SPACETIME
THE MAGAZINE OF THE AMERICAN ASTRONAUTICAL SOCIETY

JANUARY/FEBRUARY 2017
ISSUE 1—VOLUME 56

THE MAGAZINE OF THE AMERICAN ASTRONAUTICAL SOCIETY

PRESIDENT'S MESSAGE 3
FEATURES

OSIRIS-REx Mission to Asteroid Bennu 4
OSIRIS-REx is the third mission of NASA’s New Frontiers Program and will travel to a near-Earth, potentially hazardous asteroid named Bennu.
by Cindy Schumacher

The Path to Mars Goes Through Hawaii 10
Currently, two NASA robots, the Curiosity rover and Opportunity, are exploring the Martian surface while a fleet of orbiters from NASA and the European Space Agency circle above surveying the planet. At the same time, much research is also being done in the Hawaiian Islands.
by Cindy Schumacher

AAS NEWS
Robert H. Goddard Memorial Symposium 15
Welcome New AAS Officers and Board Members 18
AAS Annual Awards and Fellows 19

EUGENE M. EMME ASTRONAUTICAL LITERATURE AWARD
German Rocketeers in the Heart of Dixie: Making Sense of the Nazi Past during the Civil Rights Era 21
Reviewed by Asif Siddiqi

AAS CORPORATE AND INSTITUTIONAL MEMBERS 23

2017 SCHEDULE OF EVENTS 24

ON THE COVER
The OSIRIS-REx spacecraft executed its first deep space maneuver on December 28, 2016, which put it on course for an Earth flyby in September 2017. (Image credit: NASA Goddard Space Flight Center Conceptual Image Lab)

American Astronautical Society

SPACE TIMES • January/February 2017

6352 Rolling Mill Place, Suite 102
Springfield, VA 22152-2370 USA
Tel: 703-866-0020 ♦ Fax: 703-866-3526
aas@astronautical.org ♦ www.astronautical.org

PERIODICALS
SPACE TIMES, magazine of the American Astronautical Society, bimonthly, Volume 56, 2017—$80 domestic, $95 foreign (To order, contact the AAS at 703-866-0020.)
The Journal of the Astronautical Sciences, quarterly, print and online (To order, contact Springer at 1-800-777-4643.)

REPRINTS
Reprints are available for all articles in SPACE TIMES and all papers published in The Journal of the Astronautical Sciences.

SPACETIME
THE MAGAZINE OF THE AMERICAN ASTRONAUTICAL SOCIETY

AAS OFFICERS

PRESIDENT
Carol S. Lane, Synergy, LLC

EXECUTIVE VICE PRESIDENT
Alan DeLuna, ASDL, Inc.

VICE PRESIDENT—TECHNICAL
Jim McAdams, KinetX

VICE PRESIDENT—PROGRAMS
Kathy J. Nado

VICE PRESIDENT—PUBLICATIONS
David B. Spencer, The Pennsylvania State University

VICE PRESIDENT—STRATEGIC COMMUNICATIONS
Madhurita Sengupta, American Institute of Aeronautics and Astronautics

EDITORIAL STAFF

AAS BOARD OF DIRECTORS

TERM EXPIRES 2017
Robert H. Bishop, University of South Florida
Mark K. Craig
Laura Delgado López, Harris Corporation Space & Intelligence Systems
Kathleen Karika, Lockheed Martin Space Systems Company
Zigmund V. Leszczynski, The Aerospace Corporation
Suneel Sheikh, ASTER Labs, Inc.
David A. Spencer, Georgia Institute of Technology
Micheline Tabache, European Space Agency
Gregg Vane, Jet Propulsion Laboratory

TERM EXPIRES 2018
A. William Beckman, The Boeing Company
Vincent C. Boles, The Aerospace Corporation
Sandy Coleman, Orbital ATK
Mary Lynne Dittmar, Coalition for Deep Space Exploration
Debra Facktor Lepore, Ball Aerospace & Technologies Corp.
Todd May
Bo J. Naasz
Frank A. Slazer, Aerospace Industries Association
Anne M. Zulkosky, Lockheed Martin Corporation

TERM EXPIRES 2019
Sririsha Bandla, Virgin Galactic
Josh Brost, SpaceX
Gregg Burgess, Sierra Nevada Corporation
Thomas F. Burns, National Oceanic and Atmospheric Administration
Rebecca L. Griffin, Rebecca Griffin Space
Hal E. Hagemeier, Eagle Ray Inc.
Dan Hendrickson, Astrobotic Technology, Inc.
Falal Al Kaissi, UAE Embassy Washington DC
Brent Sherwood, Jet Propulsion Laboratory
Lyn D. Wigbels, RWI International Consulting Services

SPACE TIMES EDITORIAL STAFF

EDITOR, Diane L. Thompson
PHOTO AND GRAPHICS EDITOR, Diane L. Thompson
PRODUCTION MANAGER, Diane L. Thompson

SPACE TIMES is published bimonthly by the American Astronautical Society, a professional non-profit society. SPACE TIMES is free to members of the AAS. Individual subscriptions may be ordered from the AAS Business Office. © Copyright 2017 by the American Astronautical Society, Inc. Printed in the United States of America. ISSN 1933-2793.

PERIODICALS
SPACE TIMES, magazine of the American Astronautical Society, bimonthly, Volume 56, 2017—$80 domestic, $95 foreign (To order, contact the AAS at 703-866-0020.)
The Journal of the Astronautical Sciences, quarterly, print and online (To order, contact Springer at 1-800-777-4643.)

REPRINTS
Reprints are available for all articles in SPACE TIMES and all papers published in The Journal of the Astronautical Sciences.
PRESIDENT’S MESSAGE

I am honored and thrilled to serve the AAS members as President. As many of you know, I have been involved with AAS for many years and look forward to helping you shape our organization to be even better!

As we are poised at the beginning of a new Administration, many are concerned about the uncertainty and changes that will be brought on by our new national leadership. This transition time does give me an opportunity to ponder both the recent history of our organization and our space program, as well as reflect on the future paths of both. In thinking about this, I reflected on five individuals our community has lost recently: Richard Malow, former Clerk of the House Appropriations Subcommittee that oversees NASA; Patti Grace Smith, former FAA Associate Administrator for Commercial Space Transportation; Molly McCauley, a space economist with Resources for the Future; Piers Sellers, astronaut, renowned earth scientist and Acting Director of the Science Directorate at NASA GSFC; and Gene Cernan, the last man to walk on the moon. While these titles do not in any way convey their passion, dedication, and contributions to our space program, it does make one consider the diversity of skills that are embedded in the fabric of the space community. As we pass the baton from one Administration to the next Administration and from one generation to the next generation, we want to ensure that we are reaching out and embracing all these skills as it certainly makes the value of our space program to our technical, economic, and national security leadership much much stronger.

Perhaps even more important is the impact that each one of those individuals has made in their own way. That is my primary message. The purpose of an organization is to build on and leverage individual contributions into a greater and united whole. We are all involved with AAS because we are passionate and care about the breadth and direction of our space program. Looking at the accomplishments of each of the people mentioned above, it is quite impressive to fully realize the role one person can have on shaping the direction of our activities. The accomplishments, skills and passion of our members will lead to great progress for the AAS, our nation, and the world. I encourage each of you to engage, get more involved, and communicate what matters to you. AAS is a voice to communicate why a strong and vibrant space program is vital to our nation. We welcome your ideas, participation, and donations to help continue to make AAS a growing and more effective organization. Remember: change creates new opportunities. We should all be engaged in shaping our future!

The beginning of 2017 is a busy time with our annual Strategic Offsite on January 27. In February, the 40th Annual Guidance and Control Conference will be held in Breckenridge, Colorado, and the Space Flight Mechanics Meeting will be held in San Antonio, Texas. We are finalizing plans for the Goddard Symposium March 7-9, and our first Board Meeting for the year on March 9. Plans for our ISS R&D Conference are well underway, and it will be held in Washington, D.C., in July. Check out the agendas!

Finally, I would like to welcome all our new Directors and Officers and look forward to us working together to make 2017 a great success!

AAS – Advancing All Space

Carol S. Lane
clane@x-energy.com
OSIRIS-REx Mission to Asteroid Bennu

by Cindy Schumacher

The OSIRIS-REx mission, launched on 8 September 2016 from Cape Canaveral Florida, will travel to a near-Earth asteroid (NEA) named Bennu. OSIRIS-REx, the Origins Spectral Interpretation Resource Identification Security Regolith Explorer, is the third mission of NASA’s New Frontiers Program. Bennu, categorized as a potentially hazardous asteroid, has a possibility of impacting the Earth in the late 22nd century.

“OSIRIS-REx’s key science objective is returning and analyzing a sample of Bennu’s surface, as well as mapping the asteroid surface and measuring the orbit deviation caused by non-gravitational forces (Yarkovsky effect),” said Alinda K. Mashiku, Ph.D. an aerospace engineer in Navigation and Mission Design at NASA Goddard Space Flight Center providing navigation analysis and support for the OSIRIS-Rex mission. “A major interest in Bennu is that it is a carbonaceous (carbon-rich) asteroid that may hold scientific information on the initial stages of planet formation in the Solar System. If successful, OSIRIS-Rex will be the first US spacecraft to return samples from an asteroid, bringing at least a 2.1 ounce sample back to Earth for study.”

Organic molecules, such as amino acids, have previously been found in meteorite and comet samples, indicating that some ingredients necessary for life can be naturally synthesized in outer space. Analyzing the sample may provide additional understanding of the hazards and resources of near-Earth space.

MISSION OVERVIEW

OSIRIS-REx launched on an Atlas V 411 rocket. It will orbit the sun for a year, and then use Earth’s gravitational field to maneuver toward Bennu. The cruise phase will last until August 2018 when the spacecraft will encounter Bennu and begin the science part of the mission. During the approach, the spacecraft will use an array of small rocket thrusters to match the velocity of Bennu and rendezvous with the asteroid. The plan is for the spacecraft to return a sample to Earth in 2023.

The spacecraft will begin a detailed survey of Bennu two months after arriving at the asteroid. The survey will last over a year, and as part of it, OSIRIS-REx will map potential sample sites. After the selection of the final site, the spacecraft will briefly touch the surface of Bennu to retrieve a sample. The sampling arm will make contact with Bennu’s surface for about five seconds, during which it will release a burst of nitrogen gas, causing rocks and surface soil to be stirred up and captured in the sampler head. The spacecraft has enough nitrogen gas to allow three sampling attempts.

The solar arrays will be raised into a Y-shaped configuration to minimize the accumulation of dust during contact and to provide more ground clearance. Accelerometers will detect contact with the surface of Bennu, and the impact force will be dissipated by a spring mechanism in the Touch-And-Go Sample Acquisition Mecha-

Alinda K. Mashiku, Ph.D., an aerospace engineer in Navigation and Mission Design at NASA Goddard Space Flight Center, is providing navigation analysis and support for the OSIRIS-REx mission. (Image credit: NASA Goddard Space Flight Center Conceptual Image Lab)
nism (TAGSAM).

Upon surface contact by the TAGSAM instrument, which consists of a sampler head with an articulated 3.35-metre (11ft) arm, a five-second timer will limit collection time for overall safety. When the timer expires, a back-away maneuver will move OSIRIS-REx to a safe standoff distance. After the sampling operation, the Sample Return Capsule (SRC) lid will open to allow the sampler head to be stowed. The arm will retract into the launch configuration and the SRC lid will be closed and latched for the return to Earth.

In March 2021, the window for departure from the asteroid will open, and OSIRIS-REx will begin its return journey to Earth. The SRC will separate from the spacecraft and enter the Earth’s atmosphere, to be recovered at the Utah Test and Training Range.

The basic cost of the mission will be approximately $800 million. The Atlas V launch vehicle will cost an additional $183.5 million. NASA’s Goddard Space Flight Center in Greenbelt, Maryland provides overall mission management, systems engineering and safety and mission assurance for OSIRIS-REx. Dante Lauretta is the mission’s principal investigator at the University of Arizona, and Lockheed Marin Space Systems, who built the spacecraft, supports mission operations. The science team includes members from the United States, Canada, France, Germany, United Kingdom, and Italy.

“The OSIRIS-Rex mission is complex,” said Mashiku. “It comprises several mission phases from launch to sample return and all the intricate asteroid-proximity phases in between, which are necessary to map Bennu and safely collect the sample. Another crucial early phase includes searching for any natural satellites that may be orbiting the asteroid and that may complicate the mission.”
COLLISION AVOIDANCE STRATEGY FOR POTENTIAL NATURAL SATELLITES AROUND BENNU

“The presence of natural satellites depends on the rotation rates of the primary body,” Mashiku explained. “Bennu’s rotational period is 4.29 hours. Most NEAs having spheroidal shape and rapid rotation have been found to be primaries of a binary system. In a typical binary system, two objects revolve around their common center of mass that may lie between the objects. About 16% of NEAs with a diameter larger than 200 meters belong to binary systems.”

“Therefore,” she continued, “it is possible that the asteroid Bennu may have a natural satellite. However, ground-based radar observations of Bennu in 1999 and 2005 ruled out the possibility of natural satellites in specific ranges of diameter and rotation rate (Table 1).”

Table 1. Current radar results showing maximum satellite size based on radar observations

<table>
<thead>
<tr>
<th>Maximum Satellite Size</th>
<th>For Satellite Rotation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter &lt; 15 m</td>
<td>1 min</td>
</tr>
<tr>
<td>Diameter &lt; 5 m</td>
<td>1 hr</td>
</tr>
<tr>
<td>Diameter &lt; 2 m</td>
<td>24 hr</td>
</tr>
</tbody>
</table>

“Based on the measured radar albedo of Bennu and assuming a tidally locked rotation period, the largest possible undetected satellite within 300km of Bennu is 2m,” Mashiku said. “Additionally, there are at least three asteroids with sizes similar to Bennu that do have orbiting natural satellites or moons about them (Table 2).”

Table 2. Known Apollo asteroids with natural satellites

<table>
<thead>
<tr>
<th>Name of Asteroid</th>
<th>Asteroid Diameter (km)</th>
<th>Name of Moon</th>
<th>Moon Diameter (km)</th>
<th>Separation (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 DJ4</td>
<td>0.43 ± 0.08</td>
<td>S/2004</td>
<td>0.21 ± 0.05</td>
<td>0.8</td>
</tr>
<tr>
<td>2002 AM31</td>
<td>0.45 ± 0.05</td>
<td>S/2012</td>
<td>0.11</td>
<td>1.5</td>
</tr>
<tr>
<td>2004 DC</td>
<td>0.36</td>
<td>S/2006</td>
<td>0.07</td>
<td>0.75 ± 0.045</td>
</tr>
</tbody>
</table>

“This fact warrants a sophisticated collision avoidance strategy for successful proximity operations and to ensure overall mission success,” she said. “During approach, a natural-satellite search campaign would be implemented to find, characterize and generate
an ephemeris of any potential natural satellite.”

It is the task of the flight dynamics team (NASA Goddard Space Flight Center, Lockheed Martin and KinetX), the science team at Jet Propulsion Laboratory, and the principal investigator at University of Arizona to agree on a method to determine the natural satellite orbit, develop a realistic tracking cadence, and define a collision-avoidance strategy.

“The proximity operations for the OSIRIS-Rex missions will be taking place very close to the asteroid Bennu,” Mashiku added. “During these operations, the spacecraft has a pre-determined safe home orbit, which lies in the terminator plane, perpendicular to the Sun vector. Since Bennu is a small asteroid about 0.49 km in diameter, the solar radiation pressure exerts a significant perturbing effect on an orbit about Bennu.”

“Orbiting in the terminator plane, where the perturbing effect tends to cancel out, permits a fairly stable orbit to exist,” said Mashiku. “Consequently, if a natural satellite exists, it is likely to be in a relatively stable orbit in the terminator plane. As the mission progresses from the approach phase to proximity operations, the Osiris-REx flight dynamics team will determine action plans based on the detection of any natural satellite. Depending on whether the natural satellite would pose a threat to the OSIRIS-REx spacecraft, we will implement a collision-avoidance and decision-making scheme based on a calculated probability of collision.” In practice, the Wald Sequential Probability Ratio Test (WSPRT) will be used to compute the alarm and dismissal thresholds for sequential estimates of the probability of collision. These sequential estimates are computed at intervals leading up to some time before closest approach at which a decision is made whether to alarm for a maneuver or to dismiss.

(Image credit: NASA Goddard Space Flight Center Conceptual Image Lab)
“The decision-making strategy will also depend on the cadence of proximity operations for a particular phase of operations as well as how the decision will affect subsequent mission phases,” Mashiku said.

ADDITIONAL OBJECTIVES

In addition to its telecommunication equipment, the spacecraft will carry a suite of instruments to study the asteroid in many wavelengths, as well as image the asteroid, and to return a physical sample to Earth. The OSIRIS-REx Camera Suite (OCAMS) consists of the PolyCam, the MapCam, and the SamCam provided by the University of Arizona. Together they will acquire information on Bennu by providing global mapping, sample-site reconnaissance and characterization, high-resolution imaging, and records of the sample acquisition.

“All in all,” Mashiku concluded, “it is relatively difficult to imagine every scenario that could happen when we get to Bennu. However, we have our tools and strategic plans in place, and it will be extremely exciting to see what the future will unfold.”


Cindy Schumacher is a journalist from Maui, Hawaii. She currently writes for the Lahaina News and Maui Economic Development Board. She has written numerous articles on topics related to space science, and has covered national and international conferences including the annual AMOS (Advanced Maui Optical and Space Surveillance Technologies) Conference.
Submitting Articles for Publication in *Space Times*

The readership of *Space Times* magazine includes space professionals, space enthusiasts, educators, students, and those interested in the space program, space exploration, science, and policy. The tone of the magazine leans more toward conversational rather than formal. Articles are written for a well-educated audience that has a great interest in space topics but may not necessarily be familiar with an author’s specific topic. Virtually any topic involving space science, technology, exploration, law, or policy may be covered. Issues relevant to the civil, commercial, and military and intelligence space sectors are also welcome.

Articles published in *Space Times* magazine are written with a clear explanation of technical concepts without inclusion of footnotes, endnotes, or bibliographies. Articles range from 600 to 3,500 words, and any exceptions are handled on a case-by-case basis. Articles must be submitted in Microsoft Word format, Times New Roman font, 10.5 pt. Additional formatting will be handled during the editing process.

Submission of photos, tables, charts, and other visual support is strongly encouraged but is not required. All images must be provided in high resolution (minimum 300) JPG format, both in color (CMYK) and black and white (grayscale). Images must be provided as separate files.

Two copies of the final article must be submitted, one without any images embedded and one with images embedded for layout guide purposes. Captions and sources for all images are required. Obtaining permission from the owner of any photos or other visuals is the responsibility of the author of the article.

Articles must include:
1. a title;
2. a one to two sentence summary of the article for index purposes;
3. if applicable, subheadings providing separation between major sections of the article;
4. a one to two sentence byline/author biography which will appear at the end of the article;
5. the current mailing address of the author(s).

Five complimentary copies of the issue in which the article appears will be mailed to each author. A PDF of the final magazine will be available on the web site of the American Astronautical Society (www.astronautical.org).

The standard submission deadline is the 15th of the month prior to the issue date (i.e., December 15 for the January/February issue; February 15 for the March/April issue; etc.); however, extensions, if possible, will be granted on a case-by-case basis.

Please submit articles and graphics/images directly to Diane Thompson, Editor, at: dthompson@astronautical.org

For telephone inquiries, please call 703-866-0020 (Monday-Friday, 9 am-5 pm U.S. ET).
The Path to Mars Goes Through Hawaii

by Cindy Schumacher

Interest in Mars, the fourth planet from the Sun, began long before people were able to send spacecraft to the Red Planet. Even early astronomers were able to see Mars’ changing brightness and position in the sky. However, with the invention of powerful telescopes, astronomers were able to see the surface of Mars for the first time.

Today, we send robotic missions to Mars to study its surface. In fact, robots are blazing a trail for manned Mars missions. Their missions have shown us that Mars’ solid surface is much like that of Earth. Missions to the mysterious Red Planet continue to launch to gain a better understanding of its geological history and search for evidence of past or present life.

Currently, there are two NASA robots exploring the Martian surface – the Curiosity rover and its older cousin, Opportunity. While a fleet of orbiters from NASA and the European Space Agency circle above surveying the planet, much research is also being done in the Hawaiian Islands.

PISCES

“The State of Hawaii sees the realm of aerospace as one of those promising emerging areas for growth,” said Rob Kelso, executive director of Pacific International Space Center for Exploration Systems (PISCES). “For centuries, Hawaiians have had a strong connection with the moon and the stars in how they rule, how they fish, hunt and farm,” Kelso said. “In more recent times, Hawaii has directly supported manned spaceflight.”

The PISCES OD6 Alpha Argo Planetary Rover tackled its first test at a Mars planetary analog site on the Big Island. The team maneuvered the 726-pound rover over slopes of fly-ash and tephra, tested its camera, wireless communication links and successfully conducted a night-time drive at an altitude of about 9,000 feet. The PISCES Robotic Team from left to right: Casey Pearring, Max Kerr, Matt Takemoto, and Rodrigo Romo. (Image credit: PISCES)
From one of the very first tracking stations that supported John Glenn’s Mercury Friendship 7 mission, to training astronauts in lava fields for moon missions, to tracking station support for Apollo and the Space Shuttle, Hawaii has been involved from the beginning of the space age. And, of course, Hawaii provided the facilities for transferring the first-generation spacecraft off the recovery ships after their missions and for delivering several of the Apollo moon ships to Pearl Harbor for decommissioning and cleanup.

“She continues to be excited about space exploration,” said Kelso. “We seek to provide support for becoming a multi-planet species, settling on the Moon and eventually Mars. Thanks to Hawaii’s strategic resource, volcanoes, which are found on all rocky bodies (Venus, Mars, the Moon, etc.), by testing our hardware in Hawaii we learn how the hardware will perform on other planets.”

The mission of PISCES is to serve as a world-class research and education-training center that space agencies around the planet can use to develop technologies needed to live on the Moon, Mars and beyond. The PISCES staff sees robotic systems as preparing the way for humans to arrive and settle on other planets.

“These robotic systems will make solar farms, begin oxygen production, assemble water plants, hook habitats together, and so forth. Then we are destined not only to explore, but to become more than just a one-planet species,” said Kelso. “The robots will, in effect, ‘prepare the campsite’ before we arrive.”

In July 2014 the PISCES OD6 Alpha Argo Planetary Rover tackled its first test at a planetary analog site on the Big Island.

“Overcoming its first challenge on a mock-Martian/lunar surface, at a test site near Hale Pohaku on Mauna Kea, the rover’s successful mountainside traverse tested its capabilities while providing valuable work experience,” said Project Manager Rodrigo Romo.

The rover covered 4,000 meters of ground over three documented drives and successfully utilized PISCES wireless communication links that packed enough signal to cover the entire valley making up the analog site.

“Our team maneuvered the 726-pound rover over slopes of fly-ash and tephra, tested its cameras and wireless communication links, and successfully conducted a night-time drive at an altitude of about 9,000 feet. The team also accomplished a key goal of remotely operating the rover atop the mountain from Gemini Observatory’s Mission Control Room in Hilo.”

Through comprehensive study, NASA has already identified Hawaii’s Mauna Loa volcano as one of the best sites for atmospheric clarity in the United States, offering unobstructed line-of-sight views year-round for laser transmissions to space. A few years back, the Hawaii Legislature provided funding for two engineering assessments to determine the feasibility of putting a ground station on Mauna Loa. In mid-2016, the results of these studies overseen by PISCES, a Geotechnical Reconnaissance Report and a Telecommunications Infrastructure Assessment, confirmed that Mauna Loa shows promise as a future site for ground support to facilitate laser-based space communications.

This year, NASA plans to further test laser technology communication with the Laser Communication Relay Demonstration (LCRD), which will transmit data from California to an orbiting satellite, then relay it to a site on Haleakala volcano on the island of Maui. LCRD is considered a critical step toward the next generation of satellite systems going into orbit.

Currently, PISCES is also working to develop robotic systems for landing pad construction. Rockets that will need to slow the incoming descent of a spacecraft carrying astronauts will be much larger and create exponentially more thrust. It is not unreasonable to expect that these rocket engines would create deep craters in the unprotected soil. PISCES’ work is therefore instrumental in enabling future human landings on Mars and also the Moon.

HI-SEAS RESEARCH

Additional Hawaiian research is being done by HI-SEAS (Hawaii Space Exploration Analog and Simulation). Located on an isolated Mars-like site on the slopes of Mauna Loa on the Big Island of Hawaii, it is an island experiment of great interest to the
field of deep space research led by the University of Hawaii at Manoa and funded by NASA.

In 2013, at approximately 8200 feet of elevation, the first HI-SEAS experiment, an analog habitat for spaceflight to Mars, studied the human factors that contribute to how teams of astronauts will perform during isolated long-duration Mars space exploration missions.

“Our tools and technology for space exploration are very good, but as a human race we still must contend with the ‘soft side’ risks of space travel,” said Kim A. Binstead, associate professor at University of Hawaii at Manoa and principle investigator for HI-SEAS. “By practicing here on earth, in a solar-powered dome that is 36 feet in diameter, and rehearsing the things we need to do on a trip to Mars, we’re actually making it possible.”

It takes an unmanned spacecraft at least 150 to 300 days to travel between Earth and Mars. Scientists estimate that a manned journey to Mars will take about three years to complete a round-trip. “NASA believes that different emotional and psychological factors might be more important for longer duration trips,” Binstead added.

“In fact, HI-SEAS crew members, usually six to eight people, suit up in mockup spacesuits whenever they step outside of the habitat. These missions, modeled after extraterrestrial surface explorations in a geologically Mars-like environment, offer potential for analog tasks such as geological field work by human explorers and or robots.”

(Right) HI-SEAS crew members, seen here giving the traditional Hawaiian shaka greeting, hope to determine what is required to keep a space flight crew happy and healthy during an extended mission to Mars and while living on Mars. (Image credit: Ross Lockwood/University of Hawaii at Manoa)
HI-SEAS IV began in August 2015 and lasted for exactly one year. It was the subject of a film called Red Heaven. The project is planning two more HI-SEAS of 8-month mission length, one in 2017 and another in 2018. NASA’s Human Research Program continues to fund and sponsor follow-up studies. The missions are of extended duration from four months to a year.

**PLANETS**

Astronomical research in relation to Mars is also happening in Hawaii. The PLANETS (Polarized Light from Atmospheres of Nearby Extra-Terrestrial Systems) team has astrophysicists and imaging experts from several institutions hoping to make a valuable contribution to observing the Red Planet and other potentially habitable planets. The major scientific and funding partners for this project include Tohoku University in Sendai, Japan, the Kiepenheuer Institute for Solar Physics in Freiberg, Germany, and the University of Hawaii’s Institute for Astronomy (IfA).

The telescope has several scientific goals that include exploring solar system atmospheres, exoplanets, and, in general, the search for life beyond the solar system. “One of the primary goals of this telescope will be detecting the light from exoplanets and from the outer atmospheres of planets in our solar system,” explained Jeff Kuhn, the IfA scientist spearheading the development of the 2-meter PLANETS telescope on Haleakala. “Achieving this goal requires minimizing scattered light from the host star (or planet) and maximizing the ability of the telescope’s detectors to see faint objects near a very bright one. PLANETS will be different from most telescopes in that it is designed for what scientists call high photometric dynamic range. Until the Daniel K. Inouye Solar Telescope comes online in a few years, PLANETS will be the world’s largest off-axis optical telescope, which means there will be no obstructions to the incoming beam of light due to the secondary mirror and its supports.” To minimize its cost, the telescope will also use innovative technology to achieve the thinnest primary mirror of any comparable astronomical telescope. All of its design features greatly reduce the amount of diffraction, the unwanted glare from light that is spread out as a result of passing through a narrow aperture or across an edge.

“PLANETS mirror will be polished to be very smooth to minimize diffuse scattered light from mirror roughness, a major source of light scattering,” said Kuhn. “PLANETS will have a stellar coronagraph to block out the blinding glare from the star. While most coronagraphs have been used to create an artificial solar eclipse to see the corona of our Sun, the PLANETS’s stellar coronagraph can be used to see planets around other stars, the disks that form them, or the tenuous outer atmospheres of solar system planets.

“These exoplanets, outer atmospheres and disks can be millions to billions times fainter than the glare around them,” Kuhn explained. “Making a telescope capable of containing and removing the glare allows for the detection and study of the light from the faint source. In this way, PLANETS can also be used to see a variety of what would otherwise be hidden objects.”

**TO MARS VIA HAWAII**

There are many bold new missions to design and develop human capacity for deep space travel, which are needed to accommodate
the environments to be encountered in space and during surface operations. With continuing research in atmospheric, radiation, and geologic studies, the possibility exists of humans living on Mars by the mid-twenty first century. Developing the capabilities to land humans on Mars requires unrelenting application of resources and technology along with innovation in many disciplines. With a promising and bright future for aerospace in Hawaii, the state continues to offer its expertise in exploring the Red Planet as never before and in demonstrating the technology that can enable human Mars missions.

Cindy Schumacher is a journalist from Maui, Hawaii. She currently writes for the Lahaina News and Maui Economic Development Board. She has written numerous articles on topics related to space science, and has covered national and international conferences including the annual AMOS (Advanced Maui Optical and Space Surveillance Technologies) Conference.

CALLING ALL WRITERS!

Do you have a story to share? Would you like to get your piece published in Space Times?
We are looking for contributors to share their articles with our vast audience of space professionals and enthusiasts, educators and students, and all others interested in the space program, space exploration, science, policy, and relevant topics.
To get involved, please contact the AAS office at aas@astronautical.org or 703-866-0020.

Save the Dates!

International Space Station Research and Development Conference
Omni Shoreham ♦ Washington, D.C.
July 18-20, 2017

Wernher von Braun Memorial Symposium
The University of Alabama in Huntsville ♦ Huntsville, Alabama
October 24-26, 2017
ROBERT H. GODDARD MEMORIAL SYMPOSIUM

Future Space: Trends, Technologies and Missions

Tuesday, March 7

6:00 Evening Symposium Warm-up / Meet & Greet Mixer  Annapolis Room
sponsored by Northrop Grumman

Wednesday, March 8

7:00 Registration Opens / Continental Breakfast  sponsored by Harris Corporation

7:15 AAS Corporate Members Breakfast  invitation only

8:30 Welcome and Announcements  Salons A-B-C
Carol Lane, AAS President
Harley Thronson, Chair, Symposium Planning Committee; Senior Scientist for Advanced Concepts
in Astrophysics, NASA Goddard Space Flight Center

8:40 Opening Speaker – Why Science and Exploration are Partners:
The Stunning Success of a “One NASA”
Matt Mountain, President, Association of Universities for Research in Astronomy (AURA)

9:10 Introduction of Keynote Speaker
Chris Scolese, Director, NASA Goddard Space Flight Center and Symposium Honorary Chair

9:15 Keynote
Robert Lightfoot, NASA Administrator (Acting)

10:00 Break  sponsored by Harris Corporation

10:15 NASA Leadership on Science and Technology Future Trends
Moderator: Doug Terrier, Deputy Chief Technologist, NASA Headquarters
Panelists:
- Steve Jurczyk, Associate Administrator, Space Technology Mission Directorate
- Gale Allen, Deputy Chief Scientist
- Thomas Zurbuchen, Associate Administrator, Science Mission Directorate

11:45 Pre-lunch Break / Meeting Space Reconfiguration

12:00 Honors and Awards Luncheon  Salons B-C-D  sponsored by Lockheed Martin
Guest Speaker: Senator Gary Peters (D-MI), Ranking Member, Space, Science &
Competitiveness Subcommittee invited
2:15 International Exploration and Private Sector Development of Space  
**Moderator:** Bill Gerstenmaier, Associate Administrator for Human Exploration and Operations, NASA Headquarters  
**Panelists:**  
- Gilles Leclerc, Director General, Space Exploration, Canadian Space Agency  
- Eric Stallmer, President, Commercial Spaceflight Federation  
- Mary Lynne Dittmar, Executive Director, Coalition for Deep Space Exploration

3:45 Break  
**sponsored by Harris Corporation**

4:00 The Political Environment  
**Moderator:** Marcia Smith, Founder and Editor, SpacePolicyOnline.com  
**Panelists:**  
- Frank Morring, Senior Editor, *Aviation Week & Space Technology*  
- Chris Shank, Special Assistant, Department of Defense  
- Nick Cummings, Staff Director, Subcommittee on Space, Science, and Competitiveness  
  Senate Committee on Commerce, Science, and Transportation  
- Tom Hammond, Staff Director, Subcommittee on Space, House Committee on Science,  
  Space, and Technology  
  invited  
- Steve Volz, Assistant Administrator, National Environmental Satellite, Data & Information  
  Service (NESDIS), NOAA  
  invited

5:30 Closing Spotlight – Pipeline to the Future  
Sophia Porter, 2015 National Space Club and Foundation Keynote Scholar

6:00 Industry, Government, and Student Networking Reception  
**Annapolis Room**  
**sponsored by SpaceX**

**Thursday, March 9**

7:30 Registration Opens / Continental Breakfast  
**sponsored by SGT, Inc.**

8:30 Introduction of Opening Speaker  
**Salons A-B-C**  
Chris Scolese, Director, NASA Goddard Space Flight Center and Symposium Honorary Chair

8:35 Opening Speaker – Planning NOAA’s Future Space Architecture  
Karen St. Germain, Director, Office of Systems Architecture and Advanced Planning, NOAA/NESDIS

9:05 Upcoming Missions with Big Science Payoffs  
**Moderator:** Colleen Hartman, Director, Sciences and Exploration Directorate, NASA GSFC  
**Panelists:**  
  Laboratory, NASA GSFC  
- Mars 2020 Rover: Ken Farley, W.M. Keck Foundation Professor of Geochemistry; Chair,  
  Division of Geological and Planetary Sciences, Caltech  
- PACE – Plankton, Aerosol, Cloud, ocean Ecosystem: Jeremy Werdell, PACE Project
Scientist, NASA GSFC
- Solar Probe Plus: Elsayed Talaat, Project Scientist, NASA Headquarters

10:30 Break  sponsored by SGT, Inc.

10:50 Exploration Telepresence – Almost Like Being There
Moderator: Gregory Chirikjian, Professor, Department of Mechanical Engineering, Johns Hopkins University
Panelists:
- Dan Lester, Research Scientist, Exinetics
- Kip Hodges, Foundation Professor, School of Earth and Space Exploration, Arizona State University

12:15 Pre-lunch Break / Meeting Space Reconfiguration

12:30 Luncheon  Salons B-C-D  sponsored by Boeing
Guest Speaker: Roger Launius, Independent Historian
“The Value of Space Exploration in a Distracted Culture”
Future Space Leaders Foundation – Eric Stallmer, President, Commercial Spaceflight Federation

2:00 Spotlight – Space-based Environmental Intelligence
In Memoriam: Video conversation recorded in 2016 with Piers Sellers and Leonardo DiCaprio with remarks by Sandra Smalley, Director, Joint Agency Satellite Division, NASA Headquarters

2:30 Spotlight – China’s Plans for Space
Brian Weeden, Technical Advisor, Secure World Foundation

3:00 Break  sponsored by SGT, Inc.

3:15 Cislunar Space – The Next Frontier
Moderator: Harley Thronson, Chair, Symposium Planning Committee; Senior Scientist for Advanced Concepts in Astrophysics, NASA Goddard Space Flight Center
Panelists:
- Matt Duggan, Exploration Manager, The Boeing Company
- Timothy Chichan, Space Exploration Architect, Lockheed Martin
- TBD – Orbital ATK
- TBD – Sierra Nevada Corporation
- TBD – NanoRacks

4:45 Closing Conversation with Chris Scolese, NASA GSFC Center Director; John Grunsfeld, Astronaut and former NASA Associate Administrator for Science; and Jon Malay, Past President of AAS & AMS

5:15 Closing Reception  Annapolis Room
WELCOME NEW AAS OFFICERS AND BOARD MEMBERS

Introducing the New Officers
2017-2018

President - Carol S. Lane
Cynergy, LLC
Executive Vice President - Alan DeLuna
ATDL, Inc.
Vice President Technical - Jim McAdams
KinetX, Inc.
Vice President Programs - Kathy J. Nado
NASA Headquarters
Vice President Publications - David B. Spencer
The Pennsylvania State University
Vice President Strategic Communications and Outreach - Madhurita (Madi) Sengupta
American Institute of Aeronautics and Astronautics
Vice President Membership - Tracy Lamm
Space Center Houston
Vice President Education - Gale J. Allen
NASA Headquarters
Vice President Finance - Ronald J. Birk
Northrop Grumman Mission Systems
Vice President International - Aaron Lewis
Arianespace, Inc.
Vice President Public Policy - Jeff Bingham
Legal Counsel - Franceska O. Schroeder, Esq.
Fish & Richardson P.C.

Introducing the New Directors
2017-2019

Sirisha Bandla
Virgin Galactic
Josh Brost
SpaceX
Gregg Burgess
Sierra Nevada Corporation
Thomas F. Burns
National Oceanic and Atmospheric Administration
Rebecca L. Griffin
Rebecca Griffin Space
Hal E. Hagemeier
Eagle Ray Inc.
Dan Hendrickson
Astrobotic Technology, Inc.
Talal Al Kaissi
UAE Embassy Washington DC
Brent Sherwood
Jet Propulsion Laboratory
Lyn D. Wigbels
RWI International Consulting Services

And the Unsung Heroes – AAS Chairs and Editors

Ian Gravseth – Chair, Rocky Mountain Section
Ball Aerospace & Technologies Corp.
James McQuerry – Chair, Guidance & Control Committee
Lockheed Martin
Michael L. Ciancone – Chair, History Committee
NASA Johnson Space Center
Aaron Lewis – Chair, International Programs Committee
Arianespace, Inc.
Alan DeLuna – Chair, International Space Station Utilization Committee
ATDL, Inc.
Renato Zanetti – Chair, Space Flight Mechanics Committee
The University of Texas at Austin

Brandon Jones – Chair, Space Surveillance Committee
The University of Texas at Austin
Diane L. Thompson – Editor, Space Times
American Astronautical Society
Kathleen C. Howell – Editor, The Journal of the Astronautical Sciences
Purdue University
Robert H. Jacobs – AAS Publications Office
Univelt Incorporated
Richard M. Obermann – Capital Hill Liaison
House Committee on Science, Space, & Technology
Peter Jorgensen – Social Media Intern
University of South Florida
Congratulations to AAS Award Recipients and Fellows

SPACE FLIGHT AWARD
ROBERT MEYERSON

NEIL ARMSTRONG SPACE FLIGHT ACHIEVEMENT AWARD
Neil Armstrong™ used with permission from the Purdue Research Foundation
LRO MISSION TEAM

SALLY RIDE EXCELLENCE IN EDUCATION AWARD
DESTIN SANDLIN

EARTH SCIENCE AND APPLICATIONS AWARD
SERVIR

SPACE ENTREPRENEURSHIP AWARD
GATR TECHNOLOGIES

DIRK BROUWER AWARD
FELIX HOOTS

SPACE TECHNOLOGY AWARD
MARY J. “NIKI” WERKHEISER

JOHN F. KENNEDY ASTRONAUTICS AWARD
KATHRYN SULLIVAN

CARL SAGAN MEMORIAL AWARD
AURA “HST & BEYOND” COMMITTEE

ADVANCEMENT OF INTERNATIONAL COOPERATION AWARD
KENNETH HODGKINS

EUGENE M. EMME ASTRONAUTICAL LITERATURE AWARD
MONIQUE LANEY

2016 FELLows
DEBRA FACKTOR LEPORE
RENAto ZANetti
WE HAVE SPACE FOR YOU!

WE DELIVER...

- Timely Topics and Global Perspectives
- The Newest in Global Space Technology
- Industry Leaders and Decision Makers
- Plentiful Networking Opportunities

FEATURED TRACKS

Tech Track
Technology experts share forward-thinking insights

New Generation Space Leaders
Dynamic program for young professionals, age 35 or younger

Register Today and Save!

www.SpaceSymposium.net  +1.800.691.4000
German Rocketeers in the Heart of Dixie – Making Sense of the Nazi Past during the Civil Rights Era

Reviewed by Asif Siddiqi


In German Rocketeers in the Heart of Dixie: Making Sense of the Nazi Past during the Civil Rights Era, Monique Laney has made a significant contribution to the history of spaceflight. She looks specifically at the relocation of several hundred German rocket specialists from Nazi Germany who eventually settled in Huntsville, Alabama, the home of one of the largest NASA centers during the 1960s. It was here at Huntsville that the so-called “rocket team,” led by the infamous Wernher von Braun, designed the Saturn V rocket that launched American astronauts to the Moon.

Based on extensive interviews with communities in Huntsville as well documents from a wide range of official and unofficial sources, Laney’s work recasts the story of German rocket designers as one that is coterminous with two other large threads in American history, the history of immigration and the history of civil rights in the mid-twentieth century. She explores the U.S. government’s efforts to whitewash the suspect background of many of the German specialists, an imperative driven by new Cold War exigencies, but also refocuses our attentions to the local level at Huntsville, especially how these new immigrants sought to integrate themselves into the local fabric of southern life.

At a fundamental level, Laney’s oral histories of the descendents of the German families, members of the African American and Jewish communities, as well as many others who came into contact with the Germans, suggests that forging a communal identity in Huntsville, one identified principally with the burgeoning space program, was not without conflict. She argues that the debates over the rocket specialists’ involvement with Nazi atrocities led in part to ruminations over “struggles over how Americans see themselves in relationship to Nazi Germany.”

Her most striking contribution is to suggest that the relocation and integration of German rocket engineers in the Deep South was in many ways inseparable from the painful struggle for civil rights for minorities, especially African Americans, in the Deep South, and that these two strands of American history cannot be understood without relation to each other. Her chapter on the case of Arthur Rudolph, the rocket designer who was accused of direct complicity in Nazi atrocities, illuminates the complex divisions among the city’s own population, as local whites, Jews, and African Americans took different positions on the case, all under the shadow of Huntsville’s own pride in helping the nation to reach the Moon.

Overall, her most important contribution is to add a difficult but crucial strand to the social history of spaceflight in which the memory of World War II, immigration, and civil rights collided head on with one of the greatest technological achievements in American history, the landing of humans on the Moon in 1969. This is an exemplary work that deserves all its accolades.

Asif A. Siddiqi is a professor of history specializing in the history of science and technology at Fordham University in New York. He has authored a number of scholarly books on the history of spaceflight and is a member of the AAS History Committee.
Join the American Astronautical Society
or renew or update your membership online at
www.astronautical.org
or use the form below.

Follow AAS on:

www.facebook.com/AmericanAstronauticalSociety
www.twitter.com/astrosociety
www.youtube.com/user/astrosociety
http://www.slideshare.net/astrosociety

Membership Application
703-866-0020
http://astronautical.org

<table>
<thead>
<tr>
<th>Membership Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ Member</td>
<td>$100</td>
</tr>
<tr>
<td>___ Senior Member</td>
<td>$125</td>
</tr>
<tr>
<td>___ Fellow (renewal only)</td>
<td>$135</td>
</tr>
<tr>
<td>___ Retired</td>
<td>$50</td>
</tr>
<tr>
<td>___ Retired Fellow (renewal only)</td>
<td>$50</td>
</tr>
<tr>
<td>___ Teacher (K-12)</td>
<td>$45</td>
</tr>
<tr>
<td>___ Student (full-time)</td>
<td>$45</td>
</tr>
</tbody>
</table>

Payment Method
CHECK
AMEX Discover MasterCard VISA

Membership Benefits Include: Subscriptions to The Journal of the Astronautical Sciences (quarterly, online) and Space Times magazine (bi-monthly, print), as well as reduced rates at all AAS events. Visit the AAS website for additional information about benefits.

Mr./Mrs./Ms./Dr. Last Name First Name

Title Organization

Address

City State Zip Code

Phone Email

EXPIRATION DATE CODE (back or front of card)

SIGNATURE

Mail to: AAS
6352 Rolling Mill Place, Suite 102
Springfield, VA 22152-2370

Fax to: 703-866-3526
AAS Corporate and Institutional Members

a.i. solutions, Inc.
Aerojet Rocketdyne
The Aerospace Corporation
Aerospace Industries Association
Analytical Graphics, Inc.
Applied Defense Solutions, Inc.
Arianespace
Auburn University
Ball Aerospace & Technologies Corp.
Blue Origin
The Boeing Company
CASIS
The Coalition for Deep Space Exploration
Colorado Center for Astrodynamics Research (CCAR)
Dittmar Associates, Inc.
Dynetics, Inc.
Embry-Riddle Aeronautical University
Harris Corporation
Honeywell Technology Solutions, Inc.
International Space University
Jet Propulsion Laboratory
JHU / Applied Physics Laboratory
KinetX, Inc.
Lockheed Martin Corporation
Millennium Space Systems
Moog Inc., Space and Defense Group
Northrop Grumman
Orbital ATK
The Pennsylvania State University
Qwaltec
RWI International Consulting Services
SAIC
SGT, Inc.
Sierra Nevada Corporation
Space Center Houston
Space Dynamics Laboratory / Utah State University
SpaceX
The Tauri Group
Teledyne Brown Engineering
Texas A&M University
United Launch Alliance
Univelt, Inc.
University of Alabama in Huntsville
University of Florida
University of South Florida
University of Texas at Austin
Virginia Commercial Space Flight Authority / Mid-Atlantic Regional Spaceport
Women in Aerospace

Thank you for your continued support!

Charitable Giving and the AAS

A popular way of donating to an organization is through a gift by means of a will (i.e., to make a bequest). You may decide to consider either a general bequest to the AAS or a bequest targeted to an existing or new AAS scholarship or an award fund. These bequests are deductible against estate and inheritance taxes.

There are also tax advantages when making charitable donations to the AAS while you are living. Such gifts could contribute to the memory of someone who has passed away or be made in the honor of a person who is still alive. In addition, special occasions offer opportunities for gifts to be directed to the Society.

As a final note, although the AAS is able to provide suggestions for charitable giving, your financial or legal advisor should be consulted about such actions.
# 2017 Schedule of Events

<table>
<thead>
<tr>
<th>Month</th>
<th>Event</th>
<th>Location</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 7-9</td>
<td>Robert H. Goddard Memorial Symposium</td>
<td>Greenbelt Marriott</td>
<td><a href="http://www.astronautical.org">www.astronautical.org</a></td>
</tr>
<tr>
<td>April 3-6</td>
<td>Space Symposium</td>
<td>The Broadmoor Hotel</td>
<td><a href="http://www.spacefoundation.org/events">www.spacefoundation.org/events</a></td>
</tr>
<tr>
<td>May 9-11</td>
<td>Humans to Mars Summit</td>
<td>George Washington University</td>
<td><a href="http://www.exploremars.org">www.exploremars.org</a></td>
</tr>
<tr>
<td>June 9-11</td>
<td>Student CanSat Competition</td>
<td>Tarleton State University</td>
<td><a href="http://www.cansatcompetition.com">www.cansatcompetition.com</a></td>
</tr>
<tr>
<td>July 18-20</td>
<td>International Space Station Research &amp; Development Conference</td>
<td>Omni Shoreham Hotel</td>
<td><a href="http://www.issconference.org">www.issconference.org</a></td>
</tr>
<tr>
<td>August 20-24</td>
<td>AAS/AIAA Astrodynamics Specialist Conference</td>
<td>Skamania Lodge</td>
<td><a href="http://www.space-flight.org">www.space-flight.org</a></td>
</tr>
<tr>
<td>October 24-26</td>
<td>Wernher von Braun Memorial Symposium</td>
<td>The University of Alabama in Huntsville</td>
<td><a href="http://www.astronautical.org">www.astronautical.org</a></td>
</tr>
</tbody>
</table>

**ABSTRACT DEADLINE:**
- March 24, 2017 (ISS Conference)
- April 24, 2017 (AAS/AIAA Conference)
- April 24, 2017 (IAC Conference)