

# The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

**Calendar of Events**

**SUMMER STAR PARTY**  
**WEDNESDAY**  
**JUNE 21, 2006**  
**First Day of Summer**  
**after the**  
**BAND CONCERT**  
**in South Park**  
**SETUP ~ 9:15PM**

**KU STADIUM OBSERVING**  
**Cancelled**  
 until further notice

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**Report From the Officers on the May Meeting:**



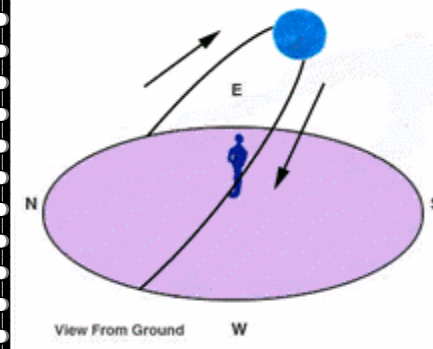
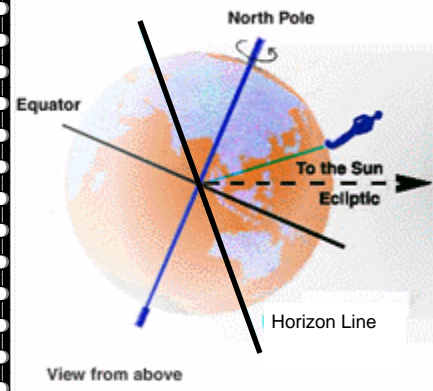
Hope everyone's summer season is off to a great start. Officially, the summer begins later this month with the arrival of the summer solstice (see the story below). The timing of the solstice this year is such that it occurs on the same day as the weekly band concert in South Park—Wed. June 21. Because of this coincidence, we will attempt to continue our tradition of post-band-concert star parties in South Park on the west side of Massachusetts St. If you can come by and set up a telescope for viewing or would like

to use one of the KU telescopes, please contact Bruce Twarog at btwarog@ku.edu. The tentative setup time is 9:15 PM, though it will be rather later when it becomes totally dark. Let's hope for clear skies! Because of the slowdown in activities during the summer, we will return to our usual mode of not having monthly meetings until the summer is over. We are organizing a number of potential events/speakers for the Fall 2006 semester,

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**SUMMER SOLSTICE:**  
**6/26/2006, 7:26 AM**



Let's pretend, for the moment, that you're the person standing on the Earth in the picture to the left, living in Lawrence, Kansas, around 40° N latitude. The picture on the left shows the view from the solar system (upper panel), and from on the surface of the earth (lower panel). Notice that some of the same features are labelled on each panel.

The upper panel shows that on the summer solstice (which occurs around June 21), the northern half of the Earth is tilted towards the Sun. Notice that the Sun is north of the equator. For you in Lawrence, the altitude of the Sun at noon is 73.5°, which is pretty high in the sky. In fact, that is as high as the Sun ever gets at that latitude. It has been getting higher and higher in the sky since the winter solstice and through the vernal equinox. The bottom panel shows how the Sun moves through the sky for someone stand-

(Continued on page 7)

## From the Officers, continued

(Continued from page 1)

so if you have any suggestions for topics, speakers, or public events, please contact Rick Heschmeyer with your ideas.

Last month, the Lawrence Club had a chance to view the operation at Farpoint Observatory, owned by NEKAAL, the amateur astronomy club in Topeka. NEKAAL now runs a NASA-funded research program to search for near-Earth asteroids, with their primary instrumentation being a 27-inch telescope equipped with a research-quality CCD camera. The telescope is near and dear to KU because it uses the 27-inch mirror that formerly operated in the Pitt telescope on campus. The half-dozen AAL members were joined by another 8 visitors from Topeka to see the sites and the impressive setup for collecting and analyzing CCD data. The weather cooperated with mostly clear skies and cool but comfortable temperatures. The only negative was the full moon, but even that generated some spectacular photo opportunities as it rose above the telescope in the fading sunlight at dusk. The last of the Lawrence group stayed until after 11PM, with a plan to return again in a few months under somewhat darker sky conditions. By the way, the Farpoint Project is always looking for help with data collection and analysis. If you or a student you know is looking for an opportunity to do some legitimate astronomical research and is willing to commit to learning the system, feel free to contact the NEKAAL group, specifically Gary Hug, for more information.



Reminders on upcoming events: Mid-states Regional Astronomical League Convention, June 16-18, Washington University, St. Louis, MO—<http://www.slasonline.org/msral2006.htm>; the **Heart of America Star Party**, sponsored by the ASKC, June 22 - 25 at a site 75 miles south of Kansas City (contact Dan Johnson ([gdj102356@hotmail.com](mailto:gdj102356@hotmail.com)) or Paul Thompson ([pjtom@highstream.net](mailto:pjtom@highstream.net)); the **Rocky Mountain Star Stare (RMSS)**, June 22-25, 65 miles west of Colorado Springs. -<http://www.rmss.org>; the Nebraska Star Party, July 23-28, Valentine, NE -[www.NebraskaStarParty.org](http://www.NebraskaStarParty.org); **ALCON/EXPO** in Dallas, August 4-5, 2006 - <http://www.alconexpo.com/>.

The Astronomical League has many activities to encourage amateur astronomy including Observing Clubs. The Observing Clubs offer certificates of accomplishment for demonstrating observing skills with a variety of instruments and objects. Each Club offers a certificate based upon achieving certain observing goals. These are usually in the form of a specific number of objects of a specific group with a given type of instrument. Occasionally there are multiple levels of accomplishment within the club. There is no time limit for completing the required observing, but good record keeping is required. When you have reached the requisite number of objects, your observing logs are examined by the appropriate authority and you will receive a certificate and pin to proclaim to all that you have reached your goal. Many local astronomical societies even post lists of those who have obtained their certificates. This month we feature the details on the **LUNAR II CLUB**. The Moon is the nearest celestial object in our observable universe and is always a public favorite at star parties. It was the target of past manned and robotic exploration missions, and it is likely that public interest will be stimulated again as new lunar missions are announced and executed. Many avid lunar observers voiced their desire for a second, more challenging program to follow the very popular Lunar Club. In response the Astronomical League formed a club for experienced lunar observers called Lunar II. Lunar II Club goals include stimulating and maintaining a continued interest in lunar observing. This new program will also require participants to make at least 100 observations of the Moon. It is designed to help members improve their observing skills and expand their knowledge of the visible lunar surface. It is similar in some ways to the Messier Club, and it requires participants to go farther than the Lunar Club had before. Some observations will be relatively easy, such as finding and describing the Sea of Isles; others, like hunting domes and rilles will be more challenging and require greater observing skill. Participants will also create a small, basic map of the visible face of the Moon. order will archive a copy and send a copy to Europe for analysis by the International Meteor Organization. For rules and details about this observing club, go to <http://www.astroleague.org/al/obsclubs/lunarII/lunarII1.html>

If you have any suggestions for talks, speakers, or public events, please feel free to contact us, particularly Rick Heschmeyer ([rcjbm@sbcglobal.net](mailto:rcjbm@sbcglobal.net)), the events coordinator for the club. Hope to see you later this month at the Summer Solstice Band Concert in June. 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: Hannah Swift at [hksswift@ku.edu](mailto:hksswift@ku.edu), Gary Webber at [gwebber@ku.edu](mailto:gwebber@ku.edu), our faculty advisor, Prof. Bruce Twarog at [btwarog@ku.edu](mailto:btwarog@ku.edu). or our events coordinator, Rick Heschmeyer at [rcjbm@sbcglobal.net](mailto: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>

## Rubblly Itokawa revealed as 'impossible' asteroid

Maggie McKee, NewScientist.com

The small asteroid Itokawa is just a loosely packed pile of rubble that collected after a collision between asteroids,



Measurements of the asteroid's gravity field combined with size data show Itokawa is an astonishing 40% empty space (Image: JAXA)

according to a slew of new studies based on data from Japan's Hayabusa spacecraft. The asteroid appears to be plagued by recurring impacts and tremors today, making its continued survival a mystery. Hayabusa made two attempts to collect samples from the 535-metre-long space rock in November 2005. The attempts appear to have failed, but that will not be clear unless the spacecraft can be returned to Earth, which scientists are hoping to do in 2010. But during its approach, the spacecraft did take images and other data on Itokawa's topology, composition and gravity field.

What they found was completely unexpected. "Five years ago, we thought that we would see a big chunk of monolithic rock, that something so small doesn't have the ability to hold onto any pieces," says Erik Asphaug, a planetary scientist at the University of California in Santa Cruz, US, who is not involved with the mission. "Everything we suspected about it turned out to be wrong."

The spacecraft showed a surface littered with boulders and gravel, suggesting it was made of the debris from a larger asteroid that was shattered in a past collision. The latest observations from Hayabusa put an approximate size limit on that parent body.

### Hot heart

Onboard gamma-ray and infrared spectrometers reveal the asteroid is composed of the "raw materials" of planets, such as olivine, pyroxene and metallic iron, says Asphaug. But these materials do not appear to have melted and separated, as would be expected if the parent body was larger than about 200 kilometres across, he says. Nonetheless, Hayabusa's cameras reveal that some large boulders appear layered, "like you'd broken off a rock from the side of a river bed," he says. That suggests Itokawa's parent body was large enough to heat up at its centre and develop some internal structure, even if it wasn't large enough to melt. "There could have been hydrothermal processes conducting water around, similar to on Earth, where steam passes through rocks and alters their compositions," he told **New Scientist**.

Measurements of the asteroid's gravity field also suggest it coalesced from the debris of a previous collision. Hayabusa scientists used the data - combined with measurements of the space rock's size - to estimate its density. It appears to be 40% porous, or filled with empty space.

"That is astonishing," says Asphaug, adding that a handful of sand has a porosity of 20%. "It's very hard to get porosities greater than that. You've got to start balancing things delicately, like you were building a house of cards," he says. "The only way to do it is to gently pack the stuff together."

### Tamping down

But that raises another mystery, he says, since repeated impacts with other space rocks over millions of years should have made Itokawa denser. "Every time you have an impact, you're going to tamp it down," he says. And Itokawa certainly appears to have had its share of cosmic run-ins, even though it does not show many craters. New craters are thought to be buried by gravel that flows into them when Itokawa shudders after being struck by a space rock. This shaking is also thought to have buried the powdery dust created in such impacts, leaving only larger boulders and gravel-sized rocks visible.

Only one other asteroid has been studied so extensively, a 33-kilometre-long rock called Eros. That asteroid appears to be a single piece of rock, but its density is more like a rubble pile. Asphaug argues that more asteroids should be visited by spacecraft, in part to determine what sort of threat they might pose if they struck the Earth. Itokawa does cross the Earth's orbit during its 1.5-year-long path around the Sun, but calculations show it will probably never hit the planet. But Asphaug says an asteroid the size of Itokawa is expected to strike the Earth once every 100,000 years, making robotic - or even human - missions to asteroids a priority. "You want to be ahead of the game" in the event that an asteroid is found on an impact course, he says.



## Not a Moment Wasted

by Dr. Tony Phillips

The Ring Nebula. Check. M13. Check. Next up: The Whirlpool galaxy.

You punch in the coordinates and your telescope takes off, slewing across the sky. You tap your feet and stare at the stars. These Messier marathons would go much faster if the telescope didn't take so long to slew. What a waste of time!

Don't tell that to the x-ray astronomers.

"We're putting our slew time to good use," explains Norbert Schartel, project scientist for the European Space Agency's XMM-Newton x-ray telescope. The telescope, named for Sir Isaac Newton, was launched into Earth orbit in 1999. It's now midway through an 11-year mission to study black holes, neutron stars, active galaxies and other violent denizens of the Universe that show up particularly well at x-ray wavelengths.

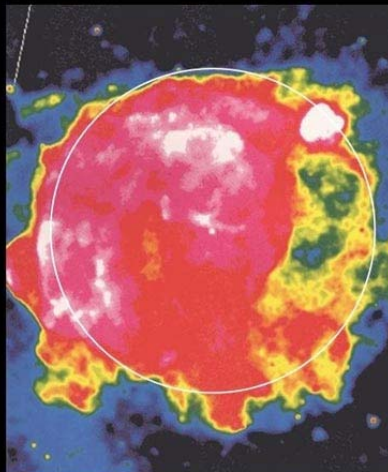
For the past four years, whenever XMM-Newton slewed from one object to another, astronomers kept the telescope's cameras running, recording whatever might drift through the field of view. The result is a stunning survey of the heavens covering 15% of the entire sky.

Sifting through the data, ESA astronomers have found entire clusters of galaxies unknown before anyone started paying attention to "slew time." Some already-known galaxies have been caught in the act of flaring—a sign, researchers believe, of a central black hole gobbling matter from nearby stars and interstellar clouds. Here in our own galaxy, the 20,000 year old Vela supernova remnant has been expanding. XMM-Newton has slewed across it many times, tracing its changing contours in exquisite detail.

The slew technique works because of XMM-Newton's great sensitivity. It has more collecting area than any other x-ray telescope in the history of astronomy. Sources flit through the field of view in only 10 seconds, but that's plenty of time in most cases to gather valuable data.

The work is just beginning. Astronomers plan to continue the slew survey, eventually mapping as much as 80% of the entire sky. No one knows how many new clusters will be found or how many black holes might be caught gobbling their neighbors. One thing's for sure: "There *will* be new discoveries," says Schartel.

### Vela Supernova Remnant



ROSAT



XMM-Newton Slew

*The image on the left is the Vela Supernova Remnant as imaged in X-rays by ROSAT. On the right are some of the slew images obtained by XMM-Newton in its "spare" time.*

Tap, tap, tap. The next time you're in the backyard with your telescope, and it takes off for the Whirlpool galaxy, don't just stand there. Try to keep up with the moving eyepiece. Look, you never know what might drift by.

See some of the other XMM-Newton images at <http://sci.esa.int>. For more about XMM-Newton's Education and Public Outreach program, including downloadable classroom materials, go to <http://xmm.sonoma.edu>. Kids can learn about black holes and play "Black Hole Rescue" at The Space Place, <http://spaceplace.nasa.gov/>, under "Games."

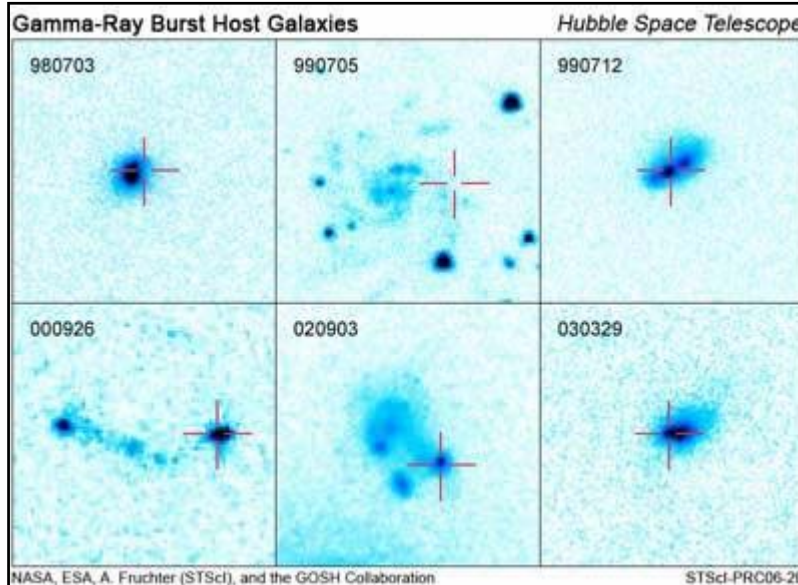
This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

## Hubble Finds that Earth is Safe from One Class of Gamma-ray Burst

HST Press Release

Homeowners may have to worry about floods, hurricanes, and tornadoes destroying their homes, but at least they can remove long-duration gamma-ray bursts (GRBs) from their list of potential natural disasters, according to recent findings

by NASA's Hubble Space Telescope.



NASA, ESA, A. Fruchter (STScI), and the GOSH Collaboration

STScI-PRC06-20

This is a sampling of the host galaxies of long-duration gamma-ray bursts taken by NASA's Hubble Space Telescope. Gamma-ray bursts are powerful flashes of high-energy radiation that arise from some supernovae, the explosive deaths of extremely massive stars. Long-duration bursts last more than one to two seconds. The crosshairs pinpoint the location of the gamma-ray bursts, now long faded away. The galaxies in these images were part of a study that compared the environments of long bursts with those of supernovae. Only a small fraction of a certain type of supernovae produces gamma-ray bursts. These six images show the wide variety of host galaxies of gamma-ray bursts. The distances of these bursts range from 2 billion to 10 billion light-years from Earth. Most of the galaxies in these images are misshapen, irregular galaxies. The only exception is the spiral galaxy in the middle image on the top row. In this image, the bright round objects above, below, and to the right of the cross hairs are foreground stars in the Small Magellanic Cloud, a satellite galaxy of our Milky Way Galaxy.

Long-duration gamma-ray bursts are powerful flashes of high-energy radiation that are sometimes seen coming from certain types of supernovae (the explosions of extremely massive stars). If Earth were flashed by a nearby long-duration burst, the devastation could range from destroying the ozone in our atmosphere to triggering climate change and altering life's evolution.

Now astronomers analyzing long-duration bursts — those lasting more than one to two seconds — in several Hubble telescope surveys have concluded that the Milky Way Galaxy is an unlikely place for them to pop off. They find that blasts tend to occur in small irregular galaxies where stars are deficient in the heavier elements. The Milky Way's starry population, by contrast, is rich in elements heavier than hydrogen and helium.

Suspecting that knowledge of their environments might help determine what types of stars produce gamma-ray bursts, the astronomers,

led by Andrew Fruchter of the Space Telescope Science Institute in Baltimore, Md., used Hubble to examine the environments of 42 long-duration bursts and 16 supernovae. They found that the small fraction of supernovae that produce the bursts live in a very different environment from the average supernova. Fruchter's results appear in the May 10 online edition of the journal *Nature*.

Fruchter's team found that most of the long bursts in the sample were detected in small, faint, misshapen, (irregular) galaxies, which are usually deficient in heavier elements. Only one of the bursts was spotted in a spiral galaxy like our Milky Way, suggesting that our galaxy is an unlikely host for long-duration bursts. By contrast, the hosts of supernovae were divided equally between spiral and irregular galaxies, those with greater or smaller concentrations of the heavier elements.

Fruchter's team also found that long bursts are far more concentrated in the brightest regions of their host galaxies where the most massive stars reside. Supernovae, on the other hand, occur throughout

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their host galaxies.

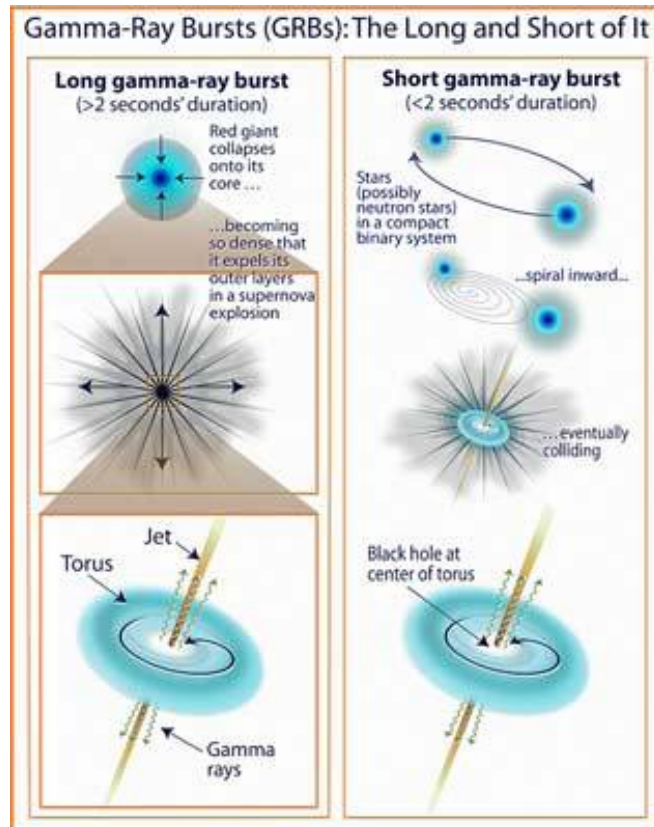
"The discovery that long-duration gamma-ray bursts lie in the brightest regions of their host galaxies suggests that they come from the most massive stars – 20 or more times as massive as our Sun," Fruchter said. "Their occurrence in small irregulars implies that only stars that lack heavy chemical elements tend to produce long-duration GRBs." This means that long bursts happened more often in the past when galaxies did not have a large supply of heavy elements. Galaxies build up a stockpile of heavier chemical elements through the ongoing evolution of successive generations of stars. Early generation stars formed before heavier elements were abundant in the universe.

Massive stars abundant in heavy elements are unlikely to trigger bursts because they may lose too much material through stellar "winds" off their surfaces before they collapse and explode. When this happens, the stars don't have enough mass left to produce the proper conditions that would trigger the phenomenon.

Astronomers think that gamma-ray bursts are produced by rotating black holes left over from stellar explosions. The energy from the collapse of a star's core escapes along a narrow jet, like a stream of water from a lawn sprinkler. The jet burns its way through the remnants of the star. The formation of directed jets, which concentrate energy along a narrow beam, would explain why the bursts are so powerful. But if a star loses too much mass, it may only leave behind a neutron star, not a black hole, and thus cannot create the jet. On the other hand, if the star loses too little mass before its collapse, the jet cannot burn its way through the dense outer layers of the star.

This means that extremely high-mass stars that puff away too much material may not be candidates for long bursts. Likewise, neither are stars that give up too little material. "It's a Goldilocks scenario," Fruchter said. "Only supernovae whose progenitor stars have lost some, but not too much, mass appear to be candidates for the formation of GRBs."

Gamma-ray bursts can be divided into two classes: short bursts, which last between milliseconds and about two seconds, and produce very high-energy radiation, and long bursts, which last between two and tens of seconds, and create less energetic gamma rays. Although long bursts are unlikely to strike in galaxies like our Milky Way, short bursts could still happen. Short bursts are believed to arise from collisions between two compact objects, such as neutron stars. However, even with their higher-energy radiation, short bursts are typically 100 to 1,000 times less powerful overall than long bursts and would pose much less of a threat to life if one were to occur in our galaxy.



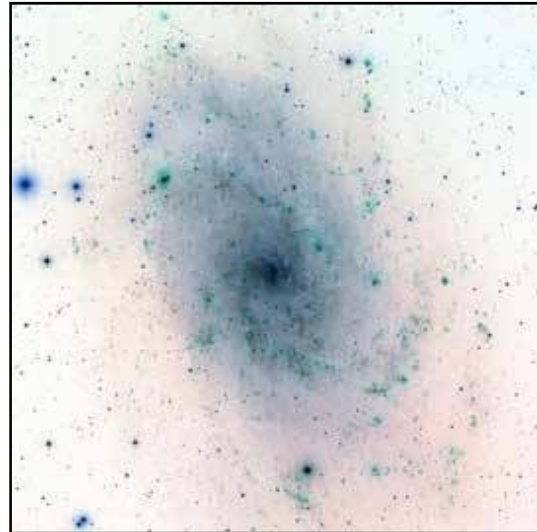
## Black Hole–Galaxy Link Extended

By Robert Naeye, [skypub.com](http://skypub.com)

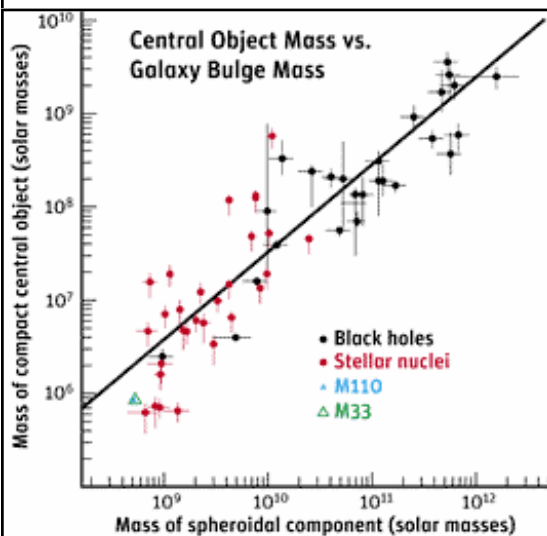
Over the past decade, astronomers have established the remarkable fact that supermassive black holes have a scaling relationship with their host galaxies. The more massive the black hole, the more massive is the galaxy's spheroidal component (either an entire elliptical galaxy or the central bulge of a spiral galaxy). This M-sigma relation tells astronomers that the evolution of galaxies and their supermassive black holes are intertwined.

Until now, this relation only applied to large and medium-size galaxies, where astronomers have found supermassive black holes. But in a paper to appear in the June 10, 2006, issue of the *Astrophysical Journal Letters*, Laura Ferrarese (Herzberg Institute of Astrophysics, Canada) and 11 colleagues say it extends all the way down to very-low-mass galaxies, albeit in a modified form.

The team studied 100 elliptical galaxies, from giant to dwarfs, imaged as part of a Hubble Space Telescope deep survey of the Virgo Cluster. Coupled with spectroscopic observations at several telescopes on Arizona's Kitt Peak, they found that the masses of compact stellar nuclei, which are found almost exclusively in the fainter galaxies, share the same scaling relationship with their host galaxies as do supermassive black holes. They also found that the nuclei of two low-mass galaxies in our Local Group, M33 in Triangulum and M110 (NGC 205), one of the Andromeda Galaxy's satellites, also follow the same relation. Neither galaxy shows evidence of a supermassive black hole.



Spiral galaxy M33 has a small, compact stellar nucleus. The masses of such nuclei scale to the mass of the host galaxy. Click to view a larger image. Courtesy Travis Rector / Mark Hanna / NOAO / AURA / NSF.



The mass of a galaxy's central, compact object is correlated to the mass of the galaxy's spheroidal component. Source: Laura Ferrarese.

The results suggest that all galaxies may form dense, central objects — either a supermassive black hole or a compact stellar cluster — that contain about 0.2% of the galaxy's spheroidal mass. The team speculates that compact stellar nuclei could be "failed black holes" — systems in which the central mass failed to collapse gravitationally all the way down to nature's ultimate abyss. The same conclusion has received further support by the work of Elizabeth Wehner and William Harris (McMaster University, Canada) and Joern Rossa (Space Telescope Science Institute).

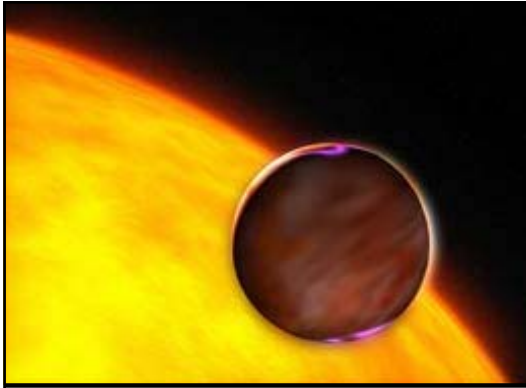
"We were quite excited when we found this result, as I think it adds another important piece of information to the puzzle," says Ferrarese. "Compact nuclei are as fundamental a constituent of galaxies as supermassive black holes. Explaining how they formed might hold important clues as to the mechanisms by which the galaxies them-

*(Continued from page 1)*

ing on the ground in Lawrence. So in general, the northern hemisphere is getting more direct sunlight, which heats the Earth most efficiently, than the southern hemisphere. This is summer for people in the northern hemisphere. During the summer, the Sun is also above the horizon longer than it is during the winter. The summer solstice is the longest day of the year.

## Amateurs Help Discover Transiting Exoplanet

Robert Naeye, skypub.com



Artist Greg Bacon created this impression of the extrasolar planet XO-1b, recently discovered by a team of professional and amateur astronomers. Courtesy NASA / ESA / Greg

For the first time, amateur astronomers have made a major contribution to the discovery of a transiting extrasolar planet. Such planets periodically cross the face of their parent star, causing a slight dip in brightness that generally lasts several hours. Transiting planets are of particular importance to professionals because the scientists can pin down their masses and diameters. Better yet, follow-up studies with space telescopes such as Hubble and Spitzer can reveal information about the planet's temperature, atmospheric composition, and cloud coverage.

Professional astronomer Peter McCullough (Space Telescope Science Institute) led the discovery team, known as the XO Project. McCullough and his colleagues monitor the brightnesses of tens of thousands of relatively bright stars (brighter than 12th magnitude) every clear night with two automated 200-millimeter telephoto cameras on Haleakala, a volcano on the Hawaiian island of Maui. The team uses CCD

detectors and sophisticated software to identify potential planet transits from the vast amount of data.

In June and July 2005, four amateur astronomers (Ron Bissinger in California, Bruce Gary in Arizona, Paul Howell in Maine, and Tonny Vanmunster in Belgium) carefully monitored one of the most promising candidates identified by XO: a magnitude-11.3 solar-type star in Corona Borealis named GSC 02041—01657. The amateur observations revealed the telltale periodic dips of a transiting object only 30 percent larger than Jupiter. The star decreases in brightness by 2 percent for 3 hours every 3.9415 days — the companion's orbital period.

To make sure the transiting object was a planet and not a low-

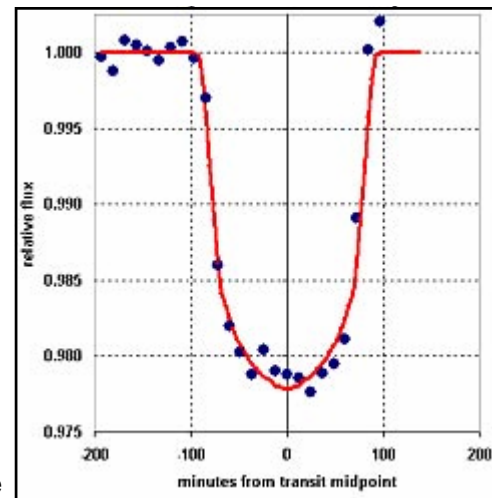


The XO Project uses this inexpensive "telescope" (a pair of 200-mm f/1.8 telephoto camera lenses) to monitor the brightnesses of tens of thousands of stars every night. The lenses are attached to CCDs, which can measure slight dips in star brightnesses that reveal a transiting planet. The telescope is on the summit of Haleakala, a volcano on Maui. Courtesy

mass star or brown dwarf (which are about the same size as a gas-giant planet), McCullough conducted follow-up spectral observations with two telescopes at the University of Texas's

McDonald Observatory. Sure enough, the spectra proved that the star wobbles back and forth slightly as it's being tugged by a companion with  $90 \pm 7$  percent of Jupiter's mass. The XO team had bagged its first planet, which it has named XO-1b.

The amateurs could not have discovered this planet without my telescope telling them where to look," says McCullough. "But when they found the drops in brightness of XO-1, that was important. We probably could have done this eventually without their assistance, but it certainly accelerated the proc-



Amateur astronomer Ron Bissinger obtained this light curve on the night of June 22-23, 2005. The light curve clearly records the dip in brightness of the host star, XO-1, during a transit. Courtesy Ron Bissinger.

(Continued on page 10)

## Giant Crater Found: Tied to Worst Mass Extinction Ever

By Robert Roy Britt, Space.com

An apparent crater as big as Ohio has been found in Antarctica. Scientists think it was carved by a space rock that caused the greatest mass extinction on Earth, 250 million years ago.

The crater, buried beneath a half-mile of ice and discovered by some serious airborne and satellite sleuthing, is more than twice as big as the one involved in the demise of the dinosaurs.

The crater's location, in the Wilkes Land region of East Antarctica, south of Australia, suggests it might have instigated the breakup of the so-called Gondwana supercontinent, which pushed Australia northward, the researchers said.

"This Wilkes Land impact is much bigger than the impact that killed the dinosaurs, and probably would have caused catastrophic damage at the time," said Ralph von Frese, a professor of geological sciences at Ohio State University.

### How they found it

The crater is about 300 miles wide. It was found by looking at differences in density that show up in gravity measurements taken with NASA's GRACE satellites. Researchers spotted a mass concentration, which they call a mascon—dense stuff that welled up from the mantle, likely in an impact.

"If I saw this same mascon signal on the Moon, I'd expect to see a crater around it," Frese said. (The Moon, with no atmosphere, retains a record of ancient impacts in the visible craters there.)

So Frese and colleagues overlaid data from airborne radar images that showed a 300-mile wide sub-surface, circular ridge. The mascon fit neatly inside the circle.

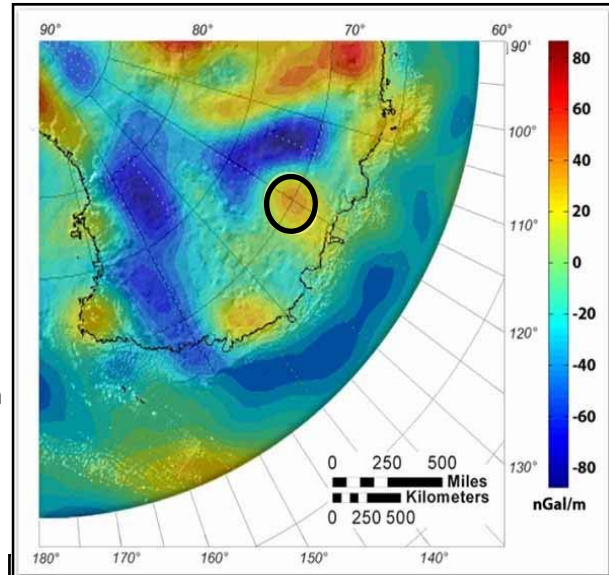
"And when we looked at the ice-probing airborne radar, there it was," he said today.

### Smoking gun?

The Permian-Triassic extinction, as it is known, wiped out most life on land and in the oceans. Researchers have long suspected a space rock might have been involved. Some scientists have blamed volcanic activity or other culprits.

The die-off set up conditions that eventually allowed dinosaurs to rule the planet.

The newfound crater is more than twice the size of the Chicxulub crater in the Yucatan peninsula, which marks the impact that may have ultimately killed the dinosaurs 65 million years ago. The Chicxulub space rock is thought to have been 6 miles wide, while the Wilkes Land meteor could have been up to 30 miles wide, the researchers said.



Gravity fluctuations beneath East Antarctica measured by GRACE satellite. The location of the Wilkes Land crater is circled (above center). Credit: Ohio State University

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ess. And it's much more fun to do it this way."

"Over several weeks, one by one, I worked through the candidate list and reported negative findings back to the team," writes Bissinger on his Web site. "But as my computer displayed a light curve on the morning of June 23, 2005, after my telescope and CCD camera took 337 one-minute images of one particular candidate throughout the night before, there was little doubt in my mind that a new exoplanet had been discovered."

XO-1b is the tenth exoplanet known to transit its star, and it's one of five whose stars are bright enough to enable detailed follow-up study. The planet is approximately 0.05 astronomical unit from its host star (1/20th the Earth-Sun distance), making it a "hot Jupiter" that is almost certainly unable to support life.

The star itself is a near-identical twin of the Sun, adding to the scientific interest. The planet's diameter is  $1.3 \pm 0.1$  Jupiters, and its density is only about 50 percent that of water, meaning it's less dense than any of the solar system's planets. The only transiting exoplanet with a lower density orbits the star HD 209458. McCullough has been awarded time on the Spitzer Space Telescope to learn more about the system and perhaps detect heat radiation from the planet itself, and he has applied for time on the Hubble Space Telescope.

McCullough also notes that further observations may reveal variations in the timing of the transits, which would indicate additional planets in the system perturbing the orbit of the transiting object. This method could, in principle, yield the discovery of Earth-mass planets around stars with transiting planets, if those planets are in resonant orbits with the transiting planet.

"I hope this announcement will attract other people interested in doing this," says McCullough. While he notes that it's relatively easy for amateurs to detect the transits of XO-1b with almost any telescope and CCD, they need to be able to measure the brightnesses of stars to an accuracy of a few millimagnitudes per measurement to contribute to the XO project. The spectral-type G1 star, which is roughly 650 light-years from Earth, is located at right ascension 16h 02m 11.83s, declination +28° 10' 11.3" (J2000.0).

"It's pretty exciting to be part of this project," says Bissinger, who has caught the transits of four other exoplanets. "Hopefully this will help recruit more amateurs to do science with their scopes."

"It's very exciting to see some well-known amateurs coming in as coauthors on such an important discovery," says Greg Laughlin (University of California, Santa Cruz), who has helped organize the Transitsearch.org amateur network for exoplanet transit searches. "The photometry that they are getting is extremely good, and they constitute a very flexible network that can be effectively tapped by projects like XO. I'm really happy to see that the system is working."

The discovery paper has been accepted for publication in the *Astrophysical Journal*.

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### **Confirmation needed**

Postdoctoral researcher Laramie Potts assisted in the discovery.

The work was financed by NASA and the National Science Foundation. The discovery, announced today, was initially presented in a poster paper at the recent American Geophysical Union Joint Assembly meeting in Baltimore.

The researchers say further work is needed to confirm the finding. One way to do that would be to go there and collect rock from the crater to see if its structure matches what would be expected from such a colossal impact.

## Extrasolar-planet hunters find triple-Neptune system

NewScientist.com, Hazel Muir

A trio of Neptune-sized worlds has been spotted circling a star 41 light years away, in the southern constellation Puppis. One of the planets is by far the smallest ever found in the “habitable zone” of a Sun-like star, where liquid water could exist.

“The astronomer’s dream would be to be able to study the composition and structure of these planets to see exactly what they look like,” says Christophe Lovis from the Geneva Observatory in Switzerland, whose team made the discovery.

Future space-based missions like NASA’s Terrestrial Planet Finder and the European Space Agency’s Darwin project could realise that dream in 15 to 20 years. Over the past decade, astronomers have discovered about 170 planets orbiting stars beyond the Sun. More than 40 lie inside multiple systems – containing two planets or more.

But so far, all these multiple systems have been dominated by at least one Jupiter-mass giant. Now Lovis and his colleagues have found a more petite multiple system containing three Neptune-sized worlds, and no whopping Jupiters.

### Habitable zone

The team discovered the planets by monitoring their parent star for two years using a 3.6-metre telescope at La Silla Observatory in Chile. The parent star, HD 69830, is about 80% as massive as our Sun and is significantly dimmer.



The star “wobbles” due to the gravitational pull of the planet family orbiting around it. The team’s observations suggest the star has three planets, all of which lie closer to their star than the Earth does to the Sun. Their masses are at least 10, 12 and 18 times that of the Earth, respectively. Lovis suspects the two innermost planets are rocky and blisteringly hot. But the outermost one lies far enough from the star to be in a habitable zone, where liquid water can exist.

### Moon life

“Theoretical models suggest that the third planet may indeed contain large amounts of water,” says Lovis. He suspects it has a rocky core surrounded by a watery layer.

The three planets with masses between 10 and 18 Earth masses circle HD 69830, a star slightly less massive than our Sun (Image: ESA)

However, the planet probably also has a crushing gassy atmosphere. So the water would be in a high-pressure phase at a temperature above 1000° kelvin, hardly conducive to life. “Of course, the planet might have moons on which physical conditions could be favourable for life, but this is just speculation,” adds Lovis.

He says the most exciting aspect of the discovery is that astronomers are uncovering ever-smaller planets in ever-larger orbits, a trend that will eventually reveal clones of Earth. “These discoveries give us a hint that low-mass, terrestrial planets are likely to be very common in our galaxy,” he says.

### Quote for the Month

Perfect as the wing of a bird may be, it will never enable the bird to fly if unsupported by the air. Facts are the air of science. Without them a man of science can never rise.

Ivan Pavlov (1849 - 1936)

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