Vendelinus Astronomy Newsletter

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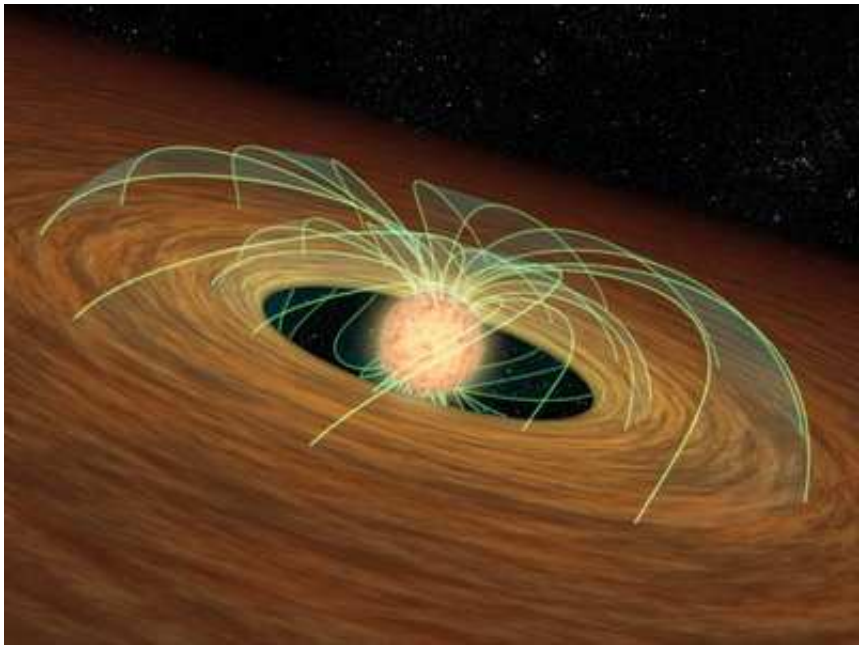

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1 Solar System

1.1 Stardust@home is launched

Source: UCBerkeley News, July 31st, 2006 [1]

On your marks, dust hunters! The University of California, Berkeley's Stardust@home project - a needle-in-a-haystack search for interstellar dust that's open to anyone with a computer - gets off the ground tomorrow (Tuesday, August 1) at 11 a.m. PDT.

The project was announced in January as NASA's Stardust spacecraft was prepared to deliver to Earth its payload of cometary and interstellar dust grains embedded in a relative ocean of aerogel detector. Almost immediately, Stardust@home drew nearly 115,000 volunteers eager to search for these interstellar motes within the millions of scans of the Stardust Interstellar Dust Collector that eventually will be put on the Internet.

Using a Web-based virtual microscope developed at UC Berkeley, volunteers will vie to find the fewer than 50 grains of submicroscopic interstellar dust expected to be there.

Stardust@home director Andrew Westphal, a UC Berkeley senior fellow and associate director of the campus's Space Sciences Laboratory, said he hopes the dust particles, made in supernova explosions as much as 10 million years ago, will provide clues to the internal processes of distant stars. Supernovas, flaring red giants and neutron stars all produce interstellar dust and generate the heavy elements like carbon, nitrogen and oxygen, that are necessary for life.

"How we analyze these grains depends a lot on how big they are," Westphal said, noting that if they are as large as the comet dust they could be studied with an X-ray microscope or probed with ion or electron beams. "These grains will be so precious that they will be studied for decades."

A panel of 132 tiles of aerogel, a foamy material that is the lightest known manmade solid, brought speeding dust to a soft landing as Stardust cruised through space toward its rendezvous with comet Wild 2 in 2004. While many of the more abundant grains of comet dust have already been extracted from a separate panel of aerogel detectors and are now being analyzed, the search for micron-sized grains of interstellar dust has been held up by the difficulty of scanning the aerogel.

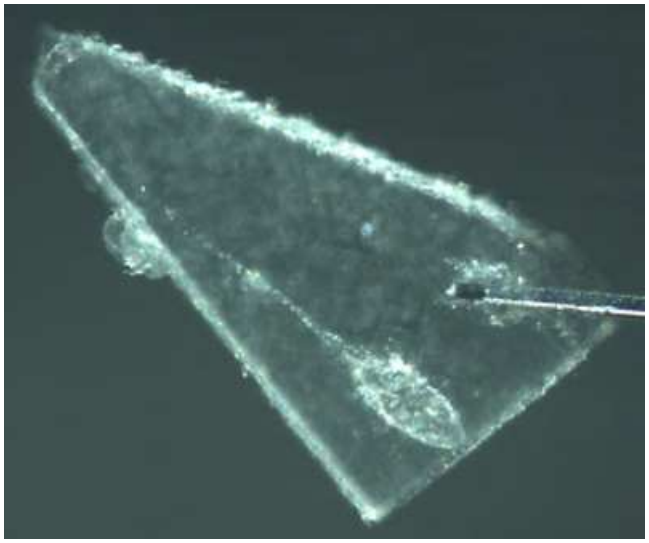

Figure 1: *Stardust@home volunteers will look for tracks like this, which was made in the Stardust spacecraft's aerogel collector by a comet grain and extracted for study earlier this year using techniques developed at UC Berkeley's Space Sciences Laboratory. (Photo by Hope Ishii/Lawrence Livermore National Laboratory)*

"The scanning, which is being done at Johnson Space Center in Houston, has been more challenging than we hoped," said Westphal. "The terrain of the aerogel surface is rougher than we expected, which makes it difficult to get the scanner in focus."

Westphal developed the digital microscope scanner based on his previous experience scanning glass detectors for cosmic ray particles. The scanner is now on loan from UC Berkeley to NASA's Johnson Space Center, where colleagues Jack Warren and Ron Bastien are scanning the interstellar dust collector in the Cosmic Dust Laboratory. In each field of view, which is about the size of a grain of salt, the scanner focuses at 42 depths into the transparent aerogel, from the surface down to 100 microns - the thickness of a human hair. These are turned into a "focus movie" that volunteers using the virtual microscope can easily view with the glide of a mouse.

Despite the scanning difficulties, he and team members Dr. Anna Butterworth, physics graduate student Joshua Von Korff, Dr. Bryan Mendez of the Center for Science Education at the Space Sciences Laboratory, undergraduate Xu Zhang, and programmer Robert Lettieri are ready to go with about

40,000 fields of view for volunteers to search.

”The volunteers may go through that in a day,” Westphal acknowledged. But it’s critical, he added, to have many eyes look at each field of view and focus up and down through the aerogel to find the rare, carrot-shaped tracks made by dust grains slamming into the detector. As volunteers search through the available scans, more will be added as NASA personnel scan up to four new tiles a week. The last should be available in early 2007 and bring the total fields of view to 700,000, entailing nearly 30 million separate scans.

”Several hundred volunteers have expressed their anxious anticipation of the launch of the project,” noted Mendez. ”All the pre-registrants will receive by August 1 an e-mail announcing the launch of the project and inviting them to come to the Web site, read the background information and practice searching in the tutorial. When they have completed that, they may take an online test to see how good they are at finding simulated star dust tracks. If they successfully complete the test, they can then register and begin using the virtual microscope to search for real stardust tracks.”

Those who find a confirmed dust grain will get the chance to name it.

Westphal came up with the Stardust@home idea as an inexpensive way to search the detectors for the several dozen grains of dust, each too small to see with the naked eye. He worked with computer scientist David Anderson, director of UC Berkeley’s SETI@home project, and graduate student Von Korff to develop the virtual microscope. Mendez and Nahide Craig, assistant research astronomers at the laboratory, are creating a teacher’s lesson guide that uses the Stardust@home virtual microscope to teach students about star dust and the origins of the solar system. Sections of the Stardust@home Web site are also aimed at the general public.

The project is funded by NASA and has received critical technical and developmental support from Amazon Web Services and The Planetary Society, which has also supported the SETI@home project to detect intelligent signals from space. SETI@home is an automated program that acts as a screen saver on home computers. Unlike SETI@home, where the computer processes all the data, Stardust@home is a hands-on activity. And it offers the public a rare chance to participate in a NASA mission.

”Think of this mission as the ultimate cosmic road trip,” said Bruce Betts, The Planetary Society’s director of projects. ”On long journeys, you’re bound to end up with a few bugs - or dust particles - smashed against the windshield, but in the case of Stardust, the research team wanted to collect them intact without smashing or vaporizing them.”

The Stardust@home project uses the Amazon Simple Storage Service (Amazon S3) to store and deliver the tens of million of images that represent the data collected from the dust particle aerogel experiment.

1.2 Possible Meteorites in the Martian Hills

Source: JPL/NASA Press Release, July 10th, 2006 [2]

From its winter outpost at ”Low Ridge” inside Gusev Crater, NASA’s Mars Exploration Rover Spirit took this spectacular, color mosaic of hilly, sandy terrain and two potential iron meteorites. The two light-colored, smooth rocks about two-thirds of the way up from the bottom of the frame have been labeled ”Zhong Shan” and ”Allan Hills.”

The two rocks’ informal names are in keeping with the rover science team’s campaign to nickname rocks and soils in the area after locations in Antarctica. Zhong Shang is an Antarctic base that the People’s Republic of China opened on Feb. 26, 1989, at the Larsemann Hills in Prydz Bay in East Antarctica. Allan Hills is a location where researchers have found many Martian meteorites, including the controversial ALH84001, which achieved fame in 1996 when NASA scientists suggested that it might contain evidence for fossilized extraterrestrial life. Zhong Shan was the given name of Dr. Sun Yat-sen (1866-1925), known as the ”Father of Modern China.” Born to a peasant family in Guangdong, Sun moved to live with his brother in Honolulu at age 13 and later became a medical doctor. He led a series of uprisings against the Qing dynasty that began in 1894 and eventually succeeded in 1911. Sun served as the first provisional president when the Republic of China was founded in 1912.

The Zhong Shan and Allan Hills rocks, at the left and right, respectively, have unusual morphologies and miniature thermal emission spectrometer signatures that resemble those of a rock known as ”Heat Shield” at the Meridiani site explored by Spirit’s twin, Opportunity. Opportunity’s analyses revealed Heat Shield to be an iron meteorite.

Spirit acquired this false-color image on the rover’s 872nd Martian day, or sol (June 16, 2006), using exposures taken through three of the panoramic camera’s filters, centered on wavelengths of 750 nanometers, 530 nanometers, and 430 nanometers. The image is presented in false color to emphasize differences among materials in the rocks and soil.

Possible Meteorites in the Martian Hills

Figure 2: *Image credit: NASA/JPL-Caltech/Cornell*

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1.3 Mars’ dust storms may produce peroxide snow

Source: UC Berkeley News, July 31st, 2006 [3]

The planet-wide dust storms that periodically cloak Mars in a mantle of red may be generating a snow of corrosive chemicals, including hydrogen peroxide, that would be toxic to life, according to two new studies published in the most recent issue of the journal Astrobiology.

Based on field studies on Earth, laboratory experiments and theoretical modeling, the researchers argue that oxidizing chemicals could be produced by the static electricity generated in the swirling dust clouds that often obscure the surface for months, said University of California, Berkeley, physicist Gregory T. Delory, first author of one of the papers. If these chemicals have been produced regularly over the last 3 billion years, when Mars has presumably been dry and dusty, the accumulated peroxide in the surface soil could have built to levels that would kill ”life as we know it,” he said.

”If true, this very much affects the interpretation of soil measurements made by the Viking landers in the 1970s,” said Delory, a senior fellow at UC Berkeley’s Space Sciences Laboratory. A major goal of the Viking mission, comprised of two spacecraft launched by NASA in 1975, was testing Mars’ red soil for signs of life. In 1976, the two landers aboard the spacecraft settled on the Martian surface and conducted four separate tests, including some that involved adding nutrients and water to the dirt and sniffing for gas production, which could be a telltale sign of living microorganisms.

The tests were inconclusive because gases were produced only briefly, and other instruments found no traces of or-

ganic materials that would be expected if life were present. These results are more indicative of a chemical reaction than the presence of life, Delory said.

”The jury is still out on whether there is life on Mars, but it’s clear that Mars has very chemically reactive conditions in the soil,” he said. ”It is possible there could be long-term corrosive effects that would impact crews and equipment due to oxidants in the Martian soil and dust.”

All in all, he said, ”the intense ultraviolet exposure, the low temperatures, the lack of water and the oxidants in the soil would make it difficult for any microbe to survive on Mars.”

The article by Delory and his colleagues appearing in the June issue of Astrobiology demonstrates that the electrical fields generated in storms and smaller tornadoes, called dust devils, could split carbon dioxide and water molecules apart, allowing them to recombine as hydrogen peroxide or more complicated superoxides. All of these oxidants react readily with and destroy other molecules, including organic molecules that are associated with life.

A second paper, coauthored by Delory, demonstrates that these oxidants could form and reach such concentrations near the ground during a storm that they would condense into falling snow, contaminating the top layers of soil. According to lead author Sushil K. Atreya of the Department of Atmospheric, Oceanic, and Space Sciences at the University of Michigan, the superoxidants not only could destroy organic material on Mars, but accelerate the loss of methane from the atmosphere.

Coauthors of the two papers are from NASA Goddard Space Flight Center; the University of Michigan; Duke University; the University of Alaska, Fairbanks; the SETI Institute; Southwest Research Institute; the University of Washington, Seattle; and the University of Bristol in England.

Delory and his colleagues have been studying dust devils in the American Southwest to understand how electricity is produced in such storms and how the electric fields would affect molecules in the air - in particular, molecules like those in the thin Martian atmosphere.

”We are trying to look at the features that make a planet habitable or uninhabitable, whether for life that developed there or for life we bring there,” he said.

Based on these studies, he and his colleagues used plasma physics models to understand how dust particles rubbing against one other during a storm become positively and negatively charged, much the way static electricity builds up when we walk across a carpet, or electricity builds in thunderclouds. Though there’s no evidence for lightning discharges on Mars, the electric field generated when charged particles separate in a dust storm could accelerate electrons to speeds sufficient to knock molecules apart, Delory and his colleagues found.

”From our field work, we know that strong electric fields are generated by dust storms on Earth. Also, laboratory experiments and theoretical studies indicate that conditions in the Martian atmosphere should produce strong electric fields during dust storms there as well,” said co-author Dr. William Farrell of NASA’s Goddard Space Flight Center in Greenbelt, Md.

Figure 3: *An artist’s concept of a Martian dust storm, showing how electrical charge builds up as in terrestrial thunderstorms. Though on Earth, lightning is common, there is no evidence that lightning accompanies storms on Mars. (NASA)*

Since water vapor and carbon dioxide are the most prevalent molecules in the Martian atmosphere, the most likely ions to form are hydrogen, hydroxyl (OH) and carbon monoxide (CO). One product of their recombination, according to the second study, would be hydrogen peroxide (H2O2). At high enough concentrations, the peroxide would condense into a solid and fall out of the air.

If this scenario has played out on Mars for much of its history, the accumulated peroxide in the soil could have fooled the Viking experiments looking for life. While the Labeled

Release and the Gas Exchange experiments on the landers detected gas when water and nutrients were added to Martian soil, the landers' Mass Spectrometer experiment found no organic matter.

At the time, researchers suggested that very reactive compounds in the soil, perhaps hydrogen peroxide or ozone, could have produced the measurements, imitating the response of living organisms. Others suggested a possible source for these oxidants: chemical reactions in the atmosphere catalyzed by ultraviolet light from the sun, which is more intense because of Mars' thin atmosphere. The predicted levels were far lower than needed to produce the Viking results, however.

Production of oxidants by dust storms and dust devils, which seem to be common on Mars, would be sufficient to cause the Viking observations, Delory said. Thirty years ago, some researchers considered the possibility that dust storms might be electrically active, like Earth's thunderstorms, and that these storms might be a source of the new reactive chemistry. But this had been untestable until now.

"The presence of peroxide may explain the quandary we have had with Mars, but there is still a lot we don't understand about the chemistry of the atmosphere and soils of the planet," he said.

The theory could be tested further by an electric field sensor working in tandem with an atmospheric chemistry system on a future Mars rover or lander, according to the team members.

1.4 Gemini Captures Close Encounter of Jupiter's Red Spots

Source: Gemini Observatory Image Release, July 20th, 2006 [4]

A high-resolution image released today by the Gemini Observatory shows Jupiter's two giant red spots brushing past one another in the planet's southern hemisphere.

The image was obtained in near-infrared light using adaptive optics which corrects, in real-time, for most of the distortions caused by turbulence in Earth's atmosphere. The result is a view from the ground that rivals images from space.

In the near-infrared, the red spots appear white rather than the reddish hue seen at visible wavelengths.

"It was tricky getting this image," said Gemini astronomer Chad Trujillo who helped lead the effort to capture the event. "Since we used adaptive optics we needed a star-like object nearby to guide on, so we had to find a time when Jupiter's moon Io would appear close enough to Jupiter and the red spots would be optimally placed on Jupiter's disk. Fortunately it all worked out on the evening of July 13th and we were able to capture this relatively rare set of circumstances," said Trujillo.

Both red spots are massive storm systems. The top of the larger one, known for a long time as the Great Red Spot, lies about 8 kilometers (5 miles) above the neighboring cloud tops and is the largest hurricane known in the solar system. The smaller storm (officially called Oval BA, but informally known as Red Spot Junior) is another hurricane-like system. Since it appears nearly as bright as the Great Red Spot in near-infrared images, Red Spot Junior may be at a similar height in the Jovian atmosphere as the Great Red Spot.

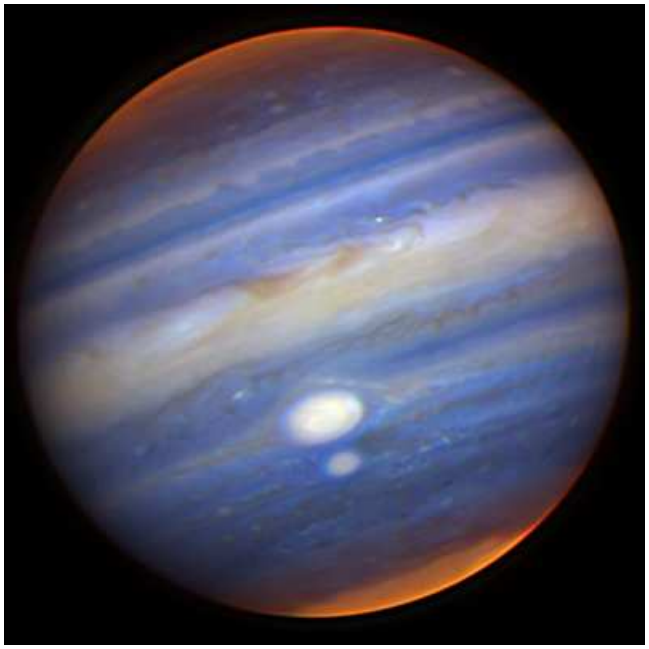

Figure 4: *Gemini North adaptive optics image of Jupiter and its two red spots (which apppear white because this is a near-infrared image; in visible light they appear reddish). In this color composite image, white indicates cloud features at relatively high altitudes; blue indicates lower cloud structures; and red represents still deeper cloud features. The two red spots appear more white than red, because their tops hover high above the surrounding clouds. Also prominent is the polar stratospheric haze, which makes Jupiter bright near the pole (unlike the other orange/red features in this image, the polar haze is high in Jupiter's atmosphere). Other tiny white spots are regions of high clouds, like towering thunderheads. In visible light Jupiter looks orangish, but in the near-infrared the blue color is due to strong ab-*

sorption features. The blue mid-level clouds are also closest to what one would see in a visual light image. Credit: Gemini Observatory ALTAIR Adaptive Optics Image

Red Spot Junior is roughly half the size of its famous cousin, but its winds blow just as strong. This mighty new storm formed between 1998 and 2000 from the merger of three long-enduring white ovals, each a similar storm system at a smaller scale, which had been observed for at least 60 years. But it was not until February 27th of this year that Philippine amateur astronomer Christopher Go discovered that the color of the newly formed white oval had turned brick red. Astronomers were witnessing the birth of a new red spot.

No one is certain why this white oval turned red. However, University of Hawai'i astronomer Toby Owen supports a hypothesis developed by New Mexico State University astronomer Reta Beebe, who suggests that the merger of the three white ovals led to an intensified storm system. This made it strong enough to dredge up reddish material from deeper in the atmosphere. As this material welled up in the middle of the spot, it is contained (or protected) from escape by the strong circulating currents at the spot's edges. "What's frustrating is that we don't know what this reddish material is," Owen said. "But it appears that the ability to dredge it up depends on the size of these oval storm systems."

Another popular hypothesis contends that the material dredged up from below Jupiter's visible clouds climbs to an altitude where the Sun's ultraviolet light chemically alters it to give it a reddish hue.

Nothing dramatic is expected to happen as the two storm systems continue their close encounter. The white ovals from which Red Spot Junior is made have passed by the Great Red Spot countless times as the atmospheric current in which they are embedded moves at a different speed from the one at the latitude of the Great Red Spot. Nevertheless, we should keep open the possibility that the Great Red Spot could now, or in the future, push Red Spot Junior into a southern jet stream that is blowing against the storm's counterclockwise rotation. If Red Spot Junior's spin slows, its color may revert back to white, but that remains to be seen. Right now, as the Gemini image shows, Red Spot Junior is demonstrating its staying power.

Each red spot is rotating with Jupiter at slightly different rates and over time, like passing cars on a highway, the two spots change relative positions causing periodic close passages like this. However, this is the first such passage since the new, smaller red spot intensified and turned red. A recent optical image from the Hubble Space Telescope was obtained in April of this year when the two spots were still separated by a considerable distance.

1.5 Saturn's Faint Rings Share Some Of Their Secrets

Source: CICLOPS Press Release, July 5th, 2006 [5]

NASA Cassini spacecraft images of Saturn's diaphanous G and E rings are yielding new clues about their structure and formation.

A sequence of recent Cassini images, which has been made into a brief movie, shows an arc of bright material looping around the inside edge of the G ring, a tenuous 7,000-kilometer-wide (4,400 miles) band of dust-sized icy particles lying beyond the F ring by 27,000 kilometers (16,800 miles). Cassini passed between the F and G rings during its insertion into orbit in June 2004.

The G ring arc is the same feature identified in images of this ring taken in May 2005. "We have seen the arc a handful of times over the past year," said Dr. Matt Hedman, Cassini imaging team associate working at Cornell University in Ithaca, New York. "It always appears to be a few times brighter than the rest of the G ring and very tightly confined to a narrow strip along the inside edge of the ?normal' G ring."

Imaging team members now believe this feature is long-lived and may be held together by resonant interactions with the moon Mimas of the type that corral the famed ring arcs around Neptune. "We've known since the days of Voyager that we had Jovian-type and Uranian-type rings within the rings of Saturn," said Cassini imaging team leader Dr. Carolyn Porco in Boulder, Colo., who was the first to work out the dynamics of the Neptunian arcs in Voyager observations. "Now it appears that Saturn may be home to Neptunian-type rings as well. Saturn's rings have it all!"

The researchers do not know exactly how the bright arc formed. One possibility is that a collision between small, perhaps meter-sized icy bodies orbiting within the G ring set loose a cloud of fine particles that eventually came under the influence of Mimas. But this new observation suggests that the remainder of the G ring itself may be derived from particles leaking away from this arc and drifting outwards. Future Cassini imaging observations are being planned to take a closer look at the G ring arc.

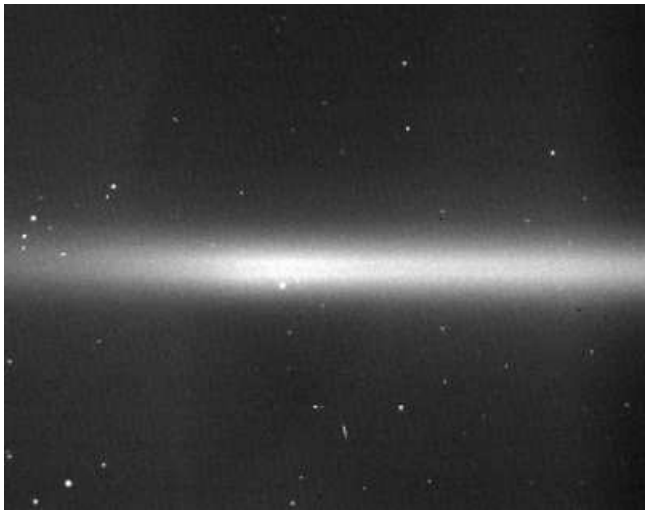

Figure 5: *Double banded structure in Saturn's E ring. Image credit: NASA/JPL/SSI*

Results from Cassini's previous encounters with Enceladus indicated its south polar geysers as the primary source of the E ring particles. Now, images of the E ring with finer resolution than has ever been obtained before show telling details that appear to confirm this relationship.

The new images, taken when Cassini was in the ring plane and consequently showing an edge-on view, reveal a double-banded appearance to the ring, created because the ring is somewhat fainter close to the ring plane than it is 500-1,000 kilometers (300-600 miles) above and below. This appearance can result if the particles comprising the ring circle Saturn on inclined orbits with a very restricted range of inclinations. (A similar effect is seen in the Jupiter's gossamer ring and in the bands of dust found within the Sun's asteroid belt.)

This special condition might arise for two reasons. First, the particles being jetted out of Enceladus and injected into Saturn orbit may begin their journey around Saturn with a very restricted range of velocities and therefore inclinations. Second, the particles may begin with a large range of inclinations but those orbiting very close to the ring plane get gravitationally scattered and removed from that region.

Future studies of the E ring, including observations and dynamical models, should decide this issue. Cassini imaging team member Dr. Joseph Burns, also of Cornell, said, "We'll want images from a few other vantage points to be sure of the structure, and then we can test several models to see why these ring particles end up in such a distinct configuration."

1.6 Methane Drizzles on Saturn's Moon, Titan

Source: NASA News, July 27th, 2006 [6]

Liquid methane drizzles on the surface of Titan, a moon of Saturn, according to a paper by NASA and university scientists that appears in today's issue of the journal, Nature.

Data from the European Space Agency's Huygens probe indicates there is a lower, barely visible, liquid methane-nitrogen cloud that drops rain to the surface of Titan, reported a team of scientists from universities, an observatory and NASA. The probe collected the data on January 14, 2005, when it approached and landed on Titan.

"The rain on Titan is just a slight drizzle, but it rains all the time, day in, day out. It makes the ground wet and muddy with liquid methane. This is why the Huygens probe landed with a splat. It landed in methane mud," said Christopher McKay, a scientist at NASA Ames Research Center in California's Silicon Valley and second author of the study. The principal author is Tetsuya Tokano from the University of Cologne, Germany.

On Titan, the clouds and rain are formed of liquid methane. On Earth, methane is a flammable gas, but Titan has no oxygen in its atmosphere that could support combustion. Also, the temperatures on Titan are so cold – minus 300 degrees Fahrenheit (minus 149 degrees Celsius) – that the methane can form liquid. Titan's landscape includes fluvial, river-like features that may well be formed by methane rain, scientists noted.

A gap separates the liquid methane cloud – the source of the rain – from a higher, upper methane ice cloud, according to the scientific study. Scientists say the downward flow of methane due to the rain is balanced by upward transport of methane gas by large-scale atmospheric circulation.

According to scientists, the rain comes from thin clouds of methane. The upper clouds are methane ice, and the lower clouds are liquid and composed of a combination of methane and nitrogen. Computer models indicate these thin liquid methane clouds cover about half of Titan, even though methane abundance on the moon decreases with latitude, the team reported.

"We determined that the rain on Titan is equal to about two inches (about 5 centimeters) a year," McKay said. "This is about as much rain as Death Valley (receives). The difference is (that) on Titan, this rain is spread out evenly over the entire year."

The scientists reported that erosion potential from the very light methane drizzle may be quite limited, but at least would be sufficient to wet the surface material, and may explain its generally wet character.

1.7 Titan's pebbles 'seen' by Huygens radio

Source: ESA Press Release, July 25th, 2006 [7]

An unexpected radio reflection from the surface of Titan has allowed ESA scientists to deduce the average size of stones and pebbles close to the Huygens' landing site. The technique could be used on other lander missions to analyse planetary surfaces for free. When Huygens came to rest on the surface of Titan on 14 January 2005, it survived the impact and continued to transmit to the Cassini mothership, orbiting above. Part of that radio signal 'leaked' downwards and hit the surface of Titan before being reflected back up to Cassini. On its way up, it interfered with the direct beam.

As Miguel Prez-Aycar, a member of the Huygens Team at ESA's European Space Research and Technology Centre (ESTEC) in The Netherlands, and his colleagues watched the signal coming back, they were initially puzzled to see the power of the signal rising and falling in a repetitive manner.

"Huygens had not been designed to necessarily survive impact so we had never thought about what the signal would look like from the surface," says Prez. After making a joke that aliens must be dragging the craft along the surface, Prez and the team began work at once to understand the signal.

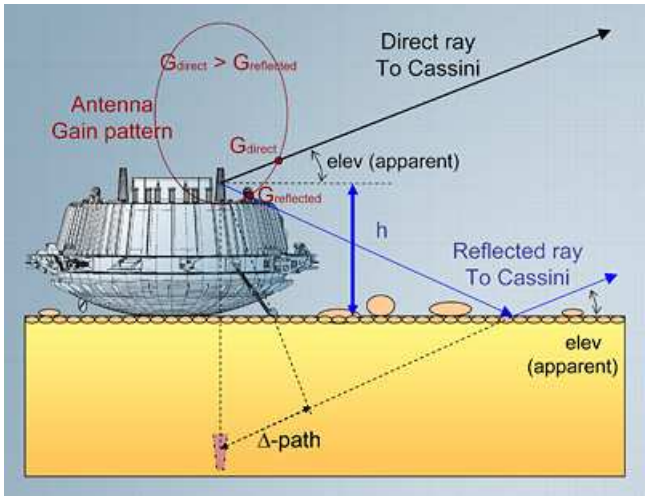

Figure 6: *This technical sketch illustrates the radio signals emitted by the Huygens probe from Titan's surface after touch down on 14 January 2005. The probe survived the impact and continued to transmit to the Cassini mothership, orbiting above. Part of that radio signal ?leaked' downwards and hit the surface of Titan before being reflected back up to Cassini. On its way up, it interfered with the direct beam. Thanks to this 'multipath' phenomena related to the Huygens radio signal, it has been possible to deduce that the surface swathe must be relatively flat and covered mostly in stones of around 5-10 centimetres in diameter. Credits: M. Prez-Aycar/ESA*

The clue was the repetitive oscillation of the power. It made Prez think about the interaction of the direct signal with that reflecting from the surface of Titan. As Cassini travelled away from the Huygens landing site, the angle between it and Huygens changed. This altered the way in which the interference between the reflected and direct beams was detected, perhaps causing the variation in power.

He began running computer models and saw that not only could he reproduce the received signal but also it was sensitive to the size of pebbles on the surface of Titan.

Cassini collected data for 71 minutes after Huygens landed. After that time, the spacecraft's motion took it below the horizon as seen from Huygens' landing site. Until then, it soaked up radio signals that encoded information about a swathe of Titan's surface from 1 metre to 2 kilometres to the west of the landed probe.

To accurately mirror the true signal, Prez and his team discovered that the surface swathe must be relatively flat and covered mostly in stones of around 5-10 centimetres in diameter.

This unique result complements the data taken by the Descent Imager and Spectral Radiometer (DISR) instrument. When Huygens came to rest on the surface of Titan, DISR was pointing due south. Its images show stones and terrain in good agreement with the newly deduced western facing radio data. "This is a real bonus to the mission. It requires no special equipment, just the usual communications subsystem," says Prez.

Now that the scientists have understood the process using the unexpected Huygens data, the technique could be implemented on future lander missions. "This experience can be inherited by any future lander," says Prez, "All that will be needed is a few refinements and it will become a powerful technique."

By subtly altering the properties of the radio beam for instance, the radio transmitter and receiver can be optimised to help deduce the chemical composition of the planetary surface.

1.8 Lakes on Titan

Source: JPL/NASA Press Release, July 24th, 2006 [8]

The Cassini spacecraft, using its radar system, has discovered very strong evidence for hydrocarbon lakes on Titan. Dark patches, which resemble terrestrial lakes, seem to be sprinkled all over the high latitudes surrounding Titan's north pole.

Scientists have speculated that liquid methane or ethane might form lakes on Titan, particularly near the somewhat colder polar regions. In the images, a variety of dark patches, some with channels leading in or out of them, appear. The channels have a shape that strongly implies they were carved by liquid. Some of the dark patches and connecting channels are completely black, that is, they reflect back essentially no radar signal, and hence must be extremely smooth. In some cases rims can be seen around the dark patches, suggesting deposits that might form as liquid evaporates. The abundant methane in Titan's atmosphere is stable as a liquid under Titan conditions, as is its abundant chemical product, ethane, but liquid water is not. For all these reasons, scientists interpret the dark areas as lakes of liquid methane or ethane, making Titan the only body in the solar system besides Earth known to possess lakes. Because such lakes may wax and wane over time, and winds may alter the roughness of their surfaces. Repeat coverage of these areas should test whether indeed these are bodies of liquid.

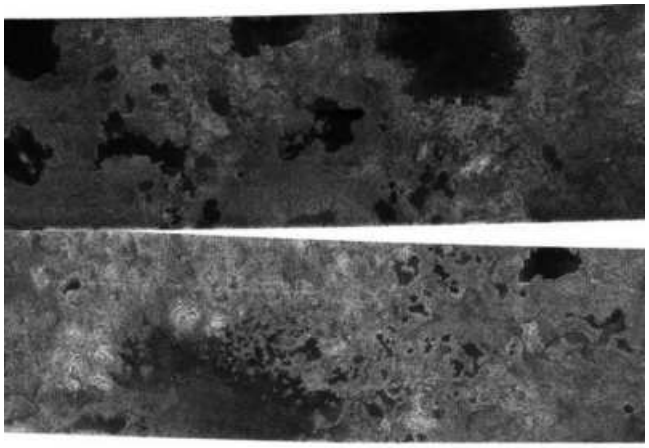

Figure 7:

These two radar images were acquired by the Cassini radar instrument in synthetic aperture mode on July 21, 2006. The top image centered near 80 degrees north, 92 degrees west measures about 420 kilometers by 150 kilometers (260 miles by 93 miles). The lower image centered near 78 degrees north, 18 degrees west measures about 475 kilometers by 150 kilometers (295 miles by 93 miles). Smallest details in this image are about 500 meters (1,640 feet) across.

2 Astrophysics

2.1 Is Proxima Centauri Flying Solo?

Source: Fraser Cain for Universe Today, July 18th, 2006 [9]

The Alpha Centauri system was first calculated as the closest star system in 1839 by the Scottish astronomer Thomas Henderson, using the parallax method - measuring the shift of a star against the background from opposite sides of the Earth's orbit. He calculated that Alpha Centauri was 2.7 light years away. Modern astronomers now know it's 4.4 light years away. Still, not bad.

Proxima Centauri took the title of closest star when its parallax was measured accurately in 1917, and it was found to be only 4.2 light years away. Since Proxima Centauri is so close to Alpha Centauri A and B, and moving in the same direction across the sky, astronomers have always assumed they were a triple star system.

This assumption came under fire about 12 years ago when a group of researchers used the best data on hand to calculate that the Alpha Centauri system doesn't have enough gravity to hold onto Proxima Centauri. One possibility is that astronomers just miscalculated their masses. Or maybe the stars are all moving together, so it just looks like Proxima is moving too quickly.

But maybe Proxima Centauri isn't a member of the Alpha Centauri system at all. It began life from a different cloud of gas and dust, and its proximity to the other stars is just random chance. The likelihood of this is extremely remote, but then, it's a big Universe, and almost anything is possible.

In 1997, ESA's Hipparcos delivered exquisite data about all three stars in the Centauri system, and this has enabled

new calculations about their mass, speed, and motions. Further observations over the last few years have delivered even more data for astronomers to crunch.

Jeremy G. Wertheimer and Gregory Laughlin from the University of California, Santa Cruz, have used all this new data to do the calculations again. They calculated that Proxima Centauri could actually be orbiting the gravitational centre of the Alpha Centauri system. Assuming, however, that its orbit is extremely eccentric, and Proxima Centauri is currently in the most distant point of this orbit.

So go ahead and launch that interstellar probe towards our nearest neighbour. Proxima Centauri should be right where you're expecting it.

2.2 Planet-Forming Disks Might Put the Brakes on Stars

Source: JPL/NASA Press Release, July 24th, 2006 [10]

Astronomers using NASA's Spitzer Space Telescope have found evidence that dusty disks of planet-forming material tug on and slow down the young, whirling stars they surround.

Young stars are full of energy, spinning around like tops in half a day or less. They would spin even faster, but something puts on the brakes. While scientists had theorized that planet-forming disks might be at least part of the answer, demonstrating this had been hard to do until now.

"We knew that something must be keeping the stars' speed in check," said Dr. Luisa Rebull of NASA's Spitzer Science Center, Pasadena, Calif. "Disks were the most logical answer, but we had to wait for Spitzer to see the disks."

Rebull, who has been working on the problem for nearly a decade, is lead author of a new paper in the July 20 issue of the Astrophysical Journal. The findings are part of a quest to understand the complex relationship between young stars and their burgeoning planetary systems.

Stars begin life as collapsing balls of gas that spin faster and faster as they shrink, like twirling ice skaters pulling in their arms. As the stars whip around, excess gas and dust flatten into surrounding pancake-like disks. The dust and gas in the disks are believed to eventually clump together to form planets.

Developing stars spin so fast that, left unchecked, they would never fully contract and become stars. Prior to the new study, astronomers had theorized that disks might be slowing the super speedy stars by yanking on their magnetic fields. When a star's fields pass through a disk, they are thought to get bogged down like a spoon in molasses. This locks a star's rotation to the slower-turning disk, so the shrinking star can't spin faster.

To prove this principle, Rebull and her team turned to Spitzer for help. Launched in August of 2003, the infrared observatory is an expert at finding the swirling disks around stars, because dust in the disks is heated by starlight and glows at infrared wavelengths.

The team used Spitzer to observe nearly 500 young stars in the Orion nebula. They divided the stars into slow spinners and fast spinners, and determined that the slow spinners are five times more likely to have disks than the fast ones.

"We can now say that disks play some kind of role in slowing down stars in at least one region, but there could be a host of other factors operating in tandem. And stars might behave differently in different environments," Rebull said.

Other factors that contribute to a star's winding down over longer periods of time include stellar winds and possibly full-grown planets.

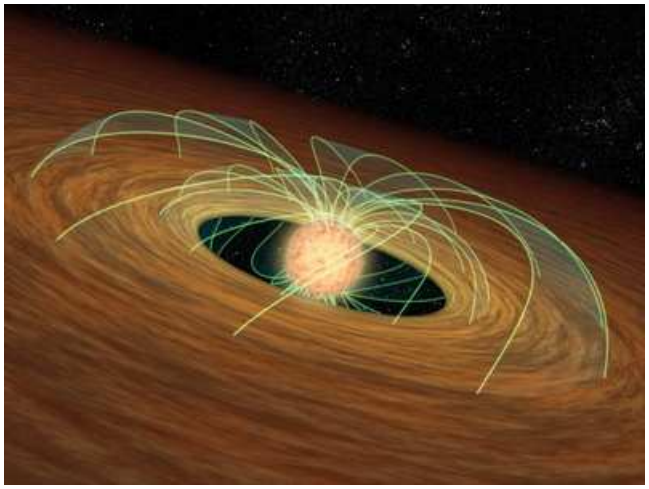

Figure 8: *This artist's concept shows a dusty planet-forming disk in orbit around a whirling young star. Image credit: NASA/JPL-Caltech*

If planet-forming disks slow down stars, does that mean stars with planets spin more slowly than stars without planets? Not necessarily, according to Rebull, who said slowly spinning stars might simply take more time than other stars to clear their disks and develop planets. Such late-blooming stars would, in effect, give their disks more time to put on the brakes and slow them down.

Ultimately, the question of how a star's rotation rate is related to its ability to support planets will fall to planet hunters. So far, all known planets in the universe circle stars that turn around lazily. Our sun is considered a slowpoke, currently plodding along at a rate of one revolution every 28 days. And, due to limits in technology, planet hunters have not been able to find any extrasolar planets around zippy stars.

"We'll have to use different tools for detecting planets around rapidly spinning stars, such as next-generation ground and space telescopes," said Dr. Steve Strom, an astronomer at the National Optical Astronomy Observatory, Tucson, Ariz.

2.3 Earth-Sized Planets Could Be Nearby

Source: University of Washington Press Release, July 24th, 2006 [11]

The steady discovery of giant planets orbiting stars other than our sun has heightened speculation that there could be Earth-type worlds in nearby planetary systems capable of sustaining life. Now researchers running computer simulations for four nearby systems that contain giant planets about the size of Jupiter have found one that could have formed an Earth-like planet with the right conditions to support life.

A second system is likely to have a belt of rocky bodies the size of Mars or smaller. The other two, the models show, do not have the proper conditions to form an Earth-size planet. Each system lies within 250 light years of Earth (a light year is about 5.88 trillion miles). Astronomers already have found evidence that each system contains at least two giant planets about the mass of Jupiter, which have migrated close to their stars, perhaps as close as Mercury is to the sun.

For each of the four systems, the researchers conducted 10 computerized simulations that placed small planet embryos, or protoplanets, in the system to see if they are able to gather more material and form a true planet the size of Earth. Each simulation assumed the same conditions in the planetary system except that the position and mass of each protoplanet was altered slightly, said Sean Raymond, a postdoctoral researcher at the University of Colorado, who took part in the work while he was an astronomy doctoral student at the University of Washington.

Raymond is lead author of a paper describing the research published in June in the Astrophysical Journal. Co-authors are Rory Barnes, a postdoctoral researcher at the University of Arizona who also took part in the work while a UW astronomy doctoral student, and Nathan Kaib, a UW doctoral student in astronomy. The work was funded by the National Aeronautics and Space Administration, NASA's Astrobiology Institute and the National Science Foundation.

"It's exciting that our models show a habitable planet, a planet with mass, temperature and water content similar to Earth's, could have formed in one of the first extrasolar multi-planet systems detected," Barnes said.

Recent studies show many known extrasolar planetary systems have regions stable enough to support planets ranging from the mass of Earth to that of Saturn. The UW models tested planet formation in systems called 55 Cancri, HD 38529, HD 37124 and HD 74156. The researchers assumed the systems are complete and the orbits of their giant planets are well established. They also assumed conditions that might allow formation of small bodies that could develop into rocky, Earth-like planets.

In the models, the scientists placed moon-sized planet embryos between giant planets and allowed them to evolve for 100 million years. With those assumptions, they found terrestrial planets formed readily in 55 Cancri, sometimes with substantial water and orbits in the system's habitable zone. They found HD 38529 is likely to support an asteroid belt and Mars-sized or smaller bodies but no notable terrestrial planets. No planets formed in HD 37124 and HD 74156.

"What surprised me the most was to see the system that only formed planets the size of Mars or smaller," Raymond said. "Anything that grew too big would be unstable, so there was an accumulation of a lot of smaller protoplanets maybe one-tenth the size of Earth"

It was significant, Kaib said, that the models showed conditions could remain stable enough for 100 million years so that a planetary embryo would have a chance to gather more substance and develop into a body the size of the moon or Mars. "In our early system, that's probably what our inner solar system looked like, with hundreds of bodies that size," he said

Extrasolar planets have been discovered with increasing frequency in recent years because of techniques that detect giant planets by their gravitational effect on their parent stars. It is uncertain how the giant planets evolve, but they are thought to form far away from their host stars and then migrate inward, pushed by the gas discs from which they formed. If the migration occurs late in the system's development, the giant planets might destroy most of the materials needed to build Earth-like planets, Raymond said. He noted that while the presence of giant planets is fairly well established, it will be some time before it is possible to detect much smaller Earth-sized planets around other stars.

For another recent paper, Raymond ran more than 450 computer simulations to map giant planet orbits that allow Earth-like planets to form. If a giant planet is too close it will prevent rocky material from amassing into an Earth-sized planet. That study showed that only about 5 percent of the known giant-planet systems are likely to have Earth-like planets. But because of long observation times and sensitive equipment needed to detect planets the size of Saturn and Jupiter, it is possible there could be many planetary systems such as ours in this galaxy, he said.

2.4 Old pulsars still have new tricks to teach us

Source: ESA Press Release, July 26th, 2006 [12]

The super-sensitivity of ESA's XMM-Newton X-ray observatory has shown that the prevailing theory of how stellar corpses, known as pulsars, generate their X-rays needs revising. In particular, the energy needed to generate the million-degree polar hotspots seen on cooling neutron stars may come predominately from inside the pulsar, not from outside. Thirty-nine years ago, Cambridge astronomers Jocelyn Bell-Burnell and Anthony Hewish discovered the pulsars. These celestial objects are the strongly magnetised spinning cores of dead stars, each one just 20 kilometres across yet containing approximately 1.4 times the mass of the Sun. Even today, they perplex astronomers across the world.

"The theory of how pulsars emit their radiation is still in its infancy, even after nearly forty years of work," says Werner Becker, Max-Planck Institut fr extraterrestrische Physik, Garching, Germany. There are many models but no accepted theory. Now, thanks to new XMM-Newton observations, Becker and colleagues may have found a crucial piece of the puzzle that will help theorists explain why cooling neutron stars have hotspots at their polar regions. Neutron stars are formed with temperatures of more than billion (1012 K) degrees during the collapse of massive stars. As soon as they are born they begin to cool down. How they cool must depend on the physical properties of the superdense matter inside them.

Observations with previous X-ray satellites have shown that the X-rays from cooling neutron stars come from three regions of the pulsar. Firstly, the whole surface is so hot that it emits X-rays. Secondly, there are charged particles in the pulsar's magnetic surroundings that also emit X-rays as they move outwards, along the magnetic field lines. Thirdly, and crucially for this latest investigation, younger pulsars show X-ray hotspots at their poles.

Until now, astronomers believed that hotspots are produced when the charged particles collide with the pulsar's surface at the poles. However, the latest XMM-Newton results have cast doubt on this view.

XMM-Newton captured detailed views of the X-ray emission from five pulsars, each of which was up to several million years old. "No other X-ray satellite can do this work. Only XMM-Newton is capable of observing details of their X-ray emission," says Becker. He and his collaborators found no evidence of surface emission, nor of polar hotspots, although they did see emission from the outwardly moving particles.

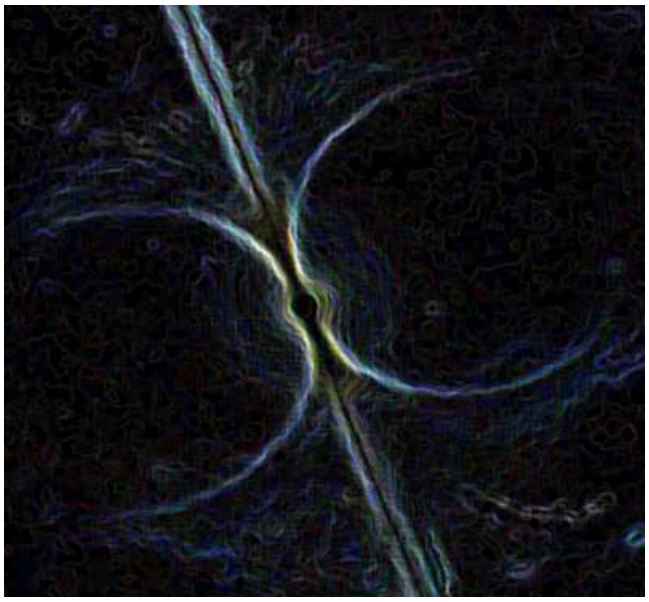

Figure 9: *An artist's impression of the 'luminescent' magnetosphere surrounding a pulsar. The pulsar itself is invisible in this view and sits at the very centre of the image. Above the pulsar's magnetic poles, charged particles are accelerated outwards along the magnetic field lines and produce intense beamed radiation that can be observed by XMM-Newton. Credits: W.Becker/Max-Planck Institut fr extraterrestrische Physik*

The lack of surface emission is no surprise. In the several million years since their birth these pulsars have cooled from billions of degrees to much less than 500 000 degrees Celsius, meaning that their surface-wide X-ray emission has faded from view.

However, the lack of the polar hotspots in old pulsars is a big surprise and shows that the heating of the polar surface regions by particle bombardment is not efficient enough to produce a significant thermal X-ray component. "In the case

of three-million-year-old pulsar PSR B1929+10 the contribution from any heated polar region is less than seven percent of the total detected X-ray flux," says Becker.

It seems that the conventional view is not the only way to look at the problem. An alternative theory is that the heat trapped in the pulsar since its birth will be guided to the poles by the intense magnetic field within the pulsar. This is because the heat is carried on electrons, which are electrically charged and so will be directed by magnetic fields.

This means that the polar hot spots in younger pulsars are produced predominantly from heat within the pulsar, rather than from the collision of particles from outside the pulsar. They will therefore fade from view in the same way as the surface-wide emission. "This view is still under discussion but is very much supported by the new XMM-Newton observations," says Becker.

Nearly forty years since the discovery of pulsars, it seems that old pulsars still have new tricks to teach astronomers.

2.5 Where are the supermassive black holes hiding?

Source: ESA Press Release, July 26th, 2006 [13]

European and American scientists, on a quest to find supermassive black holes hiding in nearby galaxies, have found surprisingly few. Either the black holes are better hidden than scientists realised or they are lurking only in the more distant universe. Scientists are convinced that some supermassive black holes must be hiding behind thick clouds of dust. These dusty shrouds allow only the highest energy X-rays to shine through. Once in space, the X-rays combine into a cosmic background of X-rays that permeates the whole of space.

The search for hidden black holes is part of the first census of the highest-energy part of the X-ray sky. Led by Loredana Bassani, IASF, Italy, a team of astronomers published results in The Astrophysical Journal Letters in January this year. They show the fraction of hidden black holes in the nearby Universe to be around 15 percent, using data from ESA's orbiting gamma-ray observation, the International Gamma Ray Astrophysics Laboratory (Integral). Now astronomers from NASA Goddard Space Flight Center in Greenbelt, Maryland, and the Integral Science Data Centre near Geneva, Switzerland, have found an even smaller fraction using nearly two years of continuous data, also from Integral. The work shows that there is clearly too few hidden black holes in the nearby Universe to create the observed X-ray background radiation.

"Naturally, it is difficult to find something we know is hiding well and which has eluded detection so far," says Volker Beckmann of NASA Goddard and the University of Maryland, Baltimore County, lead author of the new report to be published in an upcoming issue of The Astrophysical Journal. "Integral is a telescope that should see nearby hidden black holes, but we have come up short," he says.

The X-ray sky is thousands to millions of times more energetic than the visible sky familiar to our eyes. Much of the X-ray activity is thought to come from black holes violently sucking in gas from their surroundings. Recent breakthroughs in X-ray astronomy, including a thorough black hole census taken by NASA's Chandra X-ray Observatory and Rossi X-ray Timing Explorer, have all dealt with lower-energy X-rays. The energy range is roughly 2 000 to 20 000 electron-volts (optical light, in comparison, is about 2 electron-volts). The two Integral surveys are the first glimpse into the largely unexplored higher-energy, or 'hard', X-ray regime of 20 000 to 300 000 electron-volts.

"The X-ray background, this pervasive blanket of X-ray light we see everywhere in the universe, peaks at about 30 000 electron volts, yet we really know next to nothing about what produces this radiation," says Neil Gehrels of NASA Goddard, a co-author.

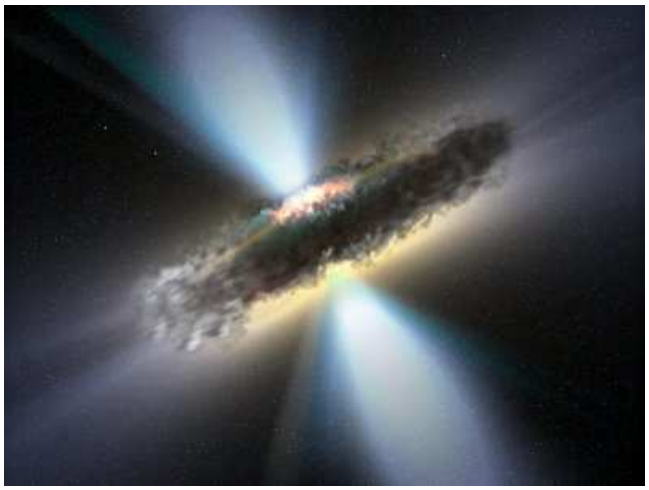

Figure 10: *This artist's impression shows the thick dust torus that astronomers believe surrounds many supermassive black holes and their accretion discs. When the torus is seen edge-on as in this case, much of the light emitted by the accretion disc is blocked, creating a "hidden" black hole. However, the sharp gamma-ray and X-ray eyes of Integral can peer through the thick dust and identify the black hole within. An Integral survey of the local universe found few hidden black holes, implying that they must have existed*

earlier (deeper) in the universe. Credits: ESA / V. Beckmann (NASA-GSFC)

The theory is that hidden black holes, which scientists call Compton-thick objects, are responsible for the 30 000 electron-volts peak of X-rays in the cosmic X-ray background. Integral is the first satellite sensitive enough to search for them in the local universe.

According to Beckmann, of all the black hole galaxies that Integral detected less than 10 percent were the heavily shrouded 'Compton thick' variety. That has serious implications for explaining where the X-rays in the cosmic X-ray background come from.

"The hidden black holes we have found so far can contribute only a few percent of the power to the cosmic X-ray background," says Bassani. This implies that if hidden black holes make up the bulk of the X-ray background, they must be located much further away in the more distant universe. Why would this be? One reason could be that in the local universe most super-massive black holes have had time to eat or blow away all the gas and dust that once enshrouded them, leaving them revealed.

This would make them less able to produce X-rays because it is the heating of the gas falling into the black hole that generates the X-rays, not the hole itself. So, if the black hole had cleared its surroundings of matter there would be nothing left to produce X-rays. Conversely, another possibility is that perhaps the hidden black holes are more hidden than astronomers realised. "The fact that we do not see them does not necessarily mean that they are not there, just that we don't see them. Perhaps they are more deeply hidden than we think and so are therefore below even Integral's detection limit," says Bassani.

Meanwhile, the NASA team is now planning to extend his search for hidden black holes further out into the universe. "This is just the tip of the iceberg. In a few more months we will have a larger survey completed with the Swift mission. Our goal is to push this kind of observation deeper and deeper into the universe to see black hole activity at early epochs. That's the next great challenge for X-ray and gamma-ray astronomers," concluded Beckmann.

2.6 A New View of Quasars

Source: Harvard-Smithsonian Center for Astrophysics Press Release, July 25th, 2006 [14]

In the distant, young universe, quasars shine with a brilliance unmatched by anything in the local cosmos. Although they appear starlike in optical telescopes, quasars are actually the bright centers of galaxies located billions of light-years from Earth.

The seething core of a quasar currently is pictured as containing a disk of hot gas spiraling into a supermassive black hole. Some of that gas is forcefully ejected outward in two opposing jets at nearly the speed of light. Theorists struggle to understand the physics of the accretion disk and jets, while observers struggle to peer into the quasar's heart. The central "engine" powering the jets is difficult to study telescopically because the region is so compact and Earth observers are so far away.

Astronomer Rudy Schild of the Harvard-Smithsonian Center for Astrophysics (CfA) and his colleagues studied the quasar known as Q0957+561, located about 9 billion light-years from Earth in the direction of the constellation Ursa Major, near the Big Dipper. This quasar holds a central compact object containing as much mass as 3-4 billion Suns. Most would consider that object to be a "black hole," but Schild's research suggests otherwise.

"We don't call this object a black hole because we have found evidence that it contains an internally anchored magnetic field that penetrates right through the surface of the collapsed central object, and that interacts with the quasar environment," commented Schild.

The researchers chose Q0957+561 for its association with a natural cosmic lens. The gravity of a nearby galaxy bends space, forming two images of the distant quasar and magnifying its light. Stars and planets within the nearby galaxy also affect the quasar's light, causing small fluctuations in brightness (in a process called "microlensing") when they drift into the line of sight between Earth and the quasar.

Schild monitored the quasar's brightness for 20 years, and led an international consortium of observers operating 14 telescopes to keep the object under steady around-the-clock watch at critical times.

"With microlensing, we can discern more detail from this so-called ?black hole' two-thirds of the way to the edge of the visible universe than we can from the black hole at the center of the Milky Way," said Schild.

Through careful analysis, the team teased out details about the quasar's core. For example, their calculations pinpointed the location where the jets form.

"How and where do these jets form? Even after 60 years of radio observations, we had no answer. Now the evidence is in, and we know," said Schild.

Schild and his colleagues found that the jets appear to emerge from two regions 1,000 astronomical units in size (about 25 times larger than Pluto-Sun distance) located 8,000 astronomical units directly above the poles of the central compact object. (An astronomical unit is defined as the average distance from the Earth to the Sun, or 93 million miles.) However, that location would be expected only if the jets were powered by reconnecting magnetic field lines that were anchored to the rotating supermassive compact object within the quasar. By interacting with a surrounding accretion disk, such spinning magnetic field lines spool up, winding tighter and tighter until they explosively unite, reconnect and break, releasing huge amounts of energy that power the jets.

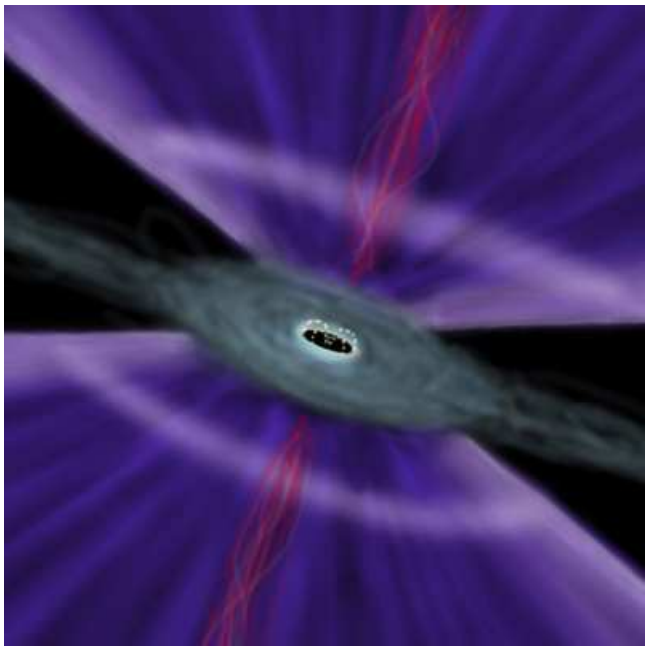

Figure 11: *Artist illustration of a quasar. Image credit: CfA*

"This quasar appears to be dynamically dominated by a magnetic field internally anchored to its central, rotating supermassive compact object," stated Schild.

Further evidence for the importance of the quasar's internally anchored magnetic field is found in surrounding structures. For example, the inner region closest to the quasar appears to have been swept clean of material. The inner edge of the accretion disk, located about 2,000 astronomical units from the central compact object, is heated to incandescence and glows brightly. Both effects are the physical signatures of a swirling, internal magnetic field being pulled around by the rotation of the central compact object - a phenomenon dubbed the "magnetic propeller effect."

Observations also suggest the presence of a broad cone-shaped outflow from the accretion disk. Where lit by the central quasar, it shines in a ring-like outline known as the Elvis structure after Schild's CfA colleague, Martin Elvis, who theorized its existence. The surprisingly large angular opening of the outflow that is observed is best explained by the influence of an intrinsic magnetic field contained within the central compact object in this quasar.

In light of these observations, Schild and his colleagues, Darryl Leiter (Marwood Astrophysics Research Center) and Stanley Robertson (Southwestern Oklahoma State University), have proposed a controversial theory that the magnetic field is intrinsic to the quasar's central, supermassive compact object, rather than only being part of the accretion disk as thought by most researchers. If confirmed, this theory would lead to a revolutionary new picture of quasar structure.

"Our finding challenges the accepted view of black holes," said Leiter. "We've even proposed a new name for them - Magnetospheric Eternally Collapsing Objects, or MECOs," a variant of the name first coined by Indian astrophysicist Abhas Mitra in 1998. "Astrophysicists of 50 years ago did not have access to the modern understanding of quantum electrodynamics that is behind our new solutions to Einstein's original equations of relativity."

This research suggests that, in addition to its mass and spin, the quasar's central compact object may have physical properties more like a highly redshifted, spinning magnetic dipole than like a black hole. For that reason, most approaching matter does not disappear forever, but instead feels the motor-like rotating magnetic fields and gets spun back out. According to this theory, a MECO does not have an event horizon, so any matter that is able to get by the magnetic propeller is gradually slowed down and stopped at the MECO's highly redshifted surface, with just a weak signal connecting the radiation from that matter to a distant observer. That signal is very hard to observe and has not been detected from Q0957+561.

2.7 A simple survey yields a cosmic conundrum

Source: UC Santa Cruz, July 31st, 2006 [15]

A survey of galaxies observed along the sightlines to quasars and gamma-ray bursts–both extremely luminous, distant objects–has revealed a puzzling inconsistency. Galaxies

appear to be four times more common in the direction of gamma-ray bursts than in the direction of quasars.

Quasars are thought to be powered by accretion of material onto supermassive black holes in the centers of distant galaxies. Gamma-ray bursts, the death throes of massive stars, are the most energetic explosions in the universe. But there is no reason to expect galaxies in the foreground to have any association with these background light sources.

"The result contradicts our basic concepts of cosmology, and we are struggling to explain it," said Jason X. Prochaska, associate professor of astronomy and astrophysics at the University of California, Santa Cruz.

Prochaska and graduate student Gabriel Prochter led the survey, which used data from NASA's Swift satellite to obtain observations of the transient, bright afterglows of long-duration gamma-ray bursts (GRBs). They described their findings in a paper accepted for publication in Astrophysical Journal Letters. The paper, which could have strange cosmological implications, has been a source of significant debate among astronomers throughout the world.

The study is based on a fairly straightforward concept. When light from a GRB or a quasar passes through a foreground galaxy, the absorption of certain wavelengths of light by gas associated with the galaxy creates a characteristic signature in the spectrum of light from the distant object. This provides a marker for the presence of a galaxy in front of the object, even if the galaxy itself is too faint to observe directly.

Prochter and Prochaska analyzed 15 GRBs in the new study and found strong absorption signatures indicating the presence of galaxies along 14 GRB sightlines. They had previously used data from the Sloan Digital Sky Survey (SDSS) to determine the incidence of galaxies along the sightlines to quasars. Based on the quasar study, they would have predicted only 3.8 galaxies instead of the 14 detected along the GRB sightlines.

The quasar analysis was based on more than 50,000 SDSS observations, so the data for quasars are much more robust statistically than the data for GRBs, Prochaska said. Nevertheless, the probability that their results are just a statistical fluke is less than about one in 10,000, he said.

The researchers examined three potential explanations for the inconsistency. The first is obscuration of some quasars by dust in galaxies. The idea is that if a quasar is behind a dusty galaxy it wouldn't be seen, and this could skew the results. "The counter argument is that with this huge database of quasar observations, the effect of dust has been well characterized and it should be minimal," Prochter said.

Another possibility is that the absorption lines in the GRB spectra are from gas ejected by the GRBs themselves, rather than from gas in intervening galaxies. But in nearly every case when researchers have taken a closer look in the direction of the GRB, they have in fact found a galaxy at the same position as the gas.

The third idea is that the intervening galaxy may act as a gravitational lens, enhancing the brightness of the background object, and that this effect is somehow different for GRBs than for quasars. Although Prochaska said he prefers this explanation, several factors make strong lensing of the GRBs seem unlikely.

"Those who know more about gravitational lensing than I do tell me it's unlikely to be the answer," Prochaska said.

The paper, a draft of which has been posted on an Internet server for several weeks, has stimulated widespread discussion and at least one new paper proposing a potential explanation. But so far the findings remain perplexing.

"A lot of people have been scratching their heads, and most hope that it goes away," Prochaska said. "The GRB sample is small, so we would like to triple or quadruple the number in our analysis. That should happen during Swift's extended mission, but it will take time."

2.8 Falling Onto the Dark

Source: ESO Press Release, July 3rd, 2006 [16]

Rare Blob Unveiled: Evidence for Hydrogen Gas Falling onto a Dark Matter Clump?

ESO's VLT has helped scientists to discover a large primordial 'blob', more than 10 billion light-years away. The most likely scenario to account for its existence and properties is that it represents the early stage in the formation of a galaxy, when gas falls onto a large clump of dark matter.

Over the last few years, astronomers have discovered in the distant Universe a few so-called 'blobs'. These are rather energetic but under-luminous objects, of the size of or much larger than our Milky Way galaxy. Their exact nature is still unclear and several scenarios have been proposed to account for their existence.

An international team of astronomers have discovered a new 'blob' located at a distance of 11.6 billion light-years (redshift 3.16). It is thus seen as it was when the Universe was only 2 billion years old, or less than 15% its present age.

The newly discovered object is located in the well-studied GOODS South field.

The object was discovered using the multi-mode FORS1 instrument on ESO's Very Large Telescope (VLT), in December 2002. The astronomers studied a small part of the GOODS South field in a narrow-band filter centred around 505 nm for more than 8 hours. This special filter allows astronomers to observe emission from hydrogen atoms that are around 11.6 billion light-years away (redshift between 3.126 and 3.174). From December 2004 till February 2005, FORS1 was used again to perform spectroscopy of some of the newly discovered sources, for a total observing time of 6 hours.

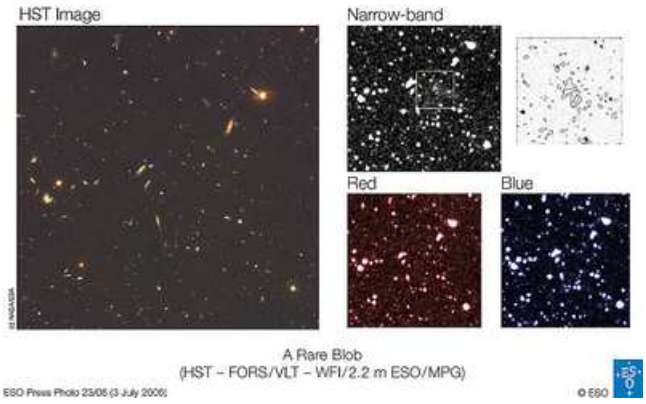

Figure 12: *Sky field around the newly discovered 'blob'. The left image shows an HST image of part of the GOODS field, centred on the position of this unusal object. The two bottom right images show the same field observed in the B (blue) and R (red) bands with the ESO/MPG 2.2-m telescope at La Silla. In none of these images is the blob visible. It does only appear in the image obtained with FORS1 on the VLT, when observed through a dedicated narrow-band filter that detects hydrogen atoms that are around 11.6 billion light-years away. The top right image shows contours of this narrow-band emission overlaid on the HST image. It represents the field of view shown by the square in the top middle image. The position of the 'blob' is now obvious.*

With a diameter of 200 000 light-years, the blob is twice as big as our Milky Way and the total energy emitted is equivalent to that of about 2 billion suns. Despite this, the object is invisible in the images taken with various telescopes observing from the infrared to the X-ray wavebands, making it a very peculiar object indeed. It is also the only such object found by the astronomers in their survey.

"We have tried to explain this blob using the most common explanations, such as the illumination by a galaxy with an active nucleus or a galaxy that produce stars at a frantic rate, but none of them apply," says Kim Nilsson (ESO), first author of the paper relating the result. "Instead, we are led to the conclusion that the observed hydrogen emission comes from primordial gas falling onto a clump of dark matter. We could thus be literally seeing the building up of a massive galaxy, like our own, the Milky Way."

2.9 Giant Gas Clouds Illuminate Universe's Largest Structure

Source: Subaru Telescope Press Release, July 26th, 2006 [17]

A team of astronomers using the Subaru and Keck telescopes on Mauna Kea has discovered giant, three-dimensional filaments of galaxies extending across 200 million light-years of space. These filaments, which formed a mere 2 billion years after the birth of the universe, are the largest-known structures ever discovered. They are studded with more than 30 large concentrations of gas, each up to ten times as massive as our own galaxy. These giant gas clouds are probably the progenitors of the most massive galaxies that exist in the universe today.

This finding is very important because it gives researchers new insight into the large-scale structure of the cosmos. Astronomers expect the universe to look relatively smooth 2 billion years after the birth of the universe. In summarizing the importance of this finding, astronomer Ryosuke Yamauchi from Tohoku University said, "Something this large and this dense would have been rare in the early universe. The structure we discovered and others like it are probably the precursors of the largest structures we see today which contain multiple clusters of galaxies."

Giant 3D Filaments of Galaxies The research group used the Subaru telescope to make a detailed study of a region of sky 12 billion light-years from Earth that is known to have a large concentration of galaxies. They used Subaru's Suprime-cam camera outfitted with special filters designed to be sensitive to the light from galaxies at that distance. The results showed that this concentration of galaxies is just a small portion of a much larger structure.

The newly found giant structure extends over 200 million light years and has a concentration of galaxies up to four times denser than the universe's average. The only previous known structures with such a high density are much smaller, measuring about 50 million light-years in scale.

Using Subaru's Faint Object Camera and Spectrograph (FOCAS) to study the 3D distribution of galaxies in this fila-

ment, the team also discovered at least three overlapping filaments that make up the giant structure.

Large Concentrations of Gas Astronomers knew this region contained at least two large concentrations of gas. One of them, shown in figure 3, extends across 400,000 light-years. A comparison with the Andromeda Galaxy, thought to be about the same size as the Milky Way Galaxy, shows the relative immensity of this gas structure.

The researchers found that these large concentrations of gas are located near the overlap regions of the filaments.

The Subaru observations were successful in finding much fainter objects than previously discovered in this region. (Figure 4) For example, they found 33 new large concentrations of gas along the filamentary structure extending across 100,000 light-years. This is the first time that so many large concentrations of gas, known to astronomers as Lyman alpha blobs, have been discovered in the distant universe.

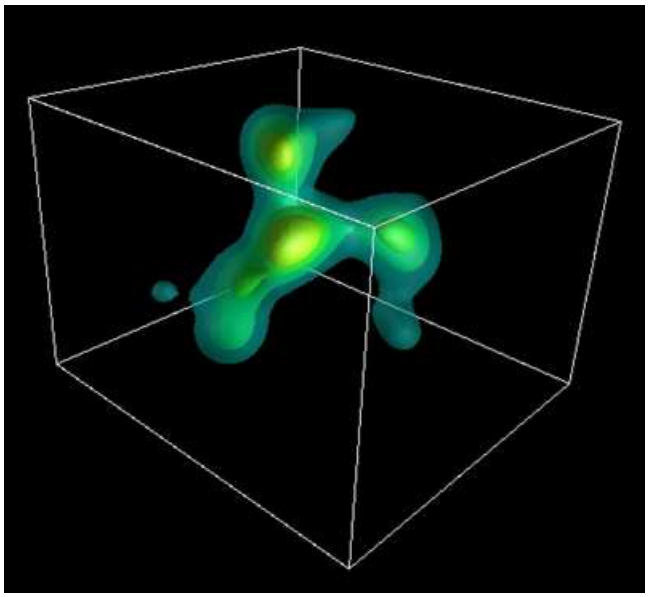

Figure 13: *The distribution of galaxies in the giant filamentary structure 12 billion light years away. There are at least three intersecting filaments.*

Astronomers think that such Lyman alpha blobs, named so since they are seen in the Lyman alpha emission line of hydrogen, are probably related to the births of the largest galaxies. In the ”gravitational heating” model, the blobs are regions where gas is collapsing under its own gravity to form a galaxy. The”photoionization” model attributes emission from the gas to ionization by ultraviolet light from newborn stars or a massive black hole. The ”shock heating” or ”galactic superwind” model hypothesizes that the glow of the gas is caused by the death of many massive stars born early in the history of the universe, living out short lives, and then dying in supernova explosions that blow out surrounding gas. Team members Yoshiaki Taniguchi and Yasuhiro Shioya (Ehime University) have been advocating for the galactic superwind model.

Observations with the DEIMOS spectrograph at the Keck II telescope revealed that the gas inside the blobs move with speeds greater that 500 kilometers per second (300 miles per second). The extent of the gas concentrations and the speed of the material within them suggest that these regions must be up to ten times as massive as the Milky Way Galaxy.

The blobs show a great variety in shape and brightness. For example, some show bubble-like features that match computer simulations of galactic winds such as those by Masao Mori (Senshu University) and Masayuki Umemura (University of Tsukuba). There are also diffuse blobs and those consisting of several galaxies (Figures 3, 5, and 6).

”Galaxies of various sizes surround us,” said Yuichi Matsuda of Kyoto University.”The large gas concentrations we found may tell us a lot about how the largest of these came to be.”

3 Space missions

3.1 Crash Landing on the Moon

Source: Science@NASA, July 28th, 2006 [18]

In 1959, a spaceship fell out of the lunar sky and hit the ground near the Sea of Serenity. The ship itself was shattered, but its mission was a success. Luna 2 from the Soviet

Union had became the first manmade object to ”land” on the Moon.

This may seem hard to believe, but Luna 2 started a trend: Crash landing on the Moon, on purpose. Dozens of spaceships have done it.

NASA’s first kamikazes were the Rangers, built and launched in the early 1960s. Five times, these car-sized spaceships plunged into the Moon, cameras clicking all the way down. They captured the first detailed images of lunar craters, then rocks and soil, then oblivion. Data beamed back to Earth about the Moon’s surface were crucial to the success of later Apollo missions.

Even after NASA mastered soft landings, however, the crashing continued. In the late 1960s and early 70s, mission controllers routinely guided massive Saturn rocket boosters into the Moon to make the ground shake for Apollo seismometers. Crashing was much easier than orbiting, they discovered. The Moon’s uneven gravity field tugs on satellites in strange ways, and without frequent course corrections, orbiters tend to veer into the ground. Thus the Moon became a convenient graveyard for old spaceships: All five of NASA’s Lunar Orbiters (1966-1972), four Soviet Luna probes (1959-1965), two Apollo sub-satellites (1970-1971), Japan’s Hiten spacecraft (1993) and NASA’s Lunar Prospector (1999) ended up in craters of their own making.

Back to the Future

All this experience is about to come in handy. NASA researchers have a daring plan to find water on the Moon and they’re going to do it by–you guessed it–crash landing. The mission’s name is LCROSS, short for Lunar CRater Observation and Sensing Satellite. Team leader Tony Colaprete of NASA Ames explains how it’s going to work:

”We think there’s frozen water hiding inside some of the Moon’s permanently-shadowed craters. So we’re going to hit one of those craters, kick up some debris, and analyze the impact plumes for signs of water.”

The experiment couldn’t be more important. NASA is returning to the Moon, and when explorers get there, they’ll need water. Water can be split into hydrogen for rocket fuel and oxygen for breathing. It can be mixed with moondust to make concrete, a building material. Water makes an excellent radiation shield, and when you get thirsty you can drink it. One option is to ship water directly from Earth, but that’s expensive. A better idea would be to mine water directly from the lunar soil.

But is it there? That’s what LCROSS aims to find out.

The quest begins in late 2008 when LCROSS leaves Earth tucked inside the same rocket as Lunar Reconnaissance Orbiter (LRO), a larger spacecraft on a scouting mission of its own. After launch, the two ships will split up and head for the Moon, LRO to orbit, LCROSS to crash.

Figure 14: *Luna 2*

Actually, says Colaprete, ”we’re going to crash twice.” LCROSS is a double spacecraft: a small, smart mothership and a big, not-so-smart rocket booster. The mothership is called the ”Shepherding Spacecraft” because it shepherds the booster to the Moon. They’ll travel to the Moon together, but hit separately.

The booster strikes first, a savage blow transforming 2-tons of mass and 10 billion joules of kinetic energy into a blinding flash of heat and light. Researchers expect the impact to gouge a crater 20 meters wide and throw up a plume of debris as high as 40 km.

Close behind, the Shepherding Spacecraft will photograph the impact and then fly right through the debris plume. Onboard spectrometers can analyze the sunlit plume for signs

of water (H2O), water fragments (OH), salts, clays, hydrated minerals and assorted organic molecules. ”If there’s water there, or anything else interesting, we’ll find it,” says Colaprete.

The Shepherd then begins its own death plunge. Like the old Rangers, it will dive toward the lunar surface, cameras clicking. Back on Earth, mission controllers will see the booster’s glowing crater swell to fill the field of view–an exhilarating rush.

Until the very end, the Shepherd’s spectrometers will keep sniffing for water. ”We’ll be able to monitor the data stream down to 10 seconds before impact,” says Colaprete. ”And we should have enough control to land within 100 meters of the booster’s crash site.”

The Shepherd is 1/3rd lighter than the booster, so its impact will be proportionally smaller. Nevertheless, the Shepherd will make its own crater and plume, adding to those of the booster. Astronomers hope the combined plumes will be visible from Earth, allowing observations to continue even after the Shepherd is destroyed.

Many readers will remember the crash of Lunar Prospector in 1999. Mission controllers guided the ship into Shoemaker crater near the Moon’s south pole in hopes of kicking up waterjust like LCROSS. But no water was found.

”LCROSS has a better chance of success,” says Colaprete. For one thing, LCROSS delivers more than 200 times the impact energy of Lunar Prospector, excavating a deeper crater and throwing debris higher where it can be plainly seen. While Lunar Prospector’s plume was observed only by telescopes on Earth a quarter-million miles away, LCROSS’s plume will be analyzed by the Shepherding Spacecraft at point blank range, using instruments specifically designed for the purpose.

Only one question remains: Where will LCROSS strike?

”We haven’t decided,” he says. The best places are probably polar craters with shadowy bottoms where water deposited by comets long ago may have frozen and survived to the present-day. Less orthodox choices include canyons, rilles and lava tubes. ”There are many candidates. We’re convening a meeting of researchers to debate the merits of various sites and, finally, to pick one.”

3.2 Hubble’s Advanced Camera for Surveys Resumes Exploring the Universe

Source: Hubble News, July 12th, 2006 [19]

After a brief hiatus, the Advanced Camera for Surveys aboard NASA’s Hubble Space Telescope is back in business, probing the far reaches of space in a quest to understand the true nature of the universe’s most dominant constituent: dark energy.

This is one of the first images of the universe taken after the ACS camera resumed science operation on July 4th. The camera was offline for nearly two weeks as NASA engineers switched to a backup power supply after the camera’s primary power supply failed.

The picture on the left is of a rich galaxy field containing a distant galaxy cluster 9 billion light-years away (redshift of z = 1.4). In a program conducted by Saul Perlmutter of the University of California at Berkeley, Hubble periodically revisits about 20 distant galaxy clusters on a ”fishing trip” to capture the glow of a class of exploding star called a Type Ia supernova. The selected clusters were chosen because they allow astronomers to study dark energy at a distance too great to be easily observed from the ground.

Type Ia supernovae are bright celestial distance markers that are invaluable for measuring how dark energy is influencing the universe. Ultimately, detailed observations like this will allow astrophysicists to better understand the nature of dark energy and its influence on the future evolution of the universe.

When Hubble looked at this field in April 2006, (upper right) no supernova was evident. Hubble first saw the supernova in June 2006, in a field galaxy that is one billion light-years closer (redshift value of z = 1.2) to us than the more distant cluster. Right after the ACS was returned to operation Hubble revisited the field to make measurements of the fading stellar explosion (arrow lower right). The bright core of the host galaxy is adjacent to the glowing supernova. A supernova can briefly become as bright as an entire galaxy of stars.

The quality of the April and July images demonstrate that the ACS is operating perfectly and sending back detailed images of the distant universe.

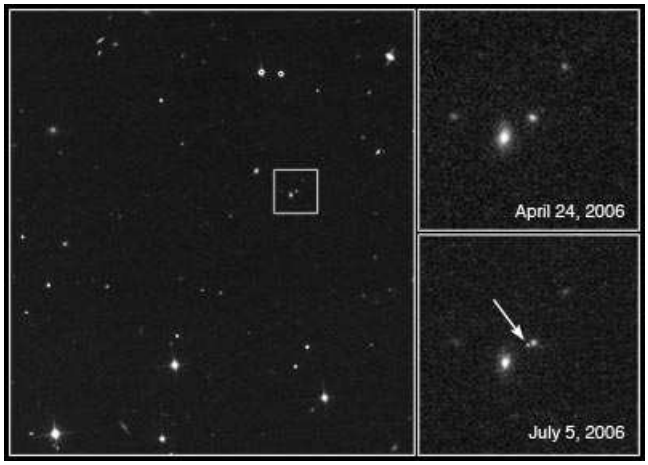

Figure 15: *Credit: NASA, ESA, S. Perlmutter (University of California, Berkeley and Lawrence Berkeley National Laboratory), and the HST Cluster Supernova Collaboration*

Discovered in 1998, dark energy seems to percolate out of empty space and provides a repulsive force that is causing the universe to expand at an ever-faster rate.

3.3 Inflatable Habitat Reaches Orbit

Source: Fraser Cain for Universe Today, July 12th, 2006 [20]

Bigelow Aerospace is a space tourism company located in Las Vegas, Nevada. Its long-term goal is to develop a space-based hotel to give wealthy space tourists an orbital experience. Since space stations are so heavy and expensive to carry into orbit, Bigelow Aerospace has been pioneering the concept of inflatable habitats. These are carried into orbit in a compressed state and then inflated to provide a large volume of space for astronauts (and space tourists).

The company took its first step today with the launch of Genesis 1. When compressed, the habitat measures 5 metres (15 feet) in length and 1.9 metres (6.2 feet) in diameter. Once in orbit, it's designed to inflate to roughly twice its compressed width.

It was carried into space on board an ISC Kosmotras Dnepr rocket - a Cold-War era ICBM - from the Yasny Launch Base.

By Wednesday evening, Bigelow Aerospace confirmed that Genesis-1 had successfully expanded and deployed its solar arrays:

5:20 PST: Bigelow Aerospace has received confirmation from the Genesis I spacecraft that it has successfully expanded. We have also confirmed that all of the solar arrays have been deployed.

Figure 16: *Image credit: Bigelow Aerospace*

4:15 PST: Bigelow Aerospace mission control has begun to acquire information from the Genesis I spacecraft. The ISC Kosmotras Dnepr rocket has flawlessly delivered the Genesis I into the target orbit of 550km altitude at 64 degrees inclination. The internal battery is reporting a full charge of 26 volts, which leads us to believe that the solar arrays have deployed.

The internal temperature of the spacecraft is reported to be 26 degrees Celsius and we have acquired the spacecraft's Global Positioning System (GPS) signal that will enable us to track the ship in flight.

We have initiated communication with the ship's onboard computers and expect to download more information over the next few hours.

The spacecraft is carrying staff photographs and memorabilia, as well as insects that will allow Bigelow to study how well the habitat holds up.

If everything goes well, it'll stay in orbit for 5 years, giving engineers time to study its performance and to gather data for the next phases of the program. It'll be exposed to years of solar radiation and cosmic rays, and should get peppered with orbital debris.

Bigelow expects to follow up the launch with Genesis-2; built to the size. It will have improvements based on the data gathered by Genesis-1, and could launch as early as late 2006 or 2007.

After the Genesis-class habitats will come the Galaxy class, and then finally the BA-330, which will contain 330 cubic metres of usable volume (the International Space Station has 425 cubic meters).

3.4 Controlling robots that search for Mars life

Source: ESA Press Release, 11th July, 2006 [21]

As part of ESA's ambitious, long-term Aurora exploration programme, ExoMars will search for traces of life on Mars. The mission requires entirely new technologies for self-controlled robots, built-in autonomy and cutting-edge visual terrain sensors. The fourth decade of this century could see Europe participating in a manned mission to Mars in what would be one of humanity's grandest space expeditions ever.

Aurora is ESA's programme aimed at the long-term robotic and human exploration of the Solar System, with Mars and the Moon as the main targets.

A human mission to the Red Planet would be a major, multi-year undertaking requiring fantastic, entirely new capabilities such as automated cargo vessels, prepositioned supplies and tools, and communication and navigation satellites in Mars orbit similar to Earth's current GPS systems.

Scientists and engineers are already working on ESA's first robotic 'precursor' mission, ExoMars, due for launch around 2011.

ExoMars will explore the biological environment on Mars in preparation for further robotic and, later, human activity. Data from the mission will also provide invaluable input for broader studies of exobiology the search for life on other planets.

The main element of the mission is a wheeled, robotic rover vehicle, similar in concept to NASA's current Mars Rover mission, but having different scientific objectives and improved capabilities.

The rover will use solar arrays to generate electricity, and will travel over the rocky orange-red surface of Mars, transporting an up to 12-kilogram scientific payload including a first-ever lightweight drilling system, as well as a sampling and handling device, and a set of scientific instruments to search for signs of past or present life.

Due to distance time-lag and complexity, ExoMars will self-navigate using 'smart' electro-optics to visually sense and interpret the surrounding terrain and will be capable of operating autonomously using intelligent onboard software. Automated control a major advance This automated mode of operation is a major advance for ESA, long used to controlling spacecraft directly using human controllers. And not only will the rover's onboard control systems be new.

"ExoMars will require entirely new techniques and technology for several aspects of the Earth-based rover control system, not just an upgrade of what we have today," says Mike McKay, a senior spacecraft controller and Mars expert based at ESOC, ESA's Spacecraft Operations Centre, in Darmstadt, Germany.

Figure 17: *The ExoMars rover will be ESA's field biologist on Mars. Its aim is to further characterise the biological environment on Mars in preparation for robotic missions and then human exploration. This mission calls for the development of a Mars orbiter, a descent module and a Mars rover. The Mars orbiter will have to be capable of reaching Mars and putting itself into orbit around the planet. On board will be a Mars rover within a descent module. The Mars descent module will deliver the rover to a specific location by using an inflatable braking device or parachute system. Using conventional solar arrays to generate electricity, the Rover will be able to travel a few kilometres over the rocky orange-red surface of Mars. The vehicle will be capable of operating autonomously by using onboard software and will navigate by using optical sensors. Included in its ap-*

proximately 40 kg exobiology payload will be a lightweight drilling system, a sampling and handling device, and a set of scientific instruments to search for signs of past or present life. Credits: ESA

ESA controllers have never before operated a mission that moved about on the surface of another body; Huygens which touched down successfully on Titan in 2005 was an atmospheric probe and not a lander, although it functioned briefly after reaching Titan's surface. Robotic task: traverse kilometres of terrain in search of life In one typical example of the rover's autonomous operation, ground controllers might radio up a high-level command telling it to drive to a scientifically interesting spot anywhere from 500 to 2000 metres away and conduct science operations, such as drilling beneath the surface to sample soil for life signs. But the vehicle would handle the details of the move on its own.

It would survey the ground with a 3D camera, create a digital terrain model, verify its present location, run internal simulations and then make an autonomous decision on the best path to follow, based on obstacles, the rover's current status and risk/resource considerations.

"Then it will drive itself to the target. We expect its target accuracy to be within one-half metre over a traverse of 20 metres," says Bob Chesson, head of the Human Spaceflight and Exploration Operations Department in ESA's Operations directorate.

ExoMars profits from current robotic explorers

As the next generation of robot, ExoMars will profit from lessons learned from the current generation, including NASA's Mars Explorer Rover (MER) mission. "We're not shy in trying to learn from the experiences of our sister agencies," says Chesson.

Innovative ground control to enable autonomous functioning For ExoMars, the controllers on Earth would most likely be located in a 'rover dedicated control room', similar in concept to the dedicated control rooms (DCR) that ESA now sets up for individual missions that orbit planets.

ESOC will serve as the overall mission operations control centre (MOCC), controlling the launch and early orbit phase (LEOP), the cruise to Mars, the separation and landing of the descent module and the rover egress, with management of rover surface operations likely to be conducted from the Rover Operation Centre located at ALTEC, the Advanced Logistic Technology Engineering Center, in Turin, Italy.

"The design of the rover ground control system, or ground segment, depends on the scientific and operational goals of the rover, which are not yet final, so the ground system is still evolving," says Chesson. "In principle, the basic telemetry and telecommand functions would be essentially the same as now, but it will have significantly new capabilities to allow for the rover's autonomous functioning."

'Letting the child walk' The ground control system will at least require computing facilities to enable high-level mission planning tools and to allow monitoring of the rover's digital terrain and 3D modelling, ground path and trajectory planning, on-ground simulation and tight integration with the payload control and scientific operations.

"Classic direct control methods just won't work when we operate on the surface of Mars in an unstructured environment and with a significant signal time delay," says Reinhold Bertrand, a planning engineer and robotics expert at ESOC. "ExoMars will require a change in culture; we have to 'let the child walk on its own' while we develop a truly interdisciplinary operations concept."

3.5 Telescope to probe early universe, more

Source: MIT Press Release, July 5th, 2006 [22]

A novel telescope that will aid the understanding of the early universe is moving closer to full-scale construction thanks to a 4.9 million sollars award from the National Science Foundation to a U.S. consortium led by MIT.

The Mileura Widefield Array - Low Frequency Demonstrator (LFD), which is being built in Australia by the United States and Australian Partners, will also allow scientists to better predict solar bursts of superheated gas that can play havoc with satellites, communication links and power grids. In support of the solar observations, the Air Force Office of Scientific Research also recently made a 0.3M dollars award to MIT for array equipment.

"The design of the new telescope is tightly focused on frontier experiments in astrophysics and heliospheric science. We plan to harness the enormous computing power of modern digital electronic devices, turning thousands of small, simple, cheap antennas into one of the most potent and unique astronomical instruments in the world," said Colin J. Lonsdale, the project's leader at MIT's Haystack Observatory.

LFD collaborators in the United States are the Haystack Observatory, the MIT Kavli Institute for Astrophysics and Space Research and the Harvard-Smithsonian Center for Astrophysics. Australian partners include the CSIRO Australia Telescope National Facility and an Australian university consortium led by the University of Melbourne, that in-

cludes the Australian National University, Curtin University of Technology and others. First galaxy, first star

Shortly after the Big Bang, the universe was a nearly featureless sea of dark matter and gas. How did structures such as our galaxy form from this bland uniformity? Over time, gravity slowly drew condensations of matter together, creating patches of higher and lower density. At some point, enough gas became concentrated into a small enough space that complex astrophysical processes were triggered, and the first stars were born.

In principle, we can see how and when this happened by looking to the farthest reaches of the universe, because as we look at greater distances, we also look back in time. Finding these first stars, and the primordial galaxies within which they ignited, is a primary mission of the LFD.

How will the telescope accomplish this?

It turns out that hydrogen, which made up most of the ordinary matter in the early universe, efficiently emits and absorbs radio waves. It is these radio waves, stretched by the expansion of the universe, which can be detected, measured and analyzed by the new telescope. By spotting the fluctuations in brightness across broad swaths of sky at these wavelengths, we can discover the state of the hydrogen gas when the universe was a tiny fraction of its current age.

”Radio astronomical telescopes operating at low frequency provide an opportunity to witness the formation of the first stars, galaxies and clusters of galaxies, and to test our theories of the origin of structure,” said Jacqueline Hewitt, director of the MIT Kavli Institute and a professor of physics. She added that ”direct observation of this early epoch of structure formation is arguably one of the most important measurements in astrophysical cosmology still to be made.”

Professor Rachel Webster of the University of Melbourne said, ”We also hope to see spherical holes created by early quasars [active cores of galaxies] in the smooth distribution of primordial hydrogen. These will appear as small dark spots where the quasar radiation has split the hydrogen apart into protons and electrons.” Understanding ’space weather’

Sometimes, the sun gets violent. Huge bursts of superheated gas, or plasma, are ejected into interplanetary space and race outward on a collision course with the Earth. These so-called ”coronal mass ejections” and the flares with which they are associated, are responsible for the polar light shows known as auroras. They can also, however, play havoc with satellites, communication links and power grids, and can endanger astronauts.

The impact of these plasma ejections can be predicted, but not very well. Sometimes, the ejected material is deflected by the Earth’s magnetic field and Earth is shielded. At other times, the shield fails and widespread damage can ensue. The difference is due to the magnetic properties of the plasma.

To improve the predictions and provide reliable advance warning of adverse space weather, scientists must measure the magnetic field that permeates the material. Until now, there has been no way to make that measurement until the material is near Earth.

The LFD promises to change that. The telescope will see thousands of bright radio sources. The plasma ejected from the sun changes those sources’ radio waves as they pass through, but in a way that depends on the magnetic field strength and direction. By analyzing those changes, scientists will at last be able to deduce the all-important magnetic field properties of coronal mass ejections.

”This is the most crucial measurement to be made in support of our National Space Weather Program, since it would provide advance notice about the space weather effects on Earth well ahead of the time of impact of the plasma burst,” said Joseph Salah, director of the Haystack Observatory. The telescope

The LFD will be an array of 500 antenna ”tiles” spread out over an area 1.5 kilometers, or almost a mile, in diameter. Each tile is about 20 feet square and consists of 16 simple and cheap dipole antennas, fixed on the ground and staring straight up.

Figure 18: *Photo / Merv Lynch, Curtin University of Technology, Australia*

Big conventional telescopes are characterized by huge concave disks that tip and tilt to focus on specific areas of the

sky. Thanks to modern digital electronics, the LFD tiles can also be ”steered” in any direction – but no moving parts are required. Rather, the signals, or data, from each small antenna are brought together and analyzed by powerful computers. By combining the signals in different ways, the computers can effectively ”point” the telescope in different directions.

”Modern digital signal processing, enabled by advances in technology, are transforming radio astronomy,” said Lincoln J. Greenhill of the Harvard-Smithsonian Center for Astrophysics.

This concept has been tested at the proposed Radio Astronomy Park at Mileura in Western Australia with three prototype tiles ”lovingly wired together by hand” by MIT and Australian graduate students and researchers, Hewitt said. ”The tiles performed very nicely. We were quite pleased with them.”

Why Mileura? The LFD telescope will operate at the same radio wavelengths where FM radio and TV broadcasts are normally found. So if it were sited near a busy metropolis, signals from the latter would swamp the radio whispers from the deep universe. The planned site at Mileura, however, is exceptionally ”radio quiet” and is also highly accessible.

3.6 Orbiting Space Shield Could Help To Image Earth-Like Planets

Source: University of Colorado News Release, July 5th, 2006 [23]

A gigantic, daisy-shaped space shield could be used to block out pesky starlight and allow astronomers using an orbiting telescope to zero in on Earth-like planets in other solar systems, according to a University of Colorado at Boulder study.

The thin plastic ”starshade” would allow a telescope trailing thousands of miles behind it to image light from distant planets skimming by the giant petals without being swamped by light from the parent stars, said CU-Boulder Professor Webster Cash. Researchers could then identify planetary features like oceans, continents, polar caps and cloud banks and even detect biomarkers like methane, oxygen and water if they exist, he said.

”We think this is a compelling concept, particularly because it can be built today with existing technology,” said Cash. ”We will be able to study Earth-like planets tens of trillions of miles away and chemically analyze their atmospheres for signs of life.”

A paper on the subject by Cash is featured on the cover of the July 6 issue of Nature. The paper includes mathematical solutions to optical challenges like the bending and scattering of light between the pliable, 50-yard-in-diameter starshade and the space telescope, which would orbit in tandem roughly 15,000 miles apart.

Scientists would launch the telescope and starshade together into an orbit roughly 1 million miles from Earth, then remotely unfurl the starshade and use small thrusters to move it into lines of sight of nearby stars thought to harbor planets, said Cash. The thrusters would be intermittently turned on to hold the starshade steady during the observations of the planets, which would appear as bright specks.

”Think of an outfielder holding up one hand to block out the sunlight as he tracks a fly ball,” said Cash, director of CU-Boulder’s Center for Astrophysics and Space Astronomy. ”We would use the starshade as a giant hand to suppress the light emanating from a central star by a factor of about 10 billion.”

The novel concept could be used to map planetary systems around distant stars and detect planets as small as Earth’s moon, said Cash. In recent years, more than 175 planets have been discovered orbiting other stars.

Dubbed the New Worlds Observer, Cash’s design was selected for a 400,000 dollars funding boost last October by NASA’s Institute for Advanced Concepts after being selected for initial study in 2004. The team includes researchers from Princeton University, NASA’s Goddard Space Flight Center, Ball Aerospace of Boulder, Northrop Grumman Corp. of Los Angeles and the Carnegie Institution in Washington, D.C.

The team also has submitted a 400 million dollars proposal with NASA’s Discovery Program to launch a stand-alone starshade to work in concert with the powerful James Webb Space Telescope. The James Webb Space Telescope is an infrared observatory slated for launch in 2013 and considered the successor to the Hubble Space Telescope.

Figure 19: *New Worlds Imager. Image credit: CU-Boulder*

Alternative proposals for imaging distant planets involve suppressing parent starlight once it has entered the telescope – a complicated, Rube Goldberg-like undertaking involving shifting mirrors and active electronics, said Marc Kuchner of NASA's Goddard Space Flight Center's Exoplanets and Stellar Astrophysics Laboratory. "In contrast, this is a very clean and simple optical concept, and may be the most promising idea yet on how to directly image our Earth-like neighbors," said Kuchner, also a member of the New Worlds Observer science team.

"For over a century, science fiction writers have speculated on the existence of Earth-like planets around nearby stars," Cash wrote in Nature. "If they actually exist, use of an occulter could find them within the next decade."

An even more advanced version of the New Worlds Imager might involve a ring of telescopes placed on the moon beneath a fleet of orbiting starshades that would allow scientists to actually photograph distant, Earth-like planets, Cash speculated. "There is a bit of Buck Rogers in the New Worlds Imager concept, but seeking and mapping new lands is something that seems to ring deep in the human psyche."

4 Internet websites

[1] http://www.berkeley.edu/news/media/releases/2006/07/31_stardust.shtml
[2] http://marsrovers.jpl.nasa.gov/gallery/press/spirit/20060710a.html
[3] http://www.berkeley.edu/news/media/releases/2006/07/31_peroxide.shtml
[4] http://www.gemini.edu/index.php?option=content&task=view&id=196
[5] http://ciclops.org/view.php?id=2096&flash=1
[6] http://www.nasa.gov/centers/ames/news/releases/2006/06_57AR.html
[7] http://www.esa.int/esaCP/SEM23SVT0PE_index_0.html
[8] http://saturn.jpl.nasa.gov/multimedia/images/image-details.cfm?imageID=2214
[9] http://www.universetoday.com/2006/07/18/is-proxima-centauri-flying-solo/
[10] http://www.jpl.nasa.gov/news/news.cfm?release=2006-094
[11] http://www.uwnews.org/article.asp?articleID=25748
[12] http://www.esa.int/esaCP/SEMB6IBUQPE_index_0.html
[13] http://www.esa.int/esaCP/SEMGM6BUQPE_index_0.html
[14] http://www.cfa.harvard.edu/press/pr0621.html
[15] http://www.ucsc.edu/news_events/press_releases/text.asp?pid=909
[16] http://www.eso.org/outreach/press-rel/pr-2006/pr-23-06.html
[17] http://subarutelescope.org/Pressrelease/2006/07/26/index.html
[18] http://science.nasa.gov/headlines/y2006/28jul_crashlanding.htm
[19] http://hubblesite.org/newscenter/newsdesk/archive/releases/2006/36/full/
[20] http://www.universetoday.com/2006/07/12/inflatable-habitat-reaches-orbit/
[21] http://www.esa.int/esaCP/SEMOQEL8IOE_index_0.html
[22] http://web.mit.edu/newsoffice/2006/telescope.html
[23] http://www.colorado.edu/news/releases/2006/224.html

5 About Vendelinus and this newsletter

Vendelinus is the adult amateur astronomy section of the Europlanetarium in Genk, Belgium. It is also a Flemish Amateur-astronomy Club (VVS).The club exists officially since January 2000 and is named after the Limburg astronomer Gottfried Wendelen (1580-1667) born in Herk de Stad.

More information can be found at:

Europlanetarium, Planetariumweg 19, B-3600 Genk, tel:089/307990 / fax: 089/307991

E-mail: Tony Dethier, antoine.dethier@skynet.be

Website: http://users.pandora.be/lode.stevens/vendelinus/volks.html

The primary function of the Vendelinus Astronomy Newsletter is to provide our members monthly with an overview of the latest astronomical news, copied, pasted and packaged into one newsletter, so that they don't have to scan through the websites themselves. Because the contents consists of the original press releases, the language is English. The newsletter appears monthly at the beginning of the month and gives and overview of news from the previous month. It comes in two formats: as plain text and as a PDF document. In the latter format, colour figures are included. The newsletter is available by email (if I agree to include you in my mailing list) and on the web at:

http://www.warwick.ac.uk/go/erwin_verwichte/amateur/vndnews/

Erwin Verwichte