The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Volume 35 Number 06 **June 2009**

Calendar of Events

PUBLIC OBSERVING
South Park—West
After the Band Concerts

Summer Schedule

Wednesday June 10
" June 24
" July 8

9:00—10:30 PM

President:
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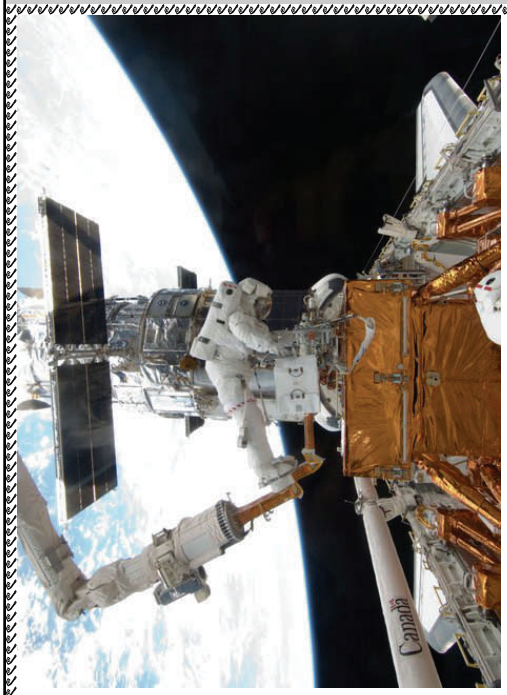

Report from the Officers:

Given the weather and sky conditions in northeastern Kansas during the month of May, we could have used a space telescope — even a small one - to see the stars. We are now operating on our usual summer schedule with public observing after the Band Concerts in South Park; the concerts have apparently survived the budget cuts. Unfortunately, the weather was so bad the evening of the first concert that even the concert was cancelled. We will try again twice during the month of June, on the 10th and 24th.

As always, if you can help, please contact Rick so we can be sure that the sessions are appropriately staffed if the weather is clear. This can be a challenge during the summer when many people head out of town on vacation. If anyone has any ideas,

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Of Local Interest : Human touch saved Hubble

Steven A. Hawley, Lawrence Journal-World, May 21, 2009

The Hubble Space Telescope has revolutionized our understanding of the universe with images unprecedented in scientific value. I was privileged to have witnessed the beginning of its mission 19 years ago, when I was entrusted with releasing Hubble from the Space Shuttle Discovery. Seven years later, I returned to the orbiting observatory as part of a mission to repair and upgrade its scientific capabilities.

Part of Hubble's fascinating story captures the challenges and rewards of maintaining and improving the observatory. This week, astronauts visited Hubble for a final servicing mission to install two new instruments and upgrade its systems, thus extending its remarkable life at least five years, while improving our ability to see the universe in ways I wouldn't have imagined in 1990.

Hubble is one of robotic exploration's most stunning achievements. But its story would have turned out differently without human space flight. Following the original launch, scientists discovered a flaw in the telescope's primary mirror — quickly mak-

(Continued on page 2)

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suggestions, or input on how we can make the club better, please contact Rick (rcjbm@sbcglobal.net). Look forward to seeing everyone at the post-Band-Concert viewing, weather-permitting, on Wed. evening, June 10.

(Continued from page 1)

ing Hubble the object of jokes on late night talk shows.

Innovative engineers developed corrective optics — eyeglasses, really — to compensate for the effects of the mirror's shape while operations teams at NASA and contractor sites developed techniques to install them. During space shuttle mission STS-61 in December 1993, billed as NASA's most important mission since Apollo 11, my colleagues installed the optical fixes, as well as new instrumentation, enabling Hubble to reach its original specifications for resolution and sensitivity.

I returned to Hubble on the second servicing mission in 1997 to install instruments expanding Hubble's wavelength sensitivity. In the 12 years since, NASA crews have performed maintenance on the telescope to continually improve its capability.

Among its most significant accomplishments, Hubble helped astronomers establish the universe's age at 13.7 billion years and provided evidence for the existence of mysterious "dark energy," which is causing the expansion of our universe to accelerate. An instrument we delivered in 1997 confirmed the presence of a black hole at the center of an active galaxy.

One of the more famous Hubble images is a 10-day exposure of what we thought was an empty region of sky near the Big Dipper. This image, known as the "Hubble Deep Field," revealed an amazing number of galaxies, some having formed when the universe was very young. Recently, Hubble has directly captured images of planets around other stars. All of these accomplishments were enabled by the servicing missions and demonstrate the tremendously productive relationship between humans and machines conducting science in space.

The successor to Hubble, the James Webb Space Telescope, is scheduled for launch in 2013. The Webb Telescope will have a mirror more than twice the size of Hubble's and will be able to look for the first galaxies that formed in the early universe. It will peer through dusty clouds to see stars forming planetary systems, connecting the Milky Way to our own solar system.

It isn't designed to be serviced. Its intended orbit 932,000 miles from Earth will likely put it out of reach of astronauts, at least in the near-term. But, perhaps heeding the lessons of Hubble, NASA has contemplated installing a device that would allow it to be captured by a robot or piloted spacecraft in the future. You never know if maintenance needs will arise!

As we look forward to the Webb Telescope launch, the Ares V cargo launch vehicle is under development as part of NASA's Constellation Program. Ares V could enable even larger, more sophisticated scientific spacecraft to travel the universe and deliver cargo for humans on the Moon. With the ability to put more than 400,000 pounds into low Earth orbit, robotic exploration will benefit as well, giving spacecraft developers more latitude in matching the design to the mission.

With this kind of lift capability the telescopes of the next generation will make Hubble look like a "Model T." Also, the capability to have astronomical facilities on the Moon offers the opportunity to conduct studies that would otherwise be impossible from Earth. Radio astronomy done on the Moon's far side would enable sensitive scientific observations in wavelength regions that are dominated by terrestrial interference. Already, NASA has commissioned studies by MIT and the Naval Research Lab to develop plans for an array of radio telescopes on the far side of the moon.

When you witness the awe-inspiring Hubble repair mission with astronauts so delicately and skillfully working to extend Hubble's life one last time, remember what this achievement represents — the unique synergy of human ingenuity and technological prowess that will serve the space program into the future.

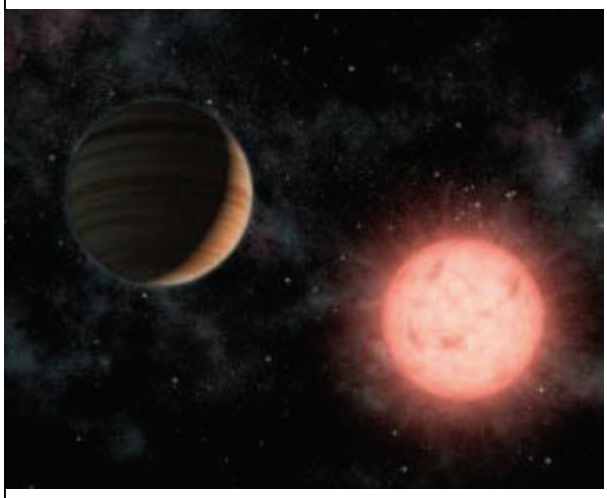
About the Astronomy Associates of Lawrence

The club is open to all people interested in sharing their love for astronomy. Monthly meetings are typically on the second Friday of each month and often feature guest speakers, presentations by club members, and a chance to exchange amateur astronomy tips. Approximately the last Sunday of each month we have an open house at the Prairie Park Nature Center. Periodic star parties are scheduled as well. For more information, please contact the club officers:our president, Rick Heschmeyer at rcjbm@sbcglobal.net, our webmaster, Gary Webber, at gwebber@ku.edu, or our faculty advisor, Prof. Bruce Twarog at btwarog@ku.edu. Because of the flexibility of the schedule due to holidays and alternate events, it is always best to check the Web site for the exact Fridays and Sundays when events are scheduled. The information about AAL can be found at

http://www.ku.edu/~aal.

Copies of the *Celestial Mechanic* can also be found on the web at
http://www.ku.edu/~aal/celestialmechanic

Planet-Hunting Method Succeeds: Jupiter-like Planet Found Orbiting One Of Smallest Stars



A long-proposed tool for hunting planets has netted its first catch -- a Jupiter-like planet orbiting one of the smallest stars known. The technique, called astrometry, was first attempted 50 years ago to search for planets outside our solar system, called exoplanets. It involves measuring the precise motions of a star on the sky as an unseen planet tugs the star back and forth. But the method requires very precise measurements over long periods of time, and until now, has failed to turn up any exoplanets.

A team of two astronomers from NASA's Jet Propulsion Laboratory, Pasadena, Calif., has, for the past 12 years, been mounting an astrometry instrument to a telescope at the Palomar Observatory near San Diego. After careful, intermittent observations of 30 stars, the team has identified a new exoplanet around one of them -- the first ever to be discovered around a star using astrometry.

"This method is optimal for finding solar-system configurations like ours that might harbor other Earths," said astronomer Steven Pravdo of JPL, lead author of a study about the results to be published in the *Astrophysical Journal*. "We found a Jupiter-like planet at around the same relative place as our Jupiter, only around a much smaller star. It's possible this star also has inner rocky planets. And since more than seven out of 10 stars are small like this one, this could mean planets are more common than we thought."

The finding confirms that astrometry could be a powerful planet-hunting technique for both ground- and space-based telescopes. For example, a similar technique would be used by SIM Lite, a NASA concept for a space-based mission that is currently being explored.

The newfound exoplanet, called VB 10b, is about 20 light-years away in the constellation Aquila. It is a gas giant, with a mass six times that of Jupiter's, and an orbit far enough away from its star to be labeled a "cold Jupiter" similar to our own. In reality, the planet's own internal heat would give it an Earth-like temperature.

The planet's star, called VB 10, is tiny. It is what's known as an M-dwarf and is only one-twelfth the mass of our sun, just barely big enough to fuse atoms at its core and shine with starlight. For years, VB 10 was the smallest star known -- now it has a new title: the smallest star known to host a planet. In fact, though the star is more massive than the newfound planet, the two bodies would have a similar girth.

Because the star is so small, its planetary system would be a miniature, scaled-down version of our own. For example, VB 10b, though considered a cold Jupiter, is located about as far from its star as Mercury is from the sun. Any rocky Earth-size planets that might happen to be in the neighborhood would lie even closer in.

"Some other exoplanets around larger M-dwarf stars are also similar to our Jupiter, making the stars fertile ground for future Earth searches," said Stuart Shaklan, Pravdo's co-author and the SIM Lite instrument scientist at JPL. "Astrometry is best suited to find cold Jupiters around all kinds of stars, and thus to find more planetary systems arranged like our home."

Two to six times a year, for the past 12 years, Pravdo and Shaklan have bolted their Stellar Planet Survey instrument onto Palomar's five-meter Hale telescope to search for planets. The instrument, which has a 16-megapixel charge-coupled device, or CCD, can detect very minute changes in the positions of stars. The VB 10b planet, for instance, causes its star to wobble a small fraction of a degree. Detecting this wobble is equivalent to measuring the width of a human hair from about three kilometers away.

Other ground-based planet-hunting techniques in wide use include radial velocity and the transit method. Like astrometry, radial velocity detects the wobble of a star, but it measures Doppler shifts in the star's light caused by motion toward and away from us. The transit method looks for dips in a star's brightness as orbiting planets pass by and block the light. NASA's space-based Kepler mission, which began searching for planets on May 12, will use the transit method to look for Earth-like worlds around stars similar to the sun.

Scoring More Energy from Less Sunlight

For spacecraft, power is everything. Without electrical power, satellites and robotic probes might as well be chunks of cold rock tumbling through space. Hundreds to millions of miles from the nearest power outlet, these spacecraft must somehow eke enough power from ambient sunlight to stay alive.

That's no problem for large satellites that can carry immense solar panels and heavy batteries. But in recent years, NASA has been developing technologies for much smaller microsatellites, which are lighter and far less expensive to launch. Often less than 10 feet across, these small spacecraft have little room to spare for solar panels or batteries, yet must still somehow power their onboard computers, scientific instruments, and navigation and communication systems. Space Technology 5 was a mission that proved, among other technologies, new concepts of power generation and storage for spacecraft.

"We tested high efficiency solar cells on ST-5 that produce almost 60 percent more power than typical solar cells. We also tested batteries that hold three times the energy of standard spacecraft batteries of the same size," says Christopher Stevens, manager of NASA's New Millennium Program. This program flight tests cutting-edge spacecraft technologies so that they can be used safely on mission-critical satellites and probes. "This more efficient power supply allows you to build a science-grade spacecraft on a miniature scale," Stevens says.

Helen Johnson, a spacecraft technician at NASA's Goddard Space Flight Center, works on one of the three tiny Space Technology 5 spacecraft in preparation for its technology validation mission.

Solar cells typically used on satellites can convert only about 18 percent of the available energy in sunlight into electrical current. ST-5 tested experimental cells that capture up to 29 percent of this solar energy. These new solar cells, developed in collaboration with the Air Force Research Laboratory in Ohio, performed flawlessly on ST-5, and they've already been swooped up and used on NASA's svelte MESSENGER probe, which will make a flyby of Mercury later this year. Like modern laptop batteries, the high-capacity batteries on ST-5 use lithium-ion technology. As a string of exploding laptop batteries in recent years shows, fire safety can be an issue with this battery type.

"The challenge was to take these batteries and put in a power management circuit that protects against internal overcharge," Stevens explains. So NASA contracted with ABSL Power Solutions to develop spacecraft batteries with design control circuits to prevent power spikes that can lead to fires. "It worked like a charm." Now that ST-5 has demonstrated the safety of this battery design, it is flying on NASA's THEMIS mission (for Time History of Events and Macroscale Interactions during Substorms) and is slated to fly aboard the Lunar Reconnaissance Orbiter and the Solar Dynamics Observatory, both of which are scheduled to launch later this year.

Thanks to ST-5, a little sunlight can go a really long way.

Find out about other advanced technologies validated in space and now being used on new missions of exploration at nmp.nasa.gov/TECHNOLOGY/scorecard. Kids can calculate out how old they would be before having to replace lithium-ion batteries in a handheld game at spaceplace.nasa.gov/en/kids/st5_bats.shtml. *This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.*

New European Telescopes to Peer into Obscure Cosmic Corners

By Andrea Thompson, Space.com

While astronomical and cosmological knowledge of the universe has grown by leaps and bounds in the past few decades, some details remain beyond the grasp of current space- and ground-based telescopes — but not for long. Two space telescopes, Herschel and Planck, are set to be launched in tandem by the European Space Agency (ESA) on May 14. They will peer deeper into space and time than any telescope in history. NASA gets most of the attention when it comes to space telescopes, with the Hubble Space Telescope leading the way (Hubble is however a joint project with ESA).

But that could soon change. The observations made by these two European observatories could revolutionize our understanding of our universe, and answer some "basic questions about our place in the universe," said Paul Goldsmith, the NASA project scientist for Herschel at the Jet Propulsion Laboratory in Pasadena, Calif., which provided some of the key technology for the telescopes. Herschel will be the largest, most powerful infrared telescope ever launched into space, and its observations in the far-infrared to sub-millimeter wavelengths of light will allow astronomers to study some of the coldest objects in space, not visible in other wavelengths.

Herschel will look for the signature of water in comets in our own solar system, as well as in the interstellar gas and dust clouds that give rise to stars and planets. When Herschel peers into those clouds, it will also be looking into the womb of star formation and should be able to see the formation of protostars for the first time. The telescope will also look back in time to get the first good glimpse at the intense star formation early in the universe's history in young galaxies that shine brightly in the infrared.

"Herschel's going to really end up rewriting the books on how stars form," Goldsmith said.

Meanwhile, Planck will be looking in the microwave part of the spectrum, mapping the fossil light of the universe, the Cosmic Microwave Background (CMB) that is the relic radiation of the Big Bang, and learning more about the universe in its infancy. Planck will be able to look at fluctuations in the CMB in more detail than ever before, which will tell astronomers more about how the large-scale structures of the universe — from galaxies to large voids — formed and evolved.

"Planck will provide the most precise data on the early Universe ever. We have never been so close to the Big Bang," said Rashid Sunyaev, director of the Max Planck Institute for Astrophysics in German, which provided some of the software for Planck. Planck will also turn its eye on two of the universe's most mysterious quantities: dark matter and dark energy.

The telescopes will be sent into space aboard an Ariane 5 ECA launcher from the Guiana Space Centre in Kourou, French Guiana. They will make their observations from the L2 Lagrangian point of the sun-Earth system — a gravitational stability point in space about 1 million miles (1.5 million kilometers) from Earth in the opposite direction of the sun — freeing the instrumentation from the interfering radiation of the sun, Earth and moon.

It will be two months before Planck and Herschel reach their final destination, and once they do, all their systems will have to be checked out before astronomers can start probing the heavens. Goldsmith estimates that the first observations will come in October. Herschel and Planck won't last forever — they are slated for 3.5-year and 15-month missions, respectively. There is some possibility of extending those missions, but ultimately the helium that cools their instruments will run out.

But even without an extension, each mission promises to enhance our understanding of the universe we live in, and right now, astronomers are "waiting eagerly for things to get going," Goldsmith said.

Fuel for US Deep Space Exploration Running Out

By SETH BORENSTEIN AP Science Writer

NASA is running out of nuclear fuel needed for its deep space exploration. The end of the Cold War's nuclear weapons buildup means that the U.S. space agency does not have enough plutonium for future faraway space probes _ except for a few missions already scheduled _ according to a new study released Thursday by the National Academy of Sciences. Deep space probes beyond Jupiter can't use solar power because they're too far from the sun. So they rely on a certain type of plutonium, plutonium-238. It powers these spacecraft with the heat of its natural decay. But plutonium-238 isn't found in nature; it's a byproduct of nuclear weaponry. The United States stopped making it about 20 years ago and NASA has been relying on the Russians. But now the Russian supply is running dry because they stopped making it, too.

The Department of Energy announced on Thursday that it will restart its program to make plutonium-238. Spokeswoman Jen Stutsman said the agency has proposed $30 million in next year's budget for preliminary design and engineering. The National Academy's study shows why it is needed, she said. "If you don't have this material, we're just not going to do" deep space missions, said Johns Hopkins University senior scientist Ralph McNutt, who has had experiments aboard several of NASA's deep space missions. So far only NASA undertakes these missions, so the shortage limits the world's look at deep space, added Doug Allen, a satellite power expert and member of the National Academy's study panel.

By law, only the Department of Energy can make the plutonium. Last year then-NASA administrator Michael Griffin wrote to then-Energy Secretary Samuel Bodman saying the agency needed more plutonium. The National Academy report says it would cost the Energy Department at least $150 million to resume making it for the 11 pounds a year that NASA needs for its space probes. Without that material "a lot of things will be shut down and they will stay shut down for a long time," McNutt said.

Upcoming NASA missions using plutonium include the overbudget and delayed Mars Science Laboratory, set to launch in 2011, and a mission to tour the solar system's outer planets scheduled for launch in 2020.The last two missions to use plutonium were the New Horizons probe headed for Pluto and the Cassini space probe that is circling Saturn. Plutonium-powered probes last a long time. The twin Voyager spacecraft headed beyond our solar system and launched in 1977 are expected to keep working until about 2020, McNutt said. Solar power is preferable to plutonium because it is cheaper and has fewer safety concerns, McNutt and Allen said. But solar power just does not work in the darkest areas of space, including deep craters of the moon. Some have protested past nuclear-powered missions, such as Cassini, worrying about potential accidents.

Sun entering weakest cycle since 1928 - NOAA releases new predictions for solar cycle

Solmaz Barazesh, Science News

The sun has entered its weakest cycle of magnetic activity since 1928, meaning fewer solar flares and coronal mass ejections, scientists predicted in a May 8 teleconference. A panel of solar scientists assembled by the National Oceanic and Atmospheric Administration's Space Weather Prediction Center reports that the cycle, which scientists believe began in December 2008, will peak in May 2013. Storms of solar magnetic activity cause flares and ejections that can spit X-rays, UV light and billions of tons of charged particles into space, and toward Earth. These outbursts can make Earth's upper atmosphere expand, potentially knocking out electrical grids and disrupting satellite communications — and can harm spacewalking astronauts.

"It's fair to say we probably won't see a whole lot of solar storms from this cycle," Douglas Biesecker of NOAA's Space Weather Prediction Center in Boulder, Colo., said at the teleconference. "But a weaker cycle won't lessen the intensity of the storms, just the number of them." Scientists use the number of sunspots, blotches of concentrated magnetic activity on the surface of the sun, as a measure of solar activity. The panel predicts the next solar cycle, cycle 24, will average 90 sunspots per day at its peak, lower than the 120 sunspots a day expected for a more typical cycle. The predictions are based on cycle 24's slow start. The new predictions update a 2007 NOAA solar cycle report. In 2007 the panel split, with some scientists forecasting a moderately strong cycle 24 and others calling for a weaker cycle. Both groups thought cycle 24 would be well underway by now, peaking in 2011.

But the transition from sun cycle 23 to 24 was not what anyone expected. Solar magnetic activity usually ebbs and flows in cycles that last about 11 years. As one cycle sinks to a minimum of activity, the next cycle begins. The panel consensus is that cycle 23 finally reached its sunspot minimum in December 2008, almost 13 years after it began, Dean Pesnell of NASA's Goddard Space Flight Center in Greenbelt, Md., said at the teleconference. The first sunspots from cycle 24 were seen in December 2008, but a recent lull in sunspots shows that cycle 24 is starting slowly. Pesnell said that in the past, when early activity has been low, the cycle has tended to have little activity overall.

"Usually, when a new sun cycle starts, it takes off pretty quickly. This one is just chugging along," comments David Hathaway of NASA's Marshall Space Flight Center in Huntsville, Ala.

Rare Radio Supernova In Nearby Galaxy Is Nearest Supernova In Five Years

Science Daily

The chance discovery last month of a rare radio supernova - an exploding star seen only at radio wavelengths and undetected by optical or X-ray telescopes - underscores the promise of new, more sensitive radio surveys to find supernovas hidden by gas and dust. "This supernova is the nearest supernova in five years, yet is completely obscured in optical, ultraviolet and X-rays due to the dense medium of the galaxy," said Geoffrey Bower, assistant professor of astronomy at the University of California, Berkeley, and coauthor of a paper describing the discovery in the June issue of the journal Astronomy & Astrophysics. "This just popped out; in the future, we want to go from discovery of radio supernovas by accident to specifically looking for them."

Sky surveys like the one just launched by the Allen Telescope Array, which will look for bright but short-lived radio bursts from supernovas, will provide better estimates of the rate of star formation in nearby galaxies, Bower said. Radio emissions from supernovas also can help astronomers understand how stars explode and what happens before their cores collapse, since radio emissions are caused when debris from the explosion collides with the stellar wind previously shed by the stars. Bower's colleagues are Andreas Bunthaler, Karl M. Menten and Christian Henkel of the Max Planck Institute for Radioastronomy in Bonn, Germany; Mark J. Reid of Harvard University's Center for Astrophysics; and Heino Falcke of the University of Nijmegen in the Netherlands.

The radio supernova was discovered on April 8 in M82, a small irregular galaxy located nearly 12 million light years from Earth in the M81 galaxy group, by the Very Large Array, a New Mexico facility operated by the National Radio Astronomy Observatory (NRAO). It was subsequently confirmed by NRAO's Very Long Baseline Array (VLBA), a 10-telescope array whose baseline stretches from Hawaii to the Virgin Islands, providing the sharpest vision of any telescope on Earth.

The Allen Telescope Array, comprising 42 of a planned 350 radio dishes and supported by UC Berkeley and the SETI Institute of Mountain View, Calif., last week began a major survey of the radio sky that should turn up many more such radio supernovas, Bower said. While the VLA and VLBA have very narrow fields of view unsuited to all-sky surveys, the ATA's wide-angle view is ideal for scanning the full sky once a day, which is necessary to find sources that brighten and dim over several days. "The ATA can detect objects at least 10 times fainter than this radio supernova, which pushes our survey an order of magnitude deeper than other radio surveys with more attention to transient and variable sources. Radio supernovas are a really strong aspect of that survey," he said. "This (new radio supernova) is the kind of discovery that we would like to make with the Allen Telescope Array."

The ATA will compile an updated catalog of radio sources much as the Sloan Digital Sky Survey updated the older Palomar Observatory Sky Survey of visible and infrared objects. At the same time, it will look for radio signals indicative of intelligent life around other stars.

Not all supernovas produce radio emissions, Bower said. If the star has not sloughed off much of its envelope before collapsing inward to form a neutron star or black hole – a classic Type II supernova – then few radio emissions are produced from gas collisions. On the other hand, supernovas in very active star-forming regions, like the center of M82, should produce copious radio emissions because of the density of gas and dust in the interstellar medium. That same gas and dust blocks optical, ultraviolet and X-rays, however, making radio surveys one of the few options to find and observe such supernovas.

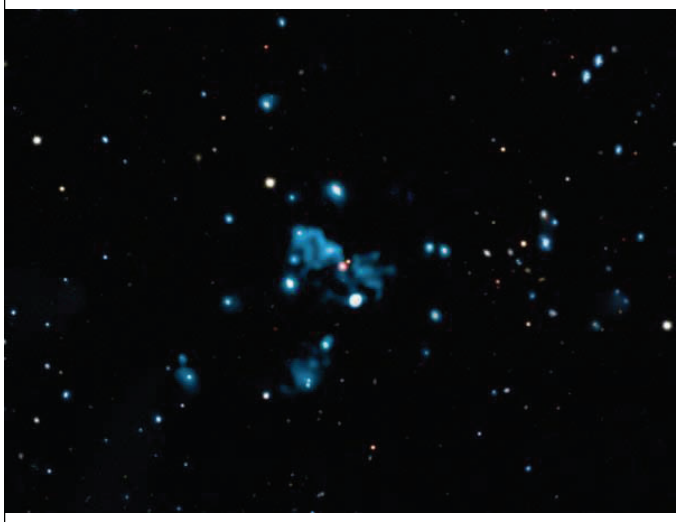
Bower and his colleagues were studying the motion of M82 with the VLBA, which links the VLA and nine other radio telescopes into a very high resolution instrument, when they noticed a very bright radio source – five times brighter than anything else in the galaxy – in the VLA data. The team looked at earlier observations and found the same source, but almost twice as bright, in data taken May 3, 2008. Data from March 24, 2008, showed an even brighter source – 10 times brighter than in April 2009 – while Oct. 29, 2007, data showed no bright radio source.

Extrapolating backward in time, the research team estimates that the star exploded sometime in January 2008, apparently near the very center of the galaxy. The team rejected alternative explanations for the dimming radio source, such as a flare created by a star falling into a supermassive black hole. The newly discovered supernova is thus the brightest in radio wavelengths in the past 20 years, Bower said, and is one of only a few dozen radio supernovas observed to date.

The team also looked at the complete data from the VLBA and detected a ring structure indicative of a shock wave plunging through the interstellar medium, bolstering its conclusion that it is a supernova. The ring is about 2,000 astronomical units across, consistent with a year-old supernova. (An astronomical unit 93 million miles, the average distance between Earth and the sun.)

Ghost Remains After Black Hole Eruption
Chandra Press Release

NASA's Chandra X-ray Observatory has found a cosmic "ghost" lurking around a distant supermassive black hole. This is the first detection of such a high-energy apparition, and scientists think it is evidence of a huge eruption produced by the black hole. This discovery presents astronomers with a valuable opportunity to observe phenomena that occurred when the Universe was very young. The X-ray ghost, so-called because a diffuse X-ray source has remained after other radiation from the outburst has died away, is in the Chandra Deep Field-North, one of the deepest X-ray images ever taken. The source, a.k.a. HDF 130, is over 10 billion light years away and existed at a time 3 billion years after the Big Bang, when galaxies and black holes were forming at a high rate.



"We'd seen this fuzzy object a few years ago, but didn't realize until now that we were seeing a ghost", said Andy Fabian of the Cambridge University in the United Kingdom. "It's not out there to haunt us, rather it's telling us something - in this case what was happening in this galaxy billions of year ago." Fabian and colleagues think the X-ray glow from HDF 130 is evidence for a powerful outburst from its central black hole in the form of jets of energetic particles traveling at almost the speed of light. When the eruption was ongoing, it produced prodigious amounts of radio and X-radiation, but after several million years, the radio signal faded from view as the electrons radiated away their energy.

However, less energetic electrons can still produce X-rays by interacting with the pervasive sea of photons remaining from the Big Bang - the cosmic background radiation. Collisions between these electrons and the background photons can impart enough energy to the photons to boost them into the X-ray energy band. This process produces an extended X-ray source that lasts for another 30 million years or so. "This ghost tells us about the black hole's eruption long after it has died," said co-author Scott Chapman, also of Cambridge University. "This means we don't have to catch the black holes in the act to witness the big impact they have."

This is the first X-ray ghost ever seen after the demise of radio-bright jets. Astronomers have observed extensive X-ray emission with a similar origin, but only from galaxies with radio emission on large scales, signifying continued eruptions. In HDF 130, only a point source is detected in radio images, coinciding with the massive elliptical galaxy seen in its optical image. This radio source indicates the presence of a growing supermassive black hole.

"This result hints that the X-ray sky should be littered with such ghosts," said co-author Caitlin Casey, also of Cambridge, "especially if black hole eruptions are as common as we think they are in the early Universe." The power contained in the black hole eruption was likely to be considerable, equivalent to about a billion supernovas. The energy is dumped into the surroundings and transports and heats the gas.

"Even after the ghost disappears, most of the energy from the black hole's eruption remains", said Fabian. "Because they're so powerful, these eruptions can have profound effects lasting for billions of years." The details of Chandra's data of HDF 130 helped secure its true nature. For example, in X-rays, HDF 130 has a cigar-like shape that extends for some 2.2 million light years. The linear shape of the X-ray source is consistent with the shape of radio jets and not with that of a galaxy cluster, which is expected to be circular. The energy distribution of the X-rays is also consistent with the interpretation of an X-ray ghost.

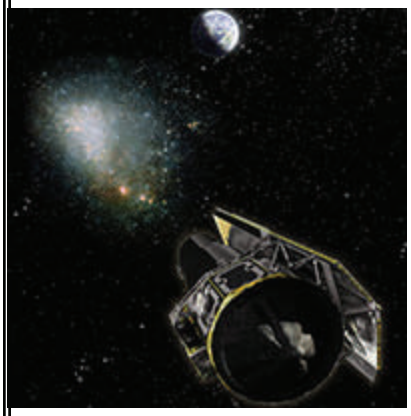
(Continued from page 9)

"Nobody had any idea Spitzer would be able to directly study exoplanets when we designed it," Werner said. "When astronomers planned the first observations, we had no idea if they would work. To our amazement and delight, they did."

These are a few of Spitzer's achievements during the past five and a half years. Data from the telescope are cited in more than 1,500 scientific papers. And scientists and engineers expect the rewards to keep on coming during Spitzer's golden years.

Some of Spitzer's new pursuits include refining estimates of Hubble's constant, or the rate at which our universe is stretching apart; searching for galaxies at the edge of the universe; assessing how often potentially hazardous asteroids might impact Earth by measuring the sizes of asteroids; and characterizing the atmospheres of gas-giant planets expected to be discovered soon by NASA's Kepler mission. As was true during the cold Spitzer mission, these and the other programs are selected through a competition in which scientists from around the world are invited to participate.

NASA's Spitzer Telescope Warms up to New Career



The primary mission of NASA's Spitzer Space Telescope is about to end after more than five and a half years of probing the cosmos with its keen infrared eye. Within about a week of May 12, the telescope is expected to run out of the liquid helium needed to chill some of its instruments to operating temperatures.

The end of the coolant will begin a new era for Spitzer. The telescope will start its "warm" mission with two channels of one instrument still working at full capacity. Some of the science explored by a warm Spitzer will be the same, and some will be entirely new.

"We like to think of Spitzer as being reborn," said Robert Wilson, Spitzer project manager at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "Spitzer led an amazing life, performing above and beyond its call of duty. Its primary mission might be over, but it will tackle new scientific pursuits, and more breakthroughs are sure to come."

Spitzer is the last of NASA's Great Observatories, a suite of telescopes designed to see the visible and invisible colors of the universe. The suite also includes NASA's Hubble and Chandra space telescopes. Spitzer has explored, with unprecedented sensitivity, the infrared side of the cosmos, where dark, dusty and distant objects hide.

For a telescope to detect infrared light — essentially heat — from cool cosmic objects, it must have very little heat of its own. During the past five years, liquid helium has run through Spitzer's "veins," keeping its three instruments chilled to -456 degrees Fahrenheit (-271 Celsius), or less than 3 degrees above absolute zero, the coldest temperature theoretically attainable. The cryogen was projected to last as little as two and a half years, but Spitzer's efficient design and careful operations enabled it to last more than five and a half years.

Spitzer's new "warm" temperature is still quite chilly at -404 degrees Fahrenheit (-242 Celsius) — much colder than a winter day in Antarctica when temperatures sometimes reach -75 degrees Fahrenheit (-59 Celsius). This temperature rise means two of Spitzer's instruments — its longer wavelength multiband imaging photometer and its infrared spectrograph — will no longer be cold enough to detect cool objects in space.

However, the telescope's two shortest-wavelength detectors in its infrared array camera will continue to function perfectly. They will still pick up the glow from a range of objects: asteroids in our solar system, dusty stars, planet-forming disks, gas-giant planets and distant galaxies. In addition, Spitzer still will be able to see through the dust that permeates our galaxy and blocks visible-light views.

"We will do exciting and important science with these two infrared channels," said Spitzer Project Scientist Michael Werner of JPL. Werner has been working on Spitzer for more than 30 years. "Our new science program takes advantage of what these channels do best. We're focusing on aspects of the cosmos that we still have much to learn about."

Since its launch from Cape Canaveral, Fla., on Aug. 25, 2003, Spitzer has made countless breakthroughs in astronomy. Observations of comets both near and far have established that the stuff of comets and planets is similar throughout the galaxy. Breathtaking photos of dusty stellar nests have led to new insights into how stars are born. And Spitzer's eye on the very distant universe, billions of light-years away, has revealed hundreds of massive black holes lurking in the dark.

Perhaps the most revolutionary and surprising Spitzer finds involve planets around other stars, called exoplanets. Exoplanets are, in almost all cases, too close to their parent stars to be seen from our Earthly point of view. Nevertheless, planet hunters continue to uncover them by looking for changes in the parent stars. Before Spitzer, everything we knew about exoplanets came from indirect observations such as these.

In 2005, Spitzer detected the first light, or photons, from an exoplanet. In a clever technique, now referred to as the secondary-eclipse method, Spitzer was able to collect the light of a hot, gaseous exoplanet and learn about its temperature. Further detailed spectroscopic studies later revealed more about the atmospheres, or "weather," on similar planets. More recently, Spitzer witnessed changes in the weather on a wildly eccentric gas exoplanet — a storm of colossal proportions brewing up in a matter of hours before quickly settling down.

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