Vendelinus Astronomy Newsletter

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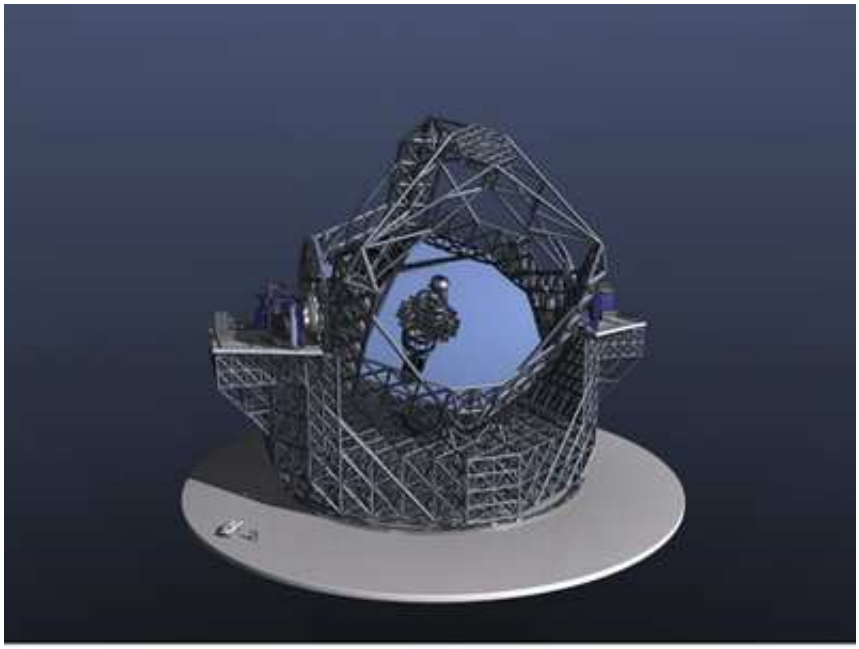

The European Extremely Large Telescope
(Artist's Impression)

ESO PR Photo 46/06 (11 December 2006) © ESO

Contents

1 Solar System

1.1 Hot stuff on Venus! Venus Express sees right down to the hell-hot surface

Source: ESA Press Release, December 14th, 2006 [1]

Thanks to ESA's Venus Express data, scientists obtained the first large-area temperature maps of the southern hemisphere of the inhospitable, lead-melting surface of Venus. The new data may help with searching and identifying 'hot spots' on the surface, considered to be possible signs of active volcanism on the planet.

The results, presented today at the American Geophysical Union (AGU) assembly in San Francisco, USA, were obtained thanks to VIRTIS, the Visible and Infrared Thermal Imaging Spectrometer on board Venus Express.

To obtain this fundamental information about the surface temperature, VIRTIS made use of the so-called infrared spectral 'windows' present in the Venusian atmosphere. Through these 'windows' thermal radiation at specific wavelengths can leak from the deepest atmospheric layers, pass through the dense cloud curtain situated at about 60 kilometres altitude, and then escape to space, where it can be detected by instruments like VIRTIS. In this way VIRTIS succeeded in looking through the thick carbon dioxide curtain surrounding Venus and detected the heat directly emitted by the hot rocks on the ground. "We are very excited about these results, as they represent a very important item in the list of Venus Express' and VIRTIS' scientific objectives at Venus", says Giuseppe Piccioni, one of the Principal Investigators of the VIRTIS experiment, from the Istituto di Astrofisica Spaziale e Fisica Cosmica in Rome, Italy.

The measurements, made in August 2006 over the Themis and Phoebe Regions in the southern hemisphere of Venus, reveal temperature variations of 30 degrees between lowlands and mountain tops, correlating well with existing topographical radar data from previous missions. The Themis Region is a highland plateau located at 270 degrees East longitude and at about 37 degrees South latitude. It is a region that has experienced strong volcanic activity, at least in the geologic past.

On Venus there are no day and night variations of the surface temperature. The heat is globally 'trapped' under the carbon-dioxide atmosphere, with pressure 90 times higher than on Earth. Instead, the main temperature variation is due to topography. Just like on Earth, mountain tops are colder, whereas the lowlands are warmer. The 'only' difference is that on Venus 'cold' means 447 degrees Celsius, while 'warm' means 477 degrees Celsius. Such high temperatures are caused by the strongest greenhouse effect found in the Solar System.

"The VIRTIS results represent a major step forward in our attempt to identify specific surface features on the surface of Venus", said Jrn Helbert from the German Aerospace Center's (DLR) Institute of Planetary Research in Berlin, Germany, and a member of the VIRTIS team. "By 'peeling' off the atmospheric layers from the VIRTIS data, we can finally measure the surface temperature," Helbert added.

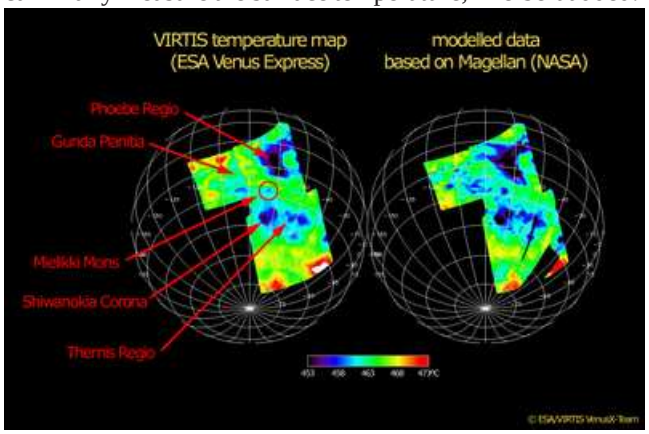

Figure 1: *Temperature maps of Venus' surface*

Eventually, the VIRTIS team hopes to identify 'hot spots' on the surface of Venus, possibly stemming from active volcanoes. In the Solar System, besides Earth, active volcanoes have been observed only on Io, a satellite of Jupiter, on Neptune's satellite Triton, and on Saturn's moon Enceladus (in the form of the so-called 'cryo-volcanism'). Venus is the most likely planet to host other active volcanoes.

In order to achieve this, the Venus Express scientists started comparing the maps of the Venusian topography obtained by NASA's Magellan orbiter in the early 1990s with the data gathered by VIRTIS. The Magellan topography maps allow for a rough prediction of the surface temperature, too. Comparing these predictions with the measurements made by VIRTIS allows searching for hot spots that show even higher temperatures than the oven-hot surface, possibly indicative of active volcanism.

This direct interdependence between temperature and topography will enable scientists to derive new topography maps of the Venusian surface from temperature measurements. This will help in complementing the Magellan maps.

”Actually, when comparing our temperature map with topographical data from Magellan, we are not only obtaining quite a good agreement, but we can even fill gaps that the Magellan and Venera 15 radar data sets left open”, concluded Pierre Drossart, the other Principal Investigator of the VIRTIS experiment, from the Observatoire de Paris Meudon, France.

1.2 Geologists Finding a Different Mars Underneath

Source: JPL/NASA Press Release, December 13th, 2006 [2]

Mars is showing scientists its older, craggier face buried beneath the surface, thanks to a pioneering sounding radar cosponsored by NASA aboard the European Space Agency’s Mars Express orbiter.

Observations by the first project to explore a planet by sounding radar strongly suggest that ancient impact craters lie buried beneath the smooth, low plains of Mars’ northern hemisphere. The technique uses echoes of waves that have penetrated below the surface.

”It’s almost like having X-ray vision,” said Dr. Thomas R. Watters of the National Air and Space Museum’s Center for Earth and Planetary Studies, Washington. ”Besides finding previously unknown impact basins, we’ve also confirmed that some of the subtle topographic depressions mapped previously in the lowlands are related to impact features.”

Studies of how Mars evolved aid understanding of early Earth. Some signs of the forces at work a few billion years ago are more evident on Mars because, on Earth, many of them have been obliterated during Earth’s more active resurfacing by tectonic activity.

Watters and nine co-authors report the findings in the Dec. 14, 2006 issue of the journal Nature.

The researchers used the orbiter’s Mars Advanced Radar for Subsurface and Ionospheric Sounding, which was provided to the European Mars mission by NASA and the Italian Space Agency. The instrument transmits radio waves that pass through the Martian surface and bounce off features in the subsurface with electrical properties that contrast with those of materials that buried them.

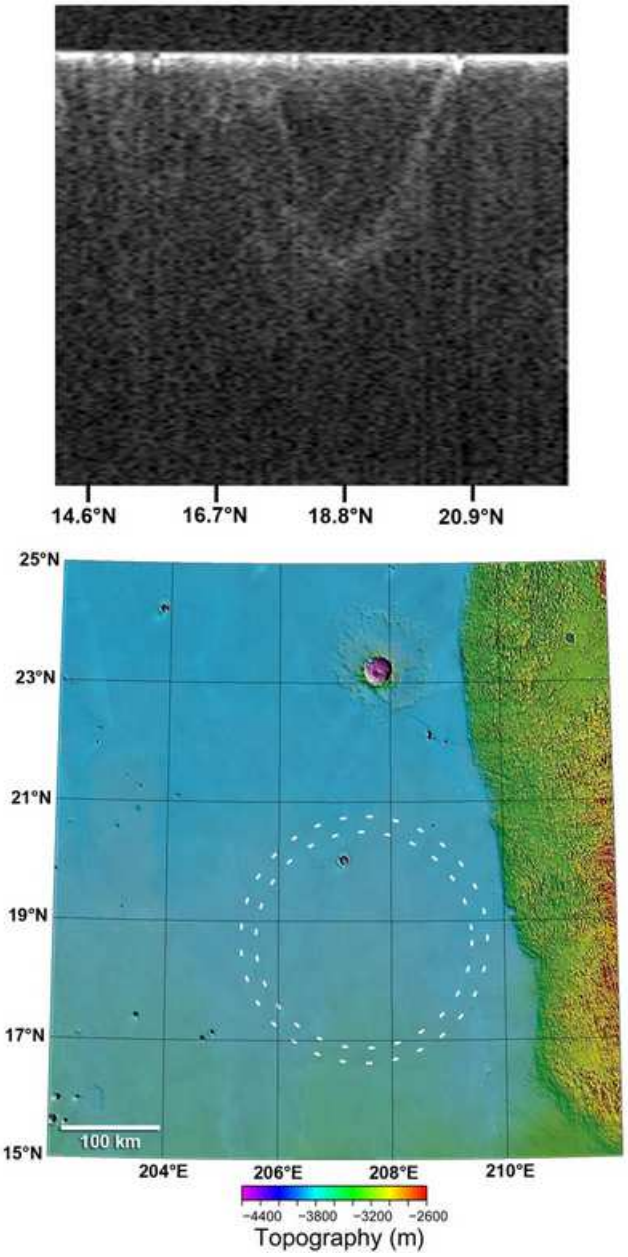

Figure 2: *The top image is a radargram presenting data collected by the Mars Advanced Radar for Subsurface and Ionospheric Sounding during the 1,886th orbit of the European Space Agency’s Mars Express orbiter. It shows parabolic-shaped echoes from the rim walls of a buried impact basin. In the lower image, parabolic echoes project to circular arcs on the surface and indicate the location of a 210-kilometer-diameter (130-mile-diameter) impact basin buried by young lava flows in the Amazonis Planitia region.*

The findings bring planetary scientists closer to understanding one of the most enduring mysteries about the geologic evolution of the planet. In contrast to Earth, Mars shows a striking difference between its northern and southern hemispheres. Almost the entire southern hemisphere has rough, heavily cratered highlands, while most of the northern hemisphere is smoother and lower in elevation.

Since the impacts that cause craters can happen anywhere on a planet, the areas with fewer craters are generally interpreted as younger surfaces where geological processes have erased the impact scars. The abundance of buried craters that the radar has detected beneath Mars' smooth northern plains means the underlying crust of the northern hemisphere is extremely old, "perhaps as ancient as the heavily cratered highland crust in the southern hemisphere."

Learning about the ancient lowland crust has been challenging because that crust was buried first by vast amounts of volcanic lava and then by sediments carried by episodic flood waters and wind.

1.3 Mars Reconnaissance Orbiter Read Layered Clues to Changes on Mars

Source: JPL/NASA Press Release, December 13th, 2006 [3]

Layers on Mars are yielding history lessons revealed by instruments flying overhead and rolling across the surface.

Some of the first radar and imaging results from NASA's newest Mars spacecraft, the Mars Reconnaissance Orbiter, show details in layers of ice-rich deposits near the poles. Observed variations in the layers' thickness and composition will yield information about recent climate cycles on the red planet.

NASA's Mars Exploration Rover Opportunity has photographed patterns in the layering of crater-wall cliffs that are the clearest evidence of ancient sand dunes the rover has seen since arriving at Mars nearly three years ago. The science team for Opportunity's twin, Spirit, is using new orbital images of the rover's surroundings to interpret how some rocks with minerals altered by water fit into the area's complex layered structure.

"The combination of instruments on Mars Reconnaissance Orbiter is such a great advantage," said Dr. Jack Mustard of Brown University, Providence, R.I. He is deputy principal investigator for the Compact Reconnaissance Imaging Spectrometer for Mars, a mineral-identifying instrument on Mars Reconnaissance Orbiter. Researchers are using mineral information from analyses of spectrometer observations, combined with images from the orbiter's High Resolution Imaging Science Experiment, to seek the source of the mineral gypsum in dunes near the Martian north pole and clay minerals elsewhere. Gypsum and clay minerals are indicators of formerly wet conditions.

Other new images from that camera show mysterious pitting in the layered terrain near the north pole. Nearby, a steep slope exposing the layers appears to be shedding blocks of icy material that disappear instead of accumulating at the bottom of the slope.

"Observations of the polar layered deposits are telling us about the material properties there," said Dr. Ken Herkenhoff of the U.S. Geological Survey, Flagstaff, Ariz. "These deposits record relatively recent climate variations on Mars, like recent ice ages on Earth."

The Shallow Subsurface Radar instrument on Mars Reconnaissance Orbiter has begun probing through similar layered deposits at Mars' south pole. "The radar is penetrating through the entire thickness of these deposits and revealing the fine-scale internal layering," said Dr. Roger Phillips of Washington University, St. Louis, the deputy team leader for that instrument.

Far from the poles, Opportunity is navigating the scalloped rim of Victoria crater about half a mile in diameter, stopping at promontories along the way to look at cliff walls of adjacent promontories. The top part of the stack of layers exposed in the cliffs appears to be rocky rubble thrown outward by the impact that dug the crater. "We see an abrupt transition between the jumbled-up material and intact layers below it that are still in place from before the impact," said Dr. Steve Squyres of Cornell University, Ithaca, N.Y., principal investigator for the rovers. Some of the intact layering resembles fossilized dunes in the U.S. Southwest.

Spirit recently found water-altered minerals in disturbed soils and granular rocks near where the rover spent the Martian winter. An image of the region from Mars Reconnaissance Orbiter is aiding interpretation of how different parts of the terrain, such as a bright platform nicknamed "Home Plate," are related to others. "It appears likely that these rocks came from one or more volcanic explosions that produced 'Home Plate,'" said Dr. Ray Arvidson, also of Washington University, deputy principal investigator for the rovers.

High Resolution Imaging Science Experiment camera on NASA's Mars Reconnaissance Orbiter shows the north polar layered deposits at top and darker materials at bottom. Image credit: NASA/JPL-Caltech/Univ. of Arizona

Dr. John Callas of NASA's Jet Propulsion Laboratory, Pasadena, Calif., project manager for the rovers, said, "The biggest news about the health of the rovers is that it is essentially unchanged from nine months ago. Each rover has operated more than 1,000 Martian days on the surface of Mars. They are well past their original design life of 90 Martian days, and there is always the possibility that a critical component on either rover could stop functioning at any time, so we operate the rovers with that in mind and value each additional day they continue to work."

1.4 NASA Images Suggest Water Still Flows in Brief Spurts on Mars

Source: JPL/NASA Press Release, December 6th, 2006 [4]

NASA photographs have revealed bright new deposits seen in two gullies on Mars that suggest water carried sediment through them sometime during the past seven years.

"These observations give the strongest evidence to date that water still flows occasionally on the surface of Mars," said Dr. Michael Meyer, lead scientist for NASA's Mars Exploration Program, Washington.

Liquid water, as opposed to the water ice and water vapor known to exist at Mars, is considered necessary for life. The new findings heighten intrigue about the potential for microbial life on Mars. The Mars Orbiter Camera on NASA's Mars Global Surveyor provided the new evidence of the deposits in images taken in 2004 and 2005.

"The shapes of these deposits are what you would expect to see if the material were carried by flowing water," said Dr. Michael Malin of Malin Space Science Systems, San Diego. "They have finger-like branches at the downhill end and are easily diverted around small obstacles." Malin is principal investigator for the camera and lead author of a report about the findings published in the journal Science.

The atmosphere of Mars is so thin and the temperature so cold that liquid water cannot persist at the surface. It would rapidly evaporate or freeze. Researchers propose that water could remain liquid long enough, after breaking out from an underground source, to carry debris downslope before totally freezing. The two fresh deposits are each several hundred meters, or yards, long.

Figure 3: *This false-color subframe of an image from the* [6]

The light tone of the deposits could be from surface frost continuously replenished by ice within the body of the deposit. Another possibility is a salty crust, which would be a sign of water's effects in concentrating the salts. If the deposits had resulted from dry dust slipping down the slope, they would likely be dark, based on the dark tones of dust freshly disturbed by rover tracks, dust devils and fresh craters on Mars.

Mars Global Surveyor has discovered tens of thousands of gullies on slopes inside craters and other depressions on Mars. Most gullies are at latitudes of 30 degrees or higher. Malin and his team first reported the discovery of the gullies in 2000. To look for changes that might indicate present-day flow of water, his camera team repeatedly imaged hundreds of the sites. One pair of images showed a gully that appeared after mid-2002. That site was on a sand dune, and the gully-cutting process was interpreted as a dry flow of sand.

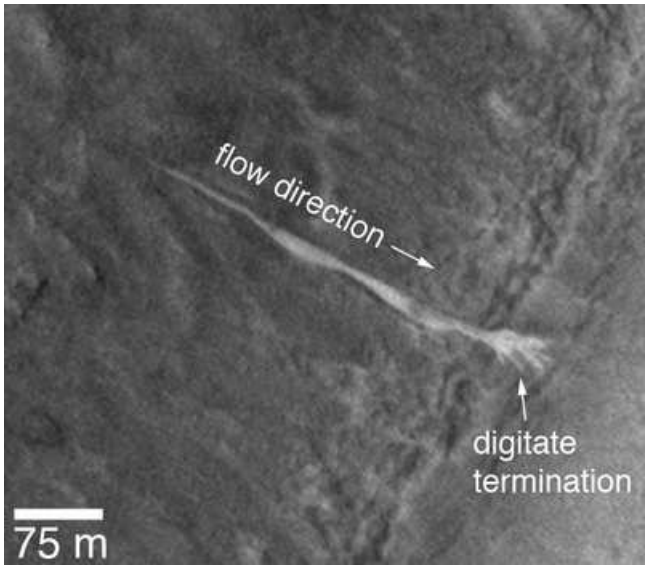

Figure 4: *Enlarged view of a new gully deposit in a crater in Terra Sirenum. Image credit: NASA/JPL/Malin Space Science Systems*

Today's announcement is the first to reveal newly deposited material apparently carried by fluids after earlier imaging of the same gullies. The two sites are inside craters in the Terra Sirenum and the Centauri Montes regions of southern Mars.

"These fresh deposits suggest that at some places and times on present-day Mars, liquid water is emerging from beneath the ground and briefly flowing down the slopes. This possibility raises questions about how the water would stay melted below ground, how widespread it might be, and whether there's a below-ground wet habitat conducive to life. Future missions may provide the answers," said Malin.

Besides looking for changes in gullies, the orbiter's camera team assessed the rate at which new impact craters appear. The camera photographed approximately 98 percent of Mars in 1999 and approximately 30 percent of the planet was photographed again in 2006. The newer images show 20 fresh impact craters, ranging in diameter from 2 meters (7 feet) to 148 meters (486 feet) that were not present approximately seven years earlier. These results have important implications for determining the ages of features on the surface of Mars. These results also approximately match predictions and imply that Martian terrain with few craters is truly young.

1.5 Scientists propose alternate model for plume on Enceladus

Source: University of Illinois Press Release, December 14th, 2006 [5]

What's causing all the commotion on Enceladus?

Last year, when the Cassini spacecraft discovered an enormous plume erupting on Enceladus, one of Saturn's moons, scientists speculated that liquid water lay at shallow depths beneath the icy surface.

Now, as reported in the Dec. 15 issue of the journal Science, researchers have proposed an alternate model to account for this spectacular plume.

"With a diameter of only 300 miles, Enceladus is a tiny moon; it would fit easily between Los Angeles and San Francisco," said Susan Kieffer, a geology professor and planetary scientist at the University of Illinois at Urbana-Champaign, and lead author of the Science paper. "This tiny satellite should be cold and inactive, like our own moon. But it isn't."

The surface of Enceladus is composed of water ice with traces of carbon dioxide. Part of this surface does appear old and cratered like Earth's moon, Kieffer said. "The south polar region, however, is geologically active, with many surface features, indicating current activity."

Kieffer, who holds a Charles R. Walgreen Jr. Chair at the U. of I., has studied geysers and volcanoes on Earth; on Io, a satellite of Jupiter; and on Triton, a satellite of Neptune.

Instruments on the Cassini spacecraft revealed a gigantic plume of gas, water vapor and ice particles erupting from Enceladus' surface. Some of the ice escapes the moon's

feeble grasp and replenishes a ring of ice particles around Saturn, called the ”E ring.”

Initial reports speculated that chambers of liquid water lay close to the moon’s surface and erupted in a giant geyser. The water would be near freezing, so scientists dubbed the model ”Cold Faithful,” after the familiar, but hotter, Old Faithful geyser in Yellowstone National Park.

”A problem with this model,” Kieffer said, ”is that 10 percent of the plume consists of the gases carbon dioxide, nitrogen and methane. You might get a carbon dioxide-driven liquid geyser there, but you can’t put this much nitrogen and methane into liquid water at the low pressures found inside Enceladus.”

Nitrogen and methane are nearly insoluble in liquid water, but highly soluble in frozen water in an ice phase called clathrate. When clathrate is exposed to a vacuum, the gas molecules burst out, ripping the ice lattice to shreds and carrying the fragments away.

Kieffer and colleagues have proposed an alternate model to explain the plume on Enceladus. The gases in the plume, they propose, are dissolved in a reservoir of clathrate under the water ice cap in the south polar region. The clathrate model allows an environment that would be 80 to 100 degrees Celsius colder than liquid water, with a ”Frigid Faithful” plume emanating from clathrates, rather than from liquid water reservoirs.

”Exposed to near-vacuum conditions by fractures at the south pole, the clathrates decompose violently, spewing out nitrogen, methane and carbon dioxide gases, and ice particles; as well as leaving fracture walls coated with water ice,” said Kieffer, who is also a professor in the university’s Center for Advanced Study, one of the highest forms of campus recognition. ”Some ice particles and ice coatings evaporate to produce the water vapor observed with the other gases,” she said.

Active tectonic processes at the south pole cause continuous formation of cracks in the ice, through which many separate vents create a plume. The total discharge is comparable to that of Old Faithful, but the plume is enormously bigger because it is erupting at very low gravity into the near vacuum of space.

”We propose that cracks in Enceladus’ ice cap may be opening and closing continuously, producing the spectacular plume we see reaching high above Enceladus’ surface,” Kieffer said. ”Even if conditions are as cold as our model suggests, there is no problem launching ice particles into Saturn’s E-ring.”

1.6 Massive Mountain Range Imaged on Saturn’s Moon Titan

Source: JPL/NASA Press Release, December 12th, 2006 [6]

The tallest mountains ever seen on Titan – coated with layers of organic material and blanketed by clouds – have been imaged by NASA’s Cassini spacecraft.

”We see a massive mountain range that kind of reminds me of the Sierra Nevada mountains in the western United States. This mountain range is continuous and is nearly 100 miles long,” said Dr. Bob Brown, team leader of the Cassini visual and infrared mapping spectrometer at the University of Arizona, Tucson.

During an Oct. 25 flyby designed to obtain the highest resolution infrared views of Titan yet, Cassini resolved surface features as small as 400 meters (1,300 feet). The images reveal a large mountain range, dunes, and a deposit of material that resembles a volcanic flow. These data, together with radar data from previous flybys, provide new information on the height and composition of geologic features on Titan.

If Titan were Earth, these mountains would lie south of the equator, somewhere in New Zealand. The range is about 150 kilometers long (93 miles) and 30 kilometers (19 miles) wide and about 1.5 kilometers (nearly a mile) high. Deposits of bright, white material, which may be methane ”snow” or exposures of some other organic material, lie at the top of the mountain ridges.

”These mountains are probably as hard as rock, made of icy materials, and are coated with different layers of organics,” said Dr. Larry Soderblom, Cassini interdisciplinary scientist at the U.S. Geological Survey, Flagstaff, Ariz.

He added, ”There seem to be layers and layers of various coats of organic ’paint’ on top of each other on these mountain tops, almost like a painter laying the background on a canvas. Some of this organic gunk falls out of the atmosphere as rain, dust, or smog onto the valley floors and mountain tops, which are coated with dark spots that appear to be brushed, washed, scoured and moved around the surface.”

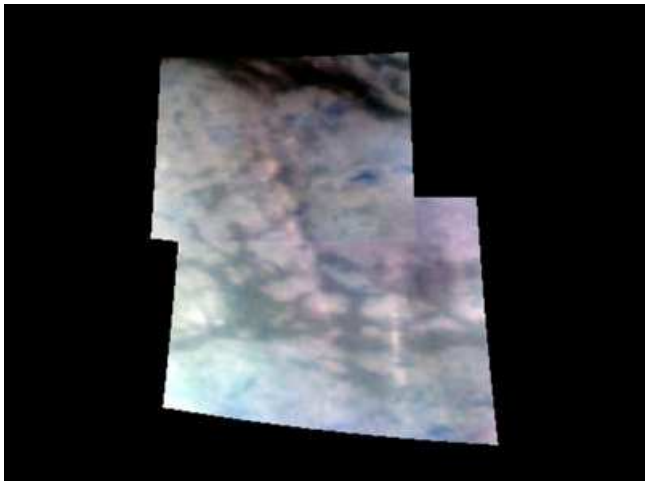

Figure 5: *This composite image shows a massive mountain range running just south of Titan's equator. Image credit: NASA/JPL/University of Arizona*

The mountains probably formed when material welled up from below to fill the gaps opened when tectonic plates pull apart, similar to the way mid-ocean ridges are formed on Earth.

Separately, the radar and infrared data are difficult to interpret, but together they are a powerful combination. In the infrared images, one can see the shadows of the mountains, and in radar, one can see their shape. But when combined, scientists begin to see variations on the mountains, which is essential to unraveling the mysteries of the geologic processes on Titan.

A fan-shaped feature, possibly a remnant of a volcanic flow, is also visible in the infrared images. The radar instrument imaged this flow and a circular feature from which the flow seems to emanate on a previous flyby, but not in this level of detail.

"The evidence is mounting that this circular feature is a volcano," said Dr. Rosaly Lopes, Cassini radar team member at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "With radar data alone, we identified it as a possible volcano, but the combination of radar and infrared makes it much clearer."

Near the wrinkled, mountainous terrain are clouds in Titan's southern mid latitudes whose source continues to elude scientists. These clouds are probably methane droplets that may form when the atmosphere on Titan cools as it is pushed over the mountains by winds.

The composition of dunes that run across much of Titan is also much clearer. "The dunes seem to consist of sand grains made of organics, built on water-ice bedrock, and there may also be some snow and bright deposits," Brown said.

Titan is a complex place and scientists are uncovering the secrets of the surface, one flyby at a time. Scientists hope to get more clues from the next Titan flyby, on Dec. 12.

2 Astrophysics

2.1 Negative Vibes From Space

Source: Harvard-Smithsonian Center for Astrophysics Press Release, December 1st, 2006 [7]

Astronomers have discovered the first negatively charged molecule in space, identifying it from radio signals that were a mystery until now. While about 130 neutral and 14 positively charged molecules are known to exist in interstellar space, this is the first negative molecule, or anion, to be found.

"We've spotted a rare and exotic species, like the white tiger of space," said astronomer Michael McCarthy of the Harvard-Smithsonian Center for Astrophysics (CfA).

By learning more about the rich broth of chemicals found in interstellar space, astronomers hope to explain how the young Earth converted these basic ingredients into the essential chemicals for life. This new finding helps to advance scientists' understanding of the chemistry of the interstellar medium, and hence the birthplaces of planets.

McCarthy worked with CfA colleagues Carl Gottlieb, Harshal Gupta (also from the Univ. of Texas), and Patrick Thaddeus to identify the molecular anion known as C6H-: a linear chain of six carbon atoms with one hydrogen atom at the end and an "extra" electron. Such molecules were thought to be extremely rare because ultraviolet light that suffuses space easily knocks electrons off molecules. The large size of C6H-, larger than most neutral and all positive molecules

known in space, may increase its stability in the harsh cosmic environment.

”The discovery of C6H- resolves a long-standing enigma in astrochemistry: the apparent lack of negatively charged molecules in space,” stated Thaddeus.

The team first conducted laboratory experiments to determine exactly what radio frequencies to use in their search. Then, they used the National Science Foundation’s Robert C. Byrd Green Bank Telescope to hunt for C6H- in celestial objects. In particular, they targeted locations in which previous searches had spotted unidentified radio signals at the appropriate frequencies.

They found C6H- in two very different locations-a shell of gas surrounding the evolved red giant star IRC +10216 in the constellation Leo, and the cold molecular cloud TMC-1 in Taurus. The presence of the anion in both regions shows that the chemical processes that form C6H- are ubiquitous. It also suggests that other molecular anions are present and will be found in the near future.

”This finding is dramatic evidence that our understanding of interstellar chemistry is still quite rudimentary. It also implies that more molecular anions, perhaps many, may now be found in the laboratory and in space,” said McCarthy.

2.2 How Do Multiple-Star Systems Form? VLA Study Reveals ”Smoking Gun”

Source: NRAO Press Release, December 15th, 2006 [8]

Astronomers have used the National Science Foundation’s Very Large Array (VLA) radio telescope to image a young, multiple-star system with unprecedented detail, yielding important clues about how such systems are formed. Most Sun-sized or larger stars in the Universe are not single, like our Sun, but are members of multiple-star systems. Astronomers have been divided on how such systems can form, producing competing theoretical models for this process.

The new VLA study produced a ”smoking gun” supporting one of the competing models, said Jeremy Lim, of the Institute of Astronomy & Astrophysics, Academia Sinica, in Taipei, Taiwan, whose study, done with Shigehisa Takakuwa of the National Astronomical Observatory of Japan, is published in the December 10 issue of the Astrophysical Journal.

Ironically, their discovery of a third, previously-unknown, young star in the system may support a second theoretical model. ”There may be more than one way to make a multiple-star system,” Lim explained.

The astronomers observed an object called L1551 IRS5, young, still-forming protostars enshrouded in a cloud of gas and dust, some 450 light-years from Earth in the direction of the constellation Taurus. Invisible to optical telescopes because of the gas and dust, this object was discovered in 1976 by astronomers using infrared telescopes. A VLA study in 1998 showed two young stars orbiting each other, each surrounded by a disk of dust that may, in time, congeal into a system of planets.

Lim and Takakuwa re-examined the system, using improved technical capabilities that greatly boosted the quality of their images. ”In the earlier VLA study, only half of the VLA’s 27 antennas had receivers that could collect the radio waves, at a frequency of 43 GigaHertz (GHz), coming from the dusty disks. When we re-observed this system, all the antennas could provide data for us. In addition, we improved the level of detail by using the Pie Town, NM, antenna of the Very Long Baseline Array, as part of an expanded system,” Lim said. The implementation and improvement of the 43 GHz receiving system was a collaborative program among the German Max Planck Institute, the Mexican National Autonomous University, and the U.S. National Radio Astronomy Observatory.

Two popular theoretical models for the formation of multiple-star systems are, first, that the two protostars and their surrounding dusty disks fragment from a larger parent disk, and, second, that the protostars form independently and then one captures the other into a mutual orbit.

”Our new study shows that the disks of the two main protostars are aligned with each other, and also are aligned with the larger, surrounding disk. In addition, their orbital motion resembles the rotation of the larger disk. This is a ’smoking gun’ supporting the fragmentation model,” Lim said.

However, the new study also revealed a third young star with a dust disk. ”The disk of this one is misaligned with those of the other two, so it may be the result of either fragmentation or capture,” Takakuwa said.

The misalignment of the third disk could have come through gravitational interactions with the other two, larger, protostars, the scientists said. They plan further observations to try to resolve the question.

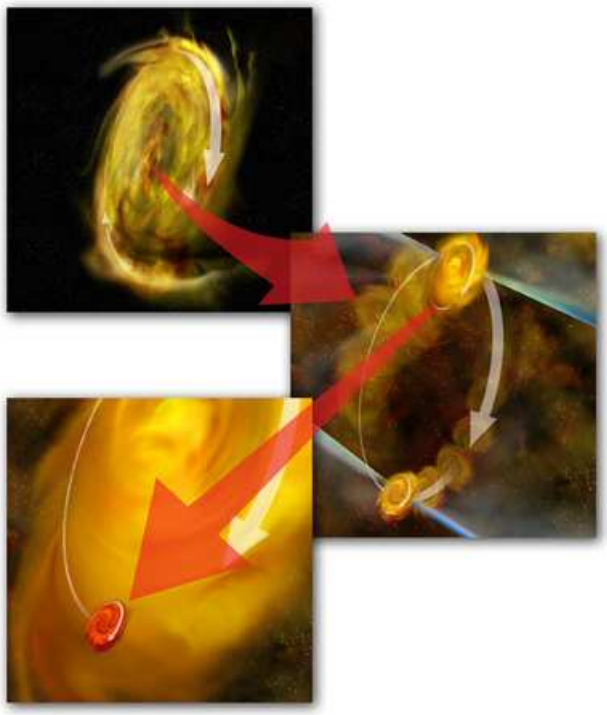

Figure 6: *Proposed Formation Process for L1551 IRS5. CREDIT: Bill Saxton, NRAO/AUI/NSF*

”We have a very firm indication that two of these protostars and their dust disks formed from the same, larger disk-like cloud, then broke out from it in a fragmentation process. That strongly supports one theoretical model for how multiple-star systems are formed. The misalignment of the third protostar and its disk leaves open the possibility that it could have formed elsewhere and been captured, and we’ll continue to work on reconstructing the history of this fascinating system,” Lim summarized.

2.3 Heavy Stars Embedded in NGC 6357

Source: Hubble News, December 11th, 2006 [9]

The small open star cluster Pismis 24 lies in the core of the large emission nebula NGC 6357 in Sagittarius, about 8,000 light-years away from Earth. Some of the stars in this cluster are extremely massive and emit intense ultraviolet radiation.

The brightest object in the picture is designated Pismis 24-1. It was once thought to weigh as much as 200 to 300 solar masses. This would not only have made it by far the most massive known star in the galaxy, but would have put it considerably above the currently believed upper mass limit of about 150 solar masses for individual stars.

However, Hubble Space Telescope high-resolution images of the star show that it is really two stars orbiting one another (inset pictures at top right and bottom right). They are estimated to each be 100 solar masses.

In addition, spectroscopic observations with ground-based telescopes further reveal that one of the stars is actually a tight binary that is too compact to be resolved even by Hubble. This divides the estimated mass for Pismis 24-1 among the three stars. Although the stars are still among the heaviest known, the mass limit has not been broken thanks to the multiplicity of the system.

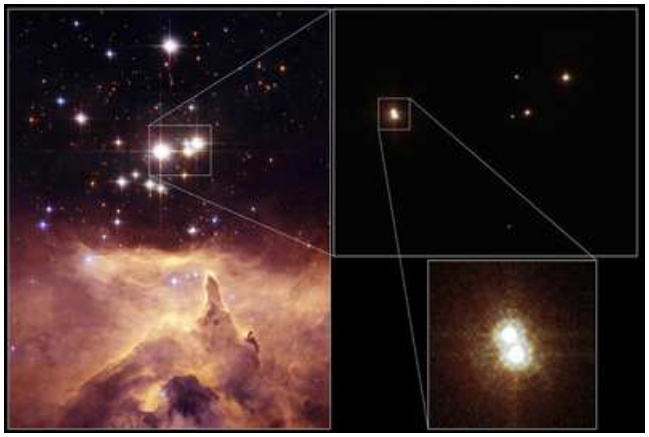

Figure 7: *Emission nebula NGC 6357. Image credit: Hubble*

The observations were performed by a team of astronomers led by J. Maz Apellniz of the Instituto de Astrofsica de Andaluca in Spain. The team imaged Pismis 24-1 with Hubble’s Advanced Camera for Surveys in April 2006.

The images of NGC 6357 were taken with Hubble’s Wide Field and Planetary Camera 2 in April 2002.

2.4 Metal Ring Round White Dwarf Solves Missing Planets Puzzle

Source: University of Warwick Press Release, December 22nd, 2006 [10]

Astrophysicists at the University of Warwick have found an unusual ring of metal-rich gas orbiting very close around a white dwarf star. The presence of the ring helps solve a problem for astronomers who, up till now, have been puzzled by the apparent absence of planets around white dwarf stars. Their research is published today in the Friday December 22nd edition of the journal Science.

The research team led by Dr Boris Gansicke and Professor Tom Marsh from the University of Warwick’s Department

of Physics found this unusual gas disc around a relatively young white dwarf star called SDSS1228+1040. It is located in the constellation Virgo and it is around 463 light years distant from our solar system. The star became a white dwarf around 100 million years ago, and is still fairly hot with a surface temperature around 22000 degrees.

The team observed double-peaked emission lines superimposed on the white dwarf's starlight caused by iron, magnesium and calcium from material in the vicinity of the star. This indicated that they were dealing with a disc of metal-gas orbiting close around the star (around 1.2 solar radii or roughly half a million miles). The observations also show that we are looking nearly edge-on to the ring around the white dwarf.

The likely origin of the disc is an asteroid, of at least 50 kilometres in size, which approached close enough to the star to be broken up by tides generated from the gravitational forces of the white dwarf. Those disrupted remains then entered a close orbit around the star and is evaporated by the radiation from the white dwarf.

White dwarfs begin as a star similar to our sun (or a star up to 8 times bigger than our sun). Late in the star's life it swells into a red giant probably destroying any inner planets at orbits such as those of Mercury and Venus and pushing out other planets and asteroids to a more distant orbit than before. Here is a link to some simple diagrams explaining this: [11]

In the evolution of what is today a white dwarf, the progenitor of SDSS1228+1040 will have destroyed all planetary material out to a distance of 1000 solar radii (roughly 500 million miles), but asteroids still exist today at larger distances. To destabilise an asteroid from an orbit that far out, it needs the gravitational force of a larger object, such as a relatively massive planetesimal, or a genuine planet. While the presence of asteroids around white dwarf has been hypothesized before, the case of SDSS1228+1040 provides the first clear proof of the debris of a planetary disc around a white dwarf, and provides an example of what our own Solar system may look like in around 5 to 8 billion years.

This "metal" disc around SDSS1228+1040 appears to be relatively rare. Before their study, three white dwarfs, out of a study of a few hundred, were suggested to be surrounded by planetary debris material. However, in none of those three cases could a definite proof of an asteroid origin be made due to the lack of information on the geometry and the chemical abundance of the material found in the vicinity of these stars. As part of their study, the Warwick team investigated data for 500 additional white dwarfs without finding conclusive evidence for another system harbouring such a disc. The rarity of such a ring made from a disrupted asteroid tells us that the majority of planetary systems may look quite different from our own Solar system. They may not have asteroid belts at all, or not as far out as it is the case in the Solar system, or they may not have planets at such great distances as Mars or Jupiter. This conclusion is consistent with the current knowledge on extrasolar planets found around others stars similar to the Sun, where the vast majority of the exo-planets are in very close orbits around their host stars.

Figure 8: *Ring around white dwarf.Picture by Mark A. Garlick*

2.5 No matter their size black holes "feed" in the same way

Source: PPARC News, December 6th, 2006 [12]

Research by UK astronomers, published today in Nature (7th December 2006) reveals that the processes at work in black holes of all sizes are the same and that supermassive black holes are simply scaled up versions of small Galactic

black holes.

For many years astronomers have been trying to understand the similarities between stellar-mass sized Galactic black hole systems and the supermassive black holes in active galactic nuclei (AGN). In particular, do they vary fundamentally in the same way, but perhaps with any characteristic timescales being scaled up in proportion to the mass of the black hole. If so, the researchers proposed, we could determine how AGN should behave on cosmological timescales by studying the brighter and much faster galactic systems.

Professor Ian McHardy, from the University of Southampton, heads up the research team whose findings are published today (along with colleagues Dr Elmar Koerding, Dr Christian Knigge, Professor Rob Fender and Dr Phil Uttley, currently working at the University of Amsterdam). Their observations were made using data from NASA's Rossi X-ray Timing Explorer and XMM Newton's X-ray Observatory.

Professor McHardy comments, "By studying the way in which the X-ray emission from black hole systems varies, we found that the accretion or 'feeding' process - where the black hole is pulling in material from its surroundings - is the same in black holes of all sizes and that AGN are just scaled-up Galactic black holes. We also found that the way in which the X-ray emission varies is strongly correlated with the width of optical emission lines from black hole systems."

He adds, "These observations have important implications for our understanding of the different types of AGN, as classified by the width of their emission lines. Thus narrow line Seyfert galaxies, which are often discussed as being unusual, are no different to other AGN; they just have a smaller ratio of mass to accretion rate."

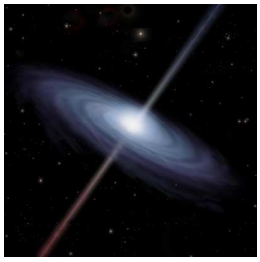

Figure 9: *An Artist's impression of an intermediate sized black hole. Credit: NASA Goddard*

The research shows that the characteristic timescale changes linearly with black hole mass, but inversely with the accretion rate (when measured relative to the maximum possible accretion rate). This result means that the accretion process is the same in black holes of all sizes. By measuring the characteristic timescale and the accretion rate, the team argues this simple relationship can help determine black hole masses where other methods are very difficult, for example in obscured AGN or in the much sought after intermediate mass black holes.

Professor McHardy continues: "Accretion of matter into a black hole produces strong X-ray emission from very close to the black hole itself. So, studying the way in which the X-ray emission varies with time, known as the X-ray lightcurves, provides one of the best ways of understanding the behaviour of black holes.

It has been known for over two decades that characteristic timescales can be seen in the X-ray lightcurves of Galactic black hole systems. The timescales are short (less than second) and so can be found in short observations. However to find the equivalent timescales in AGN is much harder as we must observe for months or years."

2.6 Galaxy Evolution Explorer Sees Black Hole Munch on a Star

Source: JPL/NASA Press Release, December 5th, 2006 [13]

A giant black hole has been caught red-handed dipping into a cosmic cookie jar of stars by NASA's Galaxy Evolution Explorer. This is the first time astronomers have seen the whole process of a black hole eating a star, from its first to nearly final bites.

"This type of event is very rare, so we are lucky to study the entire process from beginning to end," said Dr. Suvi Gezari of the California Institute of Technology, Pasadena, Calif. Gezari is lead author of a new paper appearing in the Dec. 10 issue of Astrophysical Journal Letters.

For perhaps thousands of years, the black hole rested quietly deep inside an unnamed elliptical galaxy. But then a star ventured a little too close to the sleeping black hole and was torn to shreds by the force of its gravity. Part of the shredded star swirled around the black hole, then began to plunge into it, triggering a bright ultraviolet flare that the Galaxy Evolution Explorer was able to detect.

Today, the space-based telescope continues to periodically watch this ultraviolet light fade as the black hole finishes the remaining bits of its stellar meal. The observations will ultimately provide a better understanding of how black holes evolve with their host galaxies.

"This will help us greatly in weighing black holes in the universe, and in understanding how they feed and grow in their

host galaxies as the universe evolves," said Dr. Christopher Martin of Caltech, a co-author of the paper and the principal investigator for the Galaxy Evolution Explorer.

In the early 1990s, three other resting, or dormant, black holes were suspected of having eaten stars when the joint German-American-British Rntgen X-ray satellite picked up X-ray flares from their host galaxies. Astronomers had to wait until a decade later for NASA's Chandra X-ray Observatory and the European Space Agency's XMM-Newton X-ray observatory to confirm those findings, showing that the black holes' X-rays had faded dramatically – a sign that stars were swallowed.

Now, Gezari and her colleagues have, for the first time, watched a similar feeding frenzy unfold, as it happens, through the ultraviolet eyes of the Galaxy Evolution Explorer. They used the telescope's detectors to catch an ultraviolet flare from a distant galaxy, then watched the flare diminish over time, as the galaxy's central black hole consumed the star. Additional data from Chandra, the Canada France Hawaii Telescope in Hawaii and the Keck Telescope, also in Hawaii, helped the team chronicle the event in multiple wavelengths over two years.

Black holes are heaps of concentrated matter whose gravity is so strong that even light cannot escape. Supermassive black holes are believed to reside at the cores of every galaxy, though some are thought to be more active than others. Active black holes drag surrounding material into them, heating it up and causing it to glow. Dormant black holes, like the one in our Milky Way galaxy, hardly make a peep, so they are difficult to study.

That's why astronomers get excited when an unsuspecting star wanders too close to a dormant black hole, an event thought to happen about once every 10,000 years in a typical galaxy. A star will flatten and stretch apart when a nearby black hole's gravity overcomes its own self-gravity. The same phenomenon happens on Earth every day, as the moon's gravity tugs on our world, causing the oceans to rise and fall. Once a star has been disrupted, a portion of its gaseous body will then be pulled into the black hole and heated up to temperatures that emit X-rays and ultraviolet light.

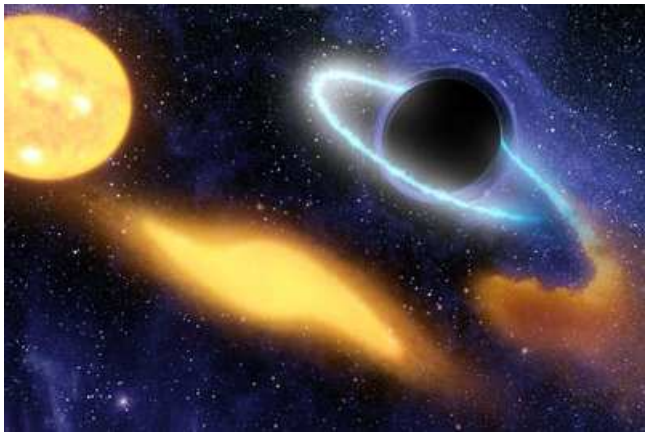

Figure 10: *This artist's concept shows a supermassive black hole at the center of a remote galaxy digesting the remnants of a star. Image credit: NASA/JPL-Caltech*

"The star just couldn't hold itself together," said Gezari, adding, "Now that we know we can observe these events with ultraviolet light, we've got a new tool for finding more."

The newfound feeding black hole is thought to be tens of millions times as massive as our sun. Its host galaxy is located 4 billion light-years away in the Bootes constellation.

2.7 Do Galaxies Follow Darwinian Evolution?

Source: ESO Press Release, December 6th, 2006 [14]

VLT Survey Provides New Insight into Formation of Galaxies

Using VIMOS on ESO's Very Large Telescope, a team of French and Italian astronomers have shown the strong influence the environment exerts on the way galaxies form and evolve. The scientists have for the first time charted remote parts of the Universe, showing that the distribution of galaxies has considerably evolved with time, depending on the galaxies' immediate surroundings. This surprising discovery poses new challenges for theories of the formation and evolution of galaxies.

The 'nature versus nurture' debate is a hot topic in human psychology. But astronomers too face similar conundrums, in particular when trying to solve a problem that goes to the very heart of cosmological theories: are the galaxies we see today simply the product of the primordial conditions in which they formed, or did experiences in the past change the path of their evolution?

In a large, three-year long survey carried out with VIMOS, the Visible Imager and Multi-Object Spectrograph on ESO's

VLT, astronomers studied more than 6,500 galaxies over a wide range of distances to investigate how their properties vary over different timescales, in different environments and for varying galaxy luminosities. They were able to build an atlas of the Universe in three dimensions, going back more than 9 billion years.

This new census reveals a surprising result. The colour-density relation, that describes the relationship between the properties of a galaxy and its environment, was markedly different 7 billion years ago. The astronomers thus found that the galaxies' luminosity, their initial genetic properties, and the environments they reside in have a profound impact on their evolution.

"Our results indicate that environment is a key player in galaxy evolution, but there's no simple answer to the 'nature versus nurture' problem in galaxy evolution," said Olivier Le Fevre from the Laboratoire d'Astrophysique de Marseille, France, who coordinates the VIMOS VLT Deep Survey team that made the discovery. "They suggest that galaxies as we see them today are the product of their inherent genetic information, evolved over time, as well as complex interactions with their environments, such as mergers."

Scientists have known for several decades that galaxies in the Universe's past look different to those in the present-day Universe, local to the Milky Way. Today, galaxies can be roughly classified as red, when few or no new stars are being born, or blue, where star formation is still ongoing. Moreover, a strong correlation exists between a galaxy's colour and the environment it resides in: the more sociable types found in dense clusters are more likely to be red than the more isolated ones.

By looking back at a wide range of galaxies of a variety of ages, the astronomers were aiming to study how this peculiar correlation has evolved over time.

"Using VIMOS, we were able to use the largest sample of galaxies currently available for this type of study, and because of the instrument's ability to study many objects at a time we obtained many more measurements than previously possible," said Angela Iovino, from the Brera Astronomical Observatory, Italy, another member of the team.

The team's discovery of a marked variation in the 'colour-density' relationship, depending on whether a galaxy is found in a cluster or alone, and on its luminosity, has many potential implications. The findings suggest for example that being located in a cluster quenches a galaxy's ability to form stars more quickly compared with those in isolation. Luminous galaxies also run out of star-forming material at an earlier time than fainter ones.

They conclude that the connection between galaxies' colour, luminosity and their local environment is not merely a result of primordial conditions 'imprinted' during their formation - but just as for humans, galaxies' relationship and interactions can have a profound impact on their evolution.

2.8 Group of galaxies found to bend the light of remote galaxies

Source: CFHT Press Release, December 22nd, 2006 [15]

The discovery of a new class of gravitational lenses, the groups of galaxies, by an international team of astronomers using the Canada-France-Hawaii Legacy Survey (CFHTLS), comes 20 years after the publication in January 1987 of the first image of a gravitational arc, made also at CFHT with one of the first CCD cameras in operation at an observatory. This discovery of gravitational arcs in the center of galaxy groups is an important step in our understanding of the large scale structures of the universe. These new results will allow a better understanding of the distribution of the dark matter and the formation mechanisms of the groups of galaxies, structures intermediate in mass between galaxies and clusters of galaxies.

Twenty years ago at CFHT, French astronomers observed for the first time galaxies distorted in giant arcs at the center of the most massive galaxy clusters. These observations brought to light one of the most spectacular effects of what is called "gravitational lensing". According to Einstein's theory of General Relativity, spacetime is curved by the presence of matter. Therefore, the light passing close to an important concentration of mass will be bent. When an observer, a galaxy cluster and a remote galaxy are in nearly perfect alignment, the remote galaxy appears to the observer as one or more luminous arcs resulting from the fusion of images of the remote galaxy distorted and amplified by the galaxy cluster acting as a complex gravitational lens. The shape, brightness and distribution of these gravitational arcs bring invaluable information on the mass distribution of the lensing cluster.

Up to recently, only the most massive galaxy clusters and the massive galaxies were the object of gravitational lensing studies. Intermediate-scale structures like the galaxy groups should however be looked in order to better understand the evolution of the structures in the Universe.

Since the arrival of the MegaCam camera in 2003 on Megaprime, the new CFHT prime focus, astronomers have been able to observe at once a large area of the sky (1 square degree or 4 Full Moon) in 340 MegaPixel digital images

with an unprecedented resolution for such a field of view. The Canadian and French communities decided to pull their resources together and to devote 500 nights of telescope time over five years to a large project, the CFHT Legacy Survey, which will cover around 1 percent of the sky visible from Hawaii.

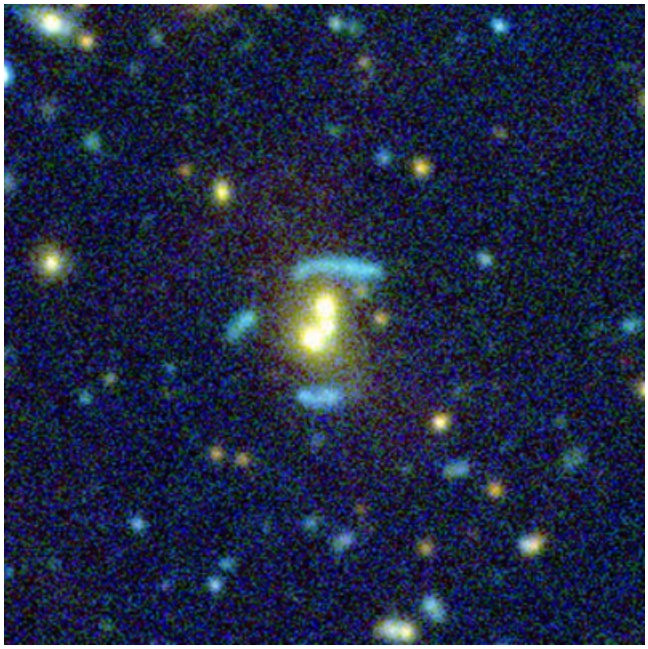

Figure 11: *Galactic lens in action. Image credit: CFHT*

Thanks to a careful inspection aimed at detecting gravitational arcs in one fourth of the CFHTLS, the team has been able to detect for the first time numerous arcs around galaxy groups. This unexpected discovery provides for the first time direct information on the structure of galaxy groups which are key environments in the formation of structures in the Universe. Scientists will be able to understand the role of dark matter in the evolution of these groups and of the mass concentrations that make the large structures of the Universe.

2.9 SWIFT Discovers New Kind of Black Hole Explosion

Source: NASA News, December 20th, 2006 [16]

Scientists using NASA data are studying a newly recognized type of cosmic explosion called a hybrid gamma-ray burst. As with other gamma-ray bursts, this hybrid blast is likely signaling the birth of a new black hole.

It is unclear, however, what kind of object or objects exploded or merged to create the new black hole. The hybrid burst exhibits properties of the two known classes of gamma-ray bursts yet possesses features that remain unexplained.

NASA's Swift first discovered the burst on June 14. Since the Swift finding, more than a dozen telescopes, including the Hubble Space Telescope and large ground-based observatories, have studied the burst.

"We have lots of data on this event, have dedicated lots of observation time, and we just can't figure out what exploded," said Neil Gehrels of NASA Goddard Space Flight Center in Greenbelt, Md., lead author on one of four reports appearing in this week's edition of the journal Nature. "All the data seem to point to a new but perhaps not so uncommon kind of cosmic explosion."

Gamma-ray bursts represent the most powerful known explosions in the universe. Yet they are random and fleeting, never appearing twice. Scientists have only recently begun to understand their nature.

Such bursts typically fall into one of two categories, long or short. The long bursts last more than two seconds and appear to be from the core collapse of massive stars forming a black hole. Most of these bursts come from the edge of the visible universe. The short bursts, which are under two seconds and often last just a few milliseconds, appear to be the merger of two neutron stars or a neutron star with a black hole, which subsequently creates a new or bigger black hole.

The hybrid burst, called GRB 060614, after the date it was detected, originated from within a galaxy 1.6 billion light years away in the southern constellation Indus. The burst lasted for 102 seconds, placing it soundly in long-burst territory. But the burst lacked the hallmark of a supernova, or star explosion, commonly seen shortly after long bursts. Also, the burst's host galaxy has a low star-formation rate with few massive stars that could produce supernovae and long gamma-ray bursts. "This was close enough to detect a supernova if it existed," said Avishay Gal-Yam of Caltech, Pasadena, Calif., lead author on another Nature report. "Even Hubble didn't see anything."

Certain properties of the burst concerning its brightness and the arrival time of photons of various energies, called the lag-luminosity relationship, suggest that burst behaved more like a short burst (from a merger) than a long burst. Yet no theoretical model of mergers can support a sustained release of gamma-ray energy for 102 seconds. "This is brand new territory; we have no theories to guide us," said Gehrels.

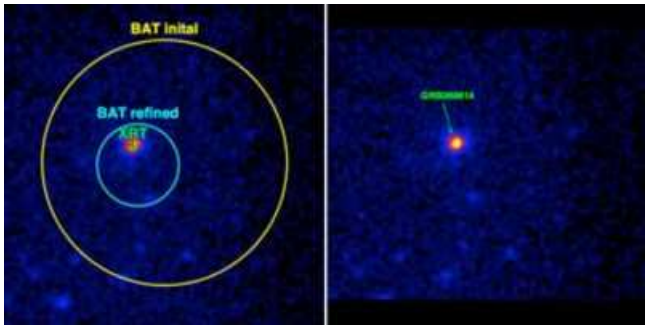

Figure 12:

The burst is perhaps not unprecedented. Archived data from the Compton Gamma-Ray Observatory in the 1990s possibly reveal other hybrid "long-short" bursts, but no follow-up observations are available to confirm this. Johan Fynbo of the Niels Bohr Institute in Copenhagen, also lead author on a Nature report, suggests that a burst from May of this year was also long, but had no associated supernova.

Scientists remain divided on whether this was a long-short burst from a merger or a long burst from a star explosion with no supernova. Most conclude, however, that some new process must be at play either the model of mergers creating second-long bursts needs a major overhaul, or the progenitor star from an explosion is intrinsically different from the kind that make supernovae.

"We siphoned out all the information we could from GRB 060614," said Massimo Della Valle of the Osservatorio Astrofisico di Arcetri in Firenze, Italy, another lead author on a Nature report. "All we can do now is wait for the next nearby hybrid burst."

2.10 Very High Frequency Radiation makes Dark Matter Visible

Source: Max Planck Society Press Release, December 14th, 2006 [17]

The stars and gas which are seen in galaxies account for only a few percent of the gravitating material in the Universe. Most of the rest has remained stubbornly invisible and is now thought to be made of a new form of matter never yet seen on Earth. Researchers at the Max Planck Institute for Astrophysics have discovered, however, that a sufficiently big radio telescope could make a picture of everything that gravitates, rivalling the images made by optical telescopes of everything that shines (online: 28. November 2006).

As light travels to us from distant objects its path is bent slightly by the gravitational effects of the things it passes. This effect was first observed in 1919 for the light of distant stars passing close to the surface of the Sun, proving Einstein's theory of gravity to be a better description of reality than Newton's. The bending causes a detectable distortion of the images of distant galaxies analogous to the distortion of a distant scene viewed through a poor window-pane or reflected in a rippled lake. The strength of the distortion can be used to measure the strength of the gravity of the foreground objects and hence their mass. If distortion measurements are available for a sufficiently large number of distant galaxies, these can be combined to make a map of the entire foreground mass.

This technique has already produced precise measurements of the typical mass associated with foreground galaxies, as well as mass maps for a number of individual galaxy clusters. It nevertheless suffers from some fundamental limitations. Even a big telescope in space can only see a limited number of background galaxies, a maximum of about 100,000 in each patch of sky the size of the Full Moon. Measurements of about 200 galaxies must be averaged together to detect the gravitational distortion signal, so the smallest area for which the mass can be imaged is about 0.2 percent that of the Full Moon. The resulting images are unacceptably blurred and are too grainy for many purposes. For example, only the very largest lumps of matter (the biggest clusters of galaxies) can be spotted in such maps with any confidence. A second problem is that many of the distant galaxies whose distortion is measured lie in front of many of the mass lumps which one would like to map, and so are unaffected by their gravity. To make a sharp image of the mass in a given direction requires more distant sources and requires many more of them. MPA scientists Ben Metcalf and Simon White have shown that radio emission coming to us from the epoch before the galaxies had formed can provide such sources.

About 400,000 years after the Big Bang, the Universe had cooled off sufficiently that almost all its ordinary matter turned into a diffuse, near-uniform and neutral gas of hydrogen and helium. A few hundred million years later gravity had amplified the non-uniformities to the point where the first stars and galaxies could form. Their ultraviolet light then heated the diffuse gas back up again. During this reheating and for an extended period before it, the diffuse hydrogen was hotter or cooler than the radiation left over from the Big Bang. As a result it must have absorbed or emitted radio waves with a wavelength of 21 cm. The expansion of the Universe causes this radiation to be visible today at wavelengths of 2 to 20 metres, and a number of low-frequency radio telescopes are currently being

built to search for it. One of the most advanced is the Low Frequency Array (LOFAR) in the Netherlands, a project in which the Max Planck Institute for Astrophysics is planning to take a significant role, together with a number of other German institutions.

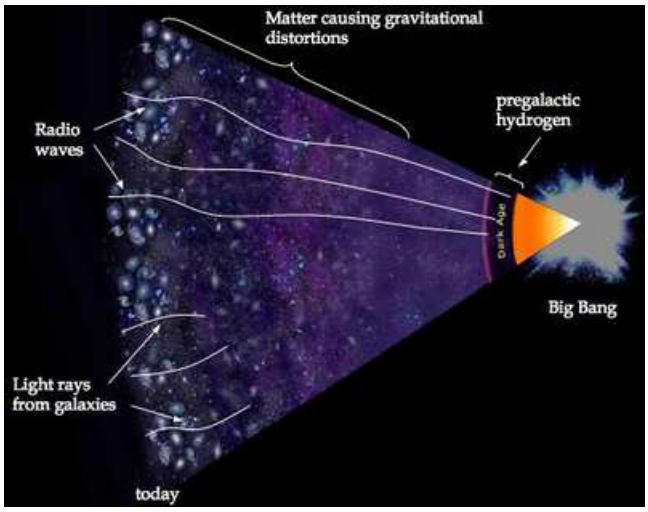

Figure 13: *The processes in the Universe after the Big Bang. The radio waves are much older than the light of galaxies. From the distortion of the images (curved lines) - caused by the gravitation of material between us and the light sources - it is possible to calculate and map the entire foreground mass. Image: Max Planck Institute of Astrophysics*

The pregalactic hydrogen has structures of all sizes which are the precursors of galaxies, and there are up to 1000 of these structures at different distances along every line of sight. A radio telescope can separate these because structures at different distances give signals at different observed wavelengths. Metcalf and White show that gravitational distortion of these structures would allow a radio telescope to produce high-resolution images of the cosmic mass distribution which are more than ten times sharper than the best that can be made using galaxy distortions. An object similar in mass to our own Milky Way could be detected all the way back to the time when the Universe was only 5 percent its present age. Such high-resolution imaging requires a extremely large telescope array, densely covering a region about 100 km across. This is 100 times the size planned for densely covered central part of LOFAR, and about 20 times bigger than densely covered core of the Square Kilometre Array (SKA) the biggest such facility currently under discussion. Such a giant telescope could map the entire gravitating mass distribution of the Universe, providing the ultimate comparison map for images produced by other telescopes which highlight only the tiny fraction of the mass which emits radiation they can detect.

We don't have to wait for the giant telescope to get unparalleled results from this technique, however. One of the most pressing issues in current physics is to gain a better understanding of the mysterious Dark Energy which currently drives the accelerated expansion of the Universe. Metcalf and White show that mass maps of a large fraction of the sky made with an instrument like SKA could measure the properties of Dark Energy more precisely than any previously suggested method, more than 10 times as accurately as mass maps of similar size based on gravitational distortions of the optical images of galaxies.

2.11 Spitzer Picks Up Glow of Universe's First Objects

Source: JPL/NASA Press Release, December 18th, 2006 [18]

New observations from NASA's Spitzer Space Telescope strongly suggest that infrared light detected in a prior study originated from clumps of the very first objects of the universe. The recent data indicate this patchy light is splattered across the entire sky and comes from clusters of bright, monstrous objects more than 13 billion light-years away.

"We are pushing our telescopes to the limit and are tantalizingly close to getting a clear picture of the very first collections of objects," said Dr. Alexander Kashlinsky of NASA's Goddard Space Flight Center, Greenbelt, Md., lead author on two reports to appear in the Astrophysical Journal Letters. "Whatever these objects are, they are intrinsically incredibly bright and very different from anything in existence today."

Astronomers believe the objects are either the first stars – humongous stars more than 1,000 times the mass of our sun – or voracious black holes that are consuming gas and spilling out tons of energy. If the objects are stars, then the observed clusters might be the first mini-galaxies containing a mass of less than about one million suns. The Milky Way galaxy holds the equivalent of approximately 100 billion suns and was probably created when mini-galaxies like these merged.

This study is a thorough follow-up to an initial observation presented in Nature in November 2005 by Kashlinksy and his team. The new analysis covered five sky regions and involved hundreds of hours of observation time.

Scientists say that space, time and matter originated 13.7 billion years ago in a tremendous explosion called the Big

Bang. Observations of the cosmic microwave background by a co-author of the recent Spitzer studies, Dr. John Mather of Goddard, and his science team strongly support this theory. Mather is a co-winner of the 2006 Nobel Prize for Physics for this work. Another few hundred million years or so would pass before the first stars would form, ending the so-called dark age of the universe.

With Spitzer, Kashlinsky's group studied the cosmic infrared background, a diffuse light from this early epoch when structure first emerged. Some of the light comes from stars or black hole activity so distant that, although it originated as ultraviolet and optical light, its wavelengths have been stretched to infrared wavelengths by the growing space-time that causes the universe's expansion. Other parts of the cosmic infrared background are from distant starlight absorbed by dust and re-emitted as infrared light.

"There's ongoing debate about what the first objects were and how galaxies formed," said Dr. Harvey Moseley of Goddard, a co-author on the papers. "We are on the right track to figuring this out. We've now reached the hilltop and are looking down on the village below, trying to make sense of what's going on."

The analysis first involved carefully removing the light from all foreground stars and galaxies in the five regions of the sky, leaving only the most ancient light. The scientists then studied fluctuations in the intensity of infrared brightness, in the relatively diffuse light. The fluctuations revealed a clustering of objects that produced the observed light pattern.

"Imagine trying to see fireworks at night from across a crowded city," said Kashlinsky. "If you could turn off the city lights, you might get a glimpse at the fireworks. We have shut down the lights of the universe to see the outlines of its first fireworks."

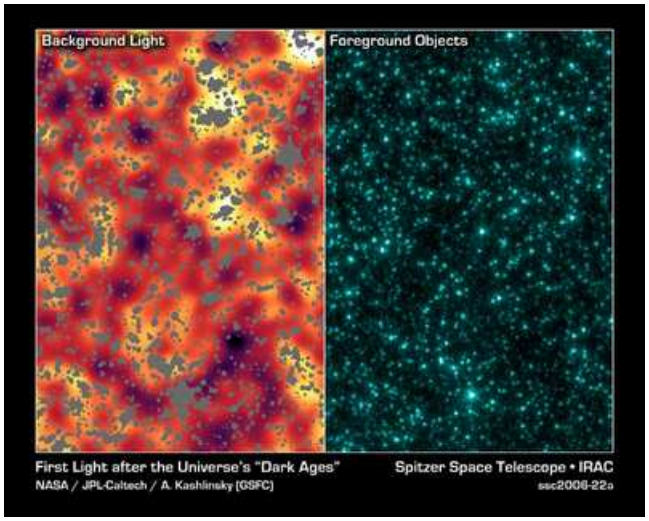

Figure 14: *The right panel is an image from NASA's Spitzer Space Telescope of stars and galaxies in the Ursa Major constellation. The left panel is the same image after stars, galaxies and other sources were masked out. Image credit: NASA/JPL-Caltech/GSFC*

Mather, who is senior project scientist for NASA's future James Webb Space Telescope, said, "Spitzer has paved the way for the James Webb Space Telescope, which should be able to identify the nature of the clusters."

3 Space missions

3.1 COROT on its way

Source: ESA Press Release, December 27th, 2006 [19]

Launched today from Kazakhstan, the unique astronomy mission COROT is on its way. Its twin goals are to detect exoplanets orbiting around other stars and to probe the mysteries of stellar interiors as never before. COROT is a French national space agency (CNES)-led mission to which ESA and European partners are adding a particularly strong international flavour. COROT was launched by a Soyuz-Fregat from Baikonur in Kazakhstan at 15:23 CET. Status reports on the mission are available from CNES at: [20] What is COROT? COROT stands for 'Convection Rotation and planetary Transits'. The name describes the mission's scientific goals. 'Convection and rotation' refer to the satellite's capability to probe stellar interiors, studying the acoustic waves that ripple across the surface of stars, a technique called asteroseismology. 'Transit' refers to the technique whereby the presence of a planet orbiting a star can be inferred from the dimming starlight caused when the planet passes in front of it. To achieve its twin scientific objectives, COROT will monitor some 120 000 stars with its 30-

centimetre telescope.

COROT will lead a bold new search for planets around other stars. In the decade since the first discovery in 1995 of an exoplanet (51 Pegasi b), more than 200 other such planets outside our solar system have been detected using ground-based observatories. The COROT space telescope promises to find many more during its two-and-a-half-year mission, expanding the frontiers of our knowledge towards ever-smaller planets.

Many of the planets COROT will detect are expected to be 'hot Jupiters', gaseous worlds. An unknown percentage of those detected are expected to be rocky planets, maybe just a few times larger than the Earth (or smaller, even). If COROT finds such planets, they will constitute a new class of planet altogether.

While it is looking at a star, COROT will also be able to detect 'starquakes', acoustic waves generated deep inside a star that send ripples across its surface, altering its brightness. The exact nature of the ripples allows astronomers to calculate the star's precise mass, age and chemical composition. COROT's European dimension The COROT mission was first proposed by CNES back in 1996. A call for potential European partners was issued in 1999. CNES gave the green light to build the spacecraft in 2000 and is now leading the mission. Its international partners are ESA, Austria, Belgium, Germany, Spain and Brazil.

CNES is responsible for the overall system and for the launch contract with Franco-Russian company Starsem, which is providing the Soyuz launch service.

Figure 15: *Artist impression of COROT. Image credit: ESA*

The contributions of the other international partners range from the provision of hardware items to ground stations, complementary ground-based observation of targets to be studied by COROT and analysis of the scientific data to come. ESA is playing a crucial role in the mission. It has contributed the optics for the telescope positioned at the heart of the spacecraft and has carried out payload testing.

The telescope's baffle was developed by a team at ESA's technical centre ESTEC. ESA has also provided the onboard data processing units. And under this truly collaborative effort, a number of scientists from various European countries - Denmark, Switzerland, the United Kingdom and Portugal - have been selected as Co-Investigators following open competition. As a result of ESA's participation, scientists from its Member States will also be given access to COROT data.

Status reports on the mission are available from CNES at: [21]

3.2 Planetary Society Offers 50,000 dollar Prize for Asteroid Tagging Designs

Source: The Planetary Society Press Release, December 13th, 2006 [22]

Today at the fall meeting of the American Geophysical Union, The Planetary Society announced the launch of their Apophis Mission Design Competition, which invites participants to submit designs for a mission to rendezvous with and "tag" a potentially dangerous near-Earth asteroid. Tagging may be necessary to track an asteroid accurately enough to determine whether it will impact Earth, and thus help facilitate the decision whether to mount a deflection mission to alter its orbit. The Planetary Society is offering 50,000 dollars in prize money for the competition.

Apophis is an approximately 400 meter near-Earth object (NEO), which will come closer to Earth in 2029 than the orbit of our geostationary satellites. On that pass, the asteroid will be gravitationally perturbed to an unknown orbit, one that could cause it to hit Earth in 2036.

"While the odds are very slim that this particular asteroid will hit Earth in 30 years, they are not zero, and Apophis and other NEOs represent threats that need to be addressed," said Rusty Schweickart, Apollo astronaut, head of the Association for Space Explorers NEO committee.

Bruce Betts, The Planetary Society's Director of Projects said, "With this competition, we hope not only to generate creative thinking about tagging Apophis, but also to stimulate greater awareness of the broader near-Earth object threat."

Very precise tracking may be needed to determine the probability of a collision in 2036. Such precise tracking may

require ”tagging” the asteroid, perhaps with a beacon – a transponder or reflector – or some other method. Exactly how an asteroid could best be tagged is not yet known, nor is it obvious. ”Learning how to do this is the point of the competition,” added Betts.

The Planetary Society is ”betting” 50,000 dollars that someone will devise an innovative solution to the problem. The prize money was contributed and competition made possible by Dan Geraci, a member of The Planetary Society Board of Directors, together with donations from Planetary Society members around the world. Geraci stated, ”The time scale may be unknown, but the danger of a near-Earth object impact is very real. We need to spur the space community and indeed all people into thinking about technical solutions.”

The Planetary Society is conducting this competition in cooperation with the European Space Agency (ESA), NASA, the Association of Space Explorers (ASE), the American Institute of Aeronautics and Astronautics (AIAA), and the Universities Space Research Association (USRA). The Society will present the winning entries to the world’s major space agencies, and the findings of the competition will be presented at relevant scientific and engineering conferences.

If Apophis passes through a several hundred-meter wide ”keyhole” in 2029, it will impact Earth in 2036. While current estimates rate the probability of impact as very low, Apophis is being used as an example to enable design of a broader type of mission to any potentially dangerous asteroid.

The competition design scenario asks participants to imagine that Earth-based observations of Apophis made over the coming years are not sufficient to know whether the asteroid will or will not pass through the 2029 keyhole, and that a better orbit determination is needed to know if a deflection mission is required. The competition requires that the tagging mission be designed to return information fast enough so that by the year 2017 space agencies could determine whether they need to send a mission to deflect the asteroid from the keyhole.

Teams or individuals intending to submit a proposal should submit a Notice of Intent to Propose by March 1, 2007. The deadline for proposals is August 31, 2007.

The Apophis Mission Design Competition is open to anyone from any country. Proposals may be submitted by individuals or teams. The competition is open to teams from academia and industry as well as student and private groups, and to government groups or individuals not using government salaries to support their participation in the Contest (see rules for details).

50,000 dollars in prize money will be awarded. The judges will determine how to distribute the award money among one or more prize winners. At least 25,000 dollars will be awarded to the first prize winner. At least 5,000 dollars is reserved for the best submission received from a student team (who is not precluded from winning the first prize), in which all substantive work was performed by current students (high school, undergraduate, or graduate), with no more than two faculty advisors. Remaining prize money may be distributed as honorable mention awards.

Additionally, the first prize winner, or one member of the first prize winning team, will receive award travel, including transportation, food, and lodging, to attend a future major science or engineering conference to present their results.

3.3 Jules Verne goes hot and cold

Source: ESA Press Release, December 14th, 2006 [23]

For 21 days in a row, Jules Verne, the first Automated Transfer Vehicle (ATV), has not only survived the most stringent conditions of the space environment, but it has successfully tested on the ground its flight software and hardware under the toughest simulated conditions of space vacuum, freezing temperatures and burning sun radiation. Jules Verne ATV, the most complex spacecraft ever developed in Europe, is due to make its inaugural flight atop an Ariane 5 in summer 2007 to re-supply the International Space Station. It has just completed its most exhaustive test campaign at ESA’s test facilities at ESTEC, in Noordwijk, the Netherlands.

”Started on 22 November, the test campaign, with different cycles of cold and hot phases, has been performed according to schedule and the ’behaviour’ of this complex spaceship has been generally in line with the expected one when reacting to the cold and hot environment”, said Bachisio Dore, the ESA ATV manager of Assembly Integration & Verification (AIV). ”The successful completion of this test campaign represents a major milestone for the ATV Programme.”

Thermal challenge The most challenging aspect of the test has been for Jules Verne ATV to keep its temperatures within strict limits compatible with all the thousands parts of hardware which make up its sophisticated subsystems. Specific software and new technology enable ATV to balance the temperatures on the spaceship and allow it to fly smoothly in the freezing darkness, the burning sunshine radiation and in the vacuum of the orbital environment.

”It is like putting your computer laptop in the freezer, then exposing it to the Sun in the summer heat and back again to

the freezer while you are continually using it", explained one of the 35 Astrium and subcontractor engineers who are monitoring the spacecraft round the clock, seven days a week.

Jules Verne is no laptop it is a 20-tonne spacecraft, the size of a double-decker bus, with dozens of powerful computers and a large amount of electronics. Its software of one million lines of code makes it the largest and most elaborate ever developed in Europe.

The 625 built-in thermal sensors and another 250 extra sensors, especially added inside and around Jules Verne for the test, have been carefully monitoring that the temperatures remain within their acceptable limits around the clock.

At the same time, inside the huge 2 300 m Large Space Simulator (LSS) chamber, in-orbit environmental conditions and thermal cycles have been reproduced. A typical vacuum level of one-millionth of a millibar was achieved, the outside chamber temperature was lowered to minus 30C or minus 80C according to the test cycle; and for short periods, the Sun simulator was activated, providing a horizontal solar beam of 6-metre diameter, to radiate a powerful flux of 1400 Watts per square metre on the dazzling white layer protecting Jules Verne.

State-of-the-art heat pipes The ATV consists of two main modules with their own temperature requirements. The pressurized Integrated Cargo Carrier, with its 48m compartment dedicated to carry the entire re-supply cargo to the Station (with a maximum mass of 7 667 kg). This module, which docks to the ISS, must remain between 20C and 30C between launch and docking, and during the attached phase with the ISS, especially when refuelling propellant is transferred to the Station.

The non-pressurized avionics/propulsion module, which includes rocket engines, electrical power, electronics, computers, communications and the avionics, has to remain between 0C and 40C.

The avionics bay, which is the brain of the ATV, produces its own heat from the large numbers of electronic equipment, and at the same time manages a very sophisticated system to control overheating. "Thanks to 40 state-of-the-art variable conductance heat pipes located in the avionics bay, the ATV is able to carry away the heat and release the energy directly into space or, otherwise, to warm up other parts in a very economic fashion. This new technology means we can get rid of 50 percent more energy for the whole spaceship, and still maintain the right internal temperature environment", explains Patrick Oger, an Astrium thermal engineer.

Another objective of the test was to monitor the outgassing of the ATV, caused by some materials of the spaceship which, under vacuum conditions, release some internal gases that are usually trapped inside them. ATV gas samples were collected during the tests in the vacuum chamber and will be later analyzed. The aerospace engineers want to be sure that ATV gases do not contaminate the critical mechanisms of the spacecraft, like those that rotate the solar panels towards the Sun. Their rotation at different temperatures performed properly, even though the four solar panels were not mounted on the ATV for the test.

One thousand test sequences The main objective of the test was to verify that under the thermal vacuum environment all the hardware items are working together properly. To achieve this goal for a complex spacecraft such ATV, the development, tuning and validation by Astrium engineers of about one thousand test procedures and automated test sequences were required.

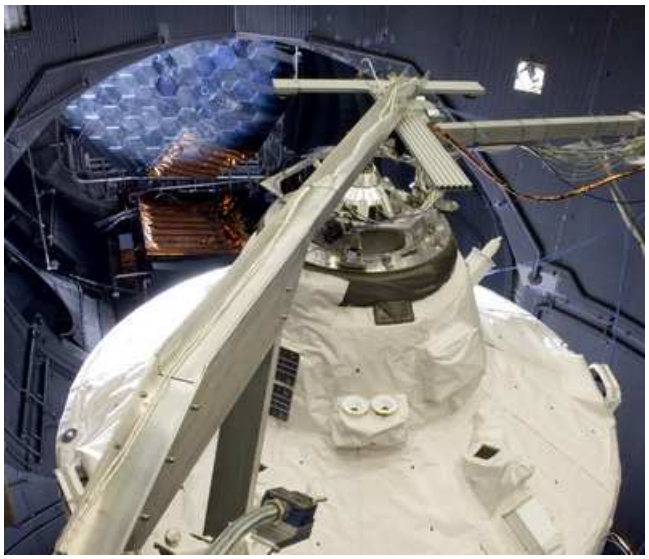

Figure 16: *Jules Verne getting tested. Image credit: ESA*

For example, during the test, ATV engineers also activated some of the moving parts of the spaceship. As soon as the order was given to extend or retract the probe of the docking system, they were able to see it moving slowly, while looking through the small LSS windows near the top of the spaceship.

In the final days of testing, several simulated firings of the 32 engine thrusters were performed with helium gas, in order to verify the proper interaction between the propulsion and avionics subsystems. Additionally all the hardware needed by ATV to perform emergency manoeuvres to avoid colli-

sion with the ISS was tested during the thermal tests by simulating the performance of four such manoeuvres.

”Thanks to these extensive tests, it has been possible to validate the whole ATV, that is to say all the hardware while it was reacting to the harsh orbital conditions. At the same time we could check the complete performance of the hardware and software needed for power and thermal control under close-to-space conditions”, says Marc Chevalier, the Astrium ATV manager of the Assembly Integration Test (AIT). ”This successful test will also show us some minor improvements in the software procedures which it would be good to implement.”

In the coming weeks, about 50 gigabytes of test data stored during the 270 hours of functional testing performed during the thermal test, which have been archived, will be carefully analyzed to be sure that any minor anomalies or bugs are fully understood.

3.4 The Rise of a Giant

Source: ESO Press Release, December 11th, 2006 [24]

ESO Council Gives Green Light to Detailed Study of the European Extremely Large Telescope

European astronomy has received a tremendous boost with the decision from ESO’s governing body to proceed with detailed studies for the European Extremely Large Telescope. This study, with a budget of 57 million euro, will make it possible to start, in three years time, the construction of an optical/infrared telescope with a diameter around 40m that will revolutionise ground-based astronomy. The chosen design is based on a revolutionary concept specially developed for a telescope of this size.

”The decision by the ESO Council to go ahead with the design study for an European Extremely Large Telescope is a very exciting one for European astronomy,”, said Richard Wade, President of the ESO Council.

”Today is a great day because the ESO Council has authorised us to go forward with the final design of the next flagship telescope of ESO,”, says Catherine Cesarsky, ESO’s Director General.

Since the end of last year, ESO has been working together with its user community of European astronomers and astrophysicists to define the new giant telescope needed by the middle of the next decade [1]. More than one hundred astronomers from all European countries have been involved throughout 2006, helping the ESO Project Offices to produce a novel concept, in which performance, cost, schedule and risk were carefully evaluated.

This fast pace has also been possible thanks to early conceptual studies in Europe (such as the ESO OWL and the EURO-50 studies) and research and development done in collaboration with a large number of European institutes and high-tech industries to develop critical enabling technologies within the framework of the EU FP6 programme and with significant contributions from all partners.

Provisionally dubbed E-ELT for the European Extremely Large Telescope, ESO’s innovative concept was presented in detail two weeks ago to more than 250 European astronomers at a conference in Marseille. Their enthusiastic welcome paved the way for the decision by the ESO Council to move to the crucial next phase: detailed design of the full facility.

”At the end of the three year Final Design Study, we will know exactly how everything is going to be built including a detailed costing,” said Cesarsky. ”We then hope to start construction and have it ready by 2017, when we can install instruments and use it!”

The present concept, estimated to cost around 800 million euro, features as a baseline a telescope with a 42-m diameter mirror, and is revolutionary.

”A telescope of this size could not be built without a complete rethinking of the way we make telescopes,” said Catherine Cesarsky.

The primary 42-m diameter mirror is composed of 906 hexagonal segments, each 1.45 m in size, while the secondary mirror is as large as 6 m in diameter. In order to overcome the fuzziness of stellar images due to atmospheric turbulence the telescope needs to incorporate adaptive mirrors into its optics. A tertiary mirror, 4.2 m in diameter, relays the light to the adaptive optics system, composed of two mirrors: a 2.5-m mirror supported by 5000 or more actuators able to distort its own shape a thousand times per second, and one 2.7 m in diameter that allows for the final image corrections. This five mirror approach results in an exceptional image quality, with no significant aberrations in the field of view.

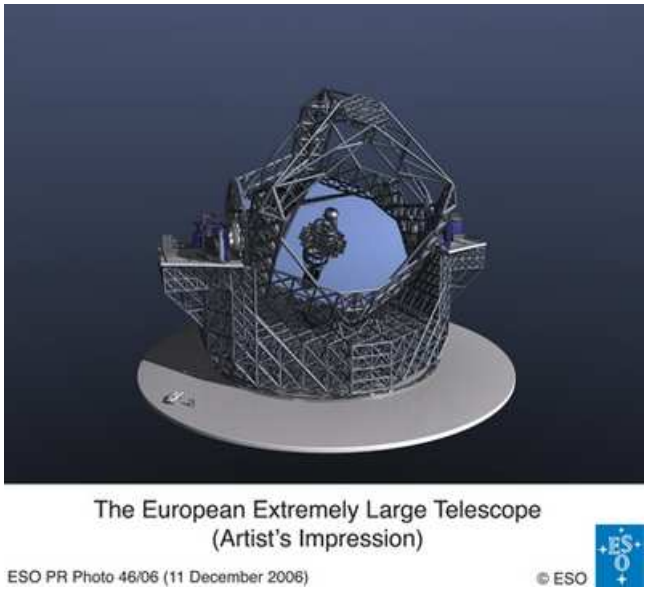

Figure 17: *The European Extremely Large Telescope*

The site of the E-ELT is not yet fixed as studies are still undergoing with a plan to make a decision by 2008.

Extremely Large Telescopes are considered worldwide as one of the highest priorities in ground-based astronomy. They will vastly advance astrophysical knowledge, allowing detailed studies of subjects including planets around other stars, the first objects in the Universe, super-massive black holes, and the nature and distribution of the dark matter and dark energy which dominate the Universe.

With a diameter of 42 m and its adaptive optics concept, the E-ELT will be more than one hundred times more sensitive than the present-day largest optical telescopes, such as the 10-m Keck telescopes or the 8.2-m VLT telescopes.

"This is really the beginning of a new era for optical and infrared astronomy," said Catherine Cesarsky.

3.5 NASA Unveils Global Exploration Strategy and Lunar Architecture

Source: NASA News, December 4th, 2006 [25]

NASA on Monday unveiled the initial elements of the Global Exploration Strategy and a proposed U.S. lunar architecture, two critical tools for achieving the nation's vision of returning humans to the moon.

NASA Deputy Administrator Shana Dale, who is guiding the long-term strategy development effort among 14 of the world's space agencies, said, "This strategy will enable interested nations to leverage their capabilities and financial and technical contributions, making optimum use of globally available knowledge and resources to help energize a coordinated effort that will propel us into this new age of discovery and exploration."

The Global Exploration Strategy focuses on two overarching issues: Why we are returning to the moon and what we plan to do when we get there. The strategy includes a comprehensive set of the reasons for embarking upon human and robotic exploration of the moon. NASA's proposed lunar architecture focuses on a third issue: How humans might accomplish the mission of exploring the moon.

In April 2006, NASA initiated development of the Global Exploration Strategy in order to meet a congressional mandate, as well as to accomplish goals outlined in the agency's strategic plan and the Vision for Space Exploration. The strategy is evolving from a lengthy dialogue among more than 1,000 individuals, including experts from NASA and 13 other space agencies, as well as non-governmental organizations and commercial interests. Experts from the Australian, Canadian, Chinese, European, French, German, British, Indian, Italian, Japanese, Russian, South Korean and Ukrainian space agencies participated.

NASA planners used the international group's deliberations as well as input from academia, private sector and private citizens as the basis for sketching a U.S. blueprint for a return to the moon. NASA's Lunar Architecture Team, chartered in May 2006, concluded that the most advantageous approach is to develop a solar-powered lunar base and to locate it near one of the poles of the moon. With such an outpost, NASA can learn to use the moon's natural resources to live off the land, make preparations for a journey to Mars, conduct a wide range of scientific investigations and encourage international participation.

"The architecture work has resulted in an understanding of what is required to implement and enable critical exploration objectives," said Doug Cooke, deputy associate administrator, Exploration Systems Directorate. "This is all important as we continue the process we have begun and better define the architecture and our various exploration roles in what is a very exciting future for the United States and the world."

As currently envisioned, an incremental buildup would begin with four-person crews making several seven-day visits to the moon until their power supplies, rovers and living quarters are operational. The first mission would begin by 2020. These would be followed by 180-day missions to prepare for journeys to Mars.

The proposed lunar architecture calls for robotic precursor

missions designed to support the human mission. These precursors include landing site reconnaissance, natural resource assays and technology risk reduction for the human lander.

Moving into 2007, NASA will continue to refine its lunar architecture, maintaining the open dialogue initiated in 2006, to enhance further the Global Exploration Strategy. NASA's goal is to enable a sustainable space exploration effort in which participating organizations can achieve individual goals with mutually beneficial results.

3.6 Mars Orbiter Photographs Spirit and Vikings on the Ground

Source: JPL/NASA Press Release, December 4th, 2006 [26]

New images from NASA's Mars Reconnaissance Orbiter show three additional NASA spacecraft that have landed on Mars: the Spirit rover active on the surface since January 2004 and the two Viking landers that successfully reached the surface in 1976. The orbiter's high-resolution camera took a dramatic photograph of Spirit's twin rover, Opportunity, at the edge of a Martian crater two months ago.

Besides providing new portraits of these robotic emissaries, the images provide scientists valuable high-resolution information about the surrounding terrain at each site. This aids both in interpreting other orbital data and in planning activities for surface missions.

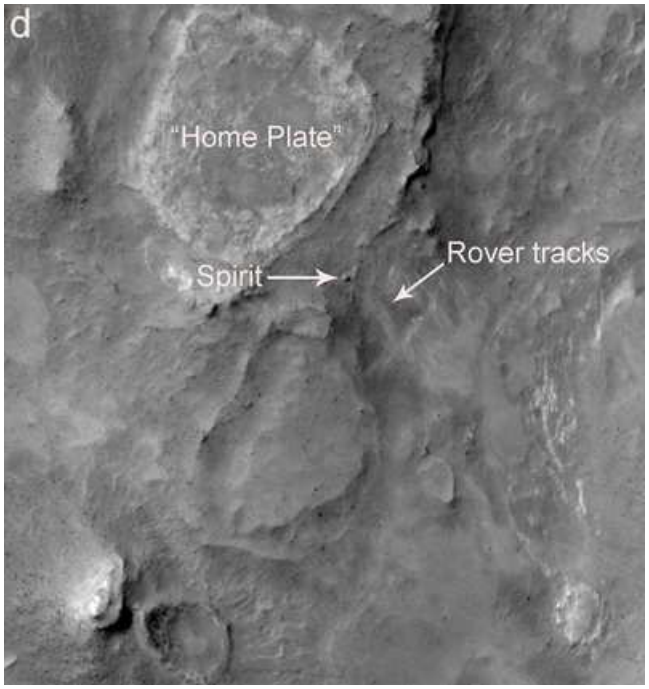

Figure 18: *Spirit rover at Gusev Crater. Image credit: NASA/JPL-Caltech/Univ. of Arizona*

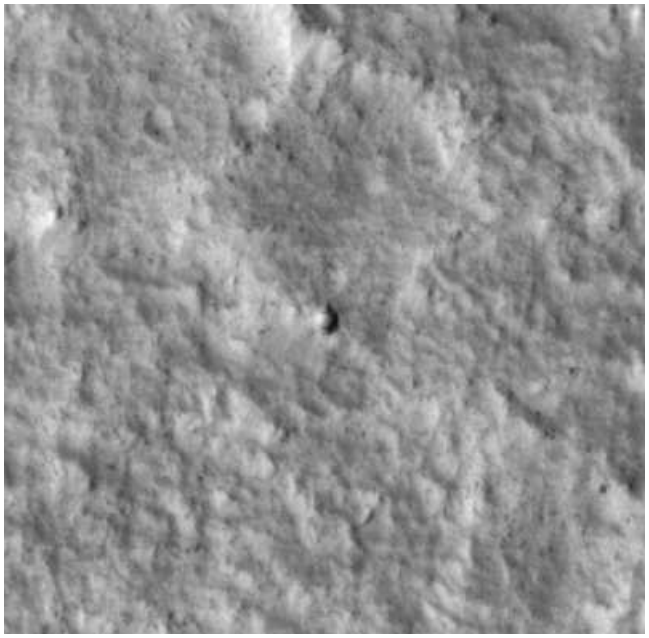

Figure 19: *Viking 1 heat shield. Image credit: NASA/JPL-Caltech/Univ. of Arizona*

4 Internet websites

[1] http://www.esa.int/esaCP/SEM4KXPJNVE_index_0.html
[2] http://www.jpl.nasa.gov/news/news.cfm?release=2006-149
[3] http://www.jpl.nasa.gov/news/news.cfm?release=2006-148
[4] http://www.jpl.nasa.gov/news/news.cfm?release=2006-145
[5] http://www.news.uiuc.edu/news/06/1214enceladus.html
[6] http://www.jpl.nasa.gov/news/news.cfm?release=2006-147
[7] http://www.cfa.harvard.edu/press/pr0631.html
[8] http://www.nrao.edu/pr/2006/multidisk/
[9] http://hubblesite.org/newscenter/archive/releases/2006/54/image/a/
[10] http://www2.warwick.ac.uk/newsandevents/pressreleases/starring/
[11] http://deneb.astro.warwick.ac.uk/phsdaj/public_html/SDSS1228+1040/
[12] http://www.pparc.ac.uk/Nw/PRBlackhole.asp
[13] http://www.jpl.nasa.gov/news/news.cfm?release=2006-144
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[16] http://www.nasa.gov/home/hqnews/2006/dec/HQ_06373_Hybrid_Burst.html
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[18] http://www.jpl.nasa.gov/news/news.cfm?release=2006-150
[19] http://www.esa.int/esaCP/SEMYOPQJNVE_index_0.html
[20] http://www.cnes.fr/corot_en/
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[22] http://www.planetary.org/about/press/releases/2006/1213_Planetary_Society_Offers_50000_Prize.html
[23] http://www.esa.int/esaCP/SEMKL4QJNVE_index_0.html
[24] http://www.eso.org/outreach/press-rel/pr-2006/pr-46-06.html
[25] http://www.nasa.gov/home/hqnews/2006/dec/HQ_06361_ESMD_Lunar_Architecture.html
[26] http://www.jpl.nasa.gov/news/news.cfm?release=2006-142

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