduled for 5:30 am, but was delayed due to more evacuations of offshore boats. By ~ 7:00 am the rocket was ready to launch. Although the wait was longer than expected, the excitement of the experience of the launch was worth the delay.

(L to R) Dominic, Derrick, and Dr. Park testing their payload.

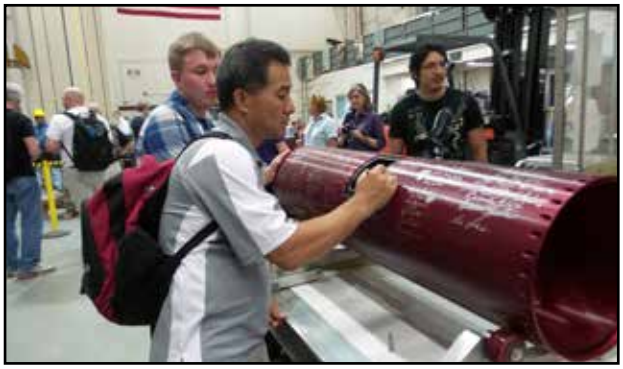
When the rocket launched, it was reminiscent of seeing and hearing a thunderstorm. We had seen the rocket lift off, and suddenly we were shaken by its thunderous roars. The sound was so loud that a car's alarm went off.

Later in the day the rocket returned to Earth and our research payload was removed. We were all excited to find out whether the data were properly collected. For some reason, the SD adapter that we used to plug into the laptop was not working properly, which caused the card not to be read. Our initial thoughts were that the card itself was damaged and we would be unable to read the data. But after swapping a card adapter for the card's USB Adapter the screen displayed the data correctly stored and ready for processing. Using the RockOn Workshop's decoder program the raw data on the card were translated into understandable values. Data were then transferred into an Excel Spreadsheet where we could view it in a graph, which would show how the environment changed for the research payload. Such representation of the data gave a much clearer and in-depth view of what the payload was experiencing through various stages of flight.

Overall, the entire experience was surreal. The three of us feel very fortunate to have been able to attend. The RockOn workshop has also inspired and motivated us as students to learn more, especially in the Engineering disciplines. There were so many amazing sights and information to absorb. We would definitely recommend any of our peers to take the chance to experience what we have at the RockOn Workshop. Θ

NASA staff integrating all participant payloads into the rocket.

Derrick awaiting the launch of their rocket.



Dr. Jung Park signing his name on the rocket prior to launch day.

Launch of the sounding rocket.

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Hawai ‘i Space Grant Consortium

Chartered under the National Space Grant College and Fellowship Program in 1990, the Hawai ‘i Space Grant Consortium develops and runs interdisciplinary education, research, and public service programs related to space science, earth science, remote sensing, human exploration and development of space, small satellites, and aerospace technology. We accomplish this through a variety of projects: Undergraduate research fellowships and traineeships, innovative college courses, workshops for educators, educational web sites, public exhibitions, lectures, tours, primary school programs, space-themed evening programs and summer camps for families, and more.

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