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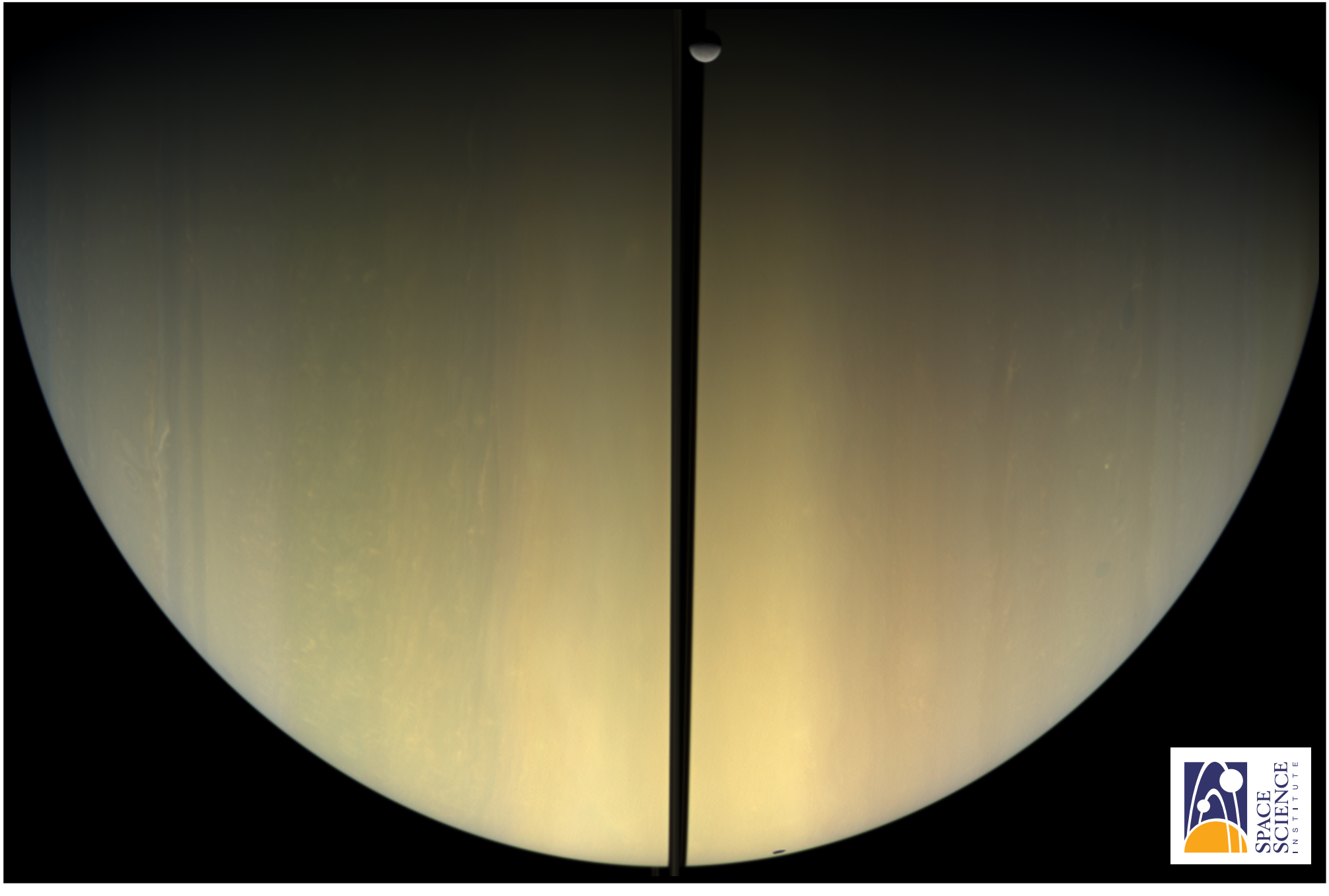
ANNUAL REPORT 2009



SPACE SCIENCE INSTITUTE

OUR VISION

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

MESSAGE FROM THE DIRECTOR

Excite. Explore. Discover. These words describe our efforts in both science 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 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 2009 revenues were $5.3M, a 6% increase from 2008.

SSI has a robust Research Branch 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. Two new researchers joined the Branch last year: Ralph Shuping (Research Scientist, Portland, OR Office) and Franz Bauer (Research Scientist, Brooklyn, NY Office).

SSI's Flight Operations Branch 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. CICLOPS and the Cassini mission scientists and engineers are now hard at work executing the two-year Cassini Equinox Mission, the first extension beyond Cassini's prime mission (which ended in 2008). The Equinox Mission will end in September 2010. Work is now underway to plan the long-term second extension that will last through Saturn's northern summer solstice (2017).

In 2009, SSI's Education Branch continued to develop its national Asteroids exhibition project *Great Balls of Fire: Comets, Asteroids, and Meteors* (supported by NSF). Development also continued on the *Science Theater Education Programming System* (STEPS) project (supported by NSF) and the *Finding NEO* projects funded by both NSF and NASA. The 3,000 square-foot *Alien Earths* exhibition was sold to the Virginia Air and Space Center and the 3,500 square-foot *Giant Worlds* traveling exhibition continued its national tour.

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 in Colorado and elsewhere. Come join our voyage of discovery.

With warmest regards,

Paul B. Dusenbery, Ph.D.
Executive Director

RESEARCH

SSI's Research Branch scientists participate in a broad array of space science activities, including earth science, planetary science, and astrophysics. Our research team's expertise continues to expand, and now encompasses investigations of phenomenon on Earth, 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 distant galaxies.

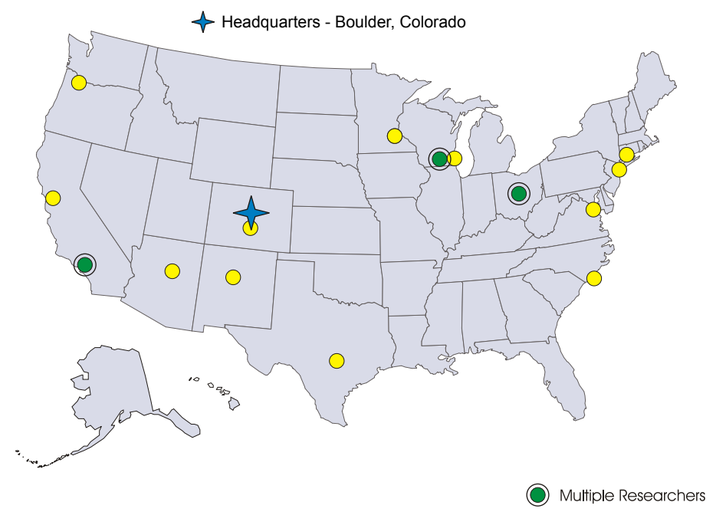
SSI researchers are closely connected to the operations of current astrophysical space facilities such as the Spitzer and Hubble Space Telescopes, and are deeply engaged in future platforms such as the James Webb Space Telescope. Closer to home, several SSI researchers focus on Mars research through active participation in the ongoing Mars Exploration Rovers and Mars Reconnaissance Orbiter missions.

SSI's off-site and on-site researchers form a network of naturally entrepreneurial scientists who support themselves through a mixture of grants and contracts. Our organization and infrastructure allow 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 our researchers with domestic constraints and environmental-impact concerns. The long-distance nature of most scientific collaborative research lends itself well to the option of remote employment: traditional interactions can be readily accomplished via the internet and phone, and supplemented by occasional travel. Access to significant computational resources no longer requires large institutional support. Furthermore, most academic journals and professional proceedings are fully accessible over the internet, 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. The map below shows where SSI's researchers are located in the United States.

Space Science Institute's Off-Site Researchers



Cover :: Saturn, stately and resplendent in this natural color view, dwarfs the icy moon Rhea. Credit: NASA/JPL/Space Science Institute

Inside Cover :: The Eagle Nebula region of the Milky Way Galaxy. Credit: NASA/Spitzer Space Telescope

Top Left :: A solar system forming. Credit: NASA

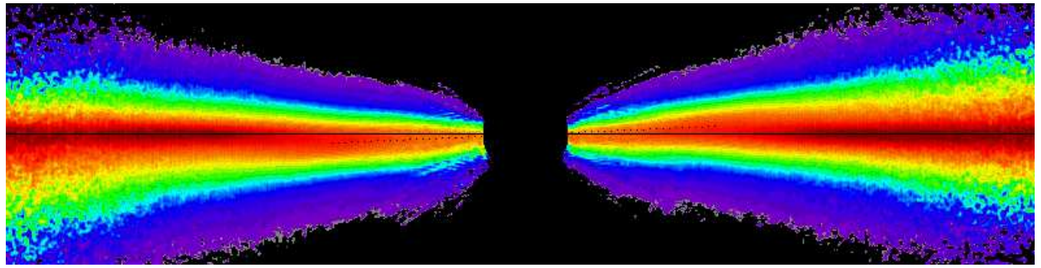
Back Inside Cover :: This panorama shows the vista from the location where NASA's Spirit rover spent its third Martian southern-hemisphere winter inside Mars' Gusev Crater. Credit: NASA/JPL/Cornell Univ

RESEARCH

2009 Research Highlights

Circumstellar Disks—sites of ongoing planet formation or planetary destruction?

Circumstellar debris disks frequently encircle a young star, with one of the most famous disks being the edge-on disk that orbits the star β Pictoris (located about 63 light years from our Solar System). The disk is composed of tiny dust particles that originate near the star and are lofted into wide orbits due to radiation pressure. The disk is very large: observable out to about 1,000 AU (an AU is approximately 150 million kilometers; Pluto orbits our Sun at about 40 AU). Debris disks are suspected sites of ongoing planet formation. The dusty debris itself is thought to be quite short-lived, usually much briefer than the age of the host star. Thus, a debris disk must be supplied with fresh dust, likely due to collisions among unseen planetesimals (small asteroidal or comet-like bodies). Planetesimals are also the seeds of planets. If collisional grinding in the planetesimal disk is too vigorous, then planetesimals might erode away before they have a chance to assemble into planets. Indeed, models for the early evolution of the Kuiper Belt—which is the swarm of icy objects orbiting just beyond Neptune—predict just that. Although that Belt probably had an initial mass comparable to ~30 Earths, it only managed to produce a handful of "Plutos" before collisions ground most of the planetesimals into dust that was then blown away by radiation pressure.

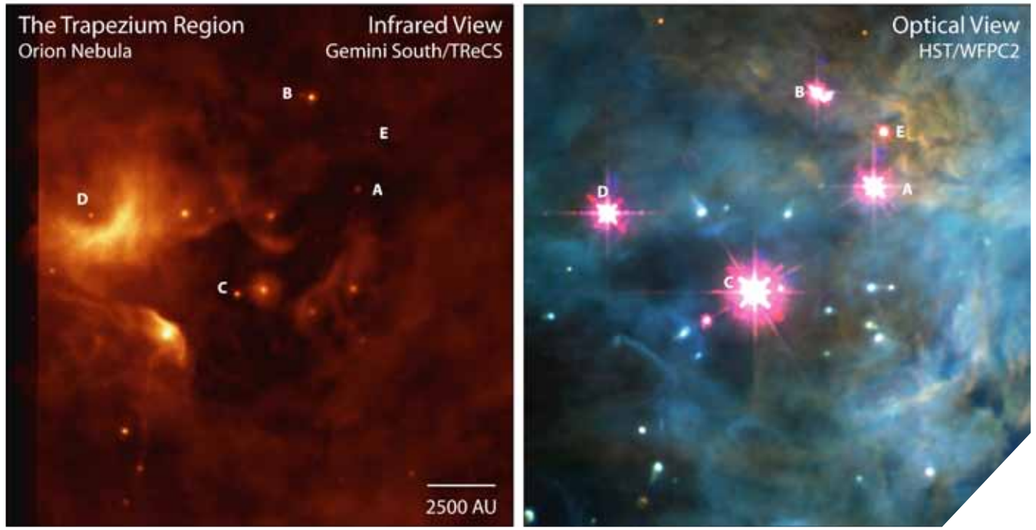


SSI Research Scientist Joe Hahn (Austin, TX Office) explores whether observed debris disks are planet-forming disks, or if they are erosive and planetesimal-destroying like our Kuiper Belt. To address this, he developed a model of a circumstellar disk that accounts for dust production, the effects of radiation pressure, and collisions among dust grains. By comparing his model with observations of disks like that of β Pictoris, the unseen planetesimals that are responsible for the observed dust can be revealed. His model of β Pictoris suggests about 10 lunar masses of dust within the disk. The model also suggests that planetesimals must be collisionally eroding at a pace that is about 300 times faster than that predicted for our own Kuiper Belt. This research indicates that the planetesimal disk is, or was, quite massive and is eroding rapidly due to collisional grinding.

Protoplanetary Disks in the Orion Nebula

The Orion Nebula, located about 1,500 light years away, is an energetic stellar nursery giving birth to thousands of young, Sun-like stars with debris disks that may one day form planetary systems (protoplanetary disks). A few of the newborn stars, however, are big babies: 10 to 30 times the mass of our Sun and 10,000 times as bright. These massive stars bathe the entire region in harsh ultraviolet radiation, which evaporates the protoplanetary disks of their lower mass neighbors. Previous studies have suggested that this evaporation would inhibit the processes leading to planet formation. The properties of dust in disks around young stars plays a pivotal role in understanding star formation, as well as determining the origins of planets in our Solar System and in extrasolar planetary systems.

SSI Research Scientist Ralph Shuping (Portland, OR Office) has been studying the effects of these huge, young stars using infrared instruments at the W. M. Keck Observatory, NOAO's Gemini Observatory, and NASA's Infrared Telescope Facility. The dusty disks are extraordinarily bright in the infrared. His observations reveal that small dust grains located in disks around young stars are growing, taking the initial steps toward forming planets despite being bathed in a flood of radiation from their highly luminous neighbors.



Left Page :: Hubble Space Telescope image of β Pictoris in false color. The dust grains seen here are illuminated by the central star that is hidden behind a black occulting mask. Credit: NASA/ESA/David Golimowski

Right Page :: Trapezium stellar nursery in the Orion Nebula. On the left, sources A-D are bright in the infrared. Credit: N. Smith, Univ. of Colorado/Gemini/HST

RESEARCH

A Habitable Mars?

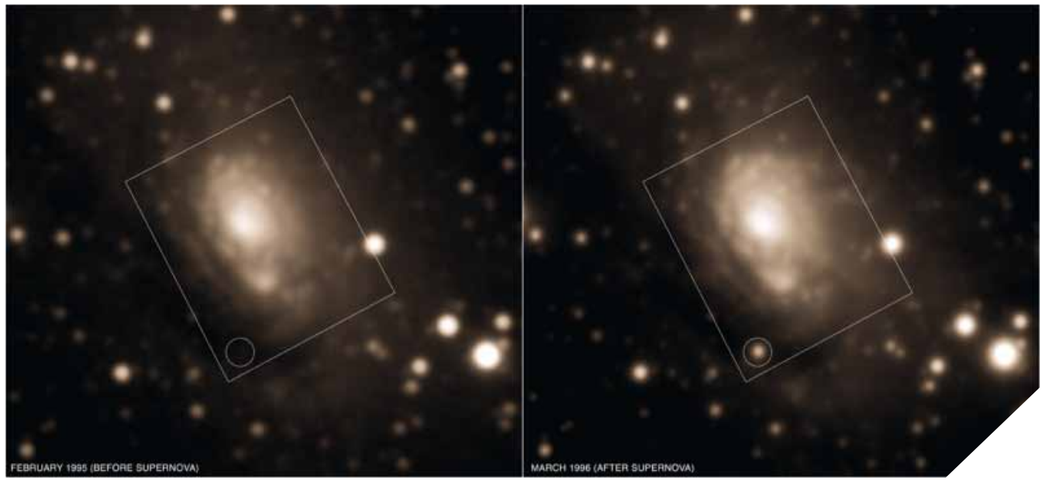
On Mars, the Spirit rover continued its exploration of the Columbia Hills. Examination of data from an unusually reddish rock outcrop the team had named "Comanche" showed peculiarities compared to other rocks in the vicinity (Ben Clark, Senior Research Scientist, Colorado Office, is a member of the Mars Exploration Rover team). The first indication was from an instrument called a Moessbauer spectrometer. In analyzing these results, Dick Morris, of NASA's Johnson Space Center, discovered that the data matched the spectrum of certain carbonate minerals. Other instrument results were re-examined and the evidence grew stronger that this rock did indeed contain significant amounts of iron-rich carbonate, although apparently not the calcium carbonate that is so common on Earth in limestones.

Scientists have been searching for evidence of carbonates on Mars ever since the discoveries nearly four decades ago that Mars once had liquid water flowing over its surface. Carbonates contain carbon dioxide molecules locked into their chemical composition, and would help explain how the past atmospheric pressures and temperatures on Mars could have been higher if more CO_2 greenhouse gas had been present in its atmosphere. On Earth, of course, there is currently considerable worry about the CO_2 we are pumping into our own atmosphere and whether it can be accommodated by nature without warming the planet. For Mars, if there were a way to take the CO_2 out of carbonates at the surface and put it back into the atmosphere, perhaps we could make it habitable for life again. Some scientists have speculated that so-called planet-scale "geoengineering" projects could be used to transform Mars from its current deep freeze, or to save the Earth from over-heating.

The Last Days of a Dying Star

Supernovae occur when massive stars explode, typically causing a dramatic brightening in the star and flurry of activity at telescopes around the world. Yet one of the closest supernovae in the past three decades, SN1996cr, exploded without fanfare and remained unidentified for years (located about 12 million light years away). This neglect was due in part to its unusual temporal evolution: it was faint at first, only rising dramatically after a few years.

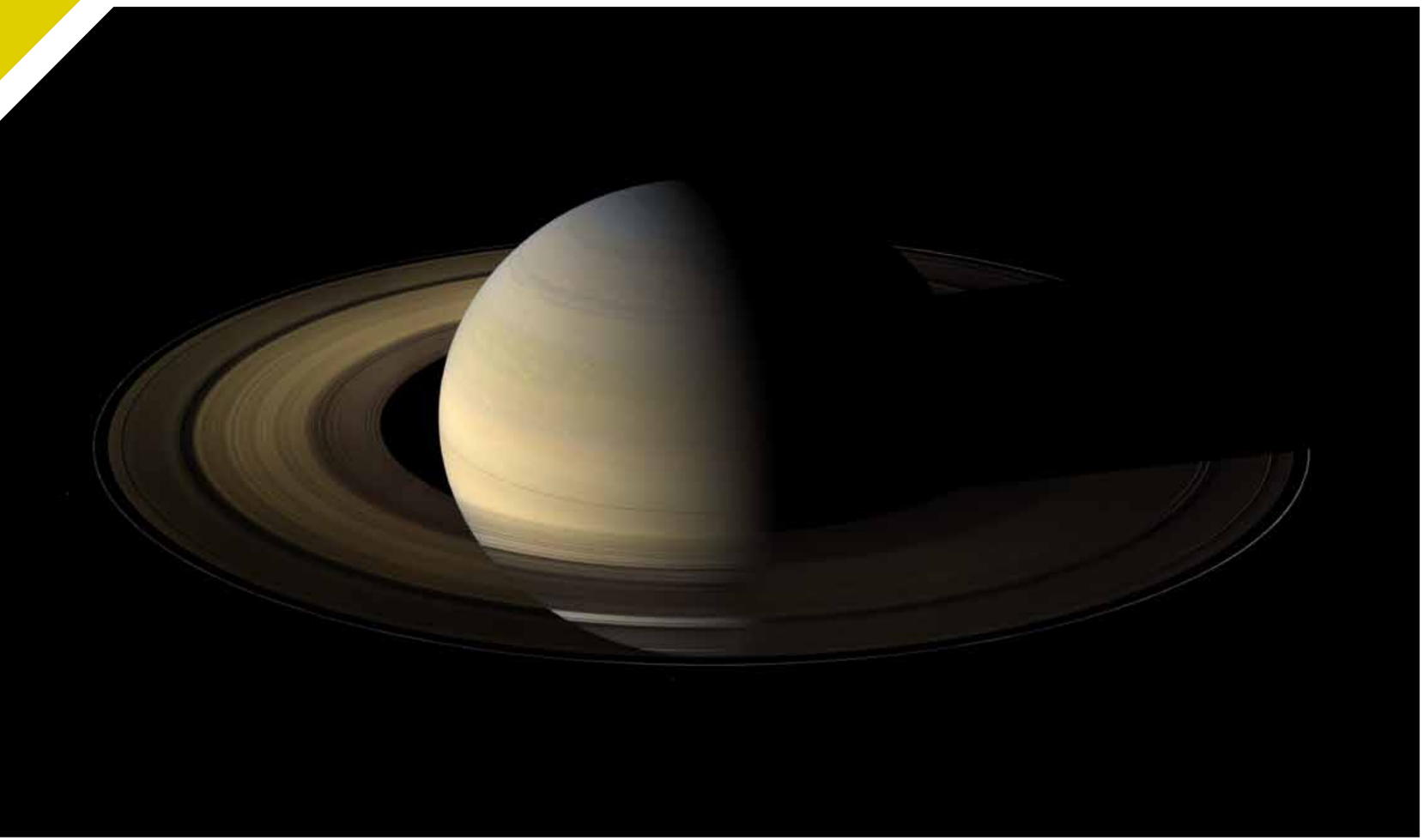
SSI's Research Scientist Franz Bauer (Brooklyn, NY Office) and colleagues investigated this unusual behavior by matching several decades of observations of SN1996cr with hydrodynamical simulations of its explosion. From this work, they inferred the nature and structure of the circumstellar material surrounding the supernova, the evolution of the supernova shock wave, and the chemical make-up of the ejecta and surrounding material. SN1996cr apparently exploded in a region of very low-density material, accounting for the initial low brightness, before finally interacting with a dense shell of material. This dense shell was likely formed during an earlier stage in this star's life. It seems this star went through some sort of a stellar "personality crisis" just prior to exploding. Such rapid changes just before explosion could have important implications for our theories of stellar evolution.



Left Page :: Spirit used its panoramic camera to capture this false-color view of the Comanche outcrop on Mars. The find at Comanche is the first unambiguous evidence from either Spirit or its twin, Opportunity, for a past Martian environment that may have been more favorable to life than the wet but acidic conditions indicated by the rovers' earlier finds. Credit: NASA/JPL-Caltech/Cornell

Right Page :: Supernovae SN1996cr (shown circled in the image on the right). Credit: NASA

FLIGHT OPERATIONS



The Cassini Imaging Central Laboratory for OperationS (CICLOPS) is located at SSI, headquartered in Boulder, Colorado. 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.

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://www.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 will come to an end. CICLOPS team members and the Cassini mission scientists and engineers are now hard at work executing the two-year Cassini Equinox Mission, the first extension beyond Cassini's prime mission (which ended in 2008). The current mission extension will end in September 2010. Work is now underway to plan the long-term extension that will last through Saturn's northern summer solstice. It is formally called the Soltice Mission.

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.

Top Left :: Saturn seen at equinox. Credit: Cassini Imaging Team and NASA/JPL/SSI

FLIGHT OPS

Cassini/Saturn Research

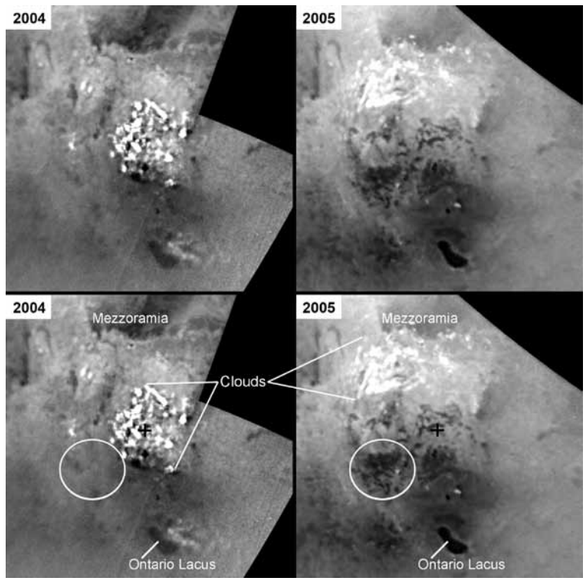
Led by Cassini Imaging Team leader Dr. Carolyn Porco, CICLOPS came to SSI in August 2003. Fourteen scientists from the United States and Europe comprise the imaging team that uses Cassini's cameras to investigate the many unique features of the Saturn system. The Imaging Team continues to publish findings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

In 2009, 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.

2009 Cassini Highlights

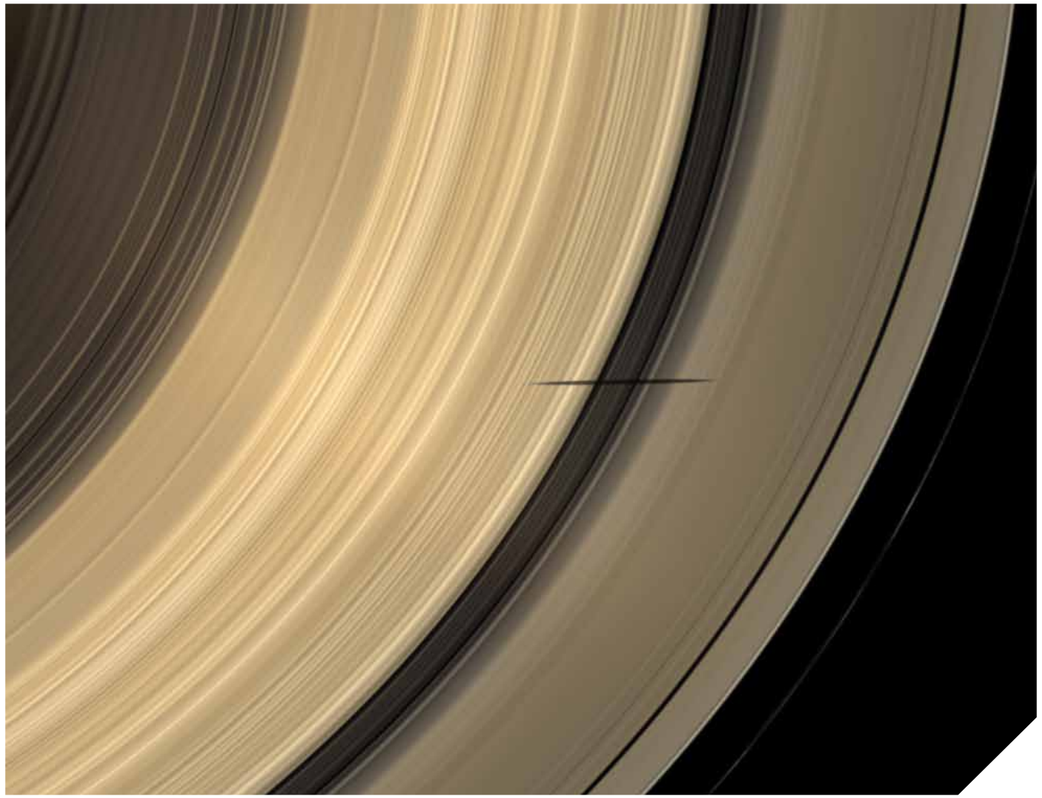
Titan's Changing Lakes

Images from the Cassini spacecraft affirmed the presence of lakes of liquid hydrocarbons on Titan by capturing changes in the lakes brought on by rainfall. Cassini scientists suspected that dark areas near the north and south poles of Saturn's largest satellite might be liquid-filled lakes. An analysis of Titan's south polar region revealed new lake features not seen in images of the same region taken a year earlier. The presence of extensive cloud systems covering the area in the intervening year suggests that the new lakes could be the result of a large rainstorm and that some lakes may thus owe their presence, size, and distribution across Titan's surface to the moon's weather and changing seasons.



Saturn's Equinox Arrives

The Cassini Equinox Mission came to fruition as Saturn's equinox occurred in early August 2009. The novel illumination geometry that accompanies equinox lowers the Sun's angle to the ring plane, significantly darkens the rings, and causes out-of-plane structures to look anomalously bright and cast shadows across the rings. These scenes are possible only during the few months before and after Saturn's equinox, which occurs only once in about 15 Earth years. Before and after equinox, Cassini's cameras spotted not only the predictable shadows of some of Saturn's moons (the shadow of the moon Mimas is shown on the rings here), but also the shadows of newly revealed vertical structures in the rings themselves.



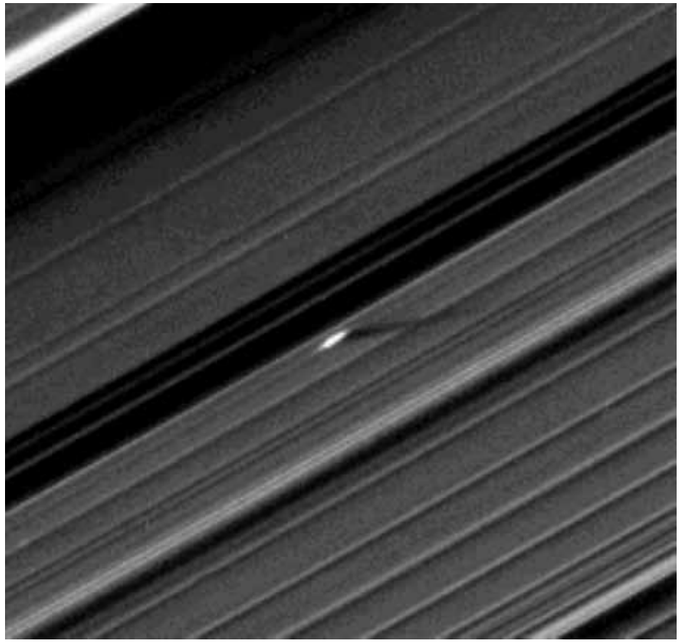
Left Page :: Changes in lakes of liquid hydrocarbon were tracked on Saturn's largest moon, Titan. Credit: Cassini Imaging Team and NASA/JPL/SSI

Right Page :: Saturn's moon Mimas (not shown) casts a shadow on the planet's rings. Credit: Cassini Imaging Team and NASA/JPL/SSI

FLIGHT OPS

New Ring Structures Revealed by Equinox

Images captured during Saturn's equinox gave scientists a unique and revealing glimpse into the physical processes underlying the rings' architecture and time-variability. These images revealed unusually large propeller-like features in the outer A ring, such as the one shown casting a shadow here. Scientists were also startled to find that a spiraling undulation with a 19-mile (30-kilometer) wavelength, first discovered in 2006 extending across 500 miles (800 kilometers) of the rings, was now shown by the low-sun-angle illumination covering a radial distance of about 11,000 miles (17,000 kilometers). The enormous extent of the corrugation now makes its existence more mysterious than ever.



The Tallest Known "Northern Lights"

In the first video showing the auroras above the northern latitudes of Saturn, Cassini spotted the tallest known auroras in the solar system. The images showed a previously unseen vertical profile to the auroras, which rippled in the video like tall curtains. These curtains reach more than 750 miles (1,200 kilometers) above the edge of the planet's northern hemisphere. While Earth's atmosphere has a lot of oxygen and nitrogen, Saturn's atmosphere is composed primarily of hydrogen. Because hydrogen is very light, the atmosphere and auroras reach far out from Saturn. Scientists are working to determine the true color of the auroras at Saturn (a false-color orange is shown here).

Left Page :: A propeller-like structure in Saturn's rings casts a shadow during equinox. Credit: Cassini Imaging Team and NASA/JPL/SSI

Right Page :: An aurora on Saturn is shown in false color orange. Credit: Cassini Imaging Team and NASA/JPL/SSI

EDUCATION

Guiding Principles

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

SSI's Education Branch is involved in a variety of innovative projects that promote inquiry and Science, Technology, Engineering and Math (STEM) literacy. We foster collaboration between scientists and educators to bring the knowledge and excitement of scientific discovery to audiences across the country. In addition, our programs help cultivate a greater appreciation and understanding of STEM's many achievements. Our programs span a range of audience needs and delivery methods, including traveling museum exhibitions; award-winning educational films, videos, and websites; hands-on teaching resources and activities; educator workshops; outreach to underserved audiences, such as girls' groups, Hispanic, Native American and rural communities; and successful partnership building between scientists and educators. Education Branch staff are committed to evaluating their projects and conducting educational research in order to improve what we do and to better understand the impact we are having on a local, regional, and national scale.

Education Program Impacts - 2009

- 275,000 visitors to SSI museum exhibits
- 450,000 visitors to SSI educational websites
- 125 participants in educator workshops, virtual workshops, and conference presentations
- 25,000 downloads of SSI educational materials, activities, and resources distributed online

Educational projects include large-scale, institutional-level efforts supported by the National Science Foundation and NASA (e.g., *Giant Worlds*, *Science Theater Education Programming System*, *Great Balls of Fire*, and the *Space Weather Outreach* program) as well as smaller-scale projects that focus on individual scientists seeking educational support for research projects (e.g., an asteroids project called *Finding NEO* with SSI Senior Research Scientist Al Harris (La Canada, CA Office)). This strategic approach allows the Education Branch 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, the Education Branch is pursuing new directions for educational programming: the continued development of documentary film production capabilities; an emerging partnership with the American Library Association to pilot small STEM exhibits in libraries in Colorado and beyond (*Discover Space*); and applications of internet and multimedia technologies to facilitate social learning experiences. Education Branch staff and their partners are leading the way to a new generation of educational innovation, which bridges the worlds of STEM research and communication.

Top Left :: Giant Worlds exhibit at Orlando Science Center. Credit: Space Science Institute

EDUCATION

2009 Education and Public Outreach Highlights

Great Balls of Fire: Asteroids, Comets, and Meteors

The National Science Foundation (NSF) is funding the development of the *Great Balls of Fire* exhibition (PI Paul Dusenbery, SSI Headquarters), with additional support coming from the NSF and NASA funded *Finding NEO* project (PI James Harold, SSI Headquarters). Additionally, NASA's WISE and Dawn missions are also project partners.

The centerpiece of this comprehensive informal education project is a 3,000-square foot traveling exhibit. To maximize audience reach, the exhibition also includes two small exhibits that will be used in a host venue's community and at small science centers across the country. The small science center exhibit will be about 500 square-feet in size. SSI 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, and other informal education professionals. A public website will provide an interactive resource for all the project's components.

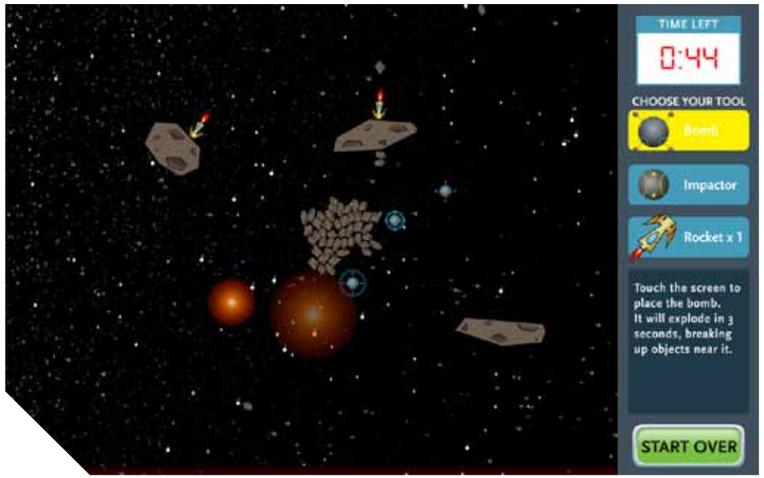
Three teams of middle school students from North Carolina, New Mexico, and Colorado are assisting with the development process and each team is creating an exhibit or multimedia piece for their community. The Institute for Learning Innovation is conducting all phases of program evaluation, including a research project about the use of Web 2.0 in the development process.

The Astronomical Society of the Pacific (ASP) is leading the development of the project's Outreach Program to amateur astronomers. As part of the Outreach Program, ASP developed the *Space Rocks ToolKit* that members of its Night Sky Network clubs of amateur astronomers can use with the public and to support their collaborations with science centers. The project team also developed prototypes of exhibit components that will be tested with visitors at the New Mexico Museum of Natural History and Science in Albuquerque, New Mexico, a partner museum. The exhibit will begin fabrication in Fall 2010 and the national tour will begin in June 2011.

Finding NEO

The *Finding NEO* project is developing a website and small library exhibit on asteroids and asteroid research. Funded by NSF (through a supplement to a research grant to Senior Research Scientist Al Harris (La Canada, CA Office)) and a NASA award, the project looks at asteroids, asteroid impacts, risk, and the role of amateur astronomers in collecting and analyzing light curve data. The project is developing several of its activities in partnership with the larger NSF *Great Balls of Fire* exhibit program.

One advantage of these topics is that they present opportunities to address fundamental issues which are relevant to a broad variety of space science and astronomy topics. In the case of the Rubble Interactive, we have used the open source Box2D physics engine to create a browser based Flash game that directly targets well documented educational issues concerning gravity and the laws of motion. In addition to addressing basic misconceptions (e.g., that gravity ends near Earth as one heads out into space), the game incorporates complex objects such as "rubble piles." Representative of many (perhaps most) asteroids, rubble piles in the game can consist of as many as 60 individual rocks that gravitationally bind and separate in realistic ways. Even bombs are modeled with sufficient physical accuracy to convince players of the hazards of trying to "blow up" incoming asteroids. The ability to efficiently build games based on underlying physical models allows us to address physical misconceptions in a natural way: by having the player operate in a world that directly "collides" with those misconceptions.



Left Page :: Visitors at a Great Balls of Fire prototyping session. Credit: Space Science Institute

Right Page :: A screen shot of the Rubble Game. Credit: Space Science Institute

EDUCATION

Discover Space – A Colorado Library Exhibit Program

The pilot version of the 500 sq. ft. *Discover Space* exhibit had its debut at the Louisville Public Library (LPL) on July 1, 2009. SSI developed the exhibit in partnership with Jeff Kennedy Associates. A formative evaluation study is being conducted by Dr. Tim Weston (University of Colorado). The target audience for the exhibit includes families and children from upper elementary through high school. The science and technology content is aligned with the Colorado Content Standards for the middle school level. The information gained from the SSI/LPL partnership will lead to an understanding of exhibit-based informal science education in library settings, refinement of the exhibit components, the creation of accompanying programs, the collection of data on visitors' engagement with the exhibits, and the learning goals that were achieved.

The goals for this project are: (1) to create an extraordinary learning experience using hands-on, interactive exhibits in a library setting that will offer students and families an exciting opportunity to immerse themselves in the fields of science and technology; and (2) to provide SSI with feedback and data that will guide a statewide dissemination of the pilot exhibit. We hope to enrich lives with the wonder of scientific discovery and develop an interest in lifelong learning in another informal education setting that complements SSI's museum-related efforts.

The exhibits become the centerpiece for auxiliary programming: screenings of educational films; family events with hands-on activities such as building rockets and using telescopes; and providing resources for follow-up studies, such as websites, books, and DVDs. SSI is also working with host libraries to offer public presentations by science and engineering professionals. Two presentations were offered at LPL: a talk about the Hubble repair mission by an engineer at Ball Aerospace and a talk by a research scientist from SSI about Mars exploration and what we have learned from the rovers. Both talks were very well attended; especially by families. Staff training at host libraries is also an important component of the project (and includes content knowledge and facilitation basics). The training program will be disseminated throughout Colorado and will, in the future, be available online from the project's Ning interactive website.

Discover Space includes two exhibit areas. Space Storms introduces audiences to space weather, covering topics such as sunspots, coronal mass ejections, and magnetic storms. This area includes a cut-away model of the Sun and several educational games. It also shows how space weather can harm astronauts, damage satellites, and disrupt power grids and communication systems on Earth. Star Quest explores how stars are born and how they die. Using a touch-screen computer, visitors can design interactive solar systems with planets, asteroid belts, and multiple suns. They learn about gravity and the important role that it plays in solar system formation.

discover SPACE™

Above :: Discover Space exhibit at the Louisville (Colorado) Public Library. Credit: Space Science Institute

EDUCATION

Science Theater Education Programming System (STEPS)

Under the direction of PI Brad McLain (Senior Education Associate, SSI Headquarters), the NSF-funded STEPS project continued its progress and entered its third year. The project's museum partnership network collaborated with Del Padre Digital, Inc. to develop and test the software that drives STEPS, which is a multi-media system that supports live performances or presentations; serving as an aid to storyboarding, script writing, and as an archive of assets and related materials. It is also used to run the digital media—video, images, sounds, animations, and recorded actors or animated characters—that is projected or played as part of the performance or used to enhance storytelling or a presentation. A stagehand can advance the media program as needed, or an actor can control the system from the stage with a wireless mouse concealed in a pocket.

In 2009, the museum partners wrote three scripts presenting astrobiology content in a dramatic and often humorous way. The project's three STEPS performances are intended to demonstrate the power and flexibility of STEPS. *Planet Hunter*, the shortest piece, is designed for performances by museum staff using an A/V cart in non-theater spaces, such as an exhibit hall or a school auditorium, and includes audience participation activities. *Planet Hunter* is currently being performed regularly at Space Center Houston. *Extremo-WHAT*? is a medium-length play (about 20 minutes) for a theater space that allows the audience to make a choice about the play's direction. Team members collaborated with a professional playwright to create the *Extremo-WHAT*? script. *Mars Interrupted* is the longest production (about 30 minutes) and requires the most stage setting, though the set will still require a minimum of construction as compared to many high school productions. *Mars Interrupted* also allows the audience to choose the play's direction. Of course, science centers or schools that acquire STEPS can use its library of scripts and archived media or they can create their own multi-media performances. The project hopes that users of STEPS will contribute their own shows to the STEPS education network.

Among the STEPS project's other deliverables are professional development products, such as in-person workshops, for the informal educators who are part of the project. For the larger informal education community, STEPS will offer online tutorials on using the system and the science content in the three scripts and multi-media assets that come with it. The deliverables also include evaluation and research components. The research focuses on enhancing informal educators' sense of professional identity, building the capacities of their institutions, and informing the field about the relationship between professional identity and multi-institution collaborative networks.

Above :: Planet Hunter performance at the 2009 Association of Science-Technology Centers meeting. Credit: Space Science Institute

FINANCIAL REPORT

Space Science Institute
Summary Statement of Financial Position
as of December 31, 2009 and 2008

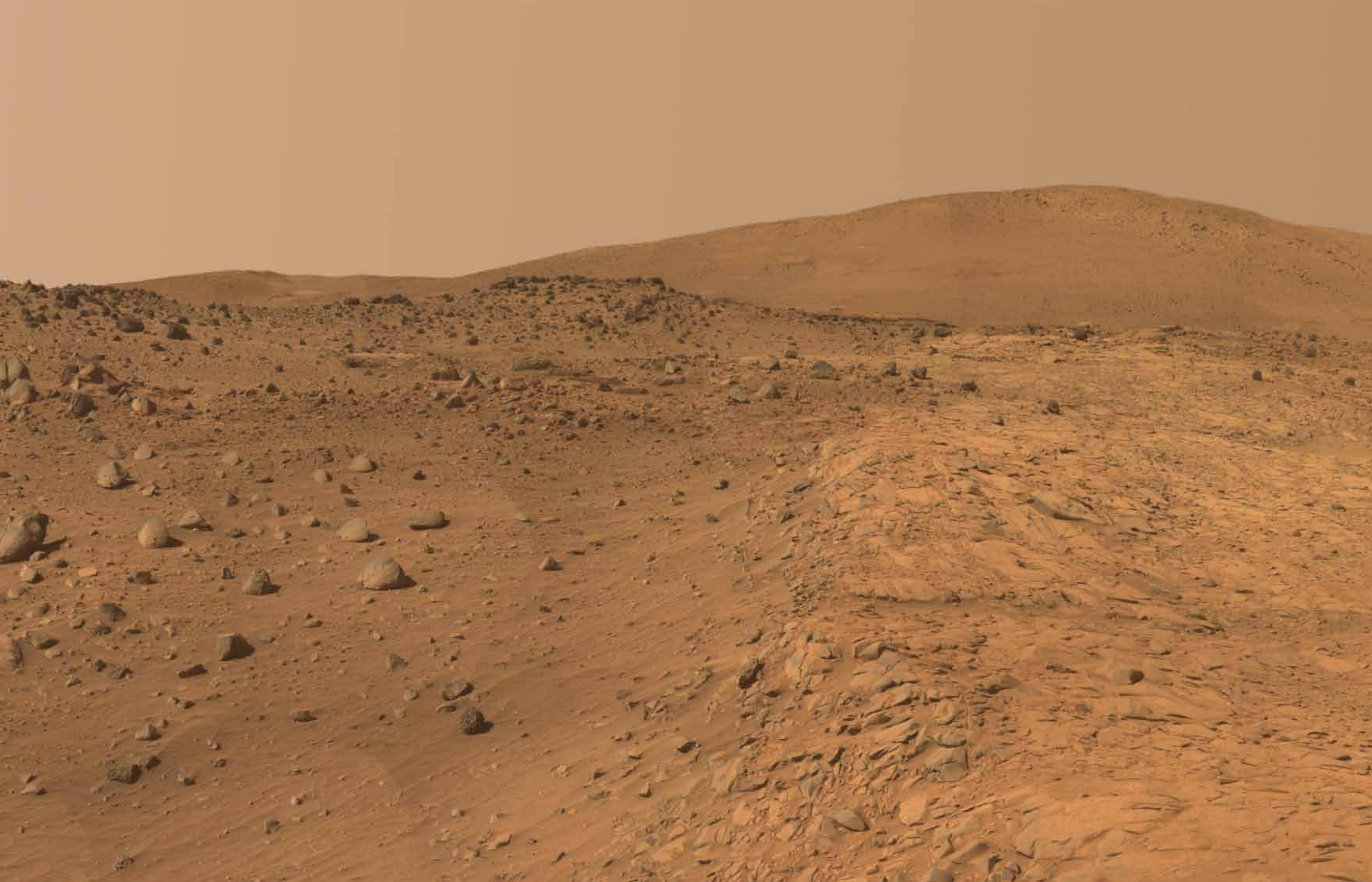
	2009	2008
Assets		
Assets		
Cash and cash equivalents	$ 611,422	$ 392,123
Accounts receivable	872,877	682,189
Prepaid expenses and deposits	77,310	64,057
Net furniture, equipment, and property	59,156	96,204
Total assets	$ 1,620,765	$ 1,234,573
Liabilities and Net Assets		
Liabilities		
Accounts payable and accrued liabilities	$ 365,265	$ 264,551
Deferred revenues	657,063	355,075
Line of credit	315,000	375,000
Total liabilities	1,337,328	994,626
Net assets		
Unrestricted	217,816	157,603
Temporarily restricted	65,621	82,344
Total net assets	283,437	239,947
Total liabilities and net assets	$ 1,620,765	$ 1,234,573

Summary Statement of Activities
for the years ended December 31, 2009 and 2008

	2009	2008
Support and revenue		
Grants, contracts, and cooperative agreements	$ 5,167,079	$ 4,956,323
Contributions	10,850	2,850
Exhibit income	89,952	29,350
Interest income	176	264
Other income	357	-
Total support and revenue	5,268,414	4,988,787
Expenses		
Program services	5,205,145	5,016,330
General and administrative	19,779	40,198
Total expenses	5,224,924	5,056,528
Change in net assets	43,490	(67,741)
Net assets, beginning of year	239,947	307,688
Net assets, end of year	$ 283,437	$ 239,947

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, 2009 and 2008, from which the summarized information was derived. A copy is available upon request.

Right Page :: Blue Marble Earth and Moon. Credit: NASA/NOAA



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