The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Volume 33 Number 04 April 2007

Calendar of Events

KU STADIUM OBSERVING
Sunday, April 29, 2007
9:00 — 10:30PM

Spring Meeting Schedule
SPECIAL EVENT
SATURDAY APRIL 14
Royall Hall , UMKC
7:30 PM
Dr. Alan Hirshfeld
The Electric Life of Michael Faraday

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Observing Clubs

INSIDE THIS ISSUE

Report from the Officers on the March Meeting:

While there wasn't a meeting last month, it was by no means uneventful. There was a well-attended public education night for the Junior Girl Scouts at the Douglas County Fairgrounds. The event, run by Rick Heschmeyer with support from Dave Kolb, Luis Vargas, and William Winkler, allowed 41 Junior Girl Scouts to earn their Sky Search Badge, while braving a Friday evening with a 19^{o} wind chill temperature. It initially looked like the clouds would ruin the evening, but they parted long enough to allow the scouts to complete

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Of Local Interest

Based on a news release issued by American Geophysical Union.

Solar Blast From The Past Dwarfed Modern Ozone Destruction

A burst of protons from the Sun in 1859 destroyed several times more ozone in Earth's atmosphere than did a 1989 solar flare that was the strongest ever monitored by satellite, a new analysis finds.

When energetic protons from the Sun penetrate Earth's stratosphere, they ionize and dissociate nitrogen and oxygen molecules, which then form ozone-depleting nitrogen oxides.

Thomas et al. developed a scale factor between known nitrate enhancements from recent solar proton events. By using data on nitrate enhancements in Greenland ice cores following the September 1859 burst, they used the scale factor to determine that the total energy released by that solar proton event was 6.5 times larger than the amount released in the 1989 event. Models using this energy total showed that 3.5 times more ozone was destroyed in the 1859 episode than in that of 1989.

Because ozone regulates the amount of harmful ultraviolet radiation reaching Earth, the authors emphasized that understanding intense solar proton events will be important to predicting potential damage to the biosphere.

B. C. Thomas: Department of Physics and Astronomy, Washburn University, Topeka, Kansas, U.S.A.; C. H. Jackman: Laboratory for Atmospheres, NASA Goddard Space Flight Center, Greenbelt, Maryland, U.S.A**.; A. L. Melott: Department of Physics and Astronomy, University of Kansas**, Lawrence, Kansas, U.S.A.

Geophysical Research Letters (GRL) paper 10.1029/2006GL029174, 2007

From the Officers, continued

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the entire planned session in one night, albeit in abbreviated fashion. The feedback Rick received from the Girl Scout Program Coordinator, who was present at the event, was very positive. In fact, she expressed interest in the club hosting another event for the Girl Scouts at a future date. Again, many thanks to those of you who help keep this activity and interest alive among the general public.

Hope you had a chance to attend the entertaining presentation by Nobel Laureate in Physics, **Sheldon Glashow**, at the Spencer Museum of Art. Dr. Glashow avoided the specifics of his research interests, the theory of quantum mechanics, and concentrated more on the rational process and its application to progress in science, highlighting his discussion with appropriate examples throughout the history of science. The consensus opinion among those in attendance gave the speaker high marks for clarity and enthusiasm.

Continuing our unusual schedule for the Spring, as we have done in past years, the meeting in April on campus will be cancelled because of the timing conflict with the **MidAmerican Regional Astrophysics Conference in Kansas City, set now for Fri/Sat April 13/14.** However, as the MARAC meeting has done in recent years, there will be a public lecture associated with the meeting at **UMKC**, this time on **SATURDAY, APRIL 14 at 7:30 PM**. The speaker is **Dr. Alan Hirshfeld**, author of the book "Parallax: The Race to Measure the Cosmos" , who will be speaking about his recently released and very well reviewed book "The Electric Life of Michael Faraday". Dr. Hirshfeld will be available to sign copies of his book after the talk and, again, AAL members are encouraged to attend the talk. If you can't attend the talk but would still like an autographed copy of the book, please contact Bruce Twarog via email at btwarog@ku.edu. He will set aside a signed copy for you; the book is being sold at the reduced price of $17 to club members. We will return to our campus meeting schedule on **Friday May 11** at **7:30 PM** in **1001 Malott** and will finally have our long-awaited talk by **Dave Kolb** of Kansas City Kansas Community College. Dave has been a regular contributor to the club through his efforts at open houses and other observing events and is one of the most respected amateur observers in the region, doing some amazing things with photography, ccds, and video cameras. We will also revisit the eclipse trip to Libya with William Winkler, who has transformed some of his pictures from the trip into a usable format for viewing this time.

Our third observing session of the year hasn't occurred yet at the time of this printing, but it's not looking good. Our next scheduled public observing session is set for **Sunday April 29**. The time period for the observing is from 9:00—10:30 PM. If this changes and/or we have an update on the schedule for the remainder of the semester, we will inform you via the newsletter, at minimum, via email, and through the web site. If you are unsure and would like to come by, weather permitting, please check the web site or call the observatory number (864-3166), as usual for a recorded message. Hopefully, we will have clearer skies next month, though the nights are getting awfully short..

COMING EVENTS: **In the Region**: The **Mid-States Regional Astronomical League (MSRAL) Convention 2007** will be held in Omaha, NE on June 8 and 9, 2007, at the Westside Community Conference Center. For details and info, check out their web site at www.omahaastro.com/msral2007. The Heart of America Star Party, run by the Astronomical Society of KC, is scheduled for June 12-17. Detailed info on the event can be found at www.hoasp.org or by contacting Dan Johnson at gdj102356@hotmail.com. Brochures are also available for the Nebraska Star Party, scheduled for July 15-20, 2007 near Valentine, NE. The web site for this event is www.NebraskaStarParty.com.

If you have any suggestions for talks, speakers, or public events, please feel free to contact us, particularly Rick Heschmeyer (rcjbm@sbcglobal.net), the events coordinator for the club. Hope to see you at one of the events over the next two months. ALL for now.

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 on Memorial Stadium. Periodic star parties are scheduled as well. For more information, please contact the club officers:Luis Vargas at lcvargas@ku.edu, Gary Webber at gwebber@ku.edu, our faculty advisor, Prof. Bruce Twarog at btwarog@ku.edu. our events coordinator, Rick Heschmeyer at rcjbm@sbcglobal.net. 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**

Hubble Pans Across Heavens To Harvest 50,000 Evolving Galaxies

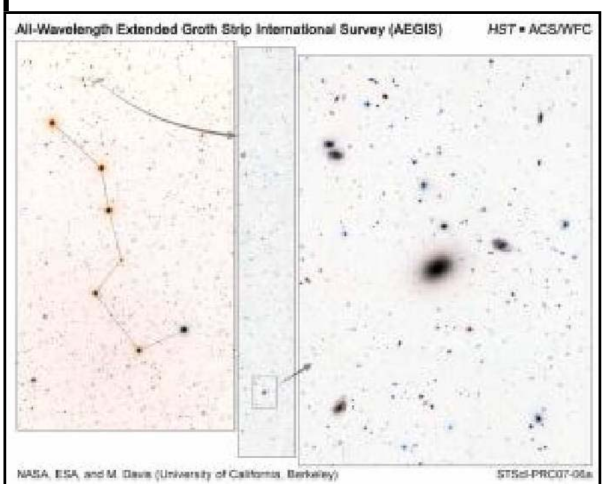
HST PRESS RELEASE

Several hundred images taken with NASA's Hubble Space Telescope have been woven together into a rich tapestry of at least 50,000 galaxies. The Hubble view is yielding new clues about the universe's youth, from its "pre-teen" years to young adulthood. The Hubble panorama does not appear evenly spread out. Some galaxies seem to be grouped together. Others are scattered through space. This uneven distribution of galaxies traces the concentration of dark matter, an invisible web-like structure stretching throughout space. Galaxies form in areas rich in dark matter.

Among the discoveries so far in this galactic tapestry are a giant red galaxy with two black holes at its core; several new gravitational lenses -- galaxies whose gravity bends the light from background galaxies into multiple images; and a rogues' gallery of weird galaxies that should keep astronomers busy for a long time trying to explain them. Hubble's wide view -- achieved by weaving together many separate exposures into a mosaic -- still only covers a comparatively small slice of sky. The entire width of the image, in angular size, is no bigger on the sky than the apparent width of your finger held at arm's length. To astronomers, however, this seemingly small area is a big piece of celestial real estate.

To cover even this much of the sky, Hubble's Advanced Camera for Surveys snapped more than 500 separate exposures, at 63 different pointings, spread out over the course of one year. The final mosaic is 21 images long by 3 images tall. (The dimensions in degrees are about 1.1 by 0.15 degrees. For comparison, the Moon is about 0.5 degrees in angular size).

"These images reveal a wealth of galaxies at many stages of their evolution through cosmic time," said astronomer Anton Koekemoer of the Space Telescope Science Institute in Baltimore, Md., who combined all the Hubble observations to create the final panoramic image, which contains over 3 billion pixels. The Hubble observation is part of a larger project to study galaxies in a moderately small area of sky, which provides a representative sample of the universe. The study, called the All-wavelength Extended Groth Strip International Survey (AEGIS), utilized four orbiting telescopes and four ground-based telescopes. The five-year project involved the cooperation of more than 50 researchers from around the world observing the same small region of sky in the radio, infrared, visible, ultraviolet, and X-ray regions of the electromagnetic spectrum.



The image at left, taken by A. Fujii with a backyard telescope, shows the location of the Hubble observations near the Big Dipper. The long, narrow image in the center is Hubble's panoramic view of the area, made by assembling 500 photographs taken over a one-year period (June 2004 to March 2005) with the Advanced Camera for Surveys. The 50,000 galaxies spied in the image are scattered across a region that is equivalent to the apparent diameter of two full Moons. The dimensions of the final mosaic are 21 images long by 3 images tall. The image at right is a section of the panoramic photo. A wide diversity of galaxies can be seen throughout both Hubble images. (Credit: NASA, ESA, M. Davis (University of California, Berkeley), S. Faber (University of California, Santa Cruz), and A. Koekemoer (STScI))

The Extended Groth Strip is named for Princeton University physicist Edward Groth. The project is jointly led by Sandra Faber, professor of physics and astronomy at the University of California at Santa Cruz, and Marc Davis, professor of astronomy at the University of California at Berkeley. "The goal was to study the universe as it was when it was about half as old as it is at present, or about 8 billion years ago, a time when youthful galaxies undergoing active formation were becoming quieter mature adults," said Davis.

The Hubble telescope images reveal a time when galaxies were starting to reach their mature shapes, looking like the nearby galaxies we see today. A wide diversity of galaxies can be seen throughout the images. Some are beautiful spirals or massive elliptical galaxies like those seen in the nearby universe, but others look like random assemblages of material, the leftovers from violent mergers of young galaxies. These resemble some of the most distant, youngest galaxies observed, AEGIS team members said.

Hubble may have spied tens of thousands of galaxies -- many of them odd and chaotic -- but other telescopes ob-

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NASA's Space Place

Early Bird Gets the Worm
or "Black Hole Breakfast"
by Dr. Tony Phillips

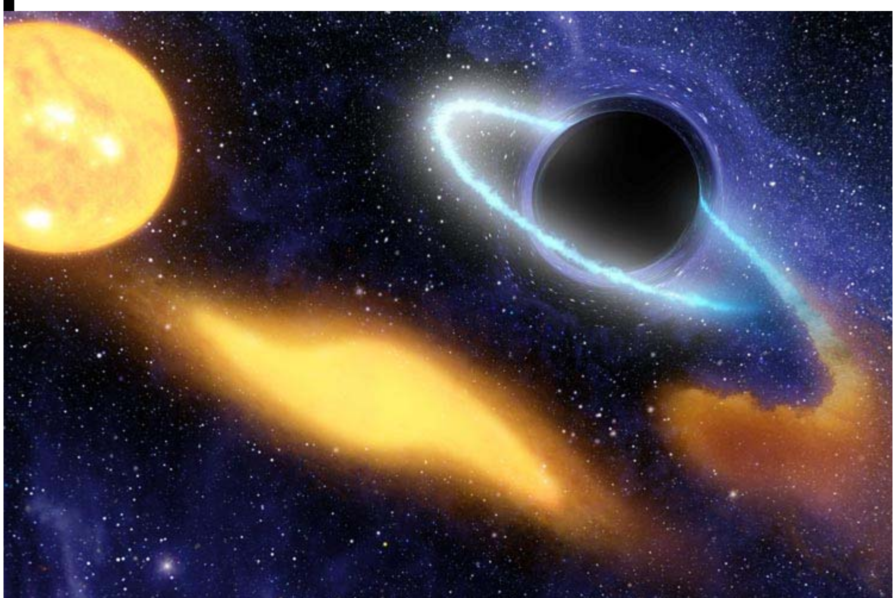
We all know that birds eat worms. Every day, millions of birds eat millions of worms. It's going on all around you! But how often have you awakened in the morning, stalked out in the dewy grass, and actually seen a bird having breakfast? Even though we know it happens all the time, a bird gulping a worm is a rare sight.

Just like a black hole gulping a star…

Every day in the Universe, millions of stars fall into millions of black holes. And that's bad news for the stars. Black holes exert terrible tides, and stars that come too close are literally ripped apart as they fall into the gullet of the monster. A long burp of X-rays and ultraviolet radiation signals the meal for all to see. Yet astronomers rarely catch a black hole in the act. "It's like the problem of the bird and the worm," says astronomer Christopher Martin of Caltech. "You have to be in the right place at the right time, looking in the right direction *and* paying attention."

A great place to look is deep in the cores of galaxies. Most galaxies have massive black holes sitting in their pinwheel centers, with dense swarms of stars all around. An occasional meal is inevitable.

A group of astronomers led by Suvi Gezari of Caltech recently surveyed more than 10,000 galactic cores—and they caught one! In a distant, unnamed elliptical galaxy, a star fell into a central black hole and "burped" a blast of ultraviolet radiation.



In this artist's concept, a giant black hole is caught devouring a star that ventured too close.

"We detected the blast using the Galaxy Evolution Explorer (GALEX), an ultraviolet space telescope," explains Gezari. Her team reported the observation in the December 2006 issue of *The Astrophysical Journal Letters*. "Other telescopes have seen black holes devouring stars before," she adds, "but this is the first time we have been able to watch the process from beginning to end."

The meal began about two years ago. After the initial blast, radiation diminished as the black hole slowly consumed the star. GALEX has monitored the process throughout. Additional data from the Chandra X-ray Observatory, the Canada-France-Hawaii Telescope and the Keck Telescope in Hawaii helped Gezari's team chronicle the event in multiple wavelengths. Studying the process in its entirety "helps us understand how black holes feed and grow in their host galaxies," notes Martin.

One down, millions to go.

"Now that we know we can observe these events with ultraviolet light," says Gezari, "we've got a new tool for finding more."

For more on this and other findings of GALEX, see www.galex.caltech.edu. For help explaining black holes to kids, visit The Space Place at spaceplace.nasa.gov. This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Discovery Telescope Funding Complete

The Arizona Daily Sun By J. Ferguson, The Arizona Daily Sun, Flagstaff

The final piece of the financial puzzle is now in place for a $37 million telescope being built by Lowell Observatory. The founder of the Discovery Channel has stepped up his commitment to the Discovery Channel Telescope by infusing the project with millions more of his own money. Lowell Observatory announced Monday March 19 that John Hendricks, the founder and chairman of Discovery Communications, along his wife Maureen, donated an additional $5 million to help build the telescope. The couple had previously donated $1 million for construction of the telescope, which being built in Happy Jack, roughly 40 miles southeast of Flagstaff. The $37 million telescope features a 14-foot primary mirror. When it's completed, the telescope is expected to be one of the most effective asteroid trackers in the world.

"We are grateful that we are in a position to assist Lowell Observatory in advancing basic research in the enormously important field of astronomy," Hendricks said in a prepared statement. Hendricks has been a member of the Lowell Observatory's advisory board for more than a decade.

Funding for the telescope has come from: Discovery Channel, $10 million; Hendricks family, $6 million; and private donors, $3 million. Lowell Observatory is responsible for the estimated $18 million in construction costs. Lowell Observatory officials have stated in the past they hoped to find a large university willing to invest in the telescope. Lowell Trustee William Lowell Putnam said that is no longer necessary. Putnam said the Lowell is still open to the possibility of an additional partner in the project, but it is no longer essential for completion of the telescope by late 2010.

Bob Millis, the director of Lowell Observatory, said the non-profit's current endowment is worth $38.5 million. Millis said after the first phase of the project is completed in 2010, Lowell will begin to install additional instruments over time. The first phase of the project will use specific arrangement of the telescope's primary mirror and secondary mirrors, called a Ritchey-Chretien configuration.

The second phase is planned after the telescope is fully operational and would add a state-of-the-art prime focus camera to the telescope. With the addition of a $10 million camera, the telescope is expected to be one of the most effective asteroid trackers in the world. When fully operational in 2010, the new telescope will be the fifth largest in the continental U.S. Facilities and infrastructure for the telescope are nearing completion at the telescope's site near Happy Jack, on the Coconino National Forest. The telescope's 14-foot diameter primary mirror was fabricated by Corning Inc. in Canton, N.Y., and is being figured and polished to its precise final shape by the College of Optical Sciences at the University of Arizona.

A study by the Center for Business Outreach at Northern Arizona University suggests the Discovery Channel Telescope will infuse $576 million in the state economy during its 50-year expected useful lifetime. Putnam said in recognition of Hendrick's donation, the existing Planetary Research Center at Lowell Observatory will be renamed the Hendricks Center for Planetary Studies.

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serving at wavelengths other than the visible over wider areas have pinpointed more extreme and exotic objects, including supermassive black holes and energetic starburst galaxies. In a summary paper now posted online in the Astrophysical Journal Letters, Davis and his colleagues note that AEGIS is providing a unique combination of deep, intensive observations over a comparatively wide area, yielding large samples even of rare types of galaxies. They contrast their work with the Sloan Digital Sky Survey, which has observed the local universe in great detail, but focuses on only the last 2 billion years of cosmic evolution. "As of this time, there is no other region this large on the sky that has been looked at so deeply in so many different wavelengths," Faber said.

A total of 19 papers based on the Groth Strip survey will appear in a special issue of ApJ Letters.

AEGIS provides many windows on this time of transition. Ultraviolet and long-wavelength infrared light from newly born stars, observed by the GALaxy Evolution eXplorer (GALEX) and the Spitzer Space Telescope, respectively, shows that stars were being formed at a much higher rate than today. Shorter-wavelength infrared light measures the total mass of the stars in each galaxy, allowing astronomers to see how galaxies grow larger over time, while X-ray and radio observations by the Chandra X-ray Observatory and the Very Large Array in New Mexico, respectively, can reveal the presence of powerful black holes at galaxies' centers.

Wealth Of New Results From AKARI Infrared Sky-surveyor

Fantastic new images and clues about stars at different stages of their evolution, and interstellar material hosting black holes, are just a few of the latest results obtained by AKARI, the newest infrared sky-surveyor mission on the scene.Since its launch in February 2006 AKARI, a Japan Aerospace Exploration Agency (JAXA) mission with ESA participation, has been working flawlessly and has already produced outstanding views of the infrared Universe. New results, to be presented this week at the annual meeting of the National Astronomical Society of Japan, provide unprecedented glimpses of regions of intense star formation, views of stars at the very end of their life, supernova remnants never detected before in the infrared, distant galaxies and active galactic nuclei harboring black holes surrounded by clouds of molecular gas.

When it concerns studying the formation and evolution of stars, and in more general, the evolution of galaxies in the Universe, infrared satellites like AKARI have a clear advantage. The matter ejected into interstellar space from old stars is warmed up by the stellar radiation from younger stars and by collisions with the material already present in interstellar space, and re-emits this energy at infrared wavelengths. Since young stars are formed in high-density regions, where the interstellar gas and dust is thickest, the surrounding material veils the light from the star making observations with normal visible light extremely difficult and sometimes impossible. The absorbed light from the central shrouded star is also re-emitted at infrared wavelength. This is also the case for distant galaxies, especially newly born ones, which (like the young stars they contain) are thought to be covered by thick interstellar material. So, infrared observations play a truly crucial role for our understanding of such ‘dusty’ targets, invisible or barely visible when observed at other wavelengths.

From stellar nurseries to dying stars

The first set of AKARI results presented in this article focuses on the evolution of interstellar material in galaxies, including the cycle of star formation, supernova remnants – the residual remaining from massive stars which end their life through a catastrophic explosion - and mass-loss from red-giant stars.

New stars are born in the densest regions of interstellar clouds of gas and dust, and among the many complicated triggers for star-formation, compression of interstellar clouds by supernova explosion shocks and the strong radiation emitted from high-mass stars are especially important. Stars born in such clouds will live out their lives and also eventually evolve into supernovae or red-giants, thus providing the material for the next generation star formation and so on. AKARI's Near- and Mid-Infrared camera (IRC) and the Far-Infrared surveyor (FIS) instruments observed this continuing cycle of star formation over three generations of stars (see image) – from the 'grandparent' stars to their 'children's children' in the nebula IC4954/4955, located in the constellation Vulpecula (about 6500 light years away from us). For the first time ever, AKARI provided coverage of this stellar nursery at seven different infrared wavelengths, each wavelength providing information about a different facet of the star formation process. The spatial scale covered by this study was huge, up to one hundred light years in size.

AKARI's IRC instrument also made the first ever infrared detection of a supernova remnant (known as Bo404-72.3) in the Small Magellanic Cloud, a small neighboring galaxy to our Milky Way situated around 200 000 light years from us. This data provided key glimpses into the still poorly understood interaction between the expanding gas from supernova explosions and the surrounding interstellar material, and about its possible role in the birth of new stars.

Stars at a later stage of their life have also been observed by AKARI's IRC instrument in the globular cluster NGC 104, situated in our Galaxy about 15 000 light years away from us. The stars that populate this cluster – thought to have formed around the time of the creation of our Galaxy itself - are similar to what our Sun will become in about 6 thousand million years from now. They have in fact extinguished their stock of fuel (hydrogen at their core) and evolved into red-giant stars. Through its observations, AKARI provided the first ever evidence for high-rate mass loss from the young red-giants in this cluster, a phenomenon thus far only observed in older red-giants.

From giant black-hole candidates to new-born galaxies

Thanks to its fine detail probing power, AKARI also studied the material surrounding a black hole in a distant galaxy, and has observed the evolution of newly born galaxies. The central part of the ultra-luminous infrared galaxy 'UGC 05101', located in the constellation Ursa Major at about 550 million light years away from the Earth, has been a true mystery until now. Covered by a thick cloud of interstellar material, the core region and the mechanisms at work within it were impenetrable to observation so far.

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Thanks to AKARI's high sensitivity, astronomers have now gathered unprecedented data about the molecular gas cloud surrounding the region, found to be over 500°C in temperature. Such measurements reinforce the idea that a giant black hole lurks at the core of this galaxy, emitting radiation that heats the surrounding gas to the temperature observed by AKARI, providing vital clues into the understanding of the structure of galaxies harboring active galactic nuclei and black holes.

Last but not least, AKARI's s data has provided an unprecedented view of galaxy formation throughout the history of the Universe. By making observations at specific (15-micron) wavelength, astronomers can observe infrared light which was actually emitted from the galaxy about 6 thousand million years ago by young galaxies undergoing intense star formation. Following on from the studies initiated by ESA's Infrared Space Observatory (ISO), AKARI detected 280 galaxies of this kind, performing the deepest ever wide-area survey of the Universe at this wavelength and confirming the intense star and galaxy formation in that early period of our cosmic history. AKARI is also performing similar studies over a wide range of wavelengths – a study that will provide a definitive description of the galaxy evolution over the entire lifetime of our Universe.

AKARI was launched on 21 February 2006. It began its all-sky survey observations in May 2006 and completed its first coverage of the sky in November 2006. About 80 percent of the entire sky has so far been imaged by AKARI. The mission is currently in a phase dedicated to pointed observations, interleaved with gap-filling observations for the all-sky survey. Most of the results presented in this release are from pointed observations. It is expected that the mission liquid Helium cryogen will last until at least September 2007.

(Continued from page 9)
These new imaging techniques provide an improved view of not only the astronomical sky, but the Earth's ionosphere as well. The full LWA will generate richly detailed measurements of the ionosphere that will complement other ionospheric data sources. Understanding the ionosphere is critically important to the Department of Defense because of its effects on communications and navigation systems.

The current prototype, referred to as the Long Wavelength Demonstrator Array (LWDA) to differentiate it from the larger LWA project, completed installation on the Plains of San Agustin in southwestern New Mexico in the fall of 2006. Funded by NRL and built by the Applied Research Laboratories of the University of Texas, Austin (ARL:UT), the telescope consists of 16 antennas connected to a suite of electronics that combine the signals from each antenna. Each antenna is only 4 feet tall and acts much like an old style television antenna, receiving radio waves from many different directions simultaneously. When combined, the data from the individual antennas is comparable to that from a more traditional dish style telescope with a diameter of 70 feet.

The antenna design, which resembles a household ceiling fan, with blades that have drooped down at an angle of 45 degrees, was conceived to allow the array to see the full sky and cover a wide range of frequencies with a single antenna "The sophisticated digital electronics used in the LWDA allow it to change observing frequency or point in a new direction in an instant, and even allow it to look in two directions at the same time," says Dr. Paul Ray, an astrophysicist at NRL who is overseeing the overall performance of the LWDA.

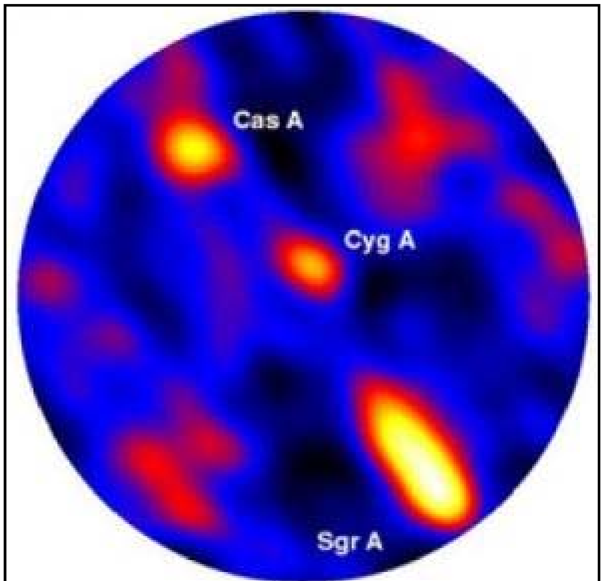
When completed, the LWA will operate in a similar manner, but on a much grander scale. Plans call for over 13,000 individual antennas, divided into 50 stations. These stations will be spread over a 250-mile area across New Mexico, and possibly beyond. Dr. Ray explains, "With so many antennas required for the final LWA, it is vital that we have a testbed on which we can demonstrate the performance of a small number of them before construction of the full LWA begins in earnest." NRL's LWDA serves this purpose, allowing the astronomers and engineers to test the dipole antennas and related computer hardware and software on a small scale, before embarking on construction.

The LWA, funding for which is managed by the Office of Naval Research, is a project of the Southwest Consortium, led by the University of New Mexico, and including NRL, ARL:UT, and Los Alamos National Laboratory, with important contributions from Virginia Tech and cooperation from the National Radio Astronomy Observatory (NRAO). The NRAO is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.

Prototype For Long Wavelength Array Sees First Light

Based upon a press release of the Naval Research Lab

Astronomers at the Naval Research Laboratory (NRL) have produced the first images of the sky from a prototype of the Long Wavelength Array (LWA), a revolutionary new radio telescope to be constructed in southwestern New Mexico. The images show emissions from the center of our Galaxy, a supermassive black hole, and the remnant of a star that exploded in a supernova over 300 years ago. Not only a milestone in the development of the LWA, the images are also a first glimpse through a new window on the cosmos. "First light" is an astronomical term for the first image produced with a telescope. It is a key milestone for any telescope because it indicates that all of the individual components are working in unison as planned.



Commissioning observations made this past fall by the LWDA show its all sky imaging capability. In this frame from the LWDA first light movie, emission from the bright sources Sagittarius A at the center of our galaxy, Cassiopeia A, and the black-hole powered radio galaxy, Cygnus A, are all clearly visible. Cassiopeia A, the strongest discrete radio source visible in the sky, is a remnant of a massive star that exploded in a supernova over 300 years ago. (Credit: Tracy Clarke, Interferometrics, Inc.)

Once completed, the LWA will provide an entirely novel view of the sky, in the radio frequency range of 20--80 MHz, currently one of the most poorly explored regions of the electromagnetic spectrum in astronomy. The LWA will be able to make sensitive high-resolution images, and scan the sky rapidly for new and transient sources of radio waves, which might represent the explosion of distant, massive stars, the emissions from planets outside of our own solar system or even previously unknown objects or phenomena.

"The LWA will allow us to make the sharpest images ever possible using very long wavelength radio waves. This newly opened window on the universe will help us understand the acceleration of relativistic particles in a variety of extreme astrophysical environments including from the most distant supermassive black holes. But perhaps most exciting is the promise of new source classes waiting to be discovered," says Dr. Namir Kassim, an NRL astronomer in the Remote Sensing Division and LWA Project Scientist. Dr. Tracy Clarke, of Interferometrics, Inc. in Herndon, Virginia, another astronomer on the NRL team adds, "By detecting distant clusters of galaxies the LWA may also provide new insights on the cosmological evolution of the mysterious dark matter and dark energy."

Although radio astronomy was discovered at low frequencies (near 20 MHz, corresponding to wavelengths of 15 meters), well below the current FM band, astronomers quickly moved up to higher frequencies (centimeter wavelengths) in search of higher resolution and to escape the corrupting effects of the Earth's ionosphere, a region of charged particles between about 50 and 600 miles above the surface.

The ionosphere, which can "bend" radio waves to produce long-distance reception of AM and shortwave radio signals, also causes distortions in radio telescope images in much the same way that atmospheric irregularities cause twinkling of stars. Ionospheric effects become much worse at low frequencies, but new imaging techniques developed at NRL and elsewhere have allowed the "ionospheric barrier" to be broken and enabled high-resolution astronomical imaging at these low frequencies for the first time.

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