Space Science Institute . 4750 Walnut Street . Suite 205 . Boulder, Colorado 80301 . 720.974.5888 . www.spacescience.org

ANNUAL REPORT 2010

MESSAGE FROM THE DIRECTOR

Excite. Explore. Discover. These words describe our efforts in both scientific research and education. In fact, they define the essence of our mission: to integrate world-class research with an innovative education program within a single institution. The Space Science Institute's (SSI) Board of Directors, with its experience and expertise in a range of business, science, and educational areas, provides guidance and vision to our enterprise. They – along with our senior management – have created an environment that continues to draw world-class scientists to SSI and enables us to develop education and outreach programs that benefit millions of people worldwide. SSI's 2010 revenues were $5.3M.

SSI has a robust scientific Research Branch (Director, Dr. Michael Wolff) with scientists participating in robotic missions such as the Mars Exploration Rovers, in flight missions such as Spitzer and Hubble, and in ground-based observation programs using facilities located all over the world. Three new researchers joined the Research Branch last year: Athanasios Boudouridis (Research Scientist, Boulder, CO Office), Julianne Moses (Senior Research Scientist, Seabrook, TX Office), Alexey Pankine (Research Scientist, Arcadia, CA Office), and Erica Rogers (Research Scientist, Atchison, KS Office).

SSI's Flight OperationS Branch (Director, Dr. Carolyn Porco) is home to the Cassini Imaging Central Laboratory for Operations (CICLOPS). CICLOPS is the center for uplink and downlink operations for the imaging science experiment on the Cassini mission to Saturn. The Cassini-Huygens mission continues to change our view of the Saturn system. Cassini's landmark exploration of the ringed planet, its mysterious moons, stunning rings, and complex magnetic environment will continue through 2017 when the spacecraft's third and final mission extension will come to an end.

SSI launched the National Center for Interactive Learning (NCIL), in May 2010, to expand its strong educational program. NCIL is organized around five interconnected groups: 1) Exhibition Development, 2) Digital Learning, 3) Professional Development, 4) Community Outreach, and 5) Learning Research and Evaluation. Two new educators joined NCIL in 2010: Kate Haley Goldman (Silver Springs, MD Office) and Robert Russell (Senior Education Associate, Washington, DC Office) who is Director of the Learning Research and Evaluation Group.

Our headquarters, located in Boulder, Colorado, enables us to maintain strong collaborations with a number of the major players in the research, education, and aerospace industries, including the University of Colorado, NOAA's Space Weather Prediction Center, the National Center for Atmospheric Research, Lockheed Martin, and Ball Aerospace. However, our impact goes far beyond Colorado. We seek and encourage strong ties to corporations, foundations, and institutions nationwide. Come join our voyage of discovery.

With warmest regards,

Paul B. Dusenbery, Ph.D.
Executive Director

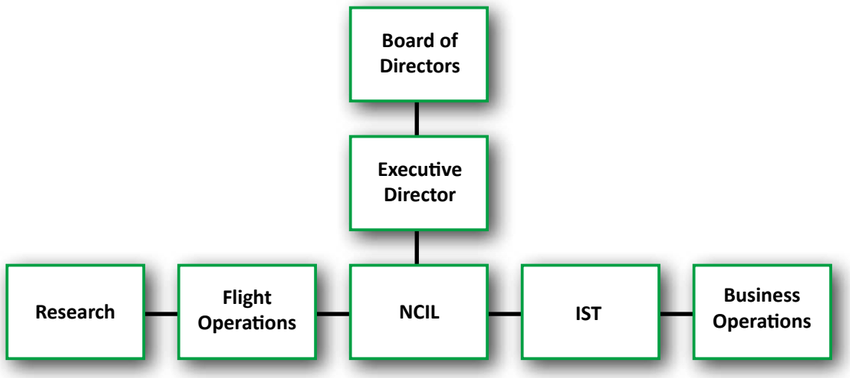
OUR VISION

Expand humankind's understanding and appreciation of planet Earth, the Solar System, and the Universe beyond.

OVERVIEW

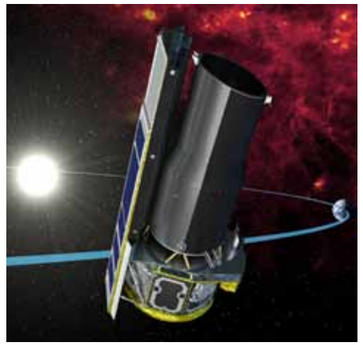
The Space Science Institute (SSI) is a nonprofit, public benefit 501(c)(3) corporation founded in 1992. SSI has five major branches: Research, Flight Operations, National Center for Interactive Learning (NCIL), Business Operations, and Information Systems and Technology (IST). SSI is on the leading edge of creating new, affordable, efficient, and far-reaching models for earth and space science research and education. In the coming years, our potential to make science accessible to large numbers of people, including underserved communities, is enormous. The key to our approach is that we offer the full continuum of discovery and education – we conduct world-class scientific research and we make it accessible to a broad population.

The organizational structure for SSI is outlined below.

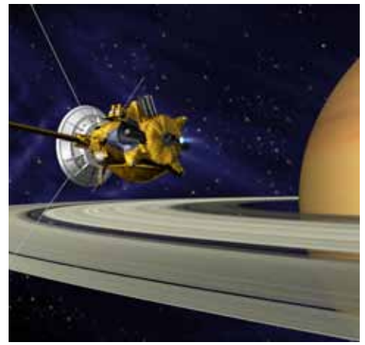


Front Cover :: Zeta Ophiuchi, a massive, hot, blue star lights up the interstellar medium. Credit: NASA/WISE
Inside Front Cover :: Tethys slips behind Titan. Credit: NASA/JPL/SSI
Image Page 32 :: A coronal mass ejection erupts from the Sun. Credit: NASA/SOHO
Right Page :: (Left) An artist's schematic of the Spitzer spacecraft. Credit: NASA/Spitzer
(Middle) The planet Saturn. Credit: NASA/JPL/SSI
(Right) A family visits the Giant Worlds exhibit. Credit: NCIL/SSI

RESEARCH



FLIGHT OPS



NCIL

As humans, we are driven to explore. There are few things that capture our imaginations more than the mysteries of space and the wonders of our own planet. The excitement of earth and space science offers a compelling hook for engaging the public in science and inspiring a new generation of innovators. Society benefits from the pursuit of new knowledge – the more we understand planetary systems and star forming regions, the more we understand our own planet.

SSI is responding to a crisis in research, public science literacy, and Science, Technology, Engineering, and Math (STEM) education. Discovery and invention are the keys to a healthy and prosperous future, and space science has a critical role to play. The future of science in the United States depends heavily on:

- A strong research infrastructure.
- A scientifically literate populace that supports investment in research.
- A pipeline of future research scientists and engineers.

All of these critical factors are at risk. Consider that 70% of the engineering workforce will retire in the next 10 years and yet our universities are graduating more visual arts and performing arts majors than engineers. Traditional research institutions are struggling under the pressures of a poor economy and an expensive infrastructure that is hard to maintain. Public understanding of science and how science is conducted continues to be a concern. Nearly half of American adults still do not know how long it takes for Earth to orbit the Sun. In 2009, our kids ranked 31st out of 56 developed countries in mathematics. In short, we are falling behind. SSI is bringing science to the public in innovative, relevant ways to ensure that science research and education will thrive for decades.

We DISCOVER

In today's marketplace of ideas, SSI has been a pioneer in remote employment, a mode that has been particularly conducive to supporting researchers and, in turn, promoting discovery.

In this environment, our science thrives. Scientists in our Research Branch are participating in robotic missions to Mars and Saturn and in space observatory missions such as Spitzer and Hubble. Our Flight Operations Branch is home to the Cassini Imaging Central Laboratory for OperationS (CICLOPS). Led by Cassini Imaging Team Leader Dr. Carolyn Porco, fourteen scientists from the United States and Europe are deepening our knowledge about Saturn and the processes by which planets – and whole planetary systems – form and develop.

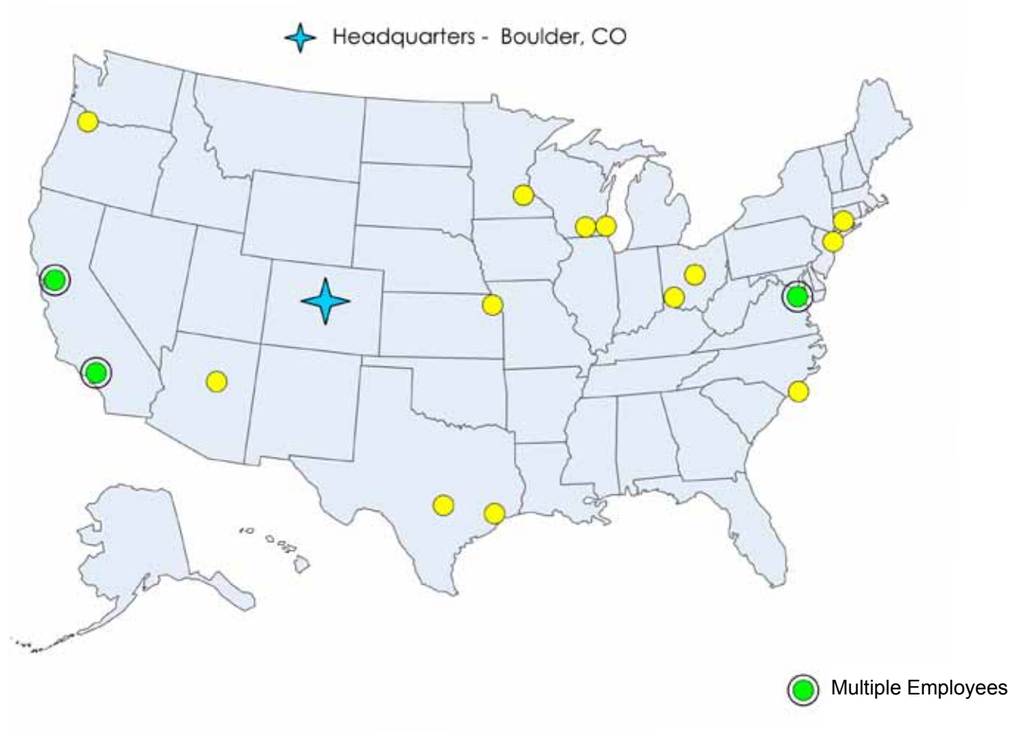
We EDUCATE

SSI's National Center for Interactive Learning is leading the way for a new generation of STEM education platforms that will make science accessible to new audiences. We foster collaboration between scientists and educators to bring the wonder of discovery directly to people wherever they are already engaged. We bridge the worlds of public schools, libraries, museums, and the Internet. Our programs span a range of audience needs and delivery methods, including traveling museum exhibitions such as MarsQuest, Alien Earths, and Giant Worlds; award-winning educational films, videos, and websites; hands-on teaching resources and activities; and educator workshops. We are capturing people's attention by using the latest in social media. We are now tapping into the enormous popularity of Facebook games to teach a large and diverse audience about the evolution of stars and planets. A simultaneous research and evaluation program will examine both the effectiveness of this medium as a learning tool, as well as the broader potential of this gaming approach for the educational community.

We INSPIRE

SSI is in the "inspiration" business. The impact of our research and education programs is increased access to STEM learning for an audience that is cross-generational and often underserved. We don't know who will be inspired to become a scientist, engineer, flight operations specialist, or maybe just a person who reads the paper with interest every day. What we do know is that our programs have the potential to ignite their curiosity and motivate them to continue learning.

The map below shows where SSI employees are located in the United States.



RESEARCH

SSI's Research Branch scientists participate in a broad array of space science activities, including earth science, space physics, planetary science, and astrophysics. Our research team's expertise continues to expand, and now encompasses investigations of phenomenon on Earth, on the Sun and in the solar wind, in atmospheres and on surfaces of other bodies in our Solar System, in our galaxy—including the early stages of the life cycles of stars and nascent planetary systems around other stars—and beyond: quasars and other types of distant galaxies.

SSI researchers are closely connected to the operations of current astrophysical facilities such as the SOFIA airborne observatory, and the Kepler, Spitzer, and Hubble Space Telescopes. Closer to home, several SSI researchers focus on Mars research through active participation in the ongoing Mars Exploration Rovers and Mars Reconnaissance Orbiter missions, as well as the upcoming Mars Science Laboratory (launching in late 2011).

SSI's off-site and on-site researchers form a network of entrepreneurial scientists who support themselves through a mixture of grants and contracts. Our organization and infrastructure allow for dynamic, collaborative efforts among individuals in fields of research that are typically separated in academic institutions. In this spirit, we continue to search out options for new and creative opportunities to increase the health and vitality of our Research Branch.

SSI's Off-Site Research Option

SSI has been a pioneer in remote employment, a mode that has been particularly conducive to the success of our researchers for whom the traditional university or research center is not a viable option. The long-distance nature of most scientific collaborative research lends itself well to the option of remote employment. Access to significant computational resources no longer requires large institutional support. Furthermore, most academic journals and professional proceedings are fully accessible through digital subscriptions, greatly mitigating the need for institutional libraries. Instrument development, which does require significant institutional support, can be done in collaboration with local facilities such as those at Lockheed Martin and Ball Aerospace.

2010 Research Highlights

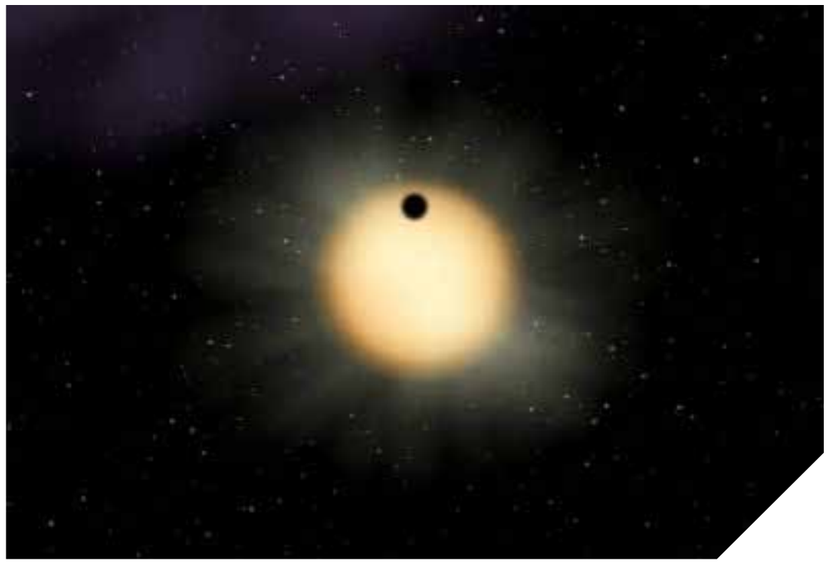
Let Your Light Shine Down: Exotic Atmospheric Chemistry on Extrasolar Planets

From the first discovery of a planet around another star over fifteen years ago, to the recent announcement of more than 1,200 planetary candidates identified from NASA's Kepler mission, it is becoming increasingly obvious that our solar system is not unique in the galaxy. Planets come in all different sizes and orbit all different types of stars at a variety of orbital distances. Exoplanet detection through the radial-velocity technique, has proven very successful over the years, and many of the exoplanets discovered this way are found to orbit astonishingly close to their host stars. Giant planets in such orbits (often called "hot Jupiters" or "hot

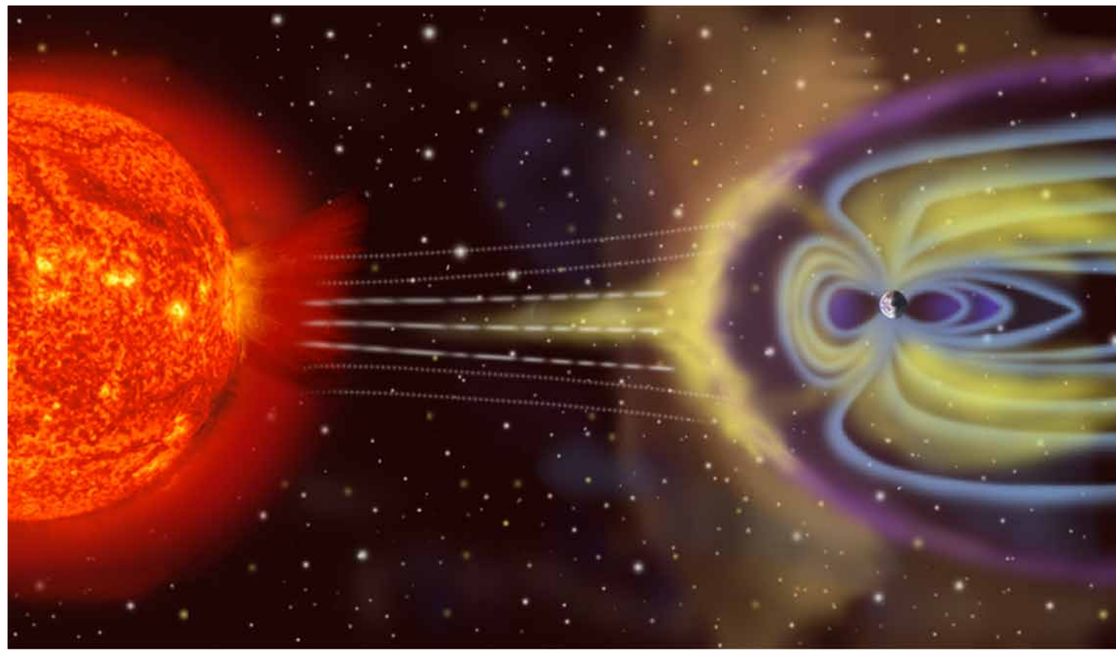
Image Left Page :: An artist's schematic of the formation of a solar system. Credit: NASA/Spitzer

Neptunes") will have much different atmospheric properties than those in our own solar system. Some fraction of these planets will have their orbital planes edge-on as seen from Earth, so that they transit in front of and behind their host stars as seen from Earth.

SSI Senior Research Scientist Julianne Moses (Seabrook, TX Office) is developing theoretical models to help predict and explain the atmospheric composition of extrasolar giant planets. Atmospheric temperatures on the close-in hot Jupiters and Neptunes are high enough at deep levels that kinetic reactions tend to push the composition toward thermodynamic equilibrium, but rapid atmospheric transport can carry deeper constituents to higher, cooler levels faster than equilibrium can be maintained, and the intense ultraviolet light from the nearby host star initiates photochemical reactions that also drive the composition away from equilibrium. The complex dance between thermochemical equilibrium and these two main disequilibrium processes results in unexpected vertical profiles for observable atmospheric constituents, which can affect the resulting spectral behavior and thermal profile of the planet (see Figure). Such processes need to be considered when interpreting the transit and eclipse observations.



Shocks from the Sun Stir Plasma Convection on Earth



Our Sun is continuously emitting fast moving, ionized particles at all directions. This continuous flow of charged particles emanating from the Sun is called the solar wind. The solar wind propagates through the interplanetary space and strongly interacts with the Earth's magnetosphere, the magnetized pocket around the Earth. The solar wind is continuous but not smooth, containing various discontinuities. Some of the most important discontinuities are sudden changes in solar wind dynamic pressure, called solar wind dynamic pressure fronts. When a pressure front impacts Earth's magnetosphere it greatly compresses it, increasing all stresses on

Image Above :: An artist's schematic of the interactions between the Sun, solar wind, and Earth's magnetosphere. Credit: NASA

Image Left Page :: A computer-generated simulation of the TrES-2 transit. Credit: Jeffrey Hall, Lowell Observatory.

it. The effects of the compression propagate through the system reaching as low as the ionosphere and upper atmosphere, leading to what we call a disturbed state of the magnetosphere.

SSI Research Scientist Athanasios Boudouridis (Boulder, CO Office) studies the effects of solar wind dynamic pressure fronts on the plasma convection in the terrestrial ionosphere, the thin ionized layer of the Earth's upper atmosphere. The plasma convection in the ionosphere is often used as a proxy of the level of geomagnetic activity on Earth, and can provide information on magnetospheric processes, such as magnetic reconnection (the reconfiguration of the Earth's magnetic field), that regulate the mass and energy transfer from the solar wind to the magnetosphere. Athanasios' most recent work involves radar measurements of the ionospheric convection using the Super Dual Auroral Radar Network (SuperDARN) that covers the high latitude ionosphere where the most direct coupling with the solar wind is manifested. His statistical study of 109 solar wind dynamic pressure fronts reveals that the ionospheric convection is enhanced both on the dayside and the nightside of Earth after the impact of a pressure front, suggesting a simultaneous reconfiguration of the magnetospheric field at the "nose" and "tail" of the magnetosphere, with implications on the energy transfer to the terrestrial system.

Extrasolar Planets: Using Methane to Identify Candidates

One of the most exciting frontiers of astrophysics research today is the discovery and characterization of sub-stellar objects. These include extrasolar planets and brown dwarfs, a class of object in between low-mass stars and giant planets. Unlike stars, such objects never reach the high central temperatures necessary to sustain hydrogen fusion as their energy source. Why are these so interesting? For one, they hold the clues to the formation of our own solar system. Nature has found a path from the raw material of the interstellar medium to planets. This path is commonly assumed to follow the paradigm of planet formation from within a circumstellar disk. Claims for the discovery of "free-floating planets" in young star clusters challenge our understanding and raise the question: "What is the lowest mass object that can directly form from present-day molecular cloud cores?"

SSI Senior Research Scientist Mary Barsony (Sebastopol, CA Office) is taking advantage of the fact that young planetary mass objects are at their brightest upon formation, making them detectable at infrared wavelengths in the nearest star-forming regions to Earth. The atmospheres of young planetary mass objects are rich in methane and water vapor. Mary is involved in imaging surveys of the nearest star-forming regions that make use of special filters sensitive to this methane absorption, using 4-meter class telescopes around the world. An image of a promising methane-absorbing candidate young planetary mass object is shown in the accompanying figure. Follow-up spectroscopy to determine this object's mass, surface gravity, and surface temperature was obtained with the NIRSPEC spectrograph at the Keck II 10-m telescope in June 2011, and spectroscopy of other promising methane absorbing candidates identified through imaging occurred in May 2011 with the newly commissioned FIRE spectrograph at the Magellan 6.5-meter telescope in Chile.

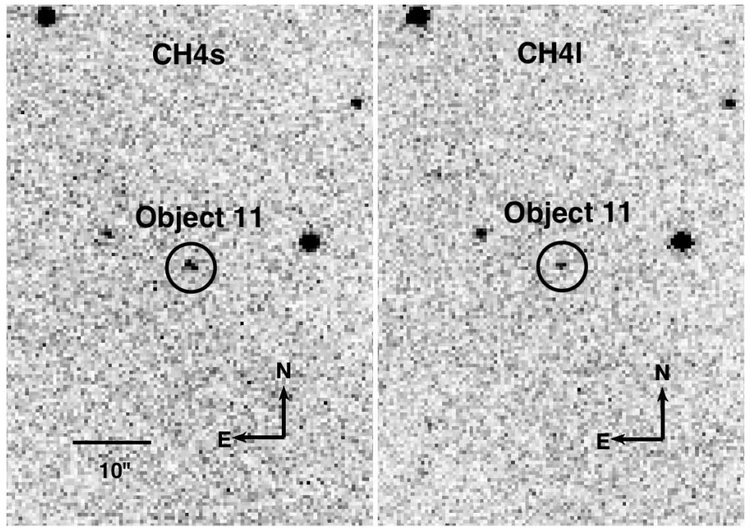


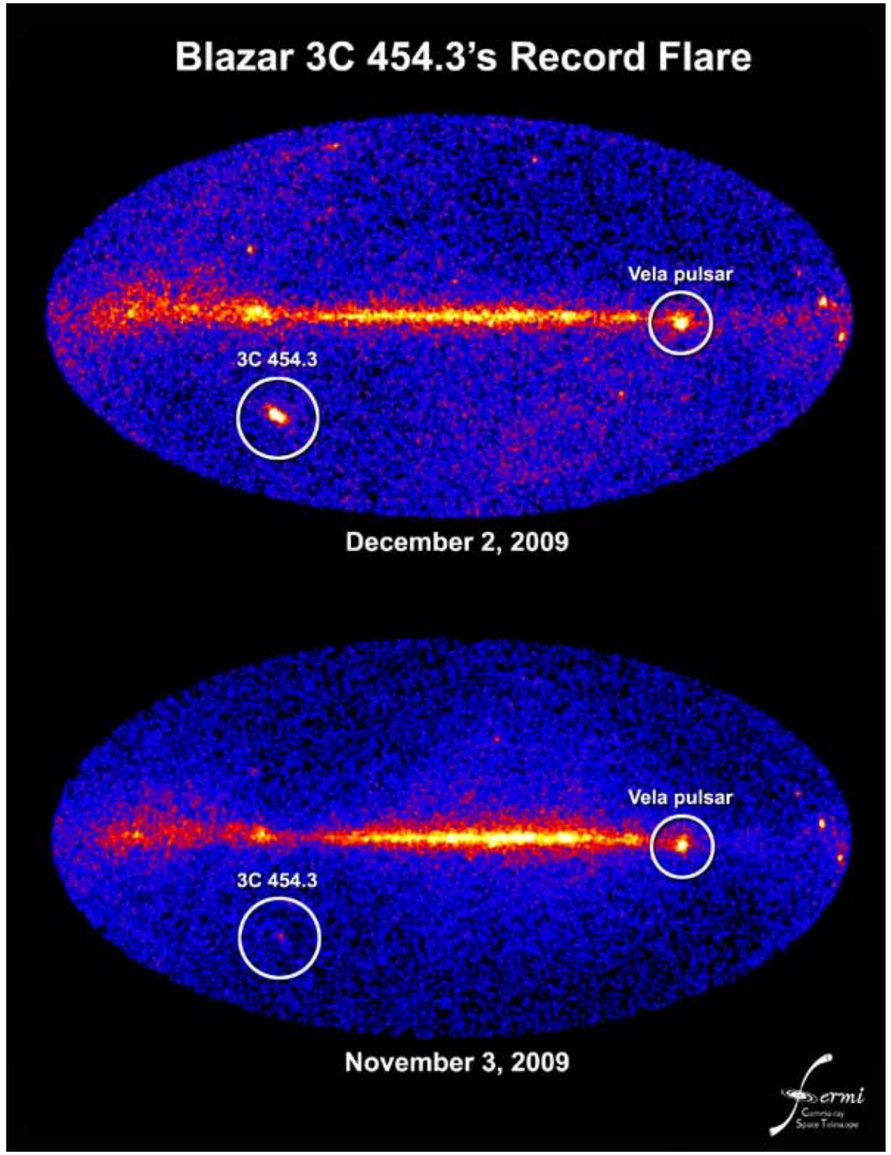
Image Above :: Methane-off (left) and methane-on (right) filter images of the young, planetary mass candidate, "Object 11" (circled). Note that this candidate methane absorbing young object is brighter in the methane-off (CH4s) filter than in the methane-on (CH4l) filter. (Credit: K. E. Haisch, Jr., M. Barsony, and C. Tinney).

Flares Near Supermassive Black Holes

Billion-solar-mass black holes lurk in the centers of massive galaxies. Matter near the black hole can orbit in an accretion disk where it will eventually fall into the black hole, or it can be channeled outward along the poles of the spinning black hole into tightly collimated, fast moving “jets”, as seen in quasars. The Fermi Space Telescope, launched in 2008 by NASA, detects very high energy gamma-ray emission from over a thousand quasars whose jets are pointed within a few degrees to our line of sight. Such objects also emit highly variable radio, infrared, optical, ultraviolet and x-ray light. An example is the quasar 3C454.3 which flared dramatically in 2009 at all wavebands.

SSI Senior Research Scientist Ann Wehrle (La Canada Flintridge, CA Office) has been studying how relativistic particles are accelerated within a few light years of the supermassive black holes in the centers of galaxies. The particles, such as electrons, positrons, and protons, move at near-light-speeds through magnetic fields surrounding the black hole, emitting radiation and subsequently scattering low-energy radio, infrared, and optical photons up to high energies such as in the gamma rays band. She observes with several instruments simultaneously, for example, with the Fermi Space Telescope in orbit around Earth and the Submillimeter Array Observatory on Mauna Kea, Hawaii, operated by the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy and Astrophysics. Her observations have shown that quasars vary twice as rapidly and strongly at high energy gamma ray bands than at low energy submillimeter bands.

Image Right Page:: Unprecedented flares from the blazar 3C 454.3 in the constellation Pegasus now make it the brightest persistent gamma-ray source in the sky. That title usually goes to the Vela pulsar in our galaxy, which is millions of times closer (Credit: NASA/DOE/Fermi LAT Collaboration).



FLIGHT OPERATIONS

The Cassini Imaging Central Laboratory for OperationS (CICLOPS) is located at SSI's Headquarters Office. CICLOPS is the center for uplink and downlink operations for the imaging science experiment on the Cassini mission to Saturn. All images produced by the two powerful telescopic cameras onboard Cassini (the Imaging Science Subsystem) make their way across more than a billion and a half kilometers (1 billion miles) of space to be archived in databases at CICLOPS and made available to imaging team members across the globe.

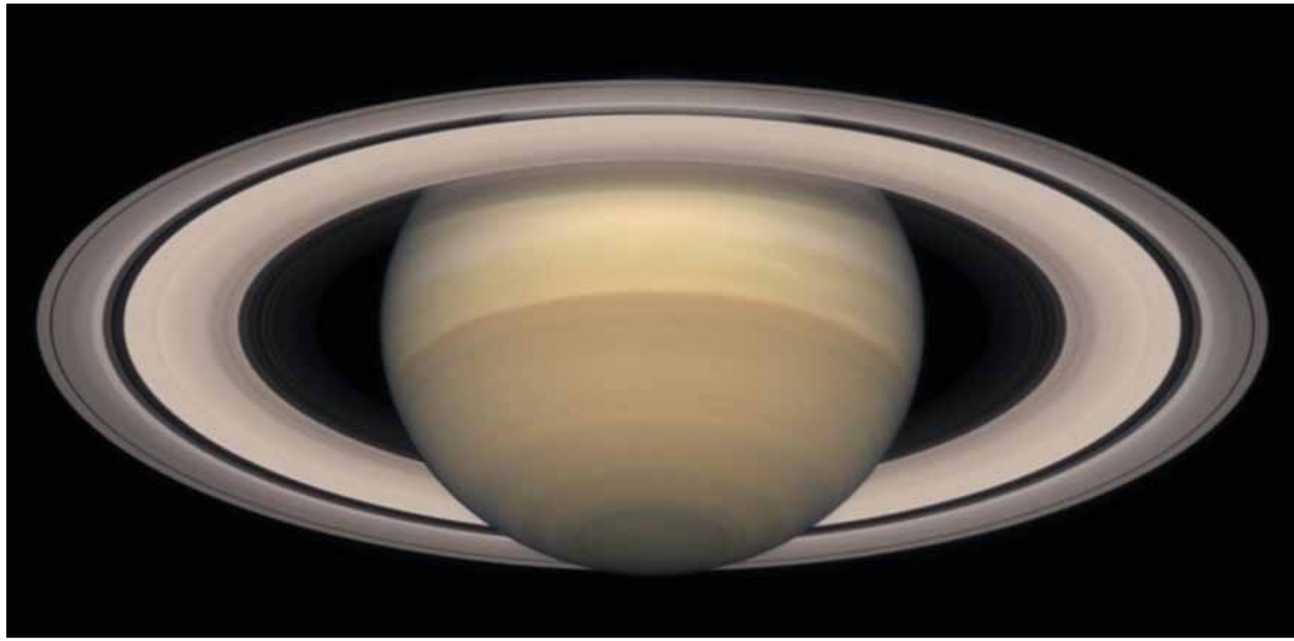
The Cassini-Huygens mission continues to change our view of the Saturn system. Since arriving at Saturn in the summer of 2004, the intrepid spacecraft has completed numerous close flybys of Saturn's moons, providing new perspectives and a wealth of data about this unique collection of objects. Cassini has monitored powerful lightning-generated radio outbursts and cloud activity produced by giant storms on Saturn that dwarf those on Earth. The Huygens probe landing on haze-shrouded Titan and Cassini's continuing survey of this moon from space have provided tantalizing glimpses of a world that is at once remarkably earthlike yet also frigid and alien. The startling revelation that Saturn's small, icy moon Enceladus may possess underground reservoirs of liquid water has widened the range of environments that might be hospitable for life.

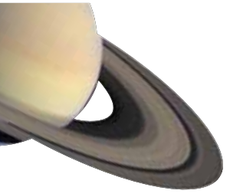
Image Left Page :: The Cassini Mission to Saturn. Credit: NASA
Image Right Page :: Saturn- The Ringed Planet. Credit: NASA/JPL/SSI

Images taken by Cassini are selected for release to the public at CICLOPS. Chosen images and movie sequences are processed to ensure quality, including the best possible color. The final products are posted to the CICLOPS website (http://ciclops.org) for distribution to the waiting world. Also posted on the CICLOPS site are imaging news stories, upcoming mission events, public discussions, Saturn-inspired artwork, and more.

Cassini's landmark exploration of the ringed planet, its mysterious moons, stunning rings, and complex magnetic environment will continue through 2017 when the spacecraft's third and final mission extension will come to an end. CICLOPS team members and the Cassini mission scientists and engineers are now hard at work executing the seven-year Cassini Solstice Mission, the second extension beyond Cassini's prime mission (which ended in 2008).

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency, and the Italian Space Agency. The Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, manages the Cassini-Huygens mission for NASA's Science Mission Directorate, Washington, D.C.



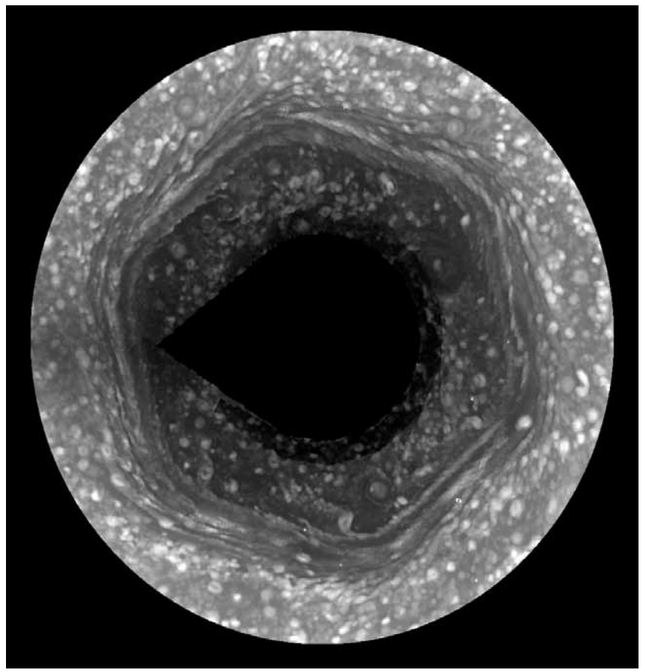


Cassini/Saturn Research

Led by Cassini Imaging Team Leader Dr. Carolyn Porco, CICLOPS came to SSI in August 2003. Fourteen scientists from the United States and Europe comprise the imaging team that uses Cassini's cameras to investigate many unique features of the Saturn system. The Imaging Team continues to publish findings from their investigations, deepening our knowledge about Saturn and the processes by which planets—and whole planetary systems—form and develop with time.

In 2010, Cassini images graced the pages of scores of magazines and websites around the globe. The mission continues to generate exciting science and exquisite imagery from the Saturn frontier.

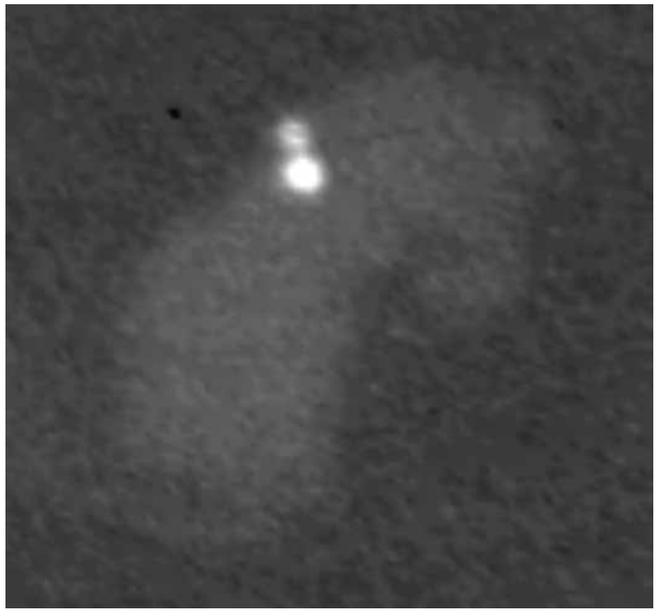
2010 Cassini Highlights

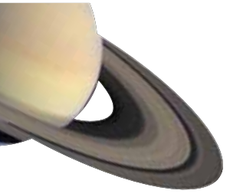


Saturn's Hexagon Reappears

After waiting years for the sun to illuminate Saturn's north pole again, cameras aboard the Cassini spacecraft captured the most detailed images yet of the intriguing hexagon shape crowning the planet as equinox approached and spring illuminated the northern latitudes. The last visible-light images of the entire hexagon were captured by NASA's Voyager spacecraft nearly 30 years ago, the last time spring began on Saturn. The new images of the hexagon, whose shape is the path of a jet stream flowing around the north pole, revealed concentric circles, curlicues, walls and streamers not seen in previous images. Scientists are still trying to figure out what causes the hexagon, where it gets and expels its energy, and how it has stayed so organized for so long.

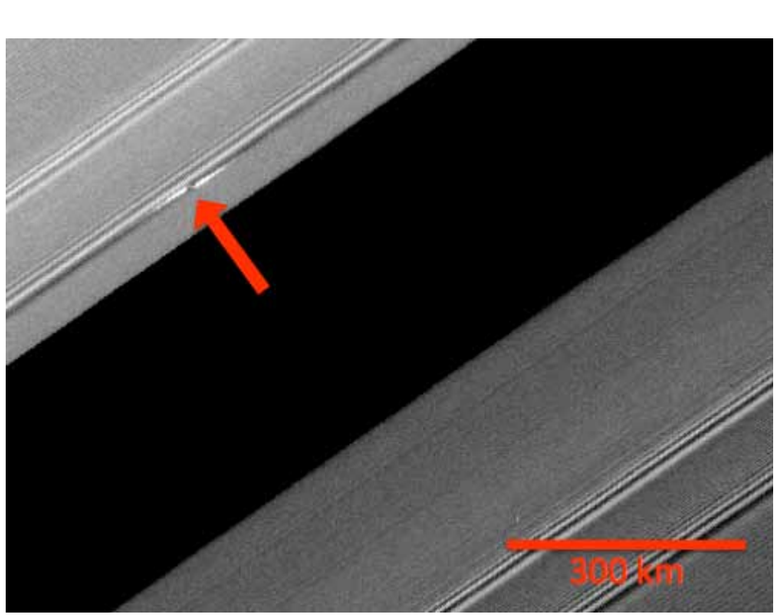
Lightning Captured on Saturn





Cassini captured the first images of lightning on Saturn, and scientists later created a movie complete with a soundtrack that featured the crackle of radio waves emitted when lightning bolts struck. The first images of the lightning were captured in August 2009, during a storm that churned from January to October 2009 and lasted longer than any other observed lightning storm in the solar system. Until the time of Saturn's August 2009 equinox, it had been difficult to see the lightning because the planet is very bright and reflective. Sunlight shining off Saturn's enormous rings made even the night side of Saturn brighter than a full-moon night on Earth. However, during equinox the sun lit the rings edge-on only and left the bulk of the rings in shadow. The movie and radio data suggest Saturn has extremely powerful storms with lightning that flashes as brightly as the brightest super-bolts on Earth.

Ring 'Propellers' Tracked for Years



Scientists used Cassini images to stalk a new class of moons in the rings of Saturn that create distinctive propeller-shaped gaps in ring material. It marked the first time scientists were able to track the orbits of individual objects in a debris disk. The research gives scientists an opportunity to time-travel back into the history of our solar system to reveal clues about disks around other stars in our universe that are too far away to observe directly. Cassini scientists first discovered double-armed propeller features in 2006 in the middle of Saturn's outermost dense ring, known as the A ring. The spaces were created by a class of moonlets - smaller than known moons, but larger than the particles in the rings - that could clear the space immediately around them. Scientists have found propellers as much as hundreds of times as large as those previously described, and these new objects have been tracked for as long as four years.

Galaxy-like Behavior of Saturn's B ring

Analysis of thousands of Cassini images of the B ring edge taken over the course of four years revealed the source of the B ring's complex behavior: the presence of at least three additional, independently rotating wave patterns, or oscillations. Astronomers believe that such self-excited oscillations exist in other astrophysical disk systems, like spiral disk galaxies and protoplanetary disks found around nearby stars. Images of the B ring's outer edge also revealed at least two perturbed regions, including a long arc of narrow shadow-casting peaks extending as high as 3.5 kilometers (two miles) above the ring plane (shown in figure on page 19). Scientists think these regions are likely populated by small moons that may have migrated across the outer part of the B ring sometime in the past to become trapped near the edge in a zone affected by the gravity of the moon Mimas. This process is commonly believed to have configured the present-day solar system.

Image Page 17 :: The hexagon-shaped feature in Saturn's north pole region. Credit: NASA/JPL/SSI

Image Page 18 :: Lightning captured on Saturn. Credit: NASA/JPL/SSI

Image Left Page :: Moons in Saturn's rings create propeller-shaped gaps. Credit: NASA/JPL/SSI

NATIONAL CENTER FOR INTERACTIVE LEARNING

NCIL is dedicated to expanding the understanding and participation of families, youth, teachers, and citizens in science and technology. Our programs are designed to be accessible to all and to inspire the next generation of STEM innovators through hands-on exhibits, community outreach, professional training, innovative partnerships, and new learning technologies. *NCIL* strives to advance the field of STEM learning through research, evaluation, and fostering the development of communities of practice.

The nature of STEM education is undergoing profound changes in the U.S. and abroad. Providing high quality STEM learning opportunities for all Americans is essential in the creation of an educated citizenry who understand the complex issues confronting our nation and the world. STEM professions and the pipelines for those professionals lack ethnic diversity. There remains a deep lack of culturally sensitive and effective STEM programs. The gap in understanding how people develop an interest in STEM, learn STEM, and develop related career interests is profound. And finally, the connection between those in STEM professions and the practice of STEM education is largely unrealized.

Dr. Paul Dusenbery, Executive Director of SSI, is also the Director of *NCIL*. *NCIL* is organized around five interconnected groups: 1) Exhibition Development, 2) Digital Learning, 3) Professional Development, 4) Community Outreach, and 5) Learning Research and Evaluation. *NCIL* programs span a range of audience needs and delivery methods. These include traveling museum exhibitions; digital learning technologies (e.g. gaming, augmented and mixed reality, novel data visualization systems, and online learning); hands-on teaching resources and activities; educator workshops; outreach to underserved audiences, such as girls' groups, Hispanics, Native Americans, urban and rural communities; and successful partnership building between scientists and educators. *NCIL* conducts external evaluations for a number of informal education organizations as well as providing internal evaluation services for on-going projects.

Educational projects include large-scale, institutional-level efforts supported by NSF and NASA (e.g., *Great Balls of Fire*, *Space Weather Outreach*, and *Open Exhibits*) as well as smaller-scale projects that

Image Left Page :: Visitors to the Giant Worlds exhibit explore gravity. Credit: NCIL/SSI

focus on individual scientists seeking educational support for research projects (e.g., an asteroids project funded by NSF called *Finding NEO*). This strategic approach allows *NCIL* to leverage the needs and effectiveness of both kinds of endeavors and to explore new educational methods and effectively "scale up" those that show promise.

In keeping with that strategy, *NCIL* is pursuing new directions for educational programming: an emerging partnership with the American Library Association to pilot interactive STEM exhibits in libraries in Colorado and beyond (e.g. *Discover Space*, *Discover Earth*, and *Discover Tech*); applications of internet technologies to facilitate social learning experiences (e.g. *Making Space Social*), and the continued development of educational multimedia capabilities. *NCIL* staff and its partners are leading the way to a new generation of educational innovation, which bridges the worlds of STEM research, education, and communication.

Image Above :: A young visitor at the Discover Space exhibit. Credit: NCIL/SSI

Guiding Principles

- Excite learners of all ages, ethnicities, and learning modalities with the thrill of scientific discovery.
- Integrate STEM research and STEM education.
- Ensure scientific accuracy in all activities.
- Rigorously evaluate and disseminate results.
- Cultivate mutually beneficial partnerships in STEM and education communities.
- Contribute significantly to educational research.

NCIL Impacts for 2010

- 275,000 visitors to museum exhibits
- 75,000 visitors to library exhibits
- 550,000 visits to *NCIL* educational websites
- 125 participants in educator workshops, virtual workshops, and conference presentations
- 25,000 downloads of *NCIL* educational materials, activities, and resources

2010 Highlights

Great Balls of Fire: Asteroids, Comets, and Meteors

NSF is funding the development of the *Great Balls of Fire* exhibition (PI Paul Dusenbery, SSI Headquarters Office), with additional support coming from the NSF and NASA funded *Finding NEO* project (PI James Harold, SSI Headquarters Office). NASA's WISE and Dawn missions are also project partners. The *Finding NEO* project is developing a public website (www.KillerAsteroids.org) and a small library exhibit on asteroids and asteroid research. It explores asteroids, asteroid impacts, risk, and the role of amateur astronomers in collecting and analyzing light curve data.

The centerpiece of the comprehensive informal education project is a 3,000-square foot traveling exhibit (the national tour beginning in May, 2011). To maximize audience reach, the exhibition also includes an exhibit for small science centers (about 750 square-feet) and a library-sized exhibit created in partnership with *Finding NEO*. *NCIL* is developing an Education/Outreach Program for museum educators, docents, and amateur astronomers, as well as a professional development program for science center staff, library staff (in partnership with the Astronomical Society of the Pacific (ASP) and Catawba Science Center in Hickory, NC), and other informal education professionals (in partnership with the Association of Science-Technology Centers) . A programmatic website provides information about the large and small exhibits as well as the project's education and outreach programs (www.GreatBallsOfFireExhibits.org). The Institute for learning Innovation (ILI) is conducting the project's evaluation.

Three teams of middle school students from North Carolina (Catawba Science Center), New Mexico (New Mexico Museum of Natural History and Science), and Colorado (Sunset Middle School) assisted with the development process, and each team created an exhibit or multimedia piece for their communities. An evaluation conducted by ILI found that the project increased student understanding about asteroids and comets as well as excitement in being involved in the development process. Many of the participants entered the program believing that science was boring and by the end of the program reported enjoying and valuing the role of science in everyday life.

MyStar: Learning Stellar and Planetary Evolution with your own Personal Solar System

With funding from the *Space Telescope Science Institute* and *NCIL's Alien Earths* project, the *NCIL* team has been developing *MyStar*: an online, multi-user stellar and planetary evolution game (PI James Harold, SSI Headquarters Office). The game is closely aligned with the national science standards and is designed to introduce visitors to the basic concepts of stellar and planetary evolution: stars are born, live, and die, and their lives are controlled by their initial mass. Visitors to the *MyStar* site can form their own star, then observe and study it as it evolves in scaled real time (a million years per minute). Over the course of days or weeks, players can receive email or

Image Above :: The Great Balls of Fire exhibit. Credit: NCIL/SSI

text message prompts as their star and accompanying planetary system enter new phases. Perhaps life will arise; perhaps not. If the system includes a giant planet, it might clear the debris from the solar system and save the inhabitants from destruction by bombardment or, if positioned poorly, the giant planet might simply eject any habitable planets. In the end, the system will meet a fate determined by the mass of the star: either the planets will be overwhelmed by the envelope of the red giant, or be obliterated by the searing heat and gamma ray blast of a supernova.

The project will be completed in 2011 with an in-classroom evaluation. In addition, *MyStar* has provided the groundwork for two new grants, one from NASA and another from NSF. These grants will be used to create a similar, but enhanced, game for the Facebook platform.

Image Above :: A screenshot of the MyStar homepage. Credit: NCIL/SSI

STAR_Net: Reaching out to Rural, Underserved Libraries

In 2007, American libraries received about 1.3 billion visits from patrons. Libraries are natural venues for engaging and educating the public about science and technology (both content and process knowledge). Over 17,000 public library outlets exist nationwide, often at the heart of rural and urban underserved and low-income populations. The public library of today is very different from that of 10 years ago. Recognizing that they are the only public institutions to offer free access to information, technology, and services to educationally at-risk populations, libraries are evolving from offering only books to offering continuing education, academic assistance, parenting classes and children's programs in accordance with the cultures and needs of their local audiences. Libraries are seeking

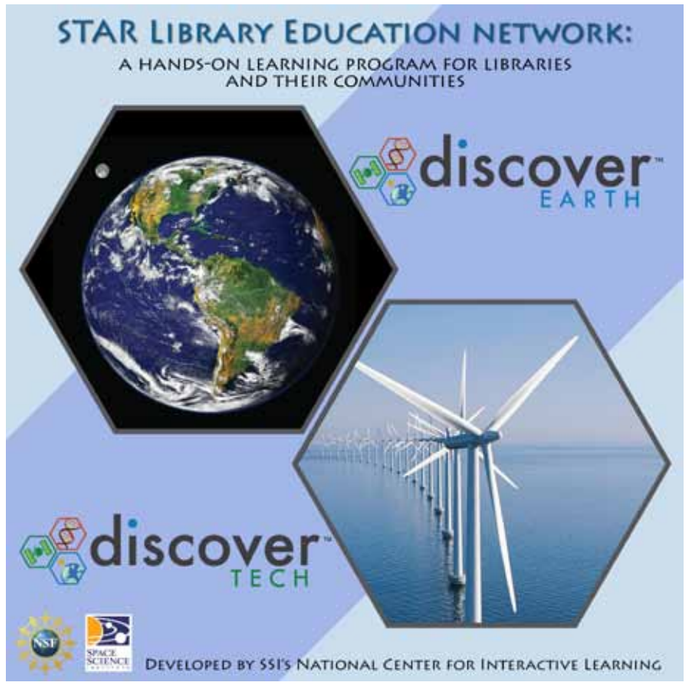


Image Above :: STAR_Net's two exhibitions: Discover Earth and Discover Tech. Credit: NCIL/SSI

innovative methods for engaging their audiences such as interactive exhibits and STEM programming for their children's and youth programs.

NSF is supporting the development of the *STAR Library Education Network: a hands-on learning program for libraries and their communities*, (STAR_Net for short). STAR stands for "Science-Technology, Activities and Resources." The overarching goal of the project is to reach underserved youth and their families with informal STEM learning experiences. This project will also deepen our knowledge of informal and lifelong learning that takes place in libraries.

Team members include *NCIL* staff, the American Library Association (ALA), Lunar and Planetary Institute (LPI), and the National Girls Collaborative Project (NGCP). STAR_Net is the result of the success of *NCIL's* currently touring library exhibit *Discover Space*. ALA has many years' experience developing library exhibit tours and LPI will be able to leverage its successful *Explore!* library project that develops inquiry-based activities and conducts workshops for librarians. The STAR_Net project also includes a comprehensive evaluation plan and a research component that compares learning in a science center or museum with what can take place in a rural library. STAR_Net will develop two important education and exhibit programs: *Discover Earth* and *Discover Tech*. These exhibit programs will serve eighteen libraries across the U.S. over a two-year tour beginning in 2011.

Open Exhibits

Kate Haley Goldman, *NCIL's* Director of Learning Research and Evaluation (Silver Spring, MD Office) is a Co-PI on a new NSF-funded project called *Open Exhibits* (PI Jim Spadaccini, Ideum). This three-year project will develop, test, and disseminate a free suite of original, multi-touch enabled, open source exhibit software components. The software will enable science centers and museums to do something very few of them have been able to do in the past: assemble their own interactive computer-based exhibits and online interactive resources.

This project opens the door for small and underfunded science centers to create and personalize interactive displays that are of interest to their specific audiences. It

Image Right Page :: Jim Spadaccini (PI for Open Exhibits) demonstrates the use of a multitouch table. Credit: Ideum

provides critical tools and support for small science museums and science centers to develop multimedia kiosks, touchscreens and multitouch tables, allowing those institutions to create deeper levels of engagement for their visitors. Small institutions receive relatively little NSF funding, and this will greatly help level the playing field.

The *Open Exhibits* software suite will consist of a core software package (already released on the website) along with easy-to-use modules and templates to build museum staff capacity in the design, implementation and updating of their own interactives. The templates include a current science news aggregator, a timeline-based exhibit, and a collections viewer. Educators will also have access to universal modules that allow a greater degree of customization and can drive further advancements to the software.

Haley Goldman will oversee the applied research of the interactives, developing a framework of best practices and up-to-date evaluation methods for assessing computer-based interactives in informal learning settings. The project has an international community of over 1,200 users on the website: www.OpenExhibits.org.

FINANCIAL REPORT

Space Science Institute
Summary Statement of Financial Position
as of December 31, 2010 and 2009

	2010	2009
Assets		
Assets		
Cash and cash equivalents	$ 558,700	$ 611,413
Accounts receivable	754,740	872,876
Prepaid expenses and deposits	68,985	77,310
Net furniture, equipment, and property	55,253	59,156
Total assets	$ 1,437,678	$ 1,620,755
Liabilities and Net Assets		
Liabilities		
Accounts payable and accrued liabilities	$ 345,570	$ 365,265
Deferred revenues	544,637	657,063
Line of credit	231,580	315,000
Total liabilities	1,121,787	1,337,328
Net assets		
Unrestricted	256,244	217,807
Temporarily restricted	59,647	65,620
Total net assets	315,891	283,427
Total liabilities and net assets	$ 1,437,678	$ 1,620,755

Summary Statement of Activities
for the years ended December 31, 2010 and 2009

	2010	2009
Support and revenue		
Grants, contracts, and cooperative agreements	$ 5,201,714	$ 5,167,075
Contributions	1,350	10,850
Exhibit income	86,885	89,952
Interest income	446	176
Loss on disposal of equipment	(13,787)	-
Other income	339	357
Total support and revenue	5,276,947	5,268,410
Expenses		
Program services	5,223,579	5,205,147
General and administrative	20,904	19,783
Total expenses	5,244,483	5,224,930
Change in net assets	32,464	43,480
Net assets, beginning of year	283,427	239,947
Net assets, end of year	$ 315,891	$ 283,427

The summary financial information does not include sufficient detail or disclosures to constitute presentation in conformity with accounting principles generally accepted in the United States of America. If the omitted detail or disclosures were included, they might influence the user's conclusions about the Organization's financial position, changes in net assets, and cash flows. Accordingly such information should be read in conjunction with the Organization's audited financial statements for the years ended December 31, 2010 and 2009, from which the summarized information was derived. A copy is available upon request.

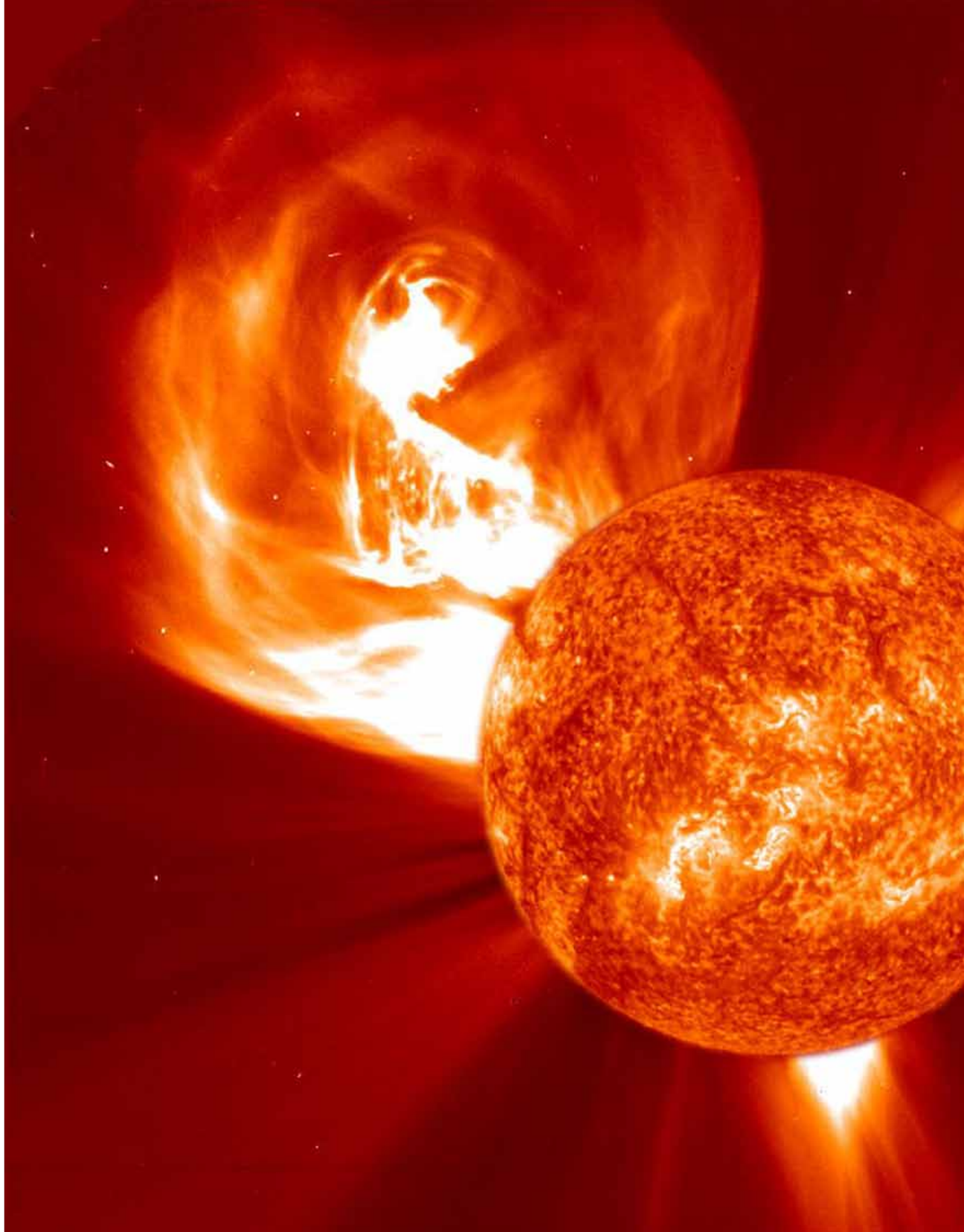


Image Right Page :: *NASA's Mars Reconnaissance Orbiter acquired this color image of "Santa Maria" crater, showing the Opportunity Rover perched on the southeast rim. Image Credit: NASA/ JPL-Caltech/Univ. of Arizona.*

WWW.SPACESCIENCE.ORG

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