PRIME FOCUS

Astronomy Department Newsletter • Adler Planetarium & Astronomy Museum • No. 6, 2007.9

Department Report

INTRODUCTION

The year 2007 has been extraordinarily fruitful for the Astronomy Department. Highlights in the following report include the 43rd annual Astro-Science Workshop, the very well received "Astronomy Conversations", a vigorous internship program, and new visualization work, just to name a few. In addition we have continued to work on projects ranging from the Night and Day podcasts to special observing events and working with media partners.

Of particular note, the department has significantly grown its research capacities with the award of a major grant to support the Adler's VERITAS group (featured in this edition's *Images of Astronomy* section). This, along with continuing grant support for our other research projects, puts our research activities on a very firm foundation.

The bright and beautiful "grand design" spiral galaxy in Ursa Major, M81, is about 12.0 million light years away. This galaxy probably resembles what are our Milky Way would looks like from such a great distance. Imaged from the Doane Observatory by Larry Ciupik.

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Interview

MARK SUBBARAO, ADLER ASTRONOMER

Dr. Mark SubbaRao has been a member of the Adler Astronomy Department for almost five years. Dr. SubbaRao is currently the Director of Visualization with Adler's new Space Visualization Lab (SVL). In this role he directly manages all the specific visualization projects on which SVL works and, jointly with the SVL Director, identifies the direction the SVL will take in future projects. Dr. SubbaRao also has an appointment with the University of Chicago where he is a Research Scientist working on the Sloan Digital Sky Survey (SDSS). His research interests are broad, but generally focus on Cosmology and the analysis of large data-sets such as that being generated by the SDSS.

PF: How did you become interested in space?

MS: I have been interested in science for as long as I can remember, but I think that it was really reading books, both popular science accounts and science fiction novels from people like Arthur C. Clarke and Isaac Asimov, that really got me thinking that astrophysics was the way to go. Museum visits also stimulated my interest in science. I grew up in New Jersey and have fond memories of taking the train into Manhattan to visit the American Museum of Natural History.

PF: What specific research do you do?

MS: I work on the Sloan Digital Sky Survey, a large project to map the Universe. The survey is an eight year project to take high quality digital images of one quarter of the sky of the sky, and take spectra of one million galaxies. My role in the project is to write the software that analyzes an object's spectrum in order to classify it and measure its distance. I'm interested in better understanding the patterns in the large-scale distributions of galaxies and using this large map to discover rare and interesting objects like supernovae. I began my research career trying to understand a puzzling observation that seemed to show periodic structures in the distribution of galaxies – regularly spaced superclusters some 400 million light years apart! At the time there was a large argument about whether this

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Interview: Mark SubbaRao, Adler Astronomer

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observation was a hint of a fundamental scale in the Universe, or just an odd coincidence. By surveying a much larger volume of space the SDSS was able to answer that question. It turns out that the answer is both: there is a fundamental scale due to sound waves in the early Universe, however the dramatic periodicity was something of a coincidence – if we look in other directions the structures aren't as regular.

PF: What is a typical day like for you?

MS: Depending on the day I'll either come in to Adler or to the University of Chicago. In the morning I may inspect some of the recently-processed SDSS spectra and look over any newly-identified supernovae candidates. After that there are a number of different projects I might work on. In the SVL we are working on the visualization of astrophysical data as well as innovative display technologies with which to view them. We are also analyzing human-computer interaction techniques to explore different ways of interacting with the datasets and visualizations. The SVL is a combination of a working laboratory and a public exhibition space and has been open to the public since April.

The 2.5-meter telescope at Apache Point Observatory. Specially built for the Sloan Digital Sky Survey, the 2.5-meter has numerous innovations such as a roll-off enclosure and advanced wind-shedding light baffles. Image credit: José Fransisco Salgado

PF: What's the most rewarding aspect of being an astronomer?

MS: Being able to think about the really big and fundamental questions. We're making a map of the Universe; I think that is pretty cool. Of course working on these big questions is much more rewarding when you are able to share the results with the public – that is what makes working at Adler so enjoyable.

PF: How has new technology allowed you to better study Astronomy?

MS: Technology has had a tremendous impact. The improvements in detector technology (digital cameras, basically) have had a profound effect. The increased ability of computers to perform simulations, process, analyze and visualize data has been equally as important. For example, in the SVL we created large tiled displays that allow us to view these extremely large images as well as stereoscopic visualizations that allow us to explore dense three-dimensional datasets from the Sloan data. This helps us to discover the parameters of galaxies, generate 3D maps and view the colors of galaxies, among other things.

PF: What are your hopes for the future of Astronomy?

MS: Astronomy is undergoing a renaissance. This is not only due to the technological improvements I've just mentioned, but also due to the support and interest of the general public, which naturally leads to increased financial support from governments. I sincerely hope that this will continue.

PF: What would you do if you weren't an astronomer?

MS: Assuming that a professional baseball career wasn't in the cards… One of the things I enjoy about working at Adler is that I get to exercise both the scientific and artistic side of my brain. I think I would enjoy another career that would allow me to use both sides of my brain. Architecture is a very spatially-oriented field. I would enjoy being an architect who designs buildings with interesting features like green roofs.

Research Notes

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tion with Dr. Farhad Yusef-Zadeh (Northwestern U.), Dr. Geoff Bowers (UC Berkeley) and Dr. Susan Stolovy (Spitzer Center). Additionally, Dr. Roberts uses the VLA and large Green Bank Telescope, of the NRAO, to observe the radial velocities of gas in order to understand how its motion is affected by various forces. *– Doug Roberts*

Research Notes

THE GALACTIC CENTER

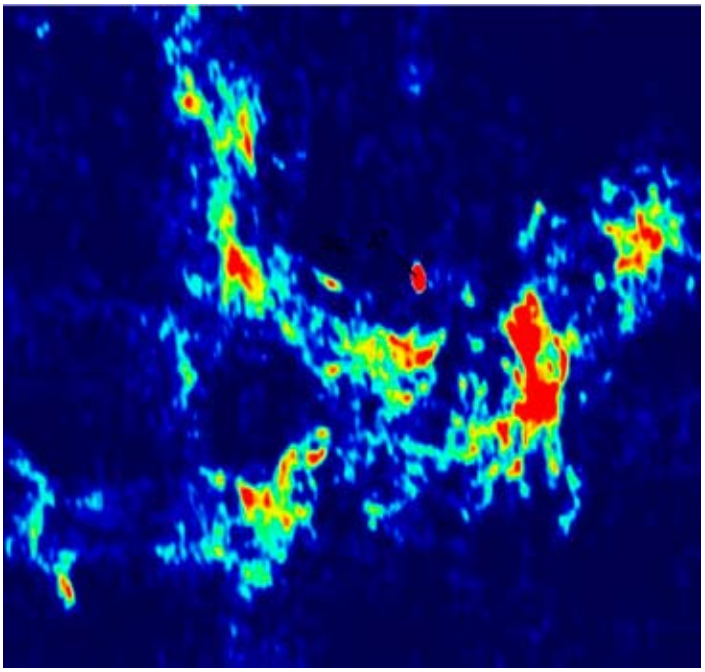
The central region of our Milky Way is a fascinating and extremely exciting place to study. Tens of thousands of stars form a dense cluster only a few light years across. In the precise center lies an enigmatic object known as Sagittarius A* (Sgr A*). Sgr A*, brilliant as a thousand Suns, emits over a wide range of wavelengths including radio, near-infrared and x-rays. Although we have not imaged it directly, strong evidence points to the conclusion that Sgr A* is a black hole of at least 3 million times the mass of the Sun.

Black holes can be divided into two different types: Supermassive black holes, such as Sgr A*, and stellar black holes. While both are described by Einstein's theory of General Relativity, they are born in very different ways. Stellar-mass black holes are the end result of the evolution of very massive stars. When a star with greater than a few tens of solar masses runs out of nuclear fuel it implodes to form a black hole. The formation of a black hole in this manner is likely accompanied by one of the most powerful explosions in the Universe, A gamma-ray burst. Although the details are not entirely known, this basic picture is quite secure. A black hole formed in this manner has a mass of only a few times that of the Sun.

Supermassive black holes, which are anywhere from a million to a billion times the mass of the sun, are a different story. Very little is definitively known about the formation of supermassive black holes. While their origins are shrouded in mystery, such supermassive black holes are believed to live at the center of every galaxy. In fact, our current understanding of galactic evolution suggests that the formation of a galaxy and the creation and growth of its central black hole are strongly linked. Every galaxy, spiral or elliptical, has a stellar component that is roughly spherical in shape. In an elliptical galaxy this is the whole galaxy, in a spiral it is the central bulge (though this can be quite small). A more massive galactic "spheroid" is always found to contain a more massive central black hole. The cause for this connection is not fully known.

A leading theory suggests that supermassive black holes grow by a combination of accretion and mergers. When galaxies collide the orbits of objects within them can be disrupted and "randomized". Gas and dust tends to be forced to the center where the black hole feeds upon it. As the gas and dust is devoured it is heated to very high temperatures, releasing tremendous amounts of energy. We see this process as an Active Galactic Nucleus or a quasar. Thus the brightest objects in the universe are powered by black holes.

The centers of galaxies immediately surrounding the central supermassive black hole retain evidence of this galactic evolution, including both internal structural evolution and the effects of mergers. The center of the Milky Way, a mere 25,000 light years away, is the closest such galactic center and astronomers are using multi-wavelength observations to understand the its nature. This understanding sheds light on the history of our Galaxy and its future and puts strong constraints on the general problems of galactic evolution.



Radio image of our Galaxy's central few light years. The bright red dot is Sgr A*, the Milky Way's central black hole with a mass of a few million time that of the Sun. The extended structure is called the "min-spiral" and contains at most a few tens of solar masses of gas and dust. The central parsec is a complex area filled with stars. To an inhabitant of a planet around one of these stars the sky would be a blaze of light. Image Credit: Doug Roberts.

Adler Astronomer Dr. Doug Roberts, in collaboration with investigators at Northwestern University, has been studying the galactic center for the past half decade. Dr. Roberts is a member of several on-going projects to observe Sgr A* and the environment in the inner few parsecs of our Galaxy. One aspect of this investigation involves comparing high-resolution radio images taken over several years for evidence of motion of some features. Another project is the involvement in a campaign intended to determine the physical mechanisms responsible for accretion processes onto compact objects with extremely low luminosities via the variability study of Sgr A*. The luminosity of Sgr A* in each band is known to be several orders of magnitude lower than could be expected, prompting a number of theoretical models to explain its faint emission. Roberts' involvement in the campaign involves radio observations (using the Very Large Array [VLA] of the National Astronomy Radio Observatory [NRAO], California Radio Millimeter Array, and the Australian Telescope Compact Array) and is being extended to include observations of ionized gas from the Hubble Space Telescope NICMOS camera. This involves collabora-

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BROADENED AUDIENCE

Beginning this spring and throughout the summer Adler astronomers have been hosting "Astronomy Conversations" in the Space Visualization Lab. These hour-long sessions give Adler guests an opportunity to meet astronomers in an informal atmosphere, ask questions, and explore the SVL visualizations with an expert guide.

On April 22, Grace Wolf-Chase hosted a private event at the Adler celebrating 100 years of Lutheran Campus Ministry. The group was composed of 150-200 people, many from Chicagoland universities. Throughout the night, they were treated to astronomy presentations in several of the galleries, including the Space Visualization Lab.

In July, Mark Hammergren taught the astronomy portion of a hands-on teacher enrichment program at Project Exploration's Science Teacher Field Institute. This one week program was held under the dark skies of the fossil-rich badlands of eastern Montana. One evening in Makoshika State Park in Glendive, Montana, Dr. Hammergren gave a public talk about the asteroid impact that caused the extinction of the dinosaurs.

On July 19, Dr. Wolf-Chase gave a very well received invited keynote presentation on the Cosmos to about 1,800 people at the Evangelical Lutheran Church in America Global Mission Event, held at Ohio State University.

In the very early morning hours of August 28, Larry Ciupik, Mark Hammergren and José Francisco Salgado helped hundreds of visitors view a total lunar eclipse visible at the Adler.

ASTRO-SCIENCE WORKSHOP

The Astro-Science Workshop continued for its 43rd year this June. University of Chicago graduate student Lauren Grodnicki, under the guidance of Mark Hammergren, designed and implemented the two-week program. This year's theme was "Exploring the Solar System: Earth as an alien planet." Following an introduction on solar system exploration, the participating junior and senior high school students built atmospheric sensors and payload capsules and lofted them to nearly 100,000 feet with high-altitude weather balloons. Following a dramatic launch from Koerner Airport in Kankakee, Illinois, the students used data from the recovered capsule to study profiles of temperature, pressure, and radiation ranging from the ground to above 98% of the Earth's atmosphere, and viewed videos taken at the edge of space by an onboard video camera.

MEDIA INTERACTIONS

José Francisco Salgado continues working on Nuestra Galaxia but he is now the sole host of the segment. Additionally we have had dozens of interactions with television, magazine and newspaper media since the beginning of this year, the most recent focusing on the lunar eclipse of August 28. Other topics include the Zula Patrol show and exhibit, black holes, climate change and UFOs.

The August 28th lunar eclipse as seen over the shoulder of the Nicolaus Copernicus statue. Image credit: Mark Hammergren.

OBSERVING

Grace Wolf-Chase and Mike Smutko continued their massive star formation observing program with 5 half-nights on the APO 3.5-meter telescope during the winter quarter.

Mark Hammergren and Geza Gyuk were awarded four half-nights on the ARC 3.5-meter telescope at the Apache Point Observatory to continue their investigation into the compositions of asteroids. Bad weather in New Mexico forced the closure of the telescope for most of that time.

In March, Grace Wolf-Chase and colleagues from institutions spanning the globe acquired Spitzer InfraRed Spectrometer (IRS) observations to study the driving mechanism of protostellar outflows.

In late April, astronomers Larry Ciupik, Lucy Fortson and David Steele helped mark "first light" of the VERITAS gamma-ray telescopes at a special ceremony at Mt. Hopkins, Arizona. Dr. Steele presented a poster on VERITAS blazar science during the public portion of the ceremony. Mr. Ciupik and Dr. [1]Steele remained at the site for an extra week to install and test pointing monitors for the two of the VERITAS telescopes. In mid-May Geza Gyuk traveled to the VERITAS site to observe potential gamma-ray sources with the completed array. Mr. Ciupik returned in July for observing and again in August to install and test pointing monitors for the remaining two telescopes.

David Steele, in partnership with UW-Madison Prof. Teresa Montaruli, was granted synoptic observing time for blazar monitoring using the WIYN 0.9m telescope on Kitt Peak for

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the spring and fall semester of 2007.

Doug Roberts was awarded 24 hours of observing time at the National Radio Astronomy Observatory Very Large Array, New Mexico, of Sagittarius A*, the supermassive black hole at the Galactic Center. These observations were part of a coordinated campaign including the Chandra X-ray observatory, Hubble Space Telescope and Very Large Telescopes in Chile.

CONFERENCES AND PRESENTATIONS

In July David Steele attended the 30th biennial International Cosmic Ray Conference in Merida, Yucatan, Mexico. Dr. Steele presented a paper entitled "Results from the Blazar Monitoring Campaign at the Whipple 10-m Telescope".

Geza Gyuk spent three weeks in Santa Fe, New Mexico in July at the annual Santa Fe Cosmology Workshop. The workshop brings together leading cosmologists for both formal and informal discussions and updates on the latest research.

In May Mark Hammergren, Andy Puckett and José Francisco Salgado attended the 210th meeting of the American Astronomical Society in Honolulu, HI. Dr. Salgado presented "Nuestra Galaxia & Adler en Español". Dr. Hammergren, Dr. Gyuk and Mr. Puckett presented a poster entitled "The Adler V-type Asteroid (AVAST) Survey - Mid-survey Status Report".

In August Doug Roberts attended SIGGRAPH 2007, the Association for Computing Machinery's premier conference on computer graphics and interactive techniques.

On August 9-10 the Adler hosted the Second Multiwavelength Workshop for Next Generation Gamma-Ray Experiments. Organized by Lucy Fortson and local colleagues, this workshop gathered together 45 scientists with a broad knowledge of gamma-ray, x-ray, optical, infrared, and radio astronomy in order to promote the exchange of information of the different wavelengths. Dr. Fortson and Dr. Steele presented at the workshop. Mr. Ciupik and Dr. Gyuk also participated.

In August Larry Ciupik went to Rio de Janeiro, Brazil to report on preparations for the June 2008 meeting of the International Planetarium Society (IPS), to be held in Chicago and hosted by Adler Planetarium.

STUDENTS & INTERNS

Scott Ogilvie, our IMSA high school intern, traveled once a week between Aurora and the Adler from September 2006 through March of this year. Scott helped David Steele analyze cross-correlations between the optical and gamma-ray emission of the active galaxy Markarian 421. This summer Adler astronomers hosted 4 interns. Vina Ganason and Tom Kudla, undergraduate students at IIT assisted with the AdlerSpace ballooning project. Vina and Tom helped design and build prototypes for the high altitude balloon experiments. SVL had two high school interns, Andy Perrotte and Benjamin Steinhorn. Andy and Benjamin set up the stereo images of Mars.

GRANTS

During the spring, the Astronomy Department received two Illinois Space Grant Consortium grants. Grace Wolf-Chase and Mike Smutko were awarded $7000 for "Shedding Infrared Light on the Earliest Stages of Massive Star Formation", while Geza Gyuk and Mark Hammergren received $6400 to help fund interns participating in our Space Science Internship program.

The Astronomy Department received a generous a grant of $100,000 from the Brinson Foundation for the 2007-1008 fiscal year. This grant will support Adler research in Astrophysics.

The VERITAS gamma ray astronomy research team at the Adler was awarded a two-year grant by the National Science Foundation for $200,000. While supporting the group as a whole, this grant will support in particular the excellent work done by Adler Post-doctoral Associate David Steele to augment the pointing accuracy of the four VERITAS telescopes and to study Active Galactic Nuclei by searching for correlations between gamma-ray data and data from neutrino detectors at the South Pole.

The Adler Planetarium was awarded a small grant of $20,000 for this year to produce education and public outreach (EPO) materials for the VERITAS project. The main aspect of the EPO work will be to develop a public website for the project and to create compelling electronic interactives for use in the Adler's Space Visualization Laboratory. These materials will highlight the science of gamma ray astronomy as well as how the VERITAS telescopes work.

APPOINTMENTS & AWARDS

Michael Smutko has been promoted to Senior Lecturer in the Department of Physics and Astronomy at Northwestern University. He was also awarded an Arts and Sciences Alumni Teaching Award which is given annually to two faculty members in Northwestern's Weinberg College of Arts and Sciences.

Mark Hammergren was selected for NASA's Student Collaboration Program Definition Team, which is charged with developing a white paper setting forth the nature of formalized student involvement in NASA's Science Mission Directorate, and in capturing the best practices in project-based learning as exemplified by NASA's scientific exploration. The Team's final report will be published in 2008 for wide distribution.

Grace Wolf-Chase was invited to be a founding member of the Astrobiology Society, the new professional society representing astrobiology nationally and internationally.

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Images of Astronomy

THE GOLDEN HILLS OF VERITAS

As the VERITAS (Very Energetic Radiation Imaging Telescope Array System) project, located about 50 miles south of Tucson, Arizona nears completion, each of its four giant multi-mirror telescopes must perform exceptionally well as they track known sources of gamma rays and attempt to discover new high-energy sources. Each massive telescope optical assembly and its associated camera and counterweight system bends and flexes a tiny bit as it tilts to different altitudes and rotates to face different directions. These distortions affect where the telescope points as it slowly tracks the sources in the sky to compensate for the spinning of the Earth. So far, the pointing accuracy has been measured to be about 1

Adler Astronomer Larry Ciupik works on the T1 VERITAS telescope with Dirk Pandel from University of Iowa to install video cameras for monitoring the position of the telescope. Image credit: David Steele

arcminute (1/60 of a degree). Such a seemingly insignificant error limits the ability of the instrument to precisely measure the locations of gamma-ray sources.

Over the past year, Adler VERITAS collaboration members have been prototyping and testing various low-light-level video cameras, fast lenses , small telescopes, and GPS timing devices. When used in tandem, and with appropriate software, they will enable better pointing of the giant gamma-ray telescopes.

The photographs above were taken by Adler Astronomer David Steele during a November, 2006 trip to the VERITAS site.

Each of the four VERITAS telescopes are 12 meters (about 40 feet) in diameter, so Adler Astronomer Larry Ciupik and Dirk Pandel from University of Iowa must use a cherry picker to work on any of the huge telescopes (in this case, T1). Image credit: David Steele

Here, against the background of the foothills of Mt. Hopkins, Adler Astronomer Larry Ciupik and Dr. Dirk Pandel of the University of Iowa work inside the cage of a cherry picker to install a low-light-level video camera inside its weather-proof enclosure. The reflection of dry brown foliage covering nearby hills produces the golden hue seen in the 350 hexagonal mirror facets. Although beautiful, this foliage is also a fire hazard, and a sign of ongoing drought in the Tuscon area.

The system being mounted will image the VERITAS Telescope 1 camera box (seen on the right). By placing a screen over the camera box, the video camera photographs the changing shape and exact position of the composite image produced by the mirrors as the massive telescope mount moves to face various sections of the sky.

Meanwhile, another low-light-level video camera system will simultaneously photograph the same section of the sky as the gamma-ray telescope. By comparing the various images the team hopes to better understand and correct the pointing errors of the huge telescope and compensate for the deflection of the mirror assembly and the camera as the telescope moves. – Larry Ciupik

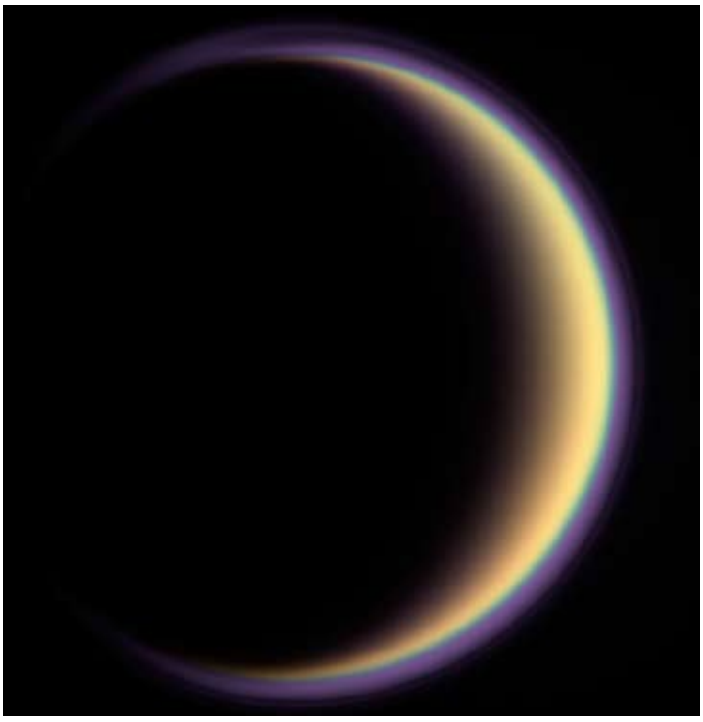
Astronomy News

LAKES ON TITAN REDUX

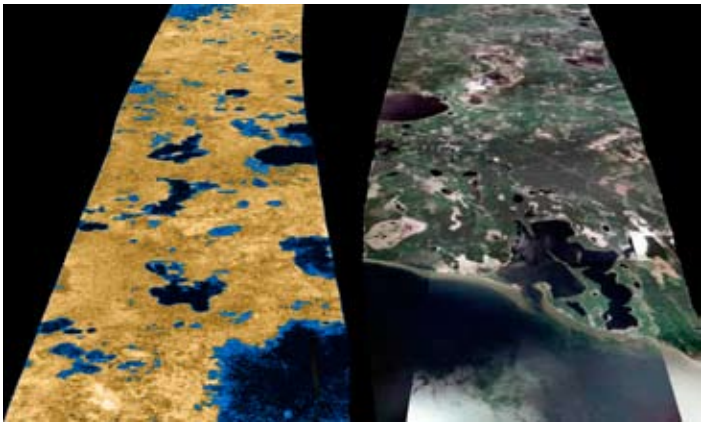
Nearly 24 years ago, Adler visitors were treated to a sky show "Moons and Rings" featuring a conversation among imaginary future explorers of Titan, Saturn's largest moon. The astronauts landed in an alien seascape of liquid natural gas and departed during a methane rainstorm. More recently, the Adler's "TimeSpace" show depicts futuristic "mining" operations on Titan to gather the rich resources of hydrocarbons. The writers of these shows used predictions by the late Carl Sagan and other scientists who forecast this strange chemical soup on Titan based on photos of the featureless orange-colored moon from the Voyager spacecraft missions and Earth-based spectroscopic analysis of Titan's opaque Nitrogen-rich atmosphere. These predictions suggested that Titan could be covered with a global ocean of hydrocarbons more than 1,300 feet deep.

However, in October 2004, the Cassini spacecraft flew by Titan at a distance of only 730 miles. Eleven of Cassini's remote-sensing instruments were focused at Titan during this flyby. Analysis of the results failed to find a global ocean. Were the earlier predictions entirely wrong?

A recent analysis of the data from the July 22, 2006 Cassini flyby of Titan finally provided more proof that the liquid natural gases methane and ethane form lakes and perhaps even seasonal rivers on Titan. Using Cassini's Titan Radar Mapper, a worldwide team of scientists, led by Ellen Stofan, found more than 75 dark-looking circular and irregular patches at high latitudes. Dark areas correspond to regions of extremely low radar reflectivity indicating a very smooth, perhaps liquid surface. Several of these dark patches have sinuous features leading into them, again strengthening the liquid interpretation. Finally, liquid methane and ethane is predicted to be abundant near the north pole of Titan, consistent with an interpretation of these dark areas as lakes.



Titan seen by the Cassini orbiter. Separate ultraviolet, blue, green and red filters were used to create this colorized view. Image Credit:NASA/JPL/Space Science Institute



This radar image, acquired by the Cassini spacecraft synthetic aperture radar, shows radar-dark suspected lakes in blue and radar bright regions in tan. The image is 140 kilometers (84 miles) across. On the right is a same sized region of the Minnesota "1000 lakes" area near Lake Bemidji. Although the formation mechanisms are very different, a striking similarity is apparent. image Credit: Larry Ciupik, NASA, JPL, Google Earth

Strong circumstantial evidence had been found before that liquids must exist on or near the surface of Titan even at its intensely cold temperature of -288˚F (-178˚C, only 95 degrees above absolute zero). The spectacular images of the Huygens probe strongly suggest that liquid had flowed in the geologically recent past. This recent analysis, however, is the first direct evidence that liquid is currently present on Titan. "Titan is right now really the [second] body in the solar system that we've been to that has an active, fluid, liquid cycle," commented Dr. Stofan. She continued, "On the Earth here, it's the hydrologic cycle. We almost have to make up a new word for it on Titan; it's the "methaneologic cycle".

The comparison to the Earth is particularly apt. Titan is the only moon in the solar system with a thick atmosphere, with a surface pressure about one and a half times that on Earth. The atmosphere, mostly composed of nitrogen, is filled with thick orange smog of complex organic molecules. These molecules, formed by the action of ultraviolet light from the Sun on methane, rain out of the atmosphere and may have built up a thick tarry layer covering areas of the surface. Titan is interesting to scientists as a possible analog to the early prebiotic Earth.

The Cassini radar team is eager to continue taking data and to learn more about the lakes of Titan. "You know, obviously at some point in the past, Mars had [active liquid processes], but on Titan, it's happening right now, and that's extremely exciting from a scientific point of view" says Dr. Stofan. "Titan has an awful lot to tell us, not just geologically, but about how life originates." *– Larry Ciupik & Geza Gyuk*

Department Report

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PERSONNEL CHANGES

Andy Puckett, our Planetary Research Fellow, has left for cooler pastures in Alaska to pursue postdoctoral work. Andy joined the department as the Public Education Fellow in September 2003 and worked with Astro-Science Workshop for three years. He rejoined the Adler Astronomy department in January of this year as our Planetary Research Fellow. Dr. Puckett is to be congratulated for his recently attained doctorate in Astronomy & Astrophysics at the University of Chicago. His thesis was "A Catalog of Slow-Moving Objects Extracted from the Sloan Digital Sky Survey: Compilation and Applications."

Michael Curran, the department's Digital Media and Administrative Assistant, left in mid May after working here for almost a year. Michael left for warmer pastures in California.

Rivka Rosen joined the department at the end of June as the Administrative and Projects Assistant. Ms. Rosen has been working at the Adler in a part-time capacity for 2 years and was a volunteer for a year before that. Rivka brings her organizational and writing skills to the department.

PUBLICATIONS

During the year members of the department were authors on 5 papers published in peer reviewed Journals:

"Observations of the Unidentified TeV γ-Ray Source TeV J2032+4130 with the Whipple Observatory 10 m Telescope", (the VERITAS collaboration- including D. Steele).;ApJ 658, 1062 (2007).

"Very High Energy Observations of Gamma-Ray Burst Locations with the Whipple Telescope",(the VERITAS collaboration - including D. Steele).;ApJ 655, 396 (2007).

"Searching for TeV Blazar Candidates in the Sloan Digital Sky Survey" Barnaby, David A.; Fortson, L.; Gyuk, G.; Steele, D.; SubbaRao, M.; Carini, M.; Maune, J.;AAS 38, 905 (2007)

"On the Selection of AGN Neutrino Source Candidates for a Source Stacking Analysis With Neutrino Telescopes", (the IceCube collaboration -including D. Steele); Astropart. Phys. 26, 282A (2006).

"The Variability of Polarized Radiation from Sgr A*", F. Yusef-Zadeh, M. Wardle, W. D. Cotton, C. O. Heinke, and D. A. Roberts; ApJ, for future publication.

Other papers are in progress.

About the Adler Astronomy Department

The Adler Planetarium & Astronomy Museum has taken the lead among planetaria world-wide in establishing an astronomy and astrophysics research group in a museum setting. Adler Planetarium astronomers possess rich and diverse expertise in many areas of astronomy as well as other closely related science fields such as particle physics and geophysics. Several members of the Adler Astronomy Department also hold joint appointments at the University of Chicago and Northwestern University. The nature of these joint appointments strengthens the integration of the Adler and its educational mission with the research community.

You can download this newsletter and our Annual Report published in the Bulletin of the American Astronomical Society from: *http://www.adlerplanetarium.org/astronomy/*

PRIME FOCUS

A Publication of: The Adler Planetarium, Astronomy Department, 1300 S. Lake Shore Drive, Chicago, IL 60605

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Colophon: Produced using InDesign 4.0, Illustrator 12.0, and Photoshop 9.0. Body copy is set in Cronos Pro. Headlines are set in Trebuchet.

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