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MEGAN WATZKE AND KIMBERLY ARCAND

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Gamma-Ray Bursts: Piecing Together a Cosmic Puzzle

ZACH CANO

These high-energy blasts continue to mystify, so astronomers are stepping up their search for the key pieces to the puzzle.

Astronomy in the News

A stationary Martian explorer, double aurora on Saturn, and new results from WMAP — these are some of the discoveries that recently made news in the astronomical community.

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Revisiting History

The Lunar Reconnaissance Orbiter (LRO) image at right never made it into Mercury after it was released in November 2009. But it has lingered on my computer’s desktop ever since.

It’s a photo of the Apollo 11 landing site, taken near high noon and at high resolution. In the image, the Lunar Module’s descent stage is labeled and the footpads of the LM are clearly discernible. Appearing as white specks below the LM are the components of the Early Apollo Science Experiments Package (EASEP). For scale, the image is about 200 meters across. And if you look carefully (assuming the image reproduces nicely), you can see several faint, dark trails in the shape of a sideways “Y”, with one tip at the LM, one tip at the EASEP, and the stem reaching toward Little West Crater. Those are astronaut tracks — human footprints on the Moon.

A wider view of the landing site shows the boulder-strewn area near West Crater that Neil Armstrong had to overfly in order to achieve a safe landing. And on a separate NASA website, you can find LRO images of some of the other Apollo landing sites.

These various LRO photos provide a fascinating snapshot of history. Having lived through the Apollo era, I find it difficult to think of the Moon landings as historical events (never mind “ancient” history, as once described by my young nephew), but so they are for the majority of the world’s population. I look at this image and I remember where I was when Apollo 11 touched down. I remember the scrapbooks I created, complete with photos cut from papers and magazines, and transcriptions of the astronaut’s conversations that I pulled from my (reel-to-reel) audio recordings of the missions. And I definitely remember thinking that I was watching history being made.

It’s not often that we can point to events we’ve lived through and know, with absolute certainty, that we’ve witnessed history in the making. It’s even less often that we’re provided with a pictorial view of historical events that we can calibrate with our memory. And unlike the physical sites of human history on Earth that are quickly eroded to oblivion, the history of our first steps on the Moon will remain there for millennia to come.

Another historic event, albeit of a somewhat lesser magnitude, will take place in Boulder at the end of July. The ASP has teamed up with the Geological Society of America to bring you two superb conferences rolled into one — Earth and Space Sciences: Making Connections in Education & Public Outreach, and Cosmos in the Classroom 2010. Dave Bruning and Andy Fraknoi explain more about Cosmos in Societal Impact, our ad for both conferences is on page 36. I hope to see you in Boulder in late July.

Paul Deans
Editor, Mercury

ON THE COVER
Front: It looks like a rip in the fabric of the space-time continuum. In fact, it’s RCW120, an expanding bubble of ionized gas about 10 light-years across that’s causing the surrounding material to collapse into dense, star-forming clumps. Courtesy: ESO / APEX / DSS2.
Back: Phobos as seen by ESA’s Mars Express on March 10, 2010. Its multitude of parallel grooves is obvious, but their origin is not. At first it was thought they radiated away from Stickney, the largest crater on Phobos. The latest idea is that they’re impacts of ejecta thrown up by an asteroid strike on Mars (“N” marks the North Pole.) Courtesy: ESA / DLR / FU Berlin.

The Astronomical Society of the Pacific increases the understanding and appreciation of astronomy by engaging scientists, educators, enthusiasts and the public to advance science and science literacy.
Moveable Feasts

We are still tied to the sky in ways that matter.

It's rainy tonight as I write this in late March, and though I can only see the Moon's play of light on the passing wet clouds, I know it's the night of the Paschal Moon, That is to say, it's the first full Moon of spring that determines both the dates of Passover and Easter*. And consequently for the Christian world, it pins down a whole slew of “moveable feasts,” whose dates must align with that of Easter.

That's what comes from holding allegiance to the Moon, which bounces feast days about the solar calendar as a result of division. The lunar cycle doesn't go into the solar cycle a whole number of times, and so the lunar calendar with its remainders — superimposed on the solar calendar that normally rules our lives — instills variety from year to year. While Christmas — anchored to a date in the solar calendar — sits still, each year we have to look up just when some of these other celebrations will fall. Variety is thus still the spice of life, and the sky is still an intervener in our everyday affairs.

I'm glad for the cosmic tethers that are otherwise so often lost in the light-polluted hubbub of our overbooked, twittered, and too-busy lives. It's good for celestial imperatives to still tap us on the shoulder from time to time; sometimes we just need to be reminded of where we come from, how we got started, and why it's important to know.

These days, location can link us to the sky every bit as much as our datebook, for most of us have to be “moveable” as well if we really want to see the kind of sky that made it an essential feature of our ancestors’ lives. For me, one of those locations is Yellowstone National Park, a singular square of rugged landscape jammed (mostly) into the upper left-hand corner of Wyoming, where it was enough out of the way and sufficiently undevelopable to be preserved for posterity in something akin to its original form (though Ken Burns’ PBS special on the national parks points out how close we came to losing it as such).

Some years ago in another professional life, when I lived and worked in Bozeman, Montana, a mere 90-minute drive from Yellowstone, I worked with the Park’s interpretation division to set up a modest program called “Stars Over Yellowstone.” For several weekends every summer, when the Moon was setting early or rising late, I and my planetarium colleagues and local amateur astronomers would head down to make the point that among the notable natural resources of the area — canyons and waterfalls, bison and bears, Old Faithful and hundreds of other geothermal features — was another: the dark sky stretching overhead on every clear night.

By day we would conduct solar observing at Old Faithful where we could easily drum up a crowd (this was back in the days when the Sun still had spots!). By night, we would convene at a park campground to present “ranger talks” dipped in astronomy, and then usher the crowd to the nearest parking lot, meadow, or lakeside to peer through our battle line of telescopes that ranged in aperture up to 20 inches.

There, while meteors flashed, laser pointers crisscrossed the sky pointing out constellations, and the Milky Way — bright and grainy and clotted with clusters and nebulae — rose to arch over our heads, we gathered the light of the universe and filled the eyes of our visitors with its glories. We roamed the spiral arms of the Whirlpool Galaxy, the three-dimensional clutch of the Hercules Cluster, the languard Ring Nebula with its doughnut hole, the

*The Paschal Moon is the first full Moon that falls on or nearest to Easter Sunday. The date of Easter is determined by the date of the Paschal Full Moon and its position in the lunar calendar.
diamonds that make up Mizar or the double-jeweled Albireo, the
glowing puff of the Lagoon Nebula, whatever planets were oblig-
ingly on hand, and as many other sights as we could manage to
reveal to the appreciative campers who “oohed” their way from one
telescope to another.

And it was glorious. When the crowd finally yawned and shuf-
fled off to tents and campers, we telescopists continued, swinging
our scopes this way and that, finding the more esoteric and elusive
celestial subjects, not wanting to leave the black and bristling sky,
until the Moon rose or fatigue overtook us and we, too, packed
up and reluctantly left the night to wheel on its own over our
wilderness camp.

Though I am now years removed from running the program, it
continues through the good offices of others, and I still try to get
back every summer to help out, to soak up the gratifying enthusi-
asm of park visitors for the opportunity to revel in another natural
resource, and to get my annual fix of that magnificent sky. For it
always reminds me that the whole sky is a moveable feast, revealing
its wonders in annual progression as the seasons shift and the
Earth trundles in its orbit around the Sun.

At the ASP, we continue the process of encouraging such celes-
tial connections for people — in a similar way, in fact, through our
NASA-funded program called “Sky Rangers.” With it we conduct
professional development experiences, both online and in national
parks, to help park rangers and nature center educators increase
their capacity to introduce their own visitors to the wonders of the
natural resource that lies above. Through such efforts, your Society
perseveres in its mission to use astronomy as an avenue to ignite
the wonder and curiosity of people for the world around them, and
to see science as a way to make deeper connections to it.

The sky still matters, and not just for scheduling appointments.
Let’s all work to remind people of that, and to encourage both the
understanding and the celebration of the moveable feasts that
punctuate our lives: the natural rhythms of Earth and sky that
order our days — and nights.

JAMES G. MANNING is the Executive Director of the
Astronomical Society of the Pacific.

*For Passover and Easter, technically it’s the date (not the Moon)
that counts in a complex interplay of Golden Numbers, ecclesiasti-
cal rules, and tables that Church officials use to determine the date
of Easter Sunday. But it is based on the lunar cycle, and the key
paschal milestone seldom strays by more than a day from the date
of the first full Moon after the start of spring. ☼
Thirty years ago, in the May-June 1980 issue of *Mercury*, David Morrison described what we had learned about Jupiter’s satellites from the Voyager spacecraft flybys of the previous year. At that time Jupiter had 14 known moons [as of this writing there are 62], including a new one discovered by the Voyagers. A great deal has been learned about the four largest: Io, Europa, Ganymede, and Callisto, and since then the Galileo spacecraft (1995-2003) contributed even more to our knowledge (see page 32). But the Voyagers gave us our first close look at these moons and showed us how individual they are.

The Voyagers were launched within about two weeks of each other in 1977. Voyager 1 reached the giant planet on March 5, 1979; Voyager 2 on July 9, 1979. Each flew past Jupiter, sending back spectacular images of the planet as well as the satellites, and then continued on out of the solar system, never to return. But the results of these flybys altered forever our view of the four large Jovian moons.

Morrison discussed each, beginning with the outermost. “Callisto is the least active geologically of the Galilean satellites. Basically a dead world, it bears the scars of innumerable meteoric impacts, with virtually no sign of major internal activity…The density of craters is very high…Geologists on the Voyager Imaging Team estimate that it would require about four billion years to accumulate this many craters. They therefore conclude that Callisto has been geologically inactive since near the time of its formation.” Large craters were absent, but there were signs of huge impact basins, surrounded by many concentric bright rings. These appeared to be “the characteristic geologic feature on an ice-rock planet.”

Scientists expected that the next and largest satellite, Ganymede, would be similar to Callisto. But its surface turned out to be “one of great diversity, indicating differing periods of geologic activity.” There were heavily cratered areas but also regions with “many straight, parallel lines of mountains and valleys,” which came to be called grooved terrain. In some places the ridges crisscross each other, suggesting several different mountain-building events. Some features might have been formed by “breaking or faulting of the crust,” and in a few cases there were signs of sideways movement along faults, similar to the drift of continental plates on Earth. This sort of activity had never been seen on another planet. Ice was also found on the surface.

Voyager’s views of Europa caused much discussion. Scientists already knew, because of its very high reflectivity, that Europa was almost completely covered with ice. But though the images revealed no obvious impact craters, “numerous thin, straight dark lines crisscrossing the surface, some extending up to 3000 km in length” were seen, some only a few kilometers wide. They had no topographic relief, so they were not actually cracks in the surface. There were also light streaks in the shape of "scallops or cusps." Morrison wrote that: “The geology of Europa remains beyond our understanding. Presumably there is a thick ice crust, perhaps floating on a liquid water ocean. Presumably, also, there is sufficient heat coming from the interior to have produced cracking or motion in the ice crust,” thereby causing the streaks. But the actual mechanism was unknown.

Io offered perhaps the biggest surprise: a large number of active volcanoes, with “brilliant reds and yellows on the surface [which] suggest the presence of sulfur.” Some of the volcanoes were emitting plumes even as the Voyagers flew past. The heat source for these eruptions was thought to be tidal effects on Io from Jupiter and the other large satellites. Io also interacts with Jupiter’s magnetosphere, producing “a donut-shaped volume, or torus, of plasma that originates at the satellite.” Gas atoms from Io lose their electrons, which are captured by Jupiter’s spinning magnetic field to form this torus. Morrison concluded his article by noting that Io is “the only planetary body known to be more geologically active than the Earth,” and truly “a remarkable world.”

Another very successful spacecraft, Galileo, swung into orbit around Jupiter in 1995 and continued observations until 2003. It found evidence for an ocean of salt water under the ice layer on Europa, leading to speculation about the possibility of life there; it also found a deeper salt-water zone in Ganymede and Callisto. Ganymede was discovered to have a magnetic field, and a surface formed by high tectonic activity. Galileo confirmed that Io’s volcanic activity might be one hundred times greater than Earth’s. Morrison was quite right when he said that these are fascinating and individual objects.

**KATHERINE BRACHER** taught astronomy at Whitman College in Walla Walla, WA, for 31 years. Retired in 1998, she currently lives in Austin, Texas. Her research focuses on eclipses and the astronomy of the ancient world; her other principal interest is early music.
Sir Isaac Newton is famous for many things, including the discovery of the nature of light and the invention of the reflecting telescope. So it may come as a surprise to learn that his studies of light were flawed, and correcting them took more than a century — to the detriment of astronomy.

Newton’s notebooks record an early version of his famous 1665 prism experiment, when he saw that light rays passing through the prism “cast colours on the opposite wall.” Once his results became known, others tried to replicate his results, but not all of them came out the same. Newton always insisted publicly that he found the spectrum five times as long as wide, even though his own 1665 observation showed it three times as long as wide.

Some researchers found a different ratio than 5:1, and when they suggested the specific nature of the glass used was responsible, Newton dismissed the claim. He said the dispersive powers of all transparent media were equal.

It did occur to Newton that different media might have different dispersive powers, and he tried an experiment with a prism of water. But he added sugar of lead (known today as lead acetate) to the water, which unfortunately gave it the same dispersive power as glass. Thus, he failed to detect a difference in the lengths of spectra by water and glass.

In exasperation at the mere suggestion he was mistaken, Newton wrote in 1676: “I see a man must either resolve to put out nothing new, or to become a slave to defend it.”

One of the reasons Newton developed the reflecting telescope, which uses mirrors, was to get away from refracting telescopes, which use lenses that are subject to both chromatic and spherical aberration and distort the image. Nearly one hundred years passed before John Dollond rescued the refracting telescope from the visual nightmare of aberration. In 1789 his son Peter published: Some account of the discovery, made by the late John Dollond, which led to the grand improvement of refracting telescopes, with an attempt to account for the mistake in an experiment made by Sir Isaac Newton.

The Account concludes that if Newton’s “prism had been made of glass of a greater or less density, he would certainly have then made the discovery, and refracting telescopes would not have remained so long in their original imperfect state.”

The invention of the achromatic lens has always been attributed to John Dollond (1706-61), and he was granted a patent for the invention in 1758. But papers in the Patent Office in London reveal a deeper story.

In 1764 a petition was lodged, signed by nearly every optician and mathematical instrument maker in London. It alleged not only that a lawyer named Chester Hall (1704-71) had invented the achromatic lens, but that Dollond actually stole the idea from Hall. Dollond’s patent was not overturned. But based on the evidence, the judge agreed that Hall was the true inventor. Hall’s mistake was in not publicizing the discovery and applying for his own patent. This case set a precedent in patent law, which has been followed every since.

It’s interesting to realize that Newton also made an error regarding polarized light. The study of polarized light is yielding a great deal of information about astronomical objects. For example, polarizing filters on the Hubble Space Telescope are helping reveal how planets grow from tiny dust grains.

In December 1819, John Herschel, son of the famous William Herschel who discovered Uranus, presented his first paper to the Royal Society. Sir Joseph Banks, the formidable President of Royal Society, was not easily impressed, but he wrote that the paper caused a stir among mathematicians, and “much interest among the Polarizers.”

Herschel’s paper was based not on theoretical work but on the same sort of experimentation so favored by Newton. Examining the colored fringes produced by biaxial crystals, Herschel saw that the patterns produced when exposed to polarized light did not correspond to what Newton observed, and could not be accounted for by any theory. While this early paper showed his acceptance of the particle theory of light, a more mature study published in 1828 saw him lean towards the wave theory.

How precocious of Herschel to correct Newton on the subject of polarized light in his very first paper! Herschel’s findings reignited the debate about the dual nature of light — particle or wave — a debate that continues in the 21st century.
Astronomy with Digital Cameras

Both point-and-shoot and DSLR cameras can do real astronomy — without a telescope!

I recently acquired two new digital cameras, one point-and-shoot and one digital single-lens-reflex camera (DSLR), and I began to wonder if these could be used for more than simple astrophotography. A search of the SAO/NASA Astrophysics Data System Abstract Service using the key words “digital camera” and “DSLR” yielded some interesting astronomical projects that can be done using just a camera and a tripod! These projects run the gamut from simple astrometry laboratory exercises to calculating orbital velocities and photometry of variable stars.

Let’s start with the humble point-and-shoot camera. Most cameras of this type do not allow users to save RAW images, and all the pre-processing that accompanies jpeg-type images make these cameras unsuitable for photometric measurements. However, images from these cameras can be used for astrometry projects. In a 2006 article, Stephen Hughes of Queensland University of Technology describes a technique to measure the orbital period of the Moon to within 0.7%. This project requires the use of a digital camera, tripod, and two images taken about 24 hours apart. Hughes uses this project in a junior-level experimental physics class.

For planetary astrometry, we need to step up to a DSLR. In 2008, Jan-Peter Meyn published an article “Observation of planetary motion using a digital camera” in which he describes the use of a DSLR with a 50-mm lens, mounted on a tripod, to measure the motion of the planets Mercury, Venus, Mars, Jupiter, and Saturn. This technique also requires only two images, because planetary motions can be discerned within a 24-hour interval.

Why use such a simple setup to observer lunar and planetary motion? Well, consumer digital cameras are inexpensive, readily available, and designed for use by anyone. Thus, the technical learning curve for data collection is very small. And yet, the CMOS or CCD sensors used in these devices share some fundamental traits with professional astronomical CCDs. So students can learn all the essential aspects of astronomical CCD imaging such as determining physical pixel size, calculating the angular field of view, and determining angular resolution.

DSLR sensors (whether CMOS or CCD) have two traits essential to astronomical CCD cameras: a linear response to photon counts over a broad range of their sensitivity (when images are recorded in RAW format) and a digital readout. This, however, is where the similarity ends. Almost all DSLRs have a feature known as “anti-blooming” which automatically protects against overexposure or “saturation” of pixels. This feature will ultimately destroy the linear response if one is not careful to limit exposure times. Compared to astronomical cameras, DSLRs have smaller sensors and lower quantum efficiencies. In addition, DSLRs are not cooled but operate at ambient temperatures. Finally, DSLR sensors have a Bayer mosaic pattern of red, green, and blue filters deposited directly onto the sensor.

In 2007 John E. Hoot explored the idea that DSLR cameras might be capable of photometric measurements. Hoot, a consulting engineer and long-time amateur astronomer, extensively tested the properties of DSLR cameras. He found that the green filters on DSLR cameras closely approximate the photometric Johnson-Cousins V band, and that DSLRs can be used to perform milli-magnitude differential photometry. This is all with the proviso that the target and comparison stars are within less than 2.5 magnitudes of each other in brightness, and that all exposure times are short enough to ensure that the camera’s response stays linear. Hoot concluded that such systems lend themselves well to large surveys.

Amateur astronomer Des Loughney of Edinburg, Scotland, has performed DSLR photometry on two eclipsing binary stars (AO Cas, and Rho Cas) and on the mysterious Epsilon Aurigae. Actually, the AAVSO organized a DSLR Photometry Workshop for Epsilon Aurigae, and the campaign is still accepting data from observers. In addition, Donald Collins and Anesh Prasai have used a DSLR to record the intrinsic variability of the eclipsing binary Beta Lyrae.

Bright variable stars pose a challenge for telescope-based CCD systems, because their light quickly saturates the detector, and the system’s field of view is generally not large enough to contain a suitable, nearby comparison star. A sturdy tripod with a modest DSLR and standard lens costs less than $1,000 these days, and this setup has the advantage of being perfectly useable for daytime photography as well. Then, there’s also the ease of setup.

Admittedly, the details of data reduction are not exactly straightforward; nonetheless, there are several resources available on the Web. Interested? Check out the Citizen Sky DSLR webpage to get started!

JENNIFER BIRRIEL is an Associate Professor of Physics in the Department of Math, Computer Science & Physics at Morehead State University in KY. If you’re using digital cameras in your physics or astronomy labs, she’d love to hear about it.
I've spent a lot of hours these last two months on a habitable moon of a gas giant planet in the Alpha Centauri system. I won't tell you how many times I saw Avatar in IMAX 3D (more than you could count on the fingers of two Na'vi hands), but suffice to say I did my part to help this movie sink Titanic in box office sales. Ever since walking out of the theater on opening night just speechless in response to the majestic beauty of Pandora and the photorealism and realistic diversity of the lush biota of that moon, I've wanted to go back again and again to explore this place in more depth.

Both the scientist/explorer and the artist in me were immediately captivated by what James Cameron — and the entire talented team that brought Avatar to the screen — had created. As I've written at least once already in this column, I was drawn to planetary science as a young teenager by a fascination with the nearly infinite potential variety of extrasolar planets and the life forms that must surely inhabit a great many of them (see, for instance, “Water Worlds among Hot Jupiters,” Mercury, Nov/Dec 2006). In Avatar, I feel I've finally been able to explore one of those worlds in a level of immersive detail that fully satisfies — both intellectually and aesthetically.

To continue to feed that insatiable appetite for exploring new worlds though, we need not limit ourselves to longing for a rain-forest moon that exists only in imagination. The very real planetary wonders regularly revealed through ongoing exploration of our own solar system, and newly discovered at an ever-increasing pace around other stars, offer a limitless screen for projecting that inherent need to find out what's over the next hill.

And, even better for those who wish to experience such places and phenomena in person, we need only look right here, on our own beautiful blue planet, to find the kinds of wonders, both geological and biological, that inspired the artists who brought Pandora to life.

You want mountains in the sky? Zhangjiajie National Forest Park lies in the northern part of China's Hunan Province, some 500 miles north of the Li River (and some 540 miles NNW of Hong Kong). This fantastical place offers some of the most dramatic mountain scenery on the planet, with stunning cloud-draped pinnacles of tree-capped sandstone. The conceptual artists who helped bring Cameron's visions of Pandora's levitating Hallelujah Mountains to life drew inspiration from high terrain around the world, especially the spires of Zhangjiajie. One of park's iconic pillars, the 3,544-foot Southern Sky Column, has now even been officially renamed “Avatar Hallelujah Mountain” in honor of its special role in establishing the visual 'look' of Pandora's legendary floating mountains.

You want bioluminescent biota? You don't have to descend to the inky depths of the ocean to see the sort of luminous organisms that clearly have made an impression on Cameron during his submarine explorations. Near the western coast of New Zealand's North Island, a world-famous limestone grotto is home to the Waitomo glowworm, the larval form of a type of fungus gnat (Arachnocampa luminosa) unique to the islands of New Zealand. Thousands of these hungry little glowworms radiate a cool luminescent blue-green light to lure flying insects into a trap of sticky silken threads that they dangle into the darkness of the cavern. This living stary spectacle is one of the more accessible examples of a multitude of bioluminescent biological phenomena that grace our planet from the deep ocean to temperate forests.

I've seen and hiked through some truly amazing geologic structures and vistas across this planet, the stuff national parks and world heritage sites are made of. From deep, colorful canyons to vast seas of dune sands and towering snow-capped volcanoes, our planet is chock full of visions of grandeur that have inspired legends.

Even more awe-inspiring to me are the ubiquitous biological treasures that make ours a truly living world. Trees that tower more than one hundred meters, beetles adorned with every iridescent color in the rainbow, and myriad glowing submarine organisms that look truly alien to our terrestrial eyes, are miracles of more than four billion years of evolution and natural selection.

So as the credits roll on your nth viewing of Avatar, and you walk out of the theater as rapt as you were the first time you saw the movie, remember that the real world you're returning to is every bit as awe-inspiring as Pandora.
Astronomers are still in a fog about the fog of gamma rays that fills the universe. In fact, they know less now than they did before the 2008 launch of NASA's Fermi Gamma-ray Space Telescope, when they were gleefully confident with their assumptions about the source of the so-called gamma-ray background.

If you had asked astronomers a year ago what generates the blanket of gamma rays that fills the sky from beyond our galaxy, most would have said galaxies with active supermassive black holes. And why not? When in doubt about the culprit, you can always blame it on a black hole, particularly when you're talking about gamma rays, the most energetic form of electromagnetic radiation. After all, the most powerful known sources of gamma rays are black holes, so the gamma-ray background, many assumed, must be the cumulative glow of a universe full of black holes. What else could it be?

Well, thanks to a year's worth of Fermi data, we now know that only about one third of this background can be from supermassive black holes. The rest — is anybody's guess. As announced at the meeting of the American Astronomical Society's High-Energy Astrophysics Division in March in Waikoloa, Hawaii, the official answer is a collective shrug of the shoulders and a "beats me."

The discovery, or perhaps better worded as a lack of discovery, has taken some scientists by surprise. It usually doesn't work this way. The X-ray background, you might recall, turns out to be from innumerable point sources, all black holes.

Marco Ajello, an astrophysicist at the Kavli Institute for Particle Astrophysics and Cosmology, set out to resolve the gamma-ray background — arguably one of the last uncharted wavebands — using the first year of Fermi data from the satellite's Large Area Telescope (LAT). This boxy instrument soaks up gamma rays with each 95-minute orbit around the earth, mapping the entire sky every two orbits. Ajello and his colleagues first carefully removed gamma rays from within the galaxy from the Fermi all-sky map. Then they compared emission from active galaxies that Fermi detected directly against the number needed to produce the observed extragalactic background.

Extrapolating to fainter sources, Ajello found that these black holes — sometimes called blazars or AGNs for active galactic nuclei — could at best only add up to about one third of the isotropic intensity that the LAT sees.

"So what is the remainder of this radiation? It is pretty much wide-open territory at the moment," said Fermi Deputy Project Scientist Dave Thompson of NASA's Goddard Space Flight Center in Greenbelt, Md. "There have been a variety of models around, ranging from normal galaxies to some really exotic processes."

Exotic? Yes, dark matter is on the table. "Dark matter may be a type of as-yet-unknown subatomic particle," Ajello said. "If that's true, dark matter particles may interact with each other in a way that produces gamma rays [and] its signature [may be] hidden in many of the observations performed by Fermi. We just need some time to work on that."

No one is ruling out the elusive dark matter signature, said Charles Dermer, a member of the Fermi collaboration at the Naval Research Laboratory in Washington, D.C. At best, though, this would make a limited contribution, he said, because we haven't yet seen such signatures in, say, dwarf spheroidal galaxies, thought to be the best type of galaxy for detecting dark matter annihilation.

Dermer is among the few scientists not terribly surprised by Ajello's result, because he predicted something similar in 2007 using data from Fermi's precursor, the Compton Gamma Ray Observatory.

"My bet is that [the gamma-ray background] is due to the superpositions of cosmic-ray induced radiations from star-forming galaxies," said Dermer, co-author of the 2009 book High Energy Radiation from Black Holes. "Besides the Milky Way and the Large Magellanic Cloud, we now detect starburst galaxies M82 and NGC 253, and simple estimates show that the many, individually weak star-forming galaxies can make a larger contribution than the few, very bright blazar active galaxies."

"Clusters of galaxies are probably contributing at some level, too, although we have not detected any cluster individually yet," said Seth Digel, an experimental physicist at Stanford Linear Accelerator Center (SLAC), who performed the bulk of all-sky map simulations during LAT's development. "I don't think that we are near a crisis in terms of lacking plausible explanations for the isotropic intensity."

No crisis, indeed, as long as astronomers remain imaginative. Ajello marked the unknown portions of the Fermi all-sky map with dragons, recalling those ancient maps when most of the seven seas were largely unknown. Considering gamma-ray energies, the source of the background, whatever it may be, will surely resemble a fire-breathing demon in some way.

Freelance health and science writer CHRISTOPHER WANJEK missed the five-foot surf waves at the HEAD meeting in Hawaii and instead confronted five-foot snow drifts at his home in Baltimore.
College professors shake their heads every fall: Incoming students seem to be less prepared each year for the rigors of college, much less for the workplace if they graduate. After 12 years of schooling, students struggle to achieve competency in basic reading, composition, and math skills. Once in college, students do not attend class, have poor study habits, and spend their time in class texting friends and playing Internet games. Work ethic is almost nonexistent. A recent poll at my institution indicates that students spend as little as two or three hours of study each week across five courses. “What are they teaching them in high school?” complain the professors.

High-school teachers increasingly wrestle with discipline problems, and likewise face poor reading, composition, and math skills. These teachers ignore the complaints about skills from college instructors, because they are too busy wondering: “What are they teaching them in Middle School?” Collectively, K-12 teachers are busy dealing with the ill-conceived, mandated testing of “Every Child Left Behind,” which does little to actually educate students but heartily reinforces students’ impressions that education is about memorizing unimportant ideas and facts.

Parents are frustrated, students are confused as to what learning means, and teachers point their fingers in each others’ directions, trying to place the blame for student failures squarely on the shoulders of others. Politicians cry for accountability and the closure of schools as some students continue to fail standardized tests.

Who is to blame for student failure?

Setting aside the issues that schools cannot succeed in communities where there are few jobs, unstable family settings, and lack of access to health care, simply put: We all are. But I contend that looking to assign blame misses the point entirely. Our students are where they are. Rather than waste time playing the blame game, we all need to do what we can to remediate the skills and attitudes of the students we have. Today’s reality is that the only thing I can control is what students know when they leave my class, not when they enter.

To build success for our skills-challenged students, my institution has started a program where we connect remediation courses with General Education (“Gen Ed”) courses. The idea is to use the Gen Ed course as a model for instruction in reading, writing, and math skills. The skills instructor and the Gen Ed instructor work together to help students develop their learning skills in the context of their coursework, rather than have generic reading or writing exercises. Connection in the remediation class enables the Gen Ed instructor to see a broader picture of student skill levels, and develops personal bridges that foster the trust that many of these students need before they feel they can safely ask questions of the instructor.

This linking of two intersecting groups is called a Learning Community. While my university is in the early stages of developing and implementing these communities, we already have one success: getting the student services staff (remediation instructors) to work together with the Gen Ed instructors. As simple as it sounds, the day-to-day reality is that these two groups generally do not speak with one another on most campuses. Both groups have the students’ best interests at heart, and we are stronger when we can share our skill sets.

Learning Communities come at a price. Meetings are needed between the two sets of instructors; instructor attendance is necessary in some of the remediation classes (and vice versa), instructors have to be willing to (Brace Yourselves!) open their classroom to other instructors, and instructors need to spend more time with students. Of course, all this generally comes with neither added compensation from the university, nor release time from other teaching duties.

With the added teaching load, why am I involved with Learning Communities? I am hoping for something game-changing: a new generation of students who are stronger learners and are better prepared to meet the demands of our rapidly changing world.

DAVID BRUNING teaches astronomy at a midwestern state university.
Anyone Can be an Astronomy Educator

Astronomy education has been around a long time. Cultures and civilizations have long used the stars and constellations to tell their stories, passing down both moral tales and practical information.

In modern times, college professors are one tier of astronomy educators. Astro 101 courses provide that one science course perceived as “easy” by countless non-science college majors. Often, pre-service teachers take these classes, and these Astro 101 graduates become astronomy educators for their elementary and middle school students. Fortunately, the National Science Education Standards and the AAAS Project 2061 deem astronomy important enough to include it in what every student should know.

Science museums and planetariums teach the general public about astronomy. Through their outreach programs, they also teach classroom teachers, who then become better equipped to pass on the astronomy course content to their students.

NASA has long been an astronomy educator. Its efforts switched into high gear about 15 years ago when all of its space science missions began to devote a percentage of their budget (usually in the 1-2% range, but sometimes more) to Education and Public Outreach. This has resulted in a wide variety of astronomy materials and programs being prepared for a wide variety of audiences.

Amateur astronomers play a large role in educating the general public through star parties. A number of clubs also provide workshops for teachers. But they also venture into arenas not immediately obvious. The 200 clubs of the ASP’s Night Sky Network provide astronomy education in a wide variety of venues, including regional and national high school science fairs, malls (including a solar presentation at a tanning salon!), the National Federation of the Blind, a city Symphony, more than a few senior citizens centers, a summer camp for children of incarcerated parents, a 4H group, the Science Olympiad training, and a dozen presentations at inner city libraries.

Consider how you first heard about astronomy or became interested: maybe through a teacher, at a museum, or via an enthusiastic amateur. We meet astronomy educators where we expect to meet them, and the Night Sky Network provides them in some unusual places. We know that some are better than others, and some can be great in front of one type of audience and terrible in front of another.

But there are others who might be our first astronomy teacher: a parent, a sibling, or a friend.

My first astronomy teacher was my father. He told the story of meeting my mother at a party given out in the country by a mutual friend. After it got dark, he took her out to the porch and showed her the stars and constellations. He always joked that he made up the constellations he pointed out to her.

But I know better. When I was young, my father took me out with his little refractor and showed me Saturn and the Orion Nebula. He later explained to me the pictures illustrating Newton’s Laws in The Golden Book of Astronomy. That was all I needed to know that astronomy was the career for me.

And sometimes an astronomy educator might be someone completely unexpected.

Pat Sajak (yes, that Pat Sajak of “Wheel of Fortune”) owns a radio station in Annapolis, Maryland, near where I live. As its owner, he claims the privilege of doing a two-minute piece every week about whatever is on his mind. Always amusing and often insightful, I look forward to hearing his thoughts every Monday morning on my way to work.

Imagine my surprise a couple of months ago when Mr. Sajak said he had been “thinking about the universe.” He talked about how really big the universe is, the countless number of stars in the universe, and prospects of finding life in the universe. And he got it right. In his two minutes, he became an astronomy educator, leaving his listeners with a clear idea about the size of the universe, the distances between galaxies, and his opinions about our searches for life in the universe.

Hearing Pat Sajak made me realize that anyone can be an astronomy educator. We all play a role, and it doesn’t have to be in an expected location. We just never need to forget the simple messages we have about our wondrous universe.

James Lochner is the E/PO Lead for the Astrophysics Science Division at NASA / Goddard Space Flight Center.
The Astronomical Society of the Pacific hosts its annual meeting, July 31 to August 4 inclusive, on one of the most beautiful university campuses in the country: the University of Colorado in Boulder.

With the Flatirons in the foreground and the majestic Rockies beyond, college astronomy instructors and informal educators will encounter scenic vistas as well as stimulating new ideas as they attend two associated symposia: *Cosmos in the Classroom 2010: A Hands-on Symposium on Teaching Introductory Astronomy and Earth and Space Science: Making Connections In Education and Public Outreach: A Symposium for Those Working in EPO*. If your interests overlap between classroom and informal education, you won’t have to choose between meetings — you can sample the best of both.

While the sessions for *Cosmos* and the EPO meeting don’t start until Monday, a hands-on workshop called *In the Footsteps of Galileo* will take place Saturday and Sunday (July 31–August 1) for teachers of grades 3-12. The workshop will appeal equally to veteran and new instructors and will explore how to do age-appropriate, inquiry-based activities in astronomy and physical science. No background in astronomy will be assumed. Participants will receive a Galileo-Scope (a small telescope especially developed for easy student and public viewing); a package of hands-on activities, background information, and resource guides that can be put to immediate use in the classroom; and certification as a Galileo Teacher Ambassador (which provides access to the national Galileo Teachers website and resources).

Both strands of the ASP annual meeting kick off Sunday night (August 1st) with an opening reception at Fiske Planetarium. Fiske has a Zeiss VI projector and is the largest planetarium between Chicago and Los Angeles.

*Cosmos in the Classroom* started in 1996 in Santa Clara, California, and has been held every two to four years since (Albuquerque 1998, Pasadena 2000, Boston, 2004, and Pomona 2007). The Boulder meeting will be the sixth *Cosmos in the Classroom* and will take place August 2–4. Whether you are a full- or part-time instructor, university or two-year college instructor, a high school teacher leading an advanced astronomy course, or a graduate student or post-doc preparing for your first teaching assignment, *Cosmos* is the place to learn — from some of the nation’s best astronomy instructors — what to do and not do in the classroom, and more importantly, how to do it.

Each day of *Cosmos* has a mixture of one or two plenary talks, hands-on workshops, poster sessions, and special-interest group sessions. At least two plenaries will be on topics common between the two symposia. Families of meeting participants are invited to a non-technical talk about astronomy on Monday evening, which will be followed by an on-campus star party.

*Cosmos* is known for hands-on workshops. Instead of hearing about a pedagogical tool or a novel lab exercise, you actually engage the learning experience as a student would. Five or six workshops are held concurrently, with some popular workshops offered more
than once to accommodate as many participants as possible.

Another unique feature of Cosmos is the "Share-a-thon," which is an opportunity to share resources without having to present a formal workshop or poster paper. The Share-a-thon also provides a means for participants to pick up materials from workshops they couldn't attend. If you're attending Cosmos, think about sharing a lab exercise, in-class activity, resource list or annotated bibliography, a syllabus for a novel astronomy course, or information about your campus' remote observatory. If you have software to share, the simplest means is to place the software on a website and then bring to the meeting a flyer that includes a short description of the program, some screen captures, and the web address where folks can download the software. If you wish to contribute to the Share-a-thon, please bring 200 copies to share.

Poster sessions are a new and popular feature of Cosmos. At the last meeting, posters ran the spectrum of assessment and inventory tools, education research, lab exercises, novel astronomy courses, electronic media, and much more. Posters in Boulder will be up the entire meeting, which should provide more than enough time to catch up with a poster author.

Yet another novel feature of Cosmos is the Special Interest Group sessions. Like the workshops, five or six are held concurrently. They allow people interested in topical areas to meet other interested parties. In the past, SIG sessions have discussed the future of textbooks, education research, astrobiology, distance education, cultural astronomy, the role of planetariums and robotic telescopes, and accreditation of community college instructors.

Lodging for the meeting consists of two main choices: the Italian Renaissance architecture of the campus residence halls and two off-campus hotels. More information about both options is available on the Lodging webpage. If you are not staying in the residence halls, you can sign up for the optional three-day lunch package that will simplify dining decisions and save time for sharing thoughts about astronomy education.

Due to the generous sponsors of the meeting, registration fees are low and the lodging costs are modest compared to many professional meetings, so most participants should find the meeting affordable. But if your institution's travel budget is strained or nonexistent, scholarships are available to help get you to Cosmos. Awards will be made up to $750 with preference given to instructors from community colleges and non-research colleges and universities, with special consideration to instructors whose institution serves under-represented minority students. Because of the governmental sources, only US citizens are eligible for scholarships. Special thanks to the following NASA projects for the support of the scholarship program: The Center for Astronomy Education at the University of Arizona, Chandra X-ray Observatory, Lunar Science Institute, the Planck Mission, and the Stratospheric Observatory for Infrared Astronomy.

If you can't make it to Cosmos, you can sample the workshops and sessions via the proceedings volume that is published after the meeting and sold through the ASP's AstroShop. Meeting participants like to buy a copy of the proceedings because there are so many workshops and sessions, it just isn't possible to attend them all. Volumes from the 2000 Pasadena, 2004 Boston, and 2007 Pomona meetings are still available.

For more information about both meetings, as well as scholarship application and registration forms, please see the ASP's meeting webpage. Registration for both meetings is now open.

DAVID BRUNING teaches astronomy at a Midwestern state university. ANDREW FRAKNOI is Chair of the Astronomy Department at Foothill College in San Francisco, California. They serve as co-chairs of Cosmos in the Classroom 2010.
Developing and educating our nation’s future STEM workforce and leaders is no small task.

by Michael G. Gibbs
As a cause-based organization, the Astronomical Society of the Pacific (ASP) strives to improve science literacy through the enjoyment of astronomy within the United States and internationally. This mission is implemented by working in partnership with the intermediate communicators who interact and educate both children and the public. This important mission is shared with other organizations that also seek to increase the knowledge of our nation in the fields of science, technology, engineering and mathematics (STEM).

**Developing a Future STEM Workforce**

While the ASP works with numerous organizations that share in its mission, there are still others who continue the pipeline of developing and educating our nation’s future STEM workforce and leaders. One such organization is Capitol College.

Recently, Capitol College established the Center for Space Science Education and Public Outreach. The Center provides hands-on educational and workforce development experiences for K–12, community college, and college students (and those who support them) in achieving leadership careers in STEM fields. The programs are intended to:

a) increase student awareness of career fields that require a college education,

b) provide information on the necessary academic preparation related to STEM courses in high school,

c) provide information on the college admission process and,

d) initiate interest in careers within the STEM fields.

Capitol College is not the only institution of higher education to focus on developing the future STEM workforce. Wheeling Jesuit University, through their Center for Educational Technologies, works to improve both teaching and learning within the STEM fields by designing and creating curriculum supplements and providing professional development for educators. In the state of Maryland, Prince George's Community College established a Collegian Center for STEM education with the goal to “provide a supportive and rewarding environment to encourage, improve and commend student success in STEM and related fields.”

The state of Colorado created the Colorado STEM Network, a grant-funded project with the goal to coordinate the many organizations within the state that focus on STEM education and “bring them together and help bring awareness to their incredible efforts and achievements.” Texas Tech University, through their T-STEM Center, supports in-service STEM educators through professional development, classroom activities, and lesson plans for teachers.

Another example is the NASA Explorer School project that provides curriculum materials along with professional development for in-service teachers, with the goal of improving the teacher's instructional abilities in STEM fields.

There are numerous examples of STEM outreach and professional development programs for both in-service and pre-service teachers. Colleges and universities across the nation concentrate on STEM education and developing the future workforce. So what makes Capitol's program unique?

**Capitol College’s Space Operations Institute**

The mission of Capitol College is to provide a practical education in engineering, computer science, information technology, and business that prepares individuals for professional careers and affords them the opportunity to thrive in a changing world. Capitol College is the only independent college in the state of Maryland dedicated to engineering, computer science, information technology, and business.

One way this mission is implemented is through the college's Space Operations Institute (left). SOI works in partnership with NASA’s Goddard Space Flight Center, and combines the infrastructure necessary to manage satellite operations with an educational program that prepares students for careers in all aspects of space mission operations. The SOI builds upon Capitol’s established engineering foundation, and works closely with NASA to understand the aerospace industry’s changing skill requirements.

The vision for Capitol College is to assist in developing and educating the future leaders in the STEM career fields. Most STEM
centers focus on providing professional development, curriculum materials, and increased awareness of the importance of investing in the future workforce through STEM education. Capitol focuses on developing the STEM leader by utilizing space science, astronomy, and other related areas of study to engage students of all ages — and those that assist them. This vision is being accomplished by working at the state, regional, and national levels; by providing leadership development opportunities (in conjunction with the Capitol College Innovation and Leadership Institute); and by enabling the students to be the future leaders within the STEM fields.

Developing Future STEM Leaders

The need to develop leaders within the STEM workforce has been identified by other organizations as well. California Polytechnic State University hosted a symposium in July 2009 that focused on preparing education leaders to improve STEM instruction within the United States. It was their second annual STEM Leadership Symposium, which fostered “greater discussion in the education field not only on how to prepare more educators who are ready to teach the STEM disciplines, but also how to train administrators to lead the STEM effort and support excellence in teaching and learning.”

Another example comes from East Tennessee State University and their Center of Excellence in Mathematics and Science Education that hosted a 2009 STEM Conference that addressed the leadership challenges related not only to workforce development within the STEM field, but also to the “citizen leaders for our 21st-century democracy.” These are but two examples of other institutions of higher education working to address the national need to develop the future STEM workforce.

Capitol is not the only college or university within the United States to have this focus on STEM education. But it does provide a rather unique vision for STEM education by combining leadership development and practical, hands-on, educational experience by working with NASA through the SOI and the college’s Innovation and Leadership Institute.

The College invites others interested in working in partnership to help advance a true national need. Like the ASP, there are numerous organizations that strive to improve science literacy within our nation. To use a phrase often heard at the ASP: “Together, we can make a difference.”

MICHAEL G. GIBBS is the vice president for advancement and director of the Center for Space Science Education and Public Outreach at Capitol College located in Laurel, Maryland. Gibbs is also a member of the ASP’s Board of Directors and previously served as the ASP’s chief advancement officer. Gibbs can be contacted at mggibbs@capitol-college.edu
Space Operations Institute at Capitol College Backs Up NASA’s WISE Mission

At Capitol College’s Space Operations Institute (SOI), astronautical engineering students will have impressive experience to add to their resume when they graduate. In addition to being the primary operations center for the Tropical Rainfall Measuring Mission (TRMM), the Space Operations Institute and its students now serve as the Backup Mission Operations Center (BMOC) for NASA’s Wide-field Infrared Survey Explorer (WISE) satellite mission.

SOI students are trained to work as the backup WISE Flight Operations Team, working in cooperation with John Hughes, the WISE east coast systems engineer. A major part of the work students perform is to monitor the BMOC computers and ensure that the SOI’s systems will be ready to take over primary operations functions should any problems occur with the primary missions operations center, located at NASA’s Jet Propulsion Laboratory in Pasadena, California.

“Participating in the WISE mission expands on our mission-based educational programs and our successful partnership with NASA,” said Dr. Michael T. Wood, president of Capitol College. “We are pleased to be of service to this important mission while providing a state of the art educational experience for our students.”

To Angela Walters, technical manager of the SOI and associate professor of astronautical engineering, the experiences and skills the students gain as a part of the BMOC are invaluable in helping them achieve their career goals.

“By working on the WISE mission, these students have the opportunity to learn first hand how to build and operate a Backup Mission Operations Center, from writing standard operating procedures and project management, to building computer systems from hardware and network perspectives,” comments Walters. “They are able to work with engineers from NASA Goddard Space Flight Center and the NASA Jet Propulsion Laboratory to learn how the data collected during the WISE mission is being used by scientists.”

As the technical manager of the SOI, Walters mentors student work groups and manages the daily activities of the operations center. She is responsible for teaching team management, software configuration, and mission assurance.

“Certainly backup operations support is important to the WISE mission, but for us to enjoy that support while training and inspiring future ‘rocket scientists’ adds a thick layer of icing to the cake,” says David Leisawitz, WISE mission scientist at Goddard Space Flight Center.

In addition to their regular duties, several students serve as WISE student ambassadors for the college’s Center for Space Science Education and Public Outreach, reaching out to area high schools to talk about the WISE mission and their experience with WISE and the SOI.

“Being part of the WISE mission is an outstanding experience for our students to receive real world workforce development in conjunction with NASA, while their participation in a coordinated national effort to provide educational experiences for K-12 and community college students works to encourage those students to enter science fields,” stated Dr. Michael G. Gibbs, vice president for advancement and director of the Center for Space Science Education and Public Outreach.

Launched in December 2009, the Wide-field Infrared Survey Explorer is a NASA-funded Explorer mission that will provide a vast storehouse of knowledge about the solar system, the Milky Way, and the universe. The unmanned satellite carries an infrared-sensitive telescope that will image the entire sky. Among the objects WISE will study are asteroids, the coolest and dimmest stars, and the most luminous galaxies.

The Space Operations Institute, established at Capitol College in 2002 with a grant from the National Aeronautics and Space Administration, is a consortium of NASA, industry, government and education partners. The Institute combines the infrastructure necessary to manage satellite operations with an educational program that prepares students for careers in all aspects of space mission operations. SOI builds upon Capitol’s established engineering foundation and works closely with NASA to understand the aerospace industry’s changing skill requirements. JPL manages the Wide-field Infrared Survey Explorer for NASA’s Science Mission Directorate, Washington.

— M. G. G.
THE UNIVERSE BROUGHT DOWN TO THE STREETS:

“FROM EARTH TO THE UNIVERSE” PROJECT

Public exhibits in parks, airports, libraries, shopping centers, art festivals, nature centers, and even prisons promote scientific awareness to millions of people worldwide.

by Megan Watzke and Kimberly Arcand
The International Year of Astronomy 2009 (IYA2009) brought an unusual set of opportunities for those of us in the profession of communicating astronomy. How could we contribute to the lofty, yet incredibly important IYA2009 goals that included “stimulating worldwide interest...in astronomy and science”?

Our answer was somewhat simple: put astronomy in unexpected places. Moreover, take advantage of astronomy in its most attractive and accessible form — its spectacular imagery — to introduce the wonders of the cosmos to the widest possible audiences. By treating science akin to art in its presentation, we hoped that people around the world might be introduced to the excitement and intrigue astronomy has to offer.

The resulting project was “From Earth to the Universe,” or FETTU for short. To date, there have been more than 500 FETTU exhibitions in nearly 70 countries on every continent (except Antarctica). In the United States, there have been more than 40 exhibits in 25 states around the country. (A full list of FETTU events is available here.)

FETTU Explained
What is “From Earth to the Universe” exactly? It is a collection of more than 125 astronomical multiwavelength images that were selected from both ground- and space-based telescopes, taken by both professional astronomers and amateurs. These images were curated into an online repository, which could be accessed to “local organizers” around the world to launch their versions of the exhibit in their locales.

Additional educational connections with the materials presented were also encouraged through on-site activities implemented by the local organizers, such as interactions with scientists, educators, and amateur astronomers. This was done through question-and-answer sessions; telescope viewings or visitor “tours”; scavenger hunts; informational takeaways such as exhibit guides, postcards, posters, and other handouts; referrals to online and regional educational resources; and more.

In the United States, many of the FETTU exhibits were funded by a NASA grant that allowed for two large displays in airports (Chicago’s O’Hare and Atlanta’s Hartsfield) as well as a traveling version that has visited nearly a dozen cities including Tucson, AZ, Anchorage, AK, Columbus, OH, Fayetteville, AR, Memphis, TN, Washington, D.C., New York City, and multiple towns in Puerto Rico. Other US FETTU locations in such places as Madison, WI, and the Bay Area in California, also partially funded by NASA, produced highly successful exhibits and corresponding activities.

Throughout the rest of the world, the response — from both organizers who made the FETTU exhibits happen and the public that was able to experience them — has been inspirational. FETTU exhibits have been placed in such locations as the hallways of the Iranian Parliament, outside on a plaza in Reykjavik, Iceland, in an art museum in Shanghai, China, during a space art contest for children in Enayetpura, Bangladesh, throughout many villages in Uruguay, in a prison in Coimbra, Portugal, and at UNESCO World Heritage sites such as Stonehenge in the UK.

It would be impossible to tell all of the stories and experiences we’ve heard tied to FETTU in the past year. In this article, we give a few snapshots of the responses we received from around the world.

New York, New York
FETTU visited the Big Apple twice during the course of IYA2009. The first was during the popular World Science Festival, which was held in early June. FETTU panels were set up in Washington Square Park during the event’s Family Day.

In October 2009, a NASA-funded FETTU exhibit was placed outdoors on the campus of Columbia University, where students and members of the neighborhood community were able to visit. Event organizers estimated at least ten thousand people visited the images, including one philosophy student, Yurina Ko:

“The starry heaven above me and the moral law within me’ filled Immanuel Kant’s mind ‘with ever new and increasing wonder and awe.’ He continued, ‘I see them in front of me and unite them
immediately with the consciousness of my own existence. As I gazed at the photographs of planets, galaxies, nebulae, and clusters in the exhibition “From Earth to the Universe” in front of Butler Library last week, I contemplated what Kant said and wondered whether we forget too often our place, as tiny human beings, in this vast universe...In the end, we are left with 50 images of outer space that we can’t ignore on our way to educating ourselves for a better future. And I almost wish that these photographs were artistic fabrications, so that I can just say, “How pretty,” and keep walking.
Russia
In Russia, the FETTU photo collection was shown, within the framework of an international exhibit of calligraphy, in multiple locations in Moscow. In the fall of 2009, it was shown at the Sokoiniki Exhibition center and at the Crocus Expo exhibition center. It will be featured in the ancient city of Novgorod in 2010.

I first saw FETTU while traveling over Europe. I was looking at those images of planets and star clusters, and I couldn’t believe we — the Earth — are a part of the endless universe. Suddenly an idea leaped in my mind. I thought, “what if someone doesn’t know about this beautiful universe we live in?” The images have not been shown in Russia ever before, so I decided to acquaint the Russians with the ‘FETTU universe’… I would be happy to see such programs in the future! Apart from the educational impact they have, they allow gathering together for the sake of the common interest. We, people, drift apart in nature, which is not good. We forget that we are a part of Nature, but looking at these eternal stars in the sky we, at least for a minute, recall who we are.

— Oleg Vetoshnikov, Head of International and Creative Projects, MVK International Exhibition Company

Canada
There was great support and enthusiasm for FETTU in Canada, and exhibits were launched almost from the very beginning of IYA2009. In Victoria, two digital displays were prominent in a large downtown shopping center and at the Victoria International Airport. These digital incarnations of FETTU, with LCD screens donated by SONY Style, ran for months and allowed thousands of people to see the imagery. The combined efforts of professional astronomers and community organizers led to the successful implementation in their country.

I heard about IYA2009 from Jim Hesser here in Victoria through a presentation he made to the Victoria Symphony where I then worked. I’ve always been keen on astronomy as a layperson for the extraordinary, breathtaking imagery.

— Natasha van Bentum, community organizer and FETTU volunteer

Natasha got this ball rolling and marshaled a set of key partners through her contacts with the business community. Her participation is one of those amazing examples of a non-astronomer becoming inspired by the IYA2009 vision and then enriching their community through volunteerism of the highest order.

— Jim Hesser, Canadian Single Point of Contact for IYA2009

Brazil
One of the truly remarkable FETTU stories from this past year has been Brazil. When we, the FETTU chairs, first started to hear about the efforts going on in this country, we were astounded. To date, there have been approximately 250 versions of FETTU throughout Brazil. The local organizers also raised enough funds to send copies of FETTU to other countries such as Angola, Mozambique, and Uruguay.

The sheer volume of images produced guaranteed that untold numbers of people were able to experience the universe,
perhaps in ways they never otherwise would be able to do.

I heard about FETTU plans since the beginning…and I realized
that this would be one of the most important global projects for
my community…The FETTU exhibitions (we call them “Cosmic
Landscapes: From Earth to the Big Bang”) had an impact on the
Brazilian public that was much bigger than we expected at the
beginning… They travelled to distant schools and isolated commu-
nities, in addition to public libraries and shopping centers in big
towns… In schools, students had access to it during the class breaks.
They commented on the panels with the teachers in the following
classes, who invited organizers to give talks.

— Augusto Damineli, Brazilian Single Point of Contact
for IYA2009

Ongoing Plans
Although the International Year of Astronomy was the impetus for
the project, FETTU exhibits and activities in conjunction with
them will last into 2010 and beyond. Plans for FETTU in 2010 in
the US include a continuation of the traveling FETTU to several
new locations.

The FETTU exhibits in Chicago’s O’Hare and Atlanta’s Hartsfield
airports have been extended and will remain in place at least
through June 2010. A new version of FETTU will appear in Chicago’s
Midway airport as well. Arrangements are being made to transfer
these panels from the airports to children’s hospitals in the Chicago
and Atlanta areas once the run in the airports is finished. Detailed
timeline maps are continually being updated for the US and inter-
national communities.

Outside the US, numerous countries around the world, including
the United Kingdom, India, Germany, Brazil, Canada, Russia, Peru,
France, and others have plans for FETTU into 2010 and more coun-
tries are working to follow suit.

For those of us involved in FETTU, this project has demonstrat-
ed the universal thirst that people from all walks of life have to
understand the universe in which they live. Barriers exist to hinder
scientific awareness, but they are not impossible to overcome.
FETTU has demonstrated that utilizing even modest means, when
combined with enthusiasm and dedication, can create access to the
knowledge and excitement that astronomy can provide.

For those of us who believe in sharing science with every citizen
of the planet, this project has motivated us to figure out how we can
do even more. We hope that FETTU serves as the beginning of a
continued global effort to connect people on Earth to their place in
the cosmic environment.

Kimberly Arcand is the multimedia coordinator and
Megan Watzke is the press officer for NASA’s
Chandra X-ray Observatory, which has its headquarters at the
Smithsonian Astrophysical Observatory in Cambridge, Massachusetts.

FETTU Wins Prize for Excellence in Astronomy Education and Public Outreach

The International Year of Astronomy 2009/Mani
Bhaumik Prize for Excellence in Astronomy
Education and Public Outreach has been awarded to
“From Earth to the Universe” (FETTU). This award
recognizes FETTU’s important contribution in improv-
ing public awareness of astronomical achievements, and
in stimulating the use of astronomy for the promotion
of scientific education and culture in 2009.

From Earth To The Universe showcases the incred-
ible variety of astronomical images available today.
The exhibit shows how astronomical objects look
when viewed across the electromagnetic spectrum,
from ultraviolet and visible light to infrared, X-rays
and gamma rays. FETTU images have been selected
for their stunning beauty and ability to engage mem-
bers of the general public who might normally ignore
or avoid astronomy. The project is a grassroots
initiative, which took an innovative approach, making
all material freely available as an open source
approach to education and public outreach. The
FETTU project, partly supported by NASA, involves
more than 500 exhibits in more than 70 countries of the most beautiful and inspiring large-format astronomical images. FETTU has
already exhibitions planned for 2010 in more than 30 countries.

“We are really pleased to award the prize to ‘From Earth to the Universe,’ a project which has really captured the spirit of the con-
test and of IYA2009 as a whole,” says Dr. Mani Bhaumik, the IYA2009 Patron. See the press release to read more about this award.

— M.W. & K.A.

A partial view of the FETTU exhibit in the crypt of the Palace of the Emperor
Charles V, at the Alhambra UNESCO World Heritage Monument, Granada, Spain.
These high-energy blasts continue to mystify, so astronomers are stepping up their search for the key pieces to the puzzle.

by Zach Cano
Instead you and the other participants are fixated upon the speaker at the front of the room who is challenging the audience to agree upon a foundation of physical processes that can lead to the creation of a gamma-ray burst (GRB).

A learned member of the crowd mentions idea after idea, and another equally learned participant rebukes them one by one. The debate rages on, and after 20 minutes you, like many of the audience, feel more than a little confused. Indeed, by the end of the debate, only one fundamental aspect of the physics required for the formation of a GRB could be agreed upon: relativistic motion is involved in the creation of a gamma-ray burst. Almost a half-century of research, and only one point of agreement! The realization is staggering.

What's a GRB?

Since the serendipitous discovery of GRBs by US spy satellites in the 1960s, thousands of papers have put forward numerous ideas and models to explain the occurrence of the brief flashes of highly energetic gamma rays. But our lack of understanding is not as dire as perhaps it first seems, for key observations during the last 20 years have allowed astronomers to piece together at least part of the puzzle surrounding the GRB phenomenon. Even more exciting, the questions resulting from these observations provide all of astrophysics with the mouth-watering prospect of revealing new physical processes that will not only decipher the long-standing GRB puzzle, but will also increase our understanding of fundamental astrophysics in general.

The first pieces of the puzzle consist of decades-long attempts to put GRBs into a theoretical framework. As the name suggests, a GRB is a brief burst of gamma rays lasting from one thousandth of a second to several tens of seconds. In the context of the electromagnetic spectrum, gamma rays are the most energetic type of radiation. The energy that is needed to create a GRB is enormous, implying that more energy than is generated by a normal supernova (SN) is needed to create a GRB.

Astronomer’s understanding of GRBs is exclusively due to their detection by spacecraft (see the sidebar). The first satellite to study GRBs was the Compton Gamma-Ray Observatory. With it, astronomers (in the 1990s) discovered that GRBs occur uniformly in all directions, implying they are located at cosmological distances (i.e. millions and billions of light-years away). This result was later vindicated by the measurement of GRB 970508’s redshift (z = 0.85; a distance of at least six billion light-years) in 1997.

Compton also revealed that GRBs can be classified according to the burst duration: short GRBs lasting two seconds or less (to as short as about 300 milliseconds), and long GRBs from two seconds up to several minutes. The intervening years since this discovery have led to the realization that these two groups (probably) have different progenitors.

GRBs: the Long and the Short of It

Of the two, we know most about the long GRBs. The “standard model” astronomers use to describe a long-duration GRB has been developed during the past couple of decades. It’s generally accepted that long GRBs are created during the collapse of a star, at least 20 times more massive than the Sun, into a black hole. The collapse of such a massive star causes a hypernova, a very energetic type of supernova.

Although the exact details are still a matter of great discussion, it’s believed that during the collapse, blobs of star stuff are ejected, at relativistic speeds, into a collimated jet along the star’s rotational axis. More than one blob is ejected along the axis, and eventually a
faster blob catches up with a slower moving one. As the blobs collide, a shock wave is generated that accelerates electrons in the jet. The accelerated electrons quickly lose energy by emitting synchrotron radiation (radiation from electrons accelerated in a magnetic field) in the form of a burst of gamma rays that astronomers term the **prompt emission**.

As the blobs continue to speed away from the progenitor star, they eventually collide with gas and dust surrounding the star. The collision creates more shocks that result in the production of more synchrotron radiation at X-ray, optical, and radio wavelengths. This radiation is long lasting, emitted for days or weeks after the initial burst, and is referred to as the **afterglow**.

Less is known about short GRBs, mainly because very few have been detected at optical wavelengths. The currently accepted model describes a situation where a neutron star merges with a neutron star or black hole (or a black hole merges with another black hole). In similar fashion to a long-duration GRB, blobs of material are ejected along the rotational axis of the two-body system in a jet, which eventually leads to the formation of a short burst of gamma rays with a peak energy higher than that of a long-duration GRB.

**The GRB-SN Connection**

So far we have collected a few pieces of our puzzle. GRBs, both short and long, are located at cosmological distances. The detected emission is due to blobs of material launched into a jet at relativistic velocities, interacting with each other, and creating shocks that ultimately lead to the observed radiation at various wavelengths. In the case of long GRBs, the formation of the burst is associated with the collapse of a massive star and its explosion as a supernova.

The first observational clue of a connection between a long GRB (hereafter referred to simply as a GRB) and a supernova was in 1998, when a special type of supernova was detected at the same time, and in the same host galaxy, as a GRB. The SN was a Type Ic — a core-collapse supernova that doesn't display hydrogen or helium lines in its spectra. The supernova detected in 1998 was dubbed 1998bw, and it remains to this day the archetype GRB-producing supernova.

There was, however, much debate surrounding this detection, because many astronomers were not satisfied that the two events (the gamma-ray burst and supernova) were actually physically connected. This controversy persisted for six years until **GRB 030329**.
was spectroscopically and photometrically connected to SN 2003dh. This was the smoking gun that astronomers needed, and showed that at least some, if not all, GRBs are created when a massive star collapses and becomes a Type Ic supernova.

To date, all of the supernovae connected to GRBs are Type Ic, though not all Type Ic’s generate gamma-ray bursts. The favored progenitor that can lead to the formation of a Type Ic SN is a Wolf-Rayet (WR) star. Wolf-Rayet stars are massive and short-lived, and occur in areas of galaxies undergoing intense star formation. A WR star has strong stellar winds that, in the latter stages of its life, expel its outer envelopes of hydrogen and helium.

To absolutely connect a SN with a GRB, spectroscopic and photometric data needs to be acquired concurrently. However, due to detection limits of current spectrometers, this is only possible for nearby GRBs. For GRBs that are farther away, it’s still possible to photometrically infer the presence of a SN with a GRB by taking a multitude of CCD images of a GRB with many photometric filters at UV, optical, and infrared wavelengths. When displaying the data as light curves, SN “bumps” are seen, which are accompanied by an increase in red color — such as those seen for GRB 060729 (see the illustration at lower left) — both of which are indicative of a supernova. This has been done for many GRBs, further vindicating the GRB-SN connection.

The Connection Strengthens

Additional evidence for the GRB-SN connection was the discovery that gamma-ray bursts occur in the brightest parts of their host galaxies. GRB host galaxies are typically small, irregular, blue galaxies that are generally lower in metallicity than the “average” galaxy at a given redshift. The brightest parts of the hosts are indicative of starbirth, which directly links GRBs to star formation.

Even more intriguing, up to 60% of the host galaxies of GRBs have recently undergone a galaxy merger or interaction. It has long been known that interactions between galaxies can trigger intense periods of star formation. Such episodes of starbirth are vigorous, leading to the formation of massive stars that are short-lived and explode at the end of their lives in spectacular fashion.

Furthermore, when studies of the positions of Type Ic SNe in their host galaxy were undertaken, they too were found to occur in the brightest parts of the host galaxies. Thus it seems that the conditions that give rise to Type Ic SNe also give rise to GRBs. But as mentioned earlier, while every GRB is seen to occur with a Type Ic SN, not every Type Ic SN
produces a GRB. Indeed studies have shown that only 5% of Type Ic's give rise to a GRB. This leads to the conclusion that there must be some unusual conditions required for a GRB to occur.

Ideas of what that those special conditions might be are currently being investigated. Theoretically, low metallicity (seen in GRB hosts) and fast rotation of the GRB-producing progenitor are thought to be necessary. But as the progenitors of GRBs are stellar-sized objects, it is not possible to resolve them to directly detect these conditions. The best chance at resolving this issue is to create a robust theory that gives predictions that can be tested observationally.

**The Final Puzzle Pieces**

The title of this segment is a bit misleading, as the puzzle is far from complete. As mentioned, a current research focus is to determine the special conditions needed to generate a GRB. Right now, the current theory is severely lacking in robust explanations, though not for lack of effort by extremely gifted scientists.

Since the launch of Swift in 2005, observations of GRBs have generated more questions than answers. The standard model does not explain many observed features, and attempts by astronomers to fit the theory to the data end up needing ad-hoc alterations to the theory. It seems that the standard model actually explains the exceptions rather than the rule!

Other issues also need addressing. For one thing, the mechanism of how the progenitor forms the black hole and creates a jet of ejecta needs to be determined. The solution will be of great interest to those who model stellar evolution.

Another key topic is how the jets are created. The accepted explanation of the source of the multi-wavelength emission is synchrotron radiation. However, it is becoming increasingly evident that there may be more than one source of emission coming from the GRB or the region around the GRB.

One way to test the validity of the various models is to check for the presence of a magnetic field in the vicinity of the progenitor. Some theories predict a prevalent magnetic field, while others maintain that any generated magnetic field is local to the shocks. To observationally distinguish between these models, measurements of the polarization of optical emission are needed, and a start was recently made.

Using a unique polarimeter on the Liverpool Telescope, a polarization of 10% was recorded in GRB 090102, which is greater than can be explained by magnetic fields generated solely by shocks. (See “Gamma-Ray Burst Engine Finally Revealed” in *Mercury*, Winter 2010, page 11.) More observations are now needed to create, if possible, a larger sample to compare universal characteristics of GRB properties.

While numerous pieces of the GRB puzzle have yet to be uncovered, the general picture is finally emerging. Many talented minds are working hard to construct a robust theory of GRBs, while an army of GRB astronomers is working day and night (literally; see my Reflections column) to solve the enigmatic puzzle that is GRB astrophysics.

ZACH CANO is a doctoral student at the Astrophysics Research Institute in Liverpool, England. When he is not knee-deep in images of GRBs, he is enjoying nature with his beautiful partner and learning to see the universe as it really exists.
Gamma-ray burst astrophysics is completely reliant upon satellites, since Earth’s atmosphere blocks incoming gamma rays. GRBs are detected in space at gamma-ray and x-ray wavelengths, and the position of the x-ray afterglow is relayed to ground-based telescopes that perform follow-up observations at UV, optical, infrared, and radio wavelengths. Many of the telescopes on the ground are robotic, such as the Liverpool Telescope located on the Canary Islands, and respond to alerts automatically, taking images only seconds after the receipt of an alert.

**Vela (1960s & 1970s)**
This was the first satellite to detect a GRB. Created by the US military to keep watch over the USSR’s nuclear activities, the discovery of a GRB by Vela 3 and 4 on July 2, 1967, was serendipitous.

One of NASA’s Great Observatories, the craft was launched in the early 1990s and acquired data for nearly a decade. During this time it was shown that GRBs appear uniformly in all directions in the sky, and it became clear that there are (probably) two different types of GRBs.

The launch of BeppoSax heralded the start of the “Afterglow Era.” The first GRB to be located in X-rays was in 1997, and later in the same year the first redshift for a GRB was determined.

**Swift (2005–present)**
Accuracy at last! Swift is able to provide arcsecond positions of GRBs in seconds, and opened a window into the GRB phenomenon that was not anticipated.

**Fermi (2008–present)**
The Fermi Gamma-ray Space Telescope is the latest addition to the GRB-searching fleet of spacecraft. It has already discovered numerous oddities in the gamma-ray universe.
Mars Rover Now Stationary Platform
NASA / JPL

After six years of unprecedented exploration of the Red Planet, NASA’s Mars Exploration Rover Spirit no longer will be a fully mobile robot. NASA has designated the once-roving scientific explorer a stationary science platform after efforts during the past several months to free it from a sand trap have been unsuccessful.

The venerable robot’s primary task in the next few weeks will be to position itself to combat the severe Martian winter. If Spirit survives, it will continue conducting significant new science from its final location. The rover’s mission could continue for several months to years.

“Spirit is not dead; it has just entered another phase of its long life,” said Doug McCuistion, director of the Mars Exploration Program at NASA Headquarters in Washington. “We told the world last year that attempts to set the beloved robot free may not be successful. It looks like Spirit’s current location on Mars will be its final resting place.”

Update: NASA’s Mars Exploration Rover Spirit is now parked for the winter. The rover team is commanding Spirit to make additional preparations for the Mars southern hemisphere winter season. The team does not plan further motion of the wheels until spring comes to Spirit’s location beside the western edge of a low plateau called Home Plate.

Spirit may enter a low-power hibernation mode within a few weeks, shutting down almost all functions except keeping a master clock running and checking its power status periodically until it has enough power to reawaken. It may go in and out of this mode a few times at the beginning and at the end of an extended hibernation period.

Layers Record a History of Changes
NASA-JPL

Near the center of a Martian crater about the size of Connecticut, hundreds of exposed rock layers form a mound as tall as the Rockies and reveal a record of major environmental changes on Mars billions of years ago.

The history told by this tall parfait of layers inside Gale Crater matches what has been proposed in recent years as the dominant planet-wide pattern for early Mars, according to a new report by geologists using instruments on NASA’s Mars Reconnaissance Orbiter.

“Looking at the layers from the bottom to the top, from the oldest to the youngest, you see a sequence of changing rocks that resulted from changes in environmental conditions through time,” said Ralph Milliken of NASA’s Jet Propulsion Laboratory, Pasadena, Calif. “This thick sequence of rocks appears to be showing different steps in the drying-out of Mars.”

Using geological layers to understand stages in the evolution of a planet’s climate has a precedent on Earth. A change about 1.8 billion years ago in the types of rock layers formed on Earth became a key to understanding a dramatic change in Earth’s ancient atmosphere.

Clay minerals, which form under very wet conditions, are concentrated in layers near the bottom of the Gale stack. Above that, sulfate minerals are intermixed with the clays. Sulfates form in wet conditions and can be deposited when the water in which they are dissolved evaporates. Higher still are sulfate-containing layers without detectable clays. And at the top is a thick formation of regularly spaced layers bearing no detectable water-related minerals.
Ganymede-Callisto Differences Explained
Southwest Research Institute

Differences in the number and speed of cometary impacts onto Jupiter’s large moons Ganymede and Callisto some 3.8 billion years ago can explain their vastly different surfaces and interior states, according to research by scientists at the Southwest Research Institute.

Ganymede and Callisto are similar in size and are made of a similar mixture of ice and rock, but data from the Galileo and Voyager spacecraft show that they look different at the surface and on the inside. A conclusive explanation for the differences between Ganymede and Callisto has eluded scientists since the Voyager Jupiter encounters 30 years ago (see page 7).

Dr. Amy C. Barr and Dr. Robin M. Canup of the SwRI Planetary Science Directorate created a model of melting by cometary impacts and rock core formation to show that Ganymede and Callisto’s evolutionary paths diverged about 3.8 billion years ago during the Late Heavy Bombardment, the phase in lunar history dominated by large impact events.

“Impacts during this period melted Ganymede so thoroughly and deeply that the heat could not be quickly removed. All of Ganymede’s rock sank to its center the same way that all the chocolate chips sink to the bottom of a melted carton of ice cream,” says Barr. “Callisto received fewer impacts at lower velocities and avoided complete melting.”

In the Barr and Canup model, Jupiter’s strong gravity focuses cometary impactors onto Ganymede and Callisto. Ganymede is closer to Jupiter and therefore is hit by twice as many icy impactors as Callisto, and the impactors hitting Ganymede have a higher average velocity.
First Temperate Exoplanet
European Southern Observatory

Combining observations from the CoRoT satellite and the ESO HARPS instrument, astronomers have discovered the first “normal” exoplanet that can be studied in great detail. Designated Corot-9b, the planet regularly passes in front of a star similar to the Sun located 1500 light-years away from Earth towards the constellation of Serpens (the Snake).

“This is a normal, temperate exoplanet just like dozens we already know, but this is the first whose properties we can study in depth,” says Claire Moutou, who is part of the international team of 60 astronomers that made the discovery. “It is bound to become a Rosetta stone in exoplanet research.”

“Corot-9b is the first exoplanet that really does resemble planets in our solar system,” adds lead author Hans Deeg. “It has the size of Jupiter and an orbit similar to that of Mercury.”

“Like our own giant planets, Jupiter and Saturn, the planet is mostly made of hydrogen and helium,” says team member Tristan Guillot, “and it may contain up to 20 Earth masses of other elements, including water and rock at high temperatures and pressures.”

Corot-9b passes in front of its host star every 95 days, as seen from Earth. This “transit” lasts for about 8 hours, and provides astronomers with much additional information on the planet. This is fortunate as the gas giant shares many features with the majority of exoplanets discovered so far.

More than 400 exoplanets have been discovered so far, 70 of them through the transit method.

Giant Magnetic Loop Sweeps Through System
National Radio Astronomy Observatory

Astronomers have found a giant magnetic loop stretched outward from one of the stars making up the famous double-star system Algol. The scientists used an international collection of radio telescopes to discover the feature, which may help explain details of previous observations of the stellar system.

“This is the first time we’ve seen a feature like this in the magnetic field of any star other than the Sun,” said William Peterson, of the University of Iowa.

The pair, 93 light-years from Earth, includes a star about 3 times more massive than the Sun and a less-massive companion, orbiting it at a distance of 5.8 million miles, only about six percent of the distance between Earth and the Sun. The newly discovered magnetic loop emerges from the poles of the less-massive star and stretches outward in the direction of the primary star. As the secondary star orbits its companion, one side — the side with the magnetic loop — constantly faces the more-massive star, just as the same side of our Moon always faces the Earth.

Algol, in the constellation Perseus, is visible to the naked eye and well known to amateur astronomers. As seen from Earth, the two stars regularly pass in front of each other, causing a notable change in brightness. The pair completes a cycle of such eclipses in less than three days, making it a popular object for amateur observers. The variability in brightness was discovered by an Italian astronomer in 1667, and the eclipsing-binary explanation was confirmed in 1889.

The newly-discovered magnetic loop helps explain phenomena seen in earlier observations of the Algol system at X-ray and radio wavelengths.
Scientists have found evidence of a “catastrophic event” they believe was responsible for halting the birth of stars in a galaxy in the early universe. The researchers, led by Durham University’s Department of Physics, observed the massive galaxy as it would have appeared just three billion years after the Big Bang when the universe was a quarter of its present age.

“We think that radio observations will soon be a more powerful tool for finding this kind of supernova in the nearby universe than gamma-ray satellites,” said Alicia Soderberg, of the Harvard-Smithsonian Center for Astrophysics.

The telltale clue came when the radio observations showed material expelled from the supernova explosion, dubbed SN2009bb, at speeds approaching that of light. This characterized the supernova, first seen last March, as the type thought to produce one kind of gamma-ray burst.

“It is remarkable that very low-energy radiation, radio waves, can signal a very high-energy event,” said Roger Chevalier of the University of Virginia.

When the nuclear fusion reactions at the cores of very massive stars no longer can provide the energy needed to hold the core up against the weight of the rest of the star, the core collapses catastrophically into a superdense neutron star or black hole. The rest of the star’s material is blasted into space in a supernova explosion. For the past decade or so, astronomers have identified one particular type of such a “core-collapse supernova” as the cause of one kind of gamma-ray burst.

Not all supernovae of this type, however, produce gamma-ray bursts. “Only about one out of a hundred do this,” according to Soderberg.

**Astronomers Find Rare Beast by New Means**

*National Radio Astronomy Observatory*

For the first time, astronomers have found a supernova explosion with properties similar to a gamma-ray burst, but without seeing any gamma rays from it. The discovery, using the National Science Foundation’s Very Large Array (VLA) radio telescope, promises, the scientists say, to point the way toward locating many more examples of these mysterious explosions.

“Properties seen in massive galaxies near to our own Milky Way suggest that a major event rapidly turned off star formation in early galaxies and halted their expansion. Theorists, including scientists at Durham University, have argued that this could be due to outflows of energy blowing galaxies apart and preventing further new stars from forming, but evidence of this has been lacking until now.”

Dr. Dave Alexander, of Durham University’s Department of Physics, said: “We are looking into the past and seeing a catastrophic event that essentially switched off star formation and halted the growth of a typical massive galaxy in the local universe.

“Effectively the galaxy is regulating its growth by preventing new stars from being born. Theorists had predicted that huge outflows of energy were behind this activity, but it’s only now that we have seen it in action.”

**Catastrophic Event Halts Star Birth**

*Durham University*

An artist’s representation showing outflow from a supermassive black hole inside the middle of a galaxy.

**More information**
Measuring Starbirth in Distant Galaxies

European Southern Observatory

For the first time, astronomers have made direct measurements of the size and brightness of regions of starbirth in a very distant galaxy, thanks to a chance discovery with the APEX telescope. The galaxy is so distant, and its light has taken so long to reach us, that we see it as it was 10 billion years ago. A cosmic “gravitational lens” is magnifying the galaxy, giving us a close-up view that would otherwise be impossible. This lucky break reveals a hectic and vigorous star-forming life for galaxies in the early universe, with stellar nurseries forming one hundred times faster than in more recent galaxies.

Astronomers were observing a massive galaxy cluster with the Atacama Pathfinder Experiment (APEX) telescope, using sub-millimetre wavelengths of light, when they found a new and uniquely bright galaxy, more distant than the cluster and the brightest very distant galaxy ever seen at submillimetre wavelengths. It is so bright because the cosmic dust grains in the galaxy are glowing after being heated by starlight. The new galaxy has been given the name SMM J2135-0102.

“We were stunned to find a surprisingly bright object that wasn’t at the expected position. We soon realised it was a previously unknown and more distant galaxy being magnified by the closer galaxy cluster,” says Carlos De Breuck from ESO, a member of the team.

The new galaxy SMM J2135-0102 is so bright because of the massive galaxy cluster that lies in the foreground. The vast mass of this cluster bends the light of the more distant galaxy, acting as a gravitational lens.

WMAP Produces New Results

NASA / WMAP

On January 26, 2010, the Wilkinson Microwave Anisotropy Probe (WMAP) science team released results from the satellite’s seven-year data set, updating the five-year data released two years earlier. Here are some highlights:

• The WMAP team has reported the first direct detection of pre-stellar helium, providing an important test of the Big Bang prediction.
• WMAP now places 50% tighter limits on the standard model of cosmology (Cold Dark Matter and a Cosmological Constant in a flat universe), and there is no compelling sign of deviations from this model.
• WMAP has detected a key signature of inflation.
• WMAP strongly constrains dark energy and geometry of the universe.
• WMAP places new constraints on the number of neutrino-like species in the early universe.
• WMAP has detected, with very high significance, temperature shifts induced by hot gas in galaxy clusters.

A representation of the 13.7 billion year evolution of the universe. The far left depicts the earliest moments, when a period of “inflation” produced a burst of exponential growth in the universe. For the next several billion years, the expansion of the universe gradually slowed down as the matter in the universe pulled on itself via gravity. More recently, the expansion has begun to speed up again as the repulsive effects of dark energy have come to dominate the expansion of the universe.
You are cordially invited to attend the 122nd Annual meeting for the Astronomical Society of the Pacific (ASP). We have an exciting new partnership this year with the Geological Society of America, which promises to make our schedule of events an unusual and unique opportunity to:

• **Network with fellow professionals and educators in the fields of Earth and space science, and connect with Cosmos in the Classroom astronomy instructors.**

• **Participate in valuable workshops, and discover exhibits that will expand your intellectual growth and professional skills.**

• **See the Fiske Planetarium, Boulder campus, and attend the ASP awards banquet.**

**Mark your calendar** for July 31 through August 4, 2010.

Visit our website to find more information and to register online.

[www.astrosociety.org/2010meeting](http://www.astrosociety.org/2010meeting)

Questions or comments? Please feel free to call Albert Silva at ASP 415-337-1100 ext. 100 or email him at asilva@astrosociety.org

**We look forward to your participation!**

*Deadline for Abstracts: April 23, 2010 • Deadline for early-bird registration: April 30, 2010*
The 2010 ASP Award Recipients

Catherine Wolfe Bruce Gold Medal
Dr. Gerry Neugebauer, Caltech and the University of Arizona’s Steward Observatory

The Astronomical Society of the Pacific (ASP) is pleased to announce that Dr. Gerry Neugebauer has been awarded the 2010 Catherine Wolfe Bruce Gold Medal for lifetime achievement in astronomy.

Dr. Neugebauer joined the Caltech faculty in 1962 as an Assistant Professor of physics, becoming a full Professor in 1970. At the same time he joined the Caltech faculty as an Assistant Professor of physics, becoming a full Professor in 1970. At the same time he joined the Palomar Observatory as a member of the Palomar Observatory staff. He has held a number of distinguished positions at Caltech, and is currently the Robert Andrew Millikan Professor and Professor Emeritus of Physics at Caltech. He is also an adjunct faculty member, Steward Observatory, University of Arizona.


In its letter of congratulations, the ASP notes that the astronomical community owes Dr. Neugebauer a great debt for his contributions throughout a distinguished career. As such, the Society is delighted to honor Gerry with this award.

Richard H. Emmons Award
Alexei V. Filippenko, University of California, Berkeley

It is with great pleasure that the ASP presents the fourth Richard H. Emmons Award for Excellence in College Astronomy Teaching to Professor Alexei (Alex) V. Filippenko of the University of California, Berkeley. Established by Jeanne and Allan Bishop to honor her father, Richard Emmons — an astronomer with a life-long dedication to astronomy education — this award celebrates outstanding achievement in the teaching of college-level introductory astronomy for non-science majors.

Alex Filippenko is the Richard and Rhoda Goldman Distinguished Professor in the Physical Sciences. His research accomplishments, recognized by several major prizes, have been documented in more than 620 published papers, and he is one of the world’s most highly cited astronomers. One of his major activities is to use supernovae as cosmological distance indicators; he was a member of both teams that discovered (in 1998) the accelerating expansion of the universe driven by mysterious “dark energy.” In 2009 he was elected to the National Academy of Sciences.

Alex has won the top teaching awards at UC Berkeley and has been voted the “Best Professor” on campus six times. His large (typically 700-800 students) introductory astronomy course, which he has taught once per year for more than two decades, has been named the “Best Course” on campus several times. In 2006, he was selected as the Carnegie/CASE National Professor of the Year among doctoral and research institutions. He has also produced four introductory astronomy video courses with The Teaching Company and coauthored an award-winning college textbook.

Muhlmann Award
Spitzer Space Telescope Team

The ASP is pleased to bestow the Maria and Eric Muhlmann Award, for important research results that are based upon the development of groundbreaking instruments and techniques, on the Spitzer Space Telescope Team. The Awards Committee recognizes the innovative way in which the satellite’s three instruments have studied objects ranging from Near Earth Objects to galaxies at z>7, the nearest and the most distant known celestial bodies. Spitzer Project Scientist Dr. Michael W. Werner and his colleagues have advanced astronomy in exactly the manner envisioned for the Muhlmann award.

“The success of Spitzer is due to literally hundreds of people who worked on development and operations, and I consider them all to be recipients of this award,” said Dr. Werner, the Spitzer Project Scientist who has worked on the space telescope for 33 years. “For me and most scientists it’s gratifying to be recognized by your peers. Spitzer has been a phenomenal success by all standards: scientific, technical, and managerial.”

Michael works at the Jet Propulsion Laboratory of the California News and information for Society members.
Institute of Technology; JPL has managed the development and operation of Spitzer for NASA. He has been Project Scientist since 1984 and as such, has ensured that the telescope’s scientific objectives are clearly defined and that Spitzer’s scientific performance will achieve those objectives. Spitzer scientists have worked very closely and productively with the project’s engineering and management teams, and this teaming has been very important to the success of the Spitzer Space Telescope.

Trumpler Award
Dr. Robert Quimby, California Institute of Technology
For his excellent thesis, “The Texas Supernova Search,” the Awards Committee of the ASP is pleased to present Dr. Robert Quimby with the 2010 Robert J. Trumpler Award — an award made to a recent recipient of a Ph.D. degree whose research is considered unusually important to the field of astronomy.

In particular, the ASP noted his technical innovation and use of the ROTSE-IIIb and Hobby-Eberly telescopes at McDonald Observatory in initiating the Texas Supernova Search to monitor nearby galaxy clusters for transient events at their earliest possible phases.

Robert's dissertation led to improved understanding of the detonation process in Type Ia supernovae, suggesting that these events may involve binary white dwarfs. His dissertation work at the University of Texas uncovered a new population of luminous supernovae (events having peak luminosities 10 to 100 times brighter than typical supernovae). The most famous of these, SN 2006gy, has been studied by research teams around the world and was honored as the #3 discovery of 2007.

Klumpke-Roberts Award
Marcia Bartusiak, Massachusetts Institute of Technology
The Astronomical Society of the Pacific gives the Klumpke-Roberts Award annually to an individual who has made significant contributions in furtherance of public appreciation and understanding of astronomy. The Society is proud to present this award to Marcia Bartusiak.

Marcia is currently an Adjunct Professor with the Graduate Program in Science Writing at the Massachusetts Institute of Technology and a columnist for Natural History magazine. She is also the author of five books including Thursday's Universe, Through a Universe Darkly, and Einstein's Unfinished Symphony. All three were named notable science books by The New York Times. Her latest is The Day We Found the Universe, a narrative saga of the birth of modern cosmology.

Starting her science-writing career as an intern at Science News and then as a charter member of Discover's writing staff, Marcia continues to write about astronomy and physics in a variety of national publications. Her work has appeared in National Geographic, Astronomy, Sky & Telescope, Natural History, Science, Popular Science, World Book Encyclopedia, Smithsonian, and Technology Review. For many years a contributing editor at Discover, she is now on the editorial advisory board of Astronomy magazine.

The ASP awards committee notes her hundreds of articles and books that delve into forefront topics in astrophysics and provide clear insight into complex topics and the lives of scientists.

Thomas Brennan Award
John Blackwell, Phillips Exeter Academy, New Hampshire
The Thomas Brennan Award recognizes exceptional achievement related to the teaching of astronomy in grades 9 through 12, whether by an active teacher or by someone whose work has had a substantial impact on high school astronomy teaching. The ASP is delighted to present this award to John Blackwell.

John teaches astronomy at Phillips Exeter Academy in New Hampshire. There he also uses facilities of the Grainger Observatory to their fullest, teaching students how to observe celestial objects, conducting brief investigations and measurements, and helping students with long-term projects and research. He is an outstanding high school astronomy educator who is deeply committed to the success of his students. John inspires a broad range of students, from those who have shown a previous talent in science to those who considered themselves to be science-phobic.

John has developed several innovative astronomy courses that involve students in a wide range of activities. Instead of just reading a graph in a text, students use observatory equipment to take images and data to generate their own graphs. He artfully balances advanced student projects — allowing students to do the research themselves — with providing the proper guidance to give the students the tools and inspiration they need to proceed.

The Brennan Award Committee noted that John has helped students conduct brief investigations and long-term projects that provided them with lessons about the nature of scientific
exploration, and that he has initiated an annual workshop series for other high school teachers — all of which makes John an excellent choice for this award.

**Las Cumbres Amateur Outreach Award**


The ASP is delighted to present the **Las Cumbres Amateur Outreach Award** to Wayne “Skip” Bird of the Westminster Astronomical Society. This award honors outstanding outreach by an amateur astronomer. The ASP recognized Wayne's exemplary outreach efforts, including the design of the Westminster Astronomical Society's observatory, collaborations with several groups to host star parties, work with libraries, and special programs for the visually impaired.

Wayne is presently the Treasurer/Observatory Director/Night Sky Network Guru for the Westminster Astronomical Society and outreach fanatic (definition of fanatic: someone who will not change his mind AND will not change the subject). He is also a 5th grade “Mad” Science teacher at William Paca Elementary School in Baltimore City. He is the world-renowned author of “Night Flying Astronomy Bird” articles (OK, maybe world-renowned is being a little modest), and the World's Greatest Dad — and he has the button to prove it!

**Amateur Achievement Award**

Clear Sky Chart Team, Canada

It gives the ASP special pleasure to announce that, on behalf of the Clear Sky Chart team composed of Allan Rahill and Attila Danko, Allan has been selected as the 2010 recipient of the **Amateur Achievement Award**.

This award has been established to recognize significant contributions to astronomy or amateur astronomy by those not employed in the field of astronomy in a professional capacity. The Award Committee noted that the Clear Sky Chart team has revolutionized the process of planning visual observing sessions with highly accurate, astronomy-oriented, high-resolution point forecasts of cloud cover, transparency, seeing, darkness, wind, temperature, and humidity over North and Central America.

Allan has a B.Sc. in Physics (1979, with a minor in astrophysics) and a M.Sc. in Meteorology (1981). He is a weather forecaster with 30 years of experience. He has worked all across Canada (Halifax, Toronto, Winnipeg, Victoria, and Montreal) and at the Canadian Meteorological Center, the equivalent of NCEP (National Centers for Environmental Prediction) in the US.

An amateur astronomer since age 12, Allan has a personal observatory with a C14 and a portable 28-inch Dobsonian. He has built 20+ telescopes for astro-amateurs and has given hundreds of presentations on many subjects to astronomy clubs, schools, and social events. Ten years ago he created an [astro-weather website](http://www.astro-weather.com) to help amateur astronomers choose the best nights and sites for observing. The site is used by Attila Danko to produce the [Clear Sky Charts](http://www.clearskycharts.com).

**Mary Kay Hemenway Awarded Education Prize by American Astronomical Society**

Dr. Mary Kay Hemenway has been awarded the 2009 AAS Education Prize by the American Astronomical Society, the major organization of professional astronomers in North America. Hemenway is a Senior Lecturer and Research Associate at The University of Texas at Austin. She received the award at the 215th meeting of the Society in Washington, D.C., in January.

The award stated that the prize was presented to Hemenway “for her leadership and dedication to astronomy education and improvement of K–20 science education at the state and national level throughout her career. For her tireless contribution to developing a new generation of astronomy educators at universities, through NASA programs, and in informal settings. For her significant service to the community as Education Officer of the American Astronomical Society from 1991–1997, and especially as Secretary to the Board of the Astronomical Society of the Pacific since 1999. For her unique contributions to K–14 teacher training in astronomy at the McDonald Observatory.” You can read more about this honor [here](http://www.americanastronomical.org/press/pr_2009_09).
and June 30. And if you’re interested in staying at one of the two hotels, please note that room availability is somewhat limited. So if you plan on attending, please register and reserve your room as room as possible.

**New Director of Advancement**

It is with great pleasure that I’d like to introduce myself to the loyal members and supporters of the ASP as your Society’s new Director of Advancement. I look forward to meeting you and talking with each of you in the years to come and discovering what inspires you about the work of the ASP — or feel free to contact me anytime with your story.

I was born in San Francisco and grew up just north of the city in beautiful Marin County. I often say that I spent more of my childhood outside than inside because my family biked or hiked everywhere.

I have worked in the (environmental and health) non-profit field — in strategic communications, marketing, and development — my entire career. By far, my favorite position was leading the beautiful Richardson Bay Audubon Center and Wildlife Sanctuary, located in Tiburon on a picturesque bluff on the edge of San Francisco Bay. During the time I was there, I was able to revitalize the organization financially and reinvigorate the sanctuary’s place in the community. I found tremendous inspiration in the thousands of children and adults who were learning about their local environment, studying science outdoors, and experiencing the wonders of nature for themselves. Although our programs were very dynamic, I realize now we missed the greatest exploration and opportunity available — the starry sky overhead.

I believe the greatest wonder in nature is the sky above, so I consider it a great honor to become an important part of the ASP — a dynamic and historically significant organization!

Michèle L. Pearson
mpperson@astrosociety.org

**A Message from Alex Filippenko**

What are you passionate about in your life and work? In my professional life, my passion is the universe. I spend my days (and nights!) studying the most exotic and exciting objects in the universe: quasars, gamma-ray bursts, black holes, and both nearby and distant supernovas that have helped us to realize that our expanding universe is actually now accelerating, driven by a mysterious “dark energy.” But I’m equally passionate about sharing the excitement of cosmic discovery with my students: the future scientists who will carry on the work, as well as the many undergraduates in whom I strive to instill a love for science that will carry into their everyday lives no matter what their career aspirations.

The Astronomical Society of the Pacific, with which I’ve been associated as a longtime supporter and past Board President, is an essential ally in this effort. It is through the many programs and initiatives of organizations like the Society that the students I teach often receive that first spark of interest in the sky, in science, and in the world around them. By providing teachers with training and resources, as well as astronomer partners for the classroom, the ASP works to improve science teaching for those students. Through its professional development opportunities for museum and nature center educators and park rangers, the Society increases the capacity for good astronomy experiences in informal settings for all. By offering activities and training to amateur astronomers across the country, the ASP helps a marching army of enthusiasts to expand their outreach efforts and scientifically inspire the public on starry nights.

But none of this happens without good people like you, who believe in our cause of advancing science literacy through astronomy and who are willing to directly support our efforts with your donations. I recognize that these continue to be challenging economic...

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[Image: Cover of "How to Find a Habitable Planet" book]
times in which to give — but this makes your contribution all the more important. I ask for your financial support of the ASP as an investment in our science future — for the kids who will be inspired to become tomorrow’s scientists, for the public benefit of having a scientifically literate society, and for the planet itself as we work on the science and technology solutions to the challenges that lie ahead.

It’s all about passion. If you love the sky as we do, and believe that astronomy can be an exciting avenue in helping to inspire a passion for science and the adventure of discovery in our children and the public, please act today. The universe won’t wait; it just gets bigger every second, and we have so much more to learn! I hope we can count on your generous support.

Sincerely,
Alex Filippenko
Professor of Astronomy
University of California, Berkeley

NEW MEMBERS — The ASP welcomes new members who joined between January 1 and March 30, 2010.

Technical Membership
Michael B. Brady, Santee, CA
Kris M. Hamada, Waikīkī, HI
Valdymar Kopec, Hudson, NY
Patrick R. Watson, Benalla, Australia

General Membership
Steve B. Butterfield, Kuna, ID
Neil F. Comins, Orono, ME
Arthur B. Congdon, Pasadena, CA
Ken Fraley, Houston, TX
Gene Hallsted, Huntington Beach, CA
Dana-Renee Lee, Deming, NM
William D. Lewis, San Jose, CA
Patrick F. Marron, Careywood, ID
John D. Panagos, Oakland, CA
Ian Ridpath, Middlesex, United Kingdom
Susanne K. Robins, Culver City, CA
Daniel J. Schuneman, Tamuning, GU
Joseph P. Sonderleiter, Portland, OR
Richard B. Taylor, Gladstone, VA

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The Skies of May

High overhead these late spring evenings, the seven stars of the Big Dipper are easy to spot, even within a city. To find another bright springtime star, extend the curve of the three end stars in the Dipper’s Handle toward the south. Your gaze will quickly reach the bright star Arcturus in Boötes, the Herdsman.

The name Arcturus comes from ancient Greek and means “the Bear watcher,” an appropriate moniker given its proximity to Ursa Major, the Great Bear. Arcturus is a yellow-orange star, the fourth brightest in the night sky. Boötes itself resembles a kite more than a herdsman, with Arcturus at the tail end of the giant kite. The constellation outline in the chart at right is an odd amalgam of the two shapes: a kite with a tail, and an outstretched “arm” of stars reaching toward the Dipper.

Under the Dipper’s Handle and west of Arcturus are the couple of stars that mark the location of Canes Venatici, the Herdsman’s hunting dogs. Cor Caroli, its brightest sun, is a beautiful white and blue-green double star, easily split in a small telescope.

In the vicinity is M3, a lovely little globular cluster that’s best sought with binoculars. To find it, slowly sweep up from Arcturus; the star cluster is a little less than halfway toward Cor Caroli.

Setting more than three hours after the Sun, Venus is a lovely sight in the twilight sky (and will continue to be so throughout the next three months). On the 15th a skinny crescent Moon can be found just below and slightly right of Venus; on the 16th the lunar crescent is to the planet’s upper left.

High in the southwest after sunset is ruddy Mars. To the planet’s upper left is Regulus in Leo, the Lion. Watch this month as the planet rapidly advances on the star; they meet in early June. The crescent Moon lies below Mars on the 19th.

Slightly west of south at sunset and also high up is the ringed world Saturn. The Moon passes below it on the 22nd.

Giant Jupiter rises near dawn and is low in the east-southeast before sunrise. On the 9th, the crescent Moon hangs above Jupiter. The following morning, if you have a clear eastern horizon, look east around 4:30 am to see the crescent Moon rising in tandem with Jupiter, although they are well separated.

Mercury skims low above the eastern horizon at dawn during the last half of this month, but it will always be difficult to spot.

The Skies of June

To the west of Spica lies Saturn. Don’t confuse the two, because they’re almost the same brightness. The Moon can help clarify the situation. On the 18th the first-quarter Moon is below Saturn; both are in the southwest after sunset. Two days later, the Moon lies below Spica. Saturn is a slow-moving planet, so it’ll be in this part of the sky for a while. In fact, Saturn moves so slowly that it won’t catch up to Spica until late 2011.
Venus continues to shine like a beacon in the sunset sky. It now sets some 2.5 hours after the Sun and is a pretty sight at dusk. Look below it on the 14th to find a thin crescent Moon; the next evening the crescent will be far to the left of this brilliant world.

Early this month Mars encounters Regulus, the brightest star in Leo, the Lion. On June 5th and 6th, watch the red planet speed past Regulus, sliding less than 1° north of Leo’s brightest star. Although both are roughly the same brightness, Mars will stand out because it’s the redder of the two. The Moon passes below Regulus on the 16th, and is well to the left of Mars the next night.

Jupiter rises around 2:00 am in June and is high in the southeast at dawn. The crescent Moon is above Jupiter on the 6th. Use the giant planet to spot Uranus. From the 1st to the 16th, this distant world will be less than 1° above Jupiter — an easy catch in binoculars or a small telescope that’s initially pointed at Jupiter.

Meanwhile, Mercury is lost in the solar glare.

The Skies of July

- Go to Sky & Telescope’s July 2010 Sky Chart
- How to use S&TT’s Interactive Sky Chart

Scorpius, the Scorpion, is a fabulous constellation to explore, particularly if you’re observing from a dark-sky site — and the farther south you are, the higher it’ll be, so the better you’ll see it. As you can see from the chart on the right, the shape of its brighter stars vaguely resembles a scorpion with pincers, and the zigzag of its easternmost stars is even nicknamed “the Stinger.” Its brightest star, Antares, exudes a definite reddish hue.

If you have a dark-sky site, and the pale band of the Milky Way is easily visible to your eyes, use binoculars to scan this region of the sky. It’s a beautiful portion of our galaxy — full of clusters and knots of stars and faint, delicate puffs of nebulosity. To the east of Scorpius is Sagittarius, the Archer. Some of its many sights were described in the Summer 2009 issue of Mercury (page 42), and you can use the chart from last year to see how the two constellations relate to each other.

Sitting just above the stars of the Scorpion’s stinger are two open clusters: M6 and M7. M7 is the larger of the two, but both are easy finds and pretty sights in binoculars.

M4 is one of the nearest and brightest globular clusters in our night sky, and it’s easy to spot — put Antares in your bino’s field of view and M4 is that fuzzy patch to the right of the star.

Three other globulars are marked on the chart. If you slide M4 out of the lower-left edge of your binocular’s field of view, small and dense M80 will slip in from the upper-right. But you’ll have to hunt a bit for slightly oblong M19 and irregularly shaped M62. These last three need somewhat dark skies to be seen, even in binos.

Let’s start the planet parade with Venus, a splendid post-sunset sight but sitting a little lower in twilight than it has during the past two months. At dusk on the 9th, Venus is about 1° north of much fainter Regulus in Leo — the same star Mars passed one month ago.

While you’re outside, look to Venus’s upper left. Can you find a dim-orange “star” in the twilight? That’s Mars. Keep going. About half-again the Venus-Mars distant is another bright light emerging from the twilight. That’s Saturn. At mid-month, the Moon moves through the area and can help you find each planet. The crescent Moon is to Venus’s lower left on the 14th, under Mars on the 15th, and to Saturn’s lower left on the 16th.

But wait, you’re not done. For those with a very clear, flat west-northwest horizon, Mercury puts in an appearance (albeit very low on the horizon) during the final two weeks of July. Your best chance of seeing it might be when it passes near dimmer Regulus on the 27th. Finally, at month’s end, Saturn and Mars are less than 2° apart on the 30th.

If you like to look ahead, Venus slides under Saturn on August 8th, and for a few days thereafter, these two worlds, with Mars to their upper left, form a small triangle.

Meanwhile, Jupiter shines alone in the east, rising around midnight and standing high in the southeast at dawn. The Moon rides high over Jupiter on July 3rd and 31st.

For eclipse chasers, the highlight of the month will occur on July 11. That’s when a total eclipse of the Sun will cross the southern Pacific Ocean, touching land in only a few isolated spots — including Mangaia in the Cook Islands and Easter Island.

Looking Ahead: August Perseids

The Perseid Meteor Shower, which peaks during the evening of August 12/13, promises to the best in several years, if only because it’ll occur only three days after new Moon. As a result, the sky will be moonlight-free during the peak hours of this meteor shower. Under a dark, clear night sky, careful observers may see upwards of 90 meteors per hour streaming away from the northern constellation of Perseus. There will be more on Perseus and the Perseids in the Summer issue of Mercury.
Thanks to Sky & Telescope magazine, Mercury readers have direct access to S&T’s online Interactive Sky Chart. While anyone can go to it on Sky’s website, registration is required to load and use the charts. Registration is free and has some advantages, but it’s not necessary for ASP members who just want to retrieve the monthly star chart.

Sky & Telescope’s Interactive Sky Chart is a Java applet that simulates a naked-eye view of the sky from any location on Earth at any time of night. Charted stars and planets are the ones typically visible without optical aid under clear suburban skies. Some deep-sky objects that can be seen in binoculars are plotted too.

Using the Chart: The Basics
When you launch Sky & Telescope’s Interactive Sky Chart applet in your Web browser, you should get a rectangular, naked-eye view of the sky on the upper left and a circular all-sky chart on the right. If the chart does not appear, see the “Tech Talk” section at the end of this article.

For instance, when you click on the link for the May Sky Chart, you should see, in a new window, a screen that looks like the image above. Each of the monthly links in Sky Sights will take you to a chart set for 40° north latitude and 100° west longitude (so it’s useful throughout the continental US) at 10:30 pm local time at midmonth in May, June, and July. The chart can be used one hour later at the start of each month and one hour earlier at month-end.

If all you want is a copy of the circular All-Sky Chart to take outside, press the “Create PDF” button, and then print the result. You’ll find the easy-to-use instructions included on the chart.

But Sky’s Interactive Chart offers much more. Click on any area of the circular All-Sky Chart that you’d like to see in more detail. The green frame will jump to where your cursor is pointing, and the scene in the Selected View window will now show this area.

Or click and hold down your mouse button within the green frame on the All-Sky Chart, then drag the frame around the sky. The scene in the Selected View window will change as the location of the green rectangle on the All-Sky Chart changes.

Finally, click and hold down your mouse button in the Selected View window, then drag the cursor to move to another part of the sky. The green frame in the All-Sky Chart will follow your movements.

Changing the Chart
Below the Selected View window you’ll find the latitude and longitude the chart is set for, as well as the date and time. These can all be changed.

To alter the date and time, click on the month, day, year, hour, or minute in the display at lower left, which will become highlighted. (You can change only one parameter at a time.) Then use the + or – button to increase or decrease the value you’ve selected. Each time you change a quantity, both the Selected View and All-Sky Chart will be updated instantly.

If you’d rather do a wholesale change, click the large “Change” button in the Date & Time display area. A pop-up window will appear. Here you can choose any date between January 1, 1600, and December 31, 2400, using the day and month pull-down lists and the year text-entry box.

To alter the location (and time zone), you’ll need to click the large “Change” button in the Location display area. A pop-up window will appear that will let you select a new location (be sure to enter data in just one of the three sections of this page). A follow-up page will let you select a time zone. But note that unless you register, the system will not remember your new location.

You’ll find more detailed instructions and hints for using the chart on the Help page. To really become familiar with this program, see the article: Fun with S&T’s Interactive Sky Chart.

Tech Talk
The applet should work properly in most Java-enabled Web browsers. For best results on a PC, use Internet Explorer 6 or Netscape 7; on a Mac, use OS X 10.3 (or higher) with Safari. If you’ve installed a “pop-up stopper” to block advertisements that automatically open in new browser windows, you’ll probably have to turn it off, as the Interactive Sky Chart needs to open in a new browser window.

If you have trouble getting the Sky Chart to open on your computer, please review Sky’s detailed system requirements to check whether you’re using a supported operating system. And don’t forget to also review the Help page.
Two Hours in the Life of a Doctoral Student

Reality interrupts a fabulous dream, but it’s worth it.

It was the last lap of the Italian Grand Prix, and I accelerated out of the Senna Esses only two car-lengths behind the Ferrari of Michael Schumacher. Going into Parabolica, I braked late and pulled even closer. With the finish line beckoning, we both hit the throttle at the same time, but I was in his slip-stream and had the advantage. As my front wing approached his diffuser, I quickly ducked out of his slip stream and pull along side. Fifty meters to go and the finish line was approaching fast…30 meters and we were side by side…10 meters and my front wing was just inches ahead of his…5 meters….

Beep Beep Beep! BEEP BEEP BEEP!!
My mobile has just received a text, and I blink a couple of times as my brain adjusts to reality.

Beep Beep Beep! BEEP BEEP BEEP!!!
Then I remember. I’m on duty tonight. I pick up my phone and check the message. It’s what I had hoped for. The Swift satellite has detected a gamma-ray burst (GRB) and sent out an alert that one of our robotic telescopes has automatically responded to. It’s 4:00 am and I have no time to lose.

My name is Zach and I’m a second-year Ph.D. student at the Astrophysics Research Institute (ARI), which is part of John Moores University in Liverpool, UK. My doctoral project is to study the connection between core-collapse supernovae and GRBs, and to do this I need lots of optical, ultraviolet, and near-infrared images of gamma-ray bursts. At the ARI, we have a small GRB group that has access to three robotic telescopes: the Liverpool Telescope (located on the side of a mountain in the Canary Islands) and two Faulkes Telescopes (in Australia and Hawaii).

Whenever a GRB occurs and is detected by any of several satellites, alerts are immediately sent to ground-based telescopes. If we’re fortunate and the seeing conditions at any of these telescopes is just right when GRB occurs, we’re able to obtain images of the GRB.

Tonight was one such night. I’m on duty this week, which means that if an alert hits, I have to be awake and ready to roll. There’s no time to waste, and as soon as the images appear, I download them onto my computer for analysis. For the analysis, I have a catalogue image of the region of sky where the burst occurred, which I visually compare with the images taken.

However, I’m not the only entity looking for a GRB transient. One of our team members has written a program that automatically detects transients in a series of images. If one is found, that makes our job all the easier. But tonight is not one of those nights.

The software has detected an object: the Liverpool Telescope turns out to be a red herring. So the search has to be done manually. Thankfully it was Swift that detected the burst, so the error-box (the region of the sky where the burst occurred) is quite small, and not many objects lie within. All I need do is check all of the objects in the error-box in a series of images to see if any of them have faded.

A short while later, my search is finished. I’m confident that I’ve found the GRB and measured how much it has faded. Group e-mails coming in from the other members of my team, who are also awake, confirm my detection. A surge of adrenaline further enhances my sense of elation, and I can’t stop smiling. Not only have we found it, we have also confirmed that it’s fading, and we are the first team in the world to do so! Time to draft a circular (GCN) declaring our result and send it to the rest of the world.

An hour later and the in-boxes of almost 1,000 GRB astronomers worldwide contain a message, with my name plus the names of my colleagues, declaring our detection of the GRB. It was an intense couple of hours, from the alert waking me from my wonderful dream, to the furious analysis of dozens of images, to the sending of our GCN — but hours that are emotionally rewarding. To be part of the GRB team at the ARI is very exciting and allows me to pursue my life-long passion of space and astronomy.

I have just started the second year of my doctorate, but the thought that I am already performing professional observations that a thousand other professionals will read is truly special. It is now 6:00 am and I feel on top of the world. (Elsewhere in this issue you can read my article about gamma-ray bursts.)