Swinburne Astronomy Online

This leading international online astronomy program provides interactive astronomy education featuring custom-made course material, newsgroup discussions led by professional astronomers, low student-staff ratios, informed commentary on the latest astronomy headlines and projects tailored to suit the individual interests of participants.

Join participants from over 30 countries already enrolled in Master of Science in Astronomy and Graduate Diploma of Science in Astronomy programs as well as individual units, which are all online and accessible worldwide.*

To enroll, you need a computer, Internet connections and most of all a keen interest in astronomy. Designed to complement the interests of amateur astronomers, science educators and science communicators generally, the program highlights the big issues in contemporary astronomy and emphasises conceptual understanding of astronomy and astrophysics.

*plus a Graduate Certificate of Science (Astronomy) program available in Australia only.

SAO Units:

- Exploring the Solar System
- Exploring the Stars & the Milky Way
- Exploring Galaxies & the Cosmos
- Theories of Space & Time
- History of Astronomy
- Tools of Modern Astronomy
- Radio Astronomy & SETI
- Astrophotography & CCD Imaging
- Studies in Space Exploration
- Stellar Astrophysics
- Particle Physics & High Energy Astrophysics
- Great Debates in Astronomy
- Astrobiology & the Origins of Life
- Major Project - History of Astronomy
- Major Project - Observational Astronomy
- Major Project - Computational Astrophysics

We also offer an online short course. For information, visit astronomy.swin.edu.au/sao/shortcourse/

For more information, visit astronomy.swin.edu.au or contact Dr Sarah Maddison at email: astro@swin.edu.au fax: +613 9214 8797
airmail: Swinburne University of Technology, H39, PO Box 218, Hawthorn, VIC 3122 Australia

“SAO has taken me on a wonderful magical carpet ride through the universe. It has been the most exciting, exhilarating and fun-filled time of my life.”

“The dedication, guidance and encouragement from the instructors made the SAO experience so worthwhile and rewarding.”

“The beauty of studying online is that you only need to travel as far as your computer. It’s incredibly easy to work around your job or social life – it’s the ultimate in flexibility.”

Swinburne Astronomy Online is produced by the Centre for Astrophysics and Supercomputing, one of the newest and most rapidly growing research centres in Australia. The Centre is engaged in research into star & planet formation, stellar dynamics, pulsars, globular clusters, galaxy formation & evolution, and cosmology & large-scale structure.

SAO is located at Swinburne University of Technology in Melbourne, Australia.
Sharing Astronomy With the World
MIKE SIMMONS
Astronomy connects us in a way no other science can. Astronomers Without Borders draws on this common interest to link stargazing enthusiasts worldwide.

GLAST: Exploring the Extreme Universe
ROBERT NAËYE AND DAVID J. THOMPSON
NASA’s Gamma-ray Large Area Space Telescope (GLAST) will give scientists an unprecedented look at active galaxies, supernovae, neutron stars, and even solar flares.

So You Want to be a Professional Astronomer!
DUNCAN FORBES
If you’re going after a career in astronomy, be warned: It is extremely competitive! But if you want to join the elite ranks of professional astronomy, here’s what to do.

Astronomy in the News
Doubt about recent water flows on Mars, an organic molecule on an exoplanet, and the smallest known black hole — these are some of the discoveries that have recently made news in the astronomical community.

navigation tips
• To go directly to an article from here, click on its title.
• Within each article click on the underlined text for additional resources.
• To visit one of our advertisers, click on their website URL.

Departments

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Author/Editor</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Editorial</td>
<td>Paul Deans</td>
</tr>
<tr>
<td></td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>First Word</td>
<td>James G. Manning</td>
</tr>
<tr>
<td></td>
<td>Snapshots in History</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Astronomer’s Notebook</td>
<td>Jennifer Birriel</td>
</tr>
<tr>
<td></td>
<td>Pinning Down Quasar Lifetimes</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Planetary Perspectives</td>
<td>Daniel D. Durda</td>
</tr>
<tr>
<td></td>
<td>Outstanding in the Field</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Armchair Astrophysics</td>
<td>Christopher Wanjek</td>
</tr>
<tr>
<td></td>
<td>To the Beginning of Time</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Echos of the Past</td>
<td>Katherine Bracher</td>
</tr>
<tr>
<td></td>
<td>75 &amp; 50 Years Ago: The Solar Cycle</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Annals of Astronomy</td>
<td>Clifford J. Cunningham</td>
</tr>
<tr>
<td></td>
<td>A Keplerian Horoscope</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Education Matters</td>
<td>David Bruning</td>
</tr>
<tr>
<td></td>
<td>The Luxury of Teaching Science</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Societal Impact</td>
<td>Michael G. Gibbs</td>
</tr>
<tr>
<td></td>
<td>Advancing Science Literacy Through Astronomy</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>GLAST: Exploring the Extreme Universe</td>
<td>Robert Naëye and David J. Thompson</td>
</tr>
<tr>
<td>24</td>
<td>So You Want to be a Professional Astronomer!</td>
<td>Duncan Forbes</td>
</tr>
<tr>
<td>29</td>
<td>Astronomy in the News</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doubt about recent water flows on Mars, an</td>
<td></td>
</tr>
<tr>
<td></td>
<td>organic molecule on an exoplanet, and the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>smallest known black hole — these are</td>
<td></td>
</tr>
<tr>
<td></td>
<td>some of the discoveries that have recently</td>
<td></td>
</tr>
<tr>
<td></td>
<td>made news in the astronomical community.</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Society Scope</td>
<td></td>
</tr>
<tr>
<td></td>
<td>News and information for Society members;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Society Awards</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Sky Sights</td>
<td>Paul Deans</td>
</tr>
<tr>
<td></td>
<td>Dancing Planets in the West</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Reflections</td>
<td>Simon Winston-Macauley</td>
</tr>
<tr>
<td></td>
<td>Sir Arthur C. Clarke: A Quiz</td>
<td></td>
</tr>
</tbody>
</table>

Spring 2008  Mercury  3
A dictionary defines transition as “a process or period in which something undergoes a change and passes from one state, stage, form, or activity to another.” And that succinctly sums up what *Mercury* is going through right now.

In my Winter 2008 editorial I talked about turning points and how that first PDF issue of *Mercury* was a key one. I don’t intend to belabor the topic — in this and future issues you’ll see *Mercury* slowly evolve, literally right before your eyes. But I know some of you are wondering what’s ahead for this publication, so let me mention a few of the things we’re doing and considering.

As Jim Manning mentions in “First Word,” *Mercury* is now officially a digital magazine. But what if — like me — you want a hard copy of *Mercury* to go with your older print issues? There’s always your desktop printer, but the quality usually isn’t very good.

So here’s another option. Check out your local Kinkos or Staples (or anywhere else that does print jobs). Take (or send) them the large hi-res *Mercury* PDF, ask for double-sided printing on quality paper, and soon you’ll have a nice-looking print copy of *Mercury* for your files. And in case you’re wondering, it cost me about $24 for a color copy but only $5 for a very nice black and white version. But I digress.

Producing a digital magazine means that we’re no longer constrained by the requirements of the print medium, which also means we’ll be trying new things. So *Mercury*’s transition is by no means complete; both its look and its content will continue to change.

For example, Sky Publishing / New Track Media, one of our Corporate Affiliate Participants, has kindly agreed to provide ASP members with free access (no sign-up required) to their online Interactive Sky Chart. When you read *Sky Sights*, the star-chart link at the start of each month will take you to a chart of that month’s sky, set for just after sunset at midmonth.

However if you take a little time to play with the chart (and please read the instructions), you’ll be able to set it for your specific location, or for any location on Earth, at any time of the night, for any year from 1600 to 2400 AD.

We also recognize that a vertical-format magazine isn’t the easiest thing to read on a horizontal computer screen. As a result, we’re looking at different options ranging from layout tweaks to a complete redesign. We’ve taken some initial steps in this issue, but we can do more. And this is where you can help.

If you receive other digital magazines, drop me a line and tell me about them. What do you like, and dislike, about their format? Many digital publications have a link to a free or a preview issue — send it along; Leslie (our Art Director) and I would like to take a look.

With your help, we can transform *Mercury* into a great-looking digital publication that continues to serve the needs of all ASP members.

Paul Deans, Editor
editor@astrosociety.org
Snapshots in History

Snapshots can reveal not only progress made, but opportunities unfulfilled.

Last October, I attended the meeting of the International Astronomical Union’s Communicating Astronomy with the Public commission in Athens, Greece. The focus of the meeting was preparing for the International Year of Astronomy (IYA) in 2009, in which the ASP can (and will) play a useful role.

IYA2009 will celebrate the 400th anniversary of Galileo’s first telescopic observations of the sky and the revolution it sparked during the following centuries in our instrument-aided understanding of the universe. But 400 years seemed a paltry sum with the antiquities of Greece looming all around us during the Athens meeting.

One evening, the assembled participants were given a walking tour around the environs of the Acropolis, which culminated in a hike up the Hill of Nymphs to the Athens Observatory as darkness fell. Eastward, we could see the Parthenon on its rocky hill, illuminated against the glittering Greek night. I found a flat surface at an overlook on which to steady my camera to take a picture of the staid temple and its attendant ruins across the space between the two heights. I thought of Aristarchus, Eratosthenes, Aristotle, and the all others who tried to make sense of the cosmos more than 2,000 years ago — some of them in the shadow of that ancient edifice — and how a snapshot in the night could create some small token of that celebrated past.

Inside the observatory building, we found antique instruments and an impressive “astrogaphysics” library. In one bookshelf-lined room, one of my tour companions pointed out a particular volume that had caught his eye: the bound Publications of the Astronomical Society of the Pacific for 1936-37.

Here, in this ancient city, we found another snapshot in time. The Publications have been around since the very beginning of the Society, and when I returned to San Francisco, I took time, one evening, to retrieve those two volumes from our archive and page through them. And they did indeed provide a snapshot, not only of the history of the Society approaching the middle of the last century but also a glimpse of where astronomy was at that time.

In the 1936 compilation, Armin O. Leuschner, then Society president and a prominent figure at the University of California-Berkeley, was the recipient of the Bruce Medal. The year before it had gone to Vesto Slipher of the Lowell Observatory in Flagstaff, Arizona. In 1937, it was Ejnar Hertzsprung, of the famous Hertzsprung-Russell Diagram, who won the Bruce.

The 1936 issues included articles by such astronomy heavyweights as Gerard Kuiper on binary stars, and Henry Norris Russell (the other half of the H-R diagram) and Fritz Zwicky on novae. Leuschner himself wrote about nailing down the orbit of the asteroid Andromache. The McDonald Observatory’s 82-inch reflector was nearing completion, and astronomy lectures on the Sun and Moon at the Pacific Gas and Electric Company in San Francisco “were illustrated by motion pictures as well as lantern slides, and were well-attended.”

Articles of interest in the 1937 issues included one about “An Outstanding Atmospheric Phenomenon of Mars” by Earl Slipher (Vesto’s brother). Another, possessing the lengthy title “The Great Perseus-Andromeda Stratum of Extra-Galactic Nebulae and Certain Clusters of Nebulae Therein As Observed from the Lowell Observatory” was by none other than Clyde Tombaugh, and is described as a “by-product of the extensive trans-Neptunian planet search” that resulted in the discovery of Pluto in 1930.

Edwin Hubble received one of the Donohoe Comet Medals awarded in 1937 for the discovery of a new comet (an award that would be discontinued in the 1950s because too many comets were being discovered to keep up). And the very next year it was Hubble who would win the Bruce by using, in 1929, Vesto Slipher’s redshift data and his own distance calculations to come up with Hubble’s Law and the expansion of the universe. (In his Bruce public lecture in 1938, he still charmingly referred to galaxies as spiral nebulae, the former term apparently not yet having caught on, at least with Hubble.)

Another snapshot in time, in an era with exciting astronomy happening and the ASP there to chronicle it.
And if we jump forward to today, the Center on Education Policy (CEP), in a newly released publication *Instructional Time in Elementary Schools: A Closer Look at Changes for Specific Subjects*, offers another snapshot. According to the CEP, since the advent of No Child Left Behind, a majority (72%) of school districts have increased instructional time in English language arts (ELA) and math at the expense of other subjects, including science — with 53% of these districts reducing science time by at least 75 minutes per week.

At the very time that we need greater science literacy, this is a troubling statistic — and one that tells us our work is not yet done. Through your support, the ASP is providing multiple avenues for educators and students to use the appeal of astronomy to improve science education and understanding — and to help build the science-literate society we need to create a promising future on planet Earth.

The ASP will continue to chronicle the astronomical discoveries of the day and advance the understanding of astronomy and science among its many constituencies. Working together, we can hasten the day when a snapshot of history may show that the 21st century not only included a new understanding of the cosmos, but that the adventure of science also flourished in the classroom, the museum, and in leisure pursuits.

And that will be a fine sight indeed!

---

JAMES G. MANNING (jmanning@astrosociety.org) is the Executive Director of the Astronomical Society of the Pacific.

---

**The Future is Digital**

We hope you enjoy this second digital issue of *Mercury*. Editor Paul Deans, in collaboration with Leslie Proudfit, our Art Director, has exciting plans for enhancing the online format and features. Some you will see in this issue; more will appear in the issues that follow.

Earlier this year, we offered our membership the option of a print version at a full, cost-recovery subscription rate, but only if a sufficient number of members expressed a willingness to go this route to make it financially feasible. Unfortunately, we did not reach the minimum number needed — falling well short — so we will not be able to offer that option.

However, in his editorial, Paul provides some details on how to create a nice hard copy from the downloadable electronic version. And we hope that his and Leslie’s good work, as well as that of the columnists and feature writers, will demonstrate that we strive to maintain and enhance the quality and content you’ve come to know in *Mercury*, even as we strive to make every membership-fee dollar count in advancing our mission.

Thank you all again for your support as we move the organization forward to continue its important work.

— J. M.
Pinning Down Quasar Lifetimes

Quasars play a unique role in cosmology. These most distant of “active galactic nuclei” are denizens of the very early universe. As such, the evolution of quasars traces out the evolution of structure in the early cosmos. At redshifts between 2 and 3, the quasar population peaks. (This corresponds to a time when the universe was roughly 2 to 3 billion years old.) By redshifts near zero, the quasar population is less than one one-hundredth of this maximum value.

All the evidence suggests that the extreme luminosity of the typical quasar results from a gigantic accretion disk surrounding a supermassive black hole at the center of a young galaxy. But how long does this luminous phase last before the quasar “turns off”? There is strong evidence that most galaxies harbor central, supermassive black holes. Does this mean that all galaxies undergo an early quasar phase?

A long quasar lifetime suggests that the quasar phase is relatively rare, while a short quasar lifetime would require that most galaxies undergo such a phase. Current estimates of quasar lifetimes range from roughly millions to hundreds of millions of years. Most of these estimates are derived from incorporating quasars into galaxy evolution models or demographic comparisons of high-redshift quasar data with present-day supermassive black holes.

Such a broad range in estimated quasar lifetimes does not allow us to determine if quasars represent a rare or common phase in galaxy evolution! Nor can we determine if the quasar stage is a single event or if multiple quasar episodes occur for an individual galaxy. The average quasar lifetime becomes a critical question if we are to understand the growth of supermassive black holes and the fueling of active galactic nuclei.

A number of different techniques to constrain quasar lifetimes have been explored. These methods fall into two broad categories: techniques that examine the properties of quasars over the entire history of the universe and those that compare quasars in the same given epoch. Each of the individual techniques used to date, such as quasar luminosity functions, spatial clustering, multi-epoch surveys, and theoretical models using the present-day mass functions of supermassive black holes, have their difficulties.

Recently, Eli Visbal and Rupert Croft of Carnegie Mellon University proposed a technique to determine quasar lifetimes using the radiative record a quasar imprints on the space surrounding it. In the past, quasars themselves have proved extremely useful tools for studying the intergalactic hydrogen clouds along the line of sight of an individual quasar, because the intervening hydrogen clouds leave their imprint on the quasar spectrum.

The spectral lines produced by these intervening clouds have come to be known as the “Lyman alpha forest”. By the same token, however, the ultraviolet radiation emitted by a quasar leaves its own signature in the volume of space around it.

The ultraviolet radiation from any given quasar ionizes the local hydrogen in the region surrounding it. Thus, a characteristic pattern of ionized hydrogen will propagate outward at the speed of light. Visbal and Croft propose using what they call the “light echo” of the quasar. This light echo will imprint itself on the Lyman alpha forest spectra of background sources.

The ionization radiation from a quasar will result in substantially lower levels of neutral hydrogen in the region surrounding the quasar. The width of a light echo is determined by the speed of light times the quasar lifetime. The outer edge represents the quasar “turn on” while the inner edge would correspond to the “turn off” event.

How does one go about detecting a light echo? Visbal and Croft created model light-echo templates, which can be placed over a real spectral data set. The templates have six adjustable parameters, three spatial coordinates, a turn-off and a turn-on time, and quasar luminosity. Data can be fitted with various templates until the best “fit” is found.

Visbal and Croft ran model simulations assuming a quasar lifetime of 10 million years. They suggest that light echoes from the brightest quasars should be detectable in observational data using their search technique. If no light echoes are detected, this would still help constrain quasar lifetimes and luminosities.

Of course, much work is yet to be done — Visbal and Croft note that cosmological parameters and strong galactic winds are complicating issues. Despite these difficulties, searches for light echoes have some exciting possibilities. For example, multiple quasar episodes might finally be identified if multiple shells are found around a given quasar. Additionally, it may be possible to detect dead quasars since the light echo should remain even after a quasar has turned off! Stay tuned.
by Daniel D. Durda

Outstanding in the Field

A field geology exercise highlights the value in training the whole lunar exploration team.

This makes the third Planetary Perspectives column I’ve written on my experiences in the field. It won’t be the last, I’m sure. That’s one of the things I like about planetary science — you can take a very hands-on approach to your research projects if you are so inclined. And if your work involves rocks of one flavor or another, you’re bound to end up in the field at some point. It’s a nice opportunity to trade the office and computer keyboard for some fresh air and a look at some real-world data.

I’ve just returned from Gila Bend, Arizona, where I participated in a two-day exercise aimed at giving those planning NASA’s return to the Moon (and beyond) a sense of what doing field geology is all about. When we go back to the Moon, explorative field geology will be a significant portion of what we’ll be doing there. Many of the still unsolved, “big picture” lunar science mysteries require the skillful application of basic field geological investigation. We haven’t done this sort of thing since Apollo, and a new generation of engineers and planetary scientists is learning how to build on what was done so well some four decades ago.

The field work that a geologist does is a bit like forensic investigation. It consists of observations to define the distribution of rocks and structures in a particular field area, and a common-sense interpretation of those observations. The observation part is fairly straightforward and relatively easy to teach. It’s largely non-quantitative (or semi-quantitative) and relies on the ability of the geologist to see and work with the rocks, and to observe and record the relationships that form the primary data set.

The interpretation part takes a bit more work. Geologists spend entire careers learning how to amalgamate disparate observations into coherent, quantitative insights into geologic processes. The purpose of the field trip I participated in was to have students become involved, with experienced field geologists, in a short field problem to help them understand the demands these kind of exploration activities will place on the design of lunar surface systems and the planning for lunar surface operations. The exercise was coordinated and led by Dean Eppler of NASA’s Johnson Space Center and included astronauts, flight controllers, spacesuit designers, and NASA program managers.

We worked on a small, relatively young shield volcano in the Sentinel Volcanic Field near Gila Bend, Arizona. It was a great site for the field trip: straightforward enough so that students with little or no background in geology could wrap their brains around the basic geologic context, but still complex enough to offer real detective-story challenges for students and instructors alike.

The exercise paired two-person student teams with an experienced field geologist. Each team planned out their first day’s explorative traverses; spent a day’s worth of work executing the initial plan; evaluated and re-planned the second day’s investigations based on the first day’s results; and then followed up with a second day’s worth of field work. A final debrief activity with the whole group captured lessons learned, both for NASA’s exploration planning activities and for future field trips with other groups.

It was a wonderful learning and team-building experience. Dean closed his post-trip wrap-up email with a quote from Gene Cernan, Commander of Apollo 17, about Harrison (Jack) Schmitt, his Lunar Module pilot.

“In thinking about why we worked so well together, the most important point was that we had confidence in each other. Jack is a very astute and dedicated individual, very talented, and I felt very comfortable with him. He was not an aviator and he’ll be the first to tell you that. But he took his responsibilities very seriously, learned quickly, and, in terms of technical understanding, was as good as anybody. He wasn’t a passenger; he had learned how to be a good co-pilot.

In much the same way, I wasn’t a geologist, I wasn’t a scientist, but I had learned to be a good observer. As soon as we hit the lunar surface, although I was still commander of the crew, Jack was the expert and I was his assistant. We had very different backgrounds. I was the professional aviator and Jack was the scientist; but we both knew enough about all aspects of the missions that we could be confident about working together.”

DANIEL D. DURDA is a Principal Scientist in the Department of Space Studies at the Southwest Research Institute in Boulder, Colorado.
To the Beginning of Time

**WMAP can take us to within a fraction of a second after the Big Bang, if it can survive NASA budget cuts.**

Sometimes NASA manages to go rather far with very little. Its Wilkinson Microwave Anisotropy Probe (WMAP), which released its third round of spectacular data this March, has taken us nearly to the beginning of time for about $150 million. Talk about fuel efficiency; that’s only a third of the cost of a single space shuttle launch!

WMAP is a tiny satellite that does one job — mapping the cosmic microwave background, a blanket of faint light filling the entire sky that is essentially the afterglow of the Big Bang. Year after year since 2002, WMAP has soaked up more and more of this light.

What WMAP has found so far is that the universe is 13.7 billion years old; stars first turned on about 400 million years after the Big Bang; and the cosmos is made of 72.1% dark energy, 23.3% dark matter, and 4.6% normal matter. Yes, everything we see, breathe, touch and eat makes up less than five percent of the universe.

WMAP provided these parameters, more or less, with just a year’s worth of data released in 2003. So some folks at NASA and on Capitol Hill would like to say: “Mission accomplished!” and scuttle the satellite. The NASA budget is lean and there are numerous projects to fund.

On one level, WMAP is merely fine-tuning its original measurements. With the release of five years of data this March, for example, WMAP has determined the age of the universe to be 13.7 billion years +/- 120 million years, an improvement of a couple dozen million years from its first measurement. This doesn’t make for captivating headlines: “The universe is still 13.7 billion years old, just like in 2003, astronomers say.”

Yet while WMAP no longer commands the attention of the news media, scientists salivate over every morsel of WMAP data. The fate of the cosmos (or at least an understanding of the fate) depends on it. The energy budget of the universe, its shape, its rate of expansion, its very origin and likely demise — these are the questions WMAP is attempting to answer.

WMAP’s goal is not a trivial pursuit to tighten constraints further to see if the universe began on a Thursday or Friday, though its determination that the recombination era, when protons and electrons combined to create neutral hydrogen, occurred 375,938 +/- 120 million years after the Big Bang is mighty impressive. What the WMAP team is after now is to understand how the universe formed and expanded.

WMAP detects radiation from the recombination era. Properties in this light, however, point back to the Big Bang itself. The main properties are temperature and polarization. WMAP has excelled so far in determining subtle temperature fluctuations (a proxy for density fluctuations), which gravity exploited to create the vast hierarchical structure we see today. The 2003 WMAP announcement was based almost entirely on temperature.

The polarization signal is more than 100 times weaker than the temperature, and there are two types, called E and B modes. The E mode points to the reionization era, when the universe, after cooling down for millions of years, became warm again with new stars. WMAP detects this directly.

B modes point way back to the inflationary epoch and to the gravitational wave produced by the Big Bang — tantamount to seeing the moment of creation. WMAP hasn’t seen B modes. But the temperature and the E-mode polarization maps continue to make specific statements about inflation, which have ruled out many inflation theories, according to Charles Bennett of Johns Hopkins University, the WMAP principal investigator.

To determine precisely what happened back then — whether inflation propelled the expansion of the universe more than 100 times faster than light speed, or whether 4-dimensional branes collided to form our 3-dimensional world — WMAP needs to soak up more data.

Bennett and David Spergel of Princeton University, lead authors on WMAP’s 2006 results (one of the most cited papers in all of astronomy and particle physics), say they won’t rule out that WMAP might detect B modes. “Seeing the B modes would be wonderful,” Bennett said, though it would be “a significant challenge.” But WMAP can lead the way to experiments that can detect B modes, he said.

The European Space Agency plans to launch a mission called Planck in October 2008, which would be more sensitive than WMAP. So the race is on, but data from that mission, however, is many years away. WMAP, at a cost of a few million dollars a year, is NASA’s ticket to the beginning of time…and a Nobel Prize or two along the way.

Some days CHRISTOPHER WANJEK feels like he has been around since the beginning of the universe. He is a communications director at the National Institutes of Health.
In March of 1933, Dr. Seth B. Nicholson of the Mount Wilson Observatory wrote an ASP Leaflet discussing the solar activity cycle. Twenty-five years later he wrote another one on the same topic. Considerable progress was made in our understanding of the solar cycle during those 25 years, and even more has occurred in the past 50, though many questions still remain.

In 1933, Nicholson described the behavior of sunspots, first observed in 1610 by Galileo and Thomas Harriot, and independently in 1611 by David and Johannes Fabricius and Christoph Scheiner. Nicholson noted that: "From 1610 to about 1645 sunspots were as numerous as now. In the next seventy years, however, very few sunspots were observed, although the telescope had been much improved and several astronomers are known to have been watching the Sun. A spot on the Sun was a rare phenomenon at that time and a new one created as much comment as the appearance of a 'new star' does today." This period of very low sunspot activity is now known as the Maunder Minimum, after E. Walter Maunder (1851–1928) who first noted it.

Since about 1750, sunspots have been numerous. But in 1843 Heinrich Schwabe discovered that they follow a roughly eleven-year cycle, though, "the cycles have varied in length from 9.0 to 13.6 years." Their location on the Sun also varies, with sunspots at the beginning (minimum) of a cycle lying about 30 degrees north and south of the Sun's equator, and later ones appearing nearer the equator: "...at maximum activity they have reached latitudes of about 15 degrees and at the end of the cycle most of the spots are less than 10 degrees from the equator."

Nicholson also pointed out that in 1908 George Ellery Hale discovered that "each sunspot has a magnetic field and that groups of spots are usually bipolar." The two hemispheres of the Sun have opposite magnetic polarities, and these reverse with the start of each new cycle.

In his 1958 Leaflet, Nicholson reviewed these aspects of the cycle. He noted that activity in the previous cycle (which reached its maximum in 1947) had been the greatest ever recorded, but that in 1958 they were in the middle of an even more active cycle: "Without doubt we are now witnessing the greatest sunspot activity ever recorded." This was (and still is) true; the four cycles that have peaked since 1958 had fewer sunspots. It is not yet clear why the level of activity varies from one cycle to the next.

He also pointed out the statistical connection between large sunspot activity and magnetic disturbances on Earth. We now know that at times of increased solar activity, solar flares and ejections of high-energy particles are more frequent; when these particles reach Earth they interact with our magnetic field and also cause such phenomena as auroral displays. One of the most intense aurorae occurred in February 1958, near the peak of the sunspot cycle Nicholson was describing.

In the past fifty years we have come to understand sunspots, and their relation to the Sun's magnetic field, a little better. Astronomers believe that sunspots are formed when the Sun's magnetic field lines, twisted by our star's differential rotation (faster at the equator than at the poles), break and emerge through the surface. But the magnetic reversal every 11 years is still not understood.

Seth B. Nicholson (1891-1963) finished his Ph.D. in 1915 at the University of California, and then went to the Mount Wilson Observatory, where he remained for the rest of his life. He retired in 1957 but continued to work informally there until his death in 1963. In addition to working on the Observatory’s solar program, he discovered Jupiter’s satellites 9-12 (Sinope, Lysithea, Carme, and Ananke, respectively), and helped determine that Venus has only very small amounts of oxygen and water vapor in its atmosphere. He was active with the ASP, being the editor of the Society’s Publications from 1943 to 1955, and twice served as the Society’s president (1935, 1960-62). In 1963 he received the ASP’s Bruce Medal for a lifetime of achievement in astronomy.

KATHARINE BRACHER (bracher@whitman.edu) taught astronomy at Whitman College in Walla Walla, Washington, 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.
One of the most famous horoscopes ever cast turns 400 years old in 2008. It should come as no surprise that back in the 17th-century, when even Isaac Newton spent much of his time exploring alchemy, Johannes Kepler dabbled in astrology.

In the early 1600s Kepler and Galileo were Europe’s most famous astronomers. While Galileo was primarily an observational astronomer, Kepler’s main focus was theory — his laws of planetary motion laid the groundwork for Newton’s theory of gravity. But for Kepler, astronomy, numerology, and a mystical view of the heavens intermixed.

It is important to understand that Kepler’s value judgments and his motivations were very unlike those we have today. For him astronomy was the science of the sacred, the science of Creation, while astrology was a profane utilitarian activity. His royal and aristocratic patrons expected Kepler to produce horoscopes for them, and he obliged. Why not? He needed to curry favor, which in turn generated funds to pay his expenses. Fortunately, many of Kepler’s letters still exist, so we can see quite clearly what he thought about astrology.

“There are many nonsensical things in astrology,” he wrote, “but not everything is to be thrown away, as there are many things in it which are in harmony with the nature of the world.”

But Kepler was also aware how dangerous astrological predictions could be in the sphere of politics. “It waylays you only the more secretly at home, in the bedroom, on the couch, deep down in the soul and sometimes provides you with ideas which one brings forth at public meetings without perceiving from where the ideas came.”

That his predictions could have great ramifications in the sphere of politics became evident in 1608, when Kepler was approached by a physician, Dr. Stromair, for the purpose of charting the horoscope of a powerful, but anonymous, man. He responded to this request with his usual élan. “My work is intended for people who understand philosophy, not for those whose minds are infected with credulous ideas, those who think an astronomer should be able to predict particular events in a person’s life.”

Kepler wrote a lengthy description of this unknown lord. “He possesses a great eagerness for glory, and a need to pursue worldly honours and power, and because of this he will make many dangerous enemies, but he will be able to overcome them.”

It did not, perhaps, require too many powers of divination to write such stuff. All ambitious men seek honors and power, and in doing so they create enemies. In this case the secret patron was none other than Albrecht von Wallenstein, commander-in-chief of the armies of Ferdinand, Emperor of the Holy Roman Empire who, as it happened, was Kepler’s royal patron. The stakes were high, but it was not for another 16 years that Kepler realized just how high.

In 1624 von Wallenstein again asked Kepler, through a third party, to answer specific questions about his future. Would he die in some foreign land? If he chose to leave his native land, would he find wealth and power there? Who were his enemies, and what would their astrological signs be?

By this time Kepler was likely well aware who his enigmatic patron was, but he spared no feelings in his reply. Anyone, he said, who turned to the heavens to find answers to daily problems or to peer at his future destiny never learned anything in school. He also rejected the whole business of signs. “Such a subdivision is not taken from the nature of things, but is purely geometrical. Astrologers — go and find something better!”

Even so, Kepler could not resist the money offered, and dutifully cast a horoscope. He predicted that Wallenstein and the Emperor would be able to work together, though their relationship would be stormy. Kepler stopped his horoscope in 1634, stating that “a horrible disorder” would assail von Wallenstein.

For a rational scientist, the fact that a horoscope ended ten years in the future with a dire prediction would be dismissed without a second thought. So what did happen a decade later? Albrecht von Wallenstein was murdered on February 25, 1634.

Which leads us back to what Kepler really thought about it all. “I can testify myself to the experience that when Man begins his independent life outside his Mother — he receives an imprint and a character from the whole celestial configuration — and this he keeps to the end of his days.”

CLIFFORD CUNNINGHAM was photographed early this year with Doris Travis, the last living dancing girl from the Ziegfeld Follies of 1918. She’s still young at 104.
What would happen if you offered a course and nobody came? This scenario is playing out at many colleges and universities as departments now compete to meet increasing demands on their teaching productivity.

Recently, a Midwestern university restructured its general education requirements for undergraduates. For the sciences, the new regulations were initially well received because they increased science credits needed for graduation and required that students spread the courses over three, instead of two, disciplines. At the same time, each department was limited to five courses they could designate as “general education” (gen ed) courses. The difficulty for the Physics and Astronomy Department was that they had to allocate four of the five gen ed courses to support majors in other science departments. Astronomy is the only course the P&A Department offers purely for non-science majors.

An unexpected “benefit” of the gen ed restructuring was that courses could no longer be cross-listed. Astronomy, though taught by physics faculty, was originally cross-listed with Earth Sciences. This cross listing was to permit teacher-education students to fulfill their science requirements for licensure with different combinations of courses. In fact, the majority of students enrolled under the Earth Sciences course number did so because they thought the physics version would be harder. Yet it was the same course, which met at the same time in the same room with the same instructor, and there were no differences in assignments or exams! But students acted as if there was a distinction and pointedly stayed away from the “physics” course. This mind-set plays into the drama that unfolded for the astronomy course.

But now that astronomy was listed only under Physics and not Earth Sciences, advisors could no longer find the course to recommend it and students stayed away in droves because “physics is hard.” It took several semesters to build enrollments, but they remain significantly lower than before restructuring.

The astronomy instructors say the lower class size is a blessing because lecture/tutorial-type activities can take a lot of energy and supervision. Smaller classes mean the instructors can interact more deeply with more students. This should be a benefit, right? Well, no.

Instead, the instructors are criticized for teaching classes with a lower-than-permitted student-contact-hour total. Physics courses in this department have fixed sizes set by lab limitations. The majority of student-contact hours were generated by the astronomy course. But now, because of gen ed restructuring, the astronomy enrollment is down and, thus, so is the total for the department. Without larger enrollments, they will lose resources, which will, of course, only punish students as courses are dropped and lab supplies dwindle. The gen ed courses begin to appear less about broadening student perspectives and providing educational foundations, and more about increasing the all important tuition dollar — the new reality for higher education.

As time progressed, another less virtuous aspect of the gen ed restructuring was revealed: increasing credit hours in one department at the expense of another. The non-science departments could now compete with science departments for science gen ed credits — read enrollments. “Bunny Courses” started to appear: “How to Build a Rain Garden” for environmental science credit, for example. Departments now competed for students by plastering hallways with posters advertising new courses. The university entered a new phase: pandering and marketing to students as if courses were Britney Spears CDs.

This sad experience should make us all reflect on what we do. Can we continue to offer an astronomy course that is rich in quantitative reasoning, has high standards, and expects students to transform their education from one of rote memorization to one of application and synthesis, while at the same time running low enrollments and thus risking criticism from the university that we are not pulling our weight in student-contact hours? Should we risk loss of departmental resources by holding onto sound educational principles, because we know that the course will enable students to succeed academically? Should we work harder and longer than our colleagues because we are trying to use the best practices, even though we know that since they play the enrollment game better, they will receive the “merit” raises, “teaching” awards, and increased departmental funding even while they do less in their classrooms? When did actually teaching science in a science course become a luxury?

DAVID BRUNING (david.bruning@uwp.edu) is a Distinguished Lecturer at the University of Wisconsin-Parkside. He finds the trend to increase the sizes of universities just to generate tuition dollars to be alarming.
Advancing Science Literacy through Astronomy

What is the ASP doing to support science education?

The United States holds a preeminent position in science and engineering (S&E) in the world, derived in larger part from its long history of public and private investment in S&E research and development (R&D) and education. Investment in R&D, science, technology, and education correlate strongly with economic growth, as well as the development of a safe, healthy, and well-educated society.

So begins the introduction of the Digest of Key Science and Engineering Indicators 2008 by the National Science Foundation. This report is issued on an annual basis to offer insight into the overall health of the science and engineering sector within the US.

The report provides some interesting information. Did you know that in 2006 the US spent $340 billion in science and engineering R&D — more than any other G7 country (the United States, Japan, Germany, France, United Kingdom, Italy, and Canada)? More than half of this amount supports defense, but the investment in space and general science research has recently increased, and "since 1960, the US science and engineering workforce has grown faster than the full workforce."

Here’s something else. While two-thirds of US high school graduates enroll in postsecondary education, the report noted that in the academic year 2003-04, "about 59% of the public secondary schools in the US reported vacancies in mathematics teaching positions, and of these nearly one-third said that they found it ‘very difficult to’ or ‘could not’ fill those vacancies.” Why could this be the case?

While many high school students continue to postsecondary education, they are not always receiving the quality science education needed to be qualified for jobs in the future workforce. The workers our economy will need (in the not-so-distant future) will be in knowledge-intensive industries rather than the traditional manual-labor or service-sector occupations.

In addition to the science and engineering issues facing our nation, there are problems with math as well. According to a March 2008 article in the Washington Post titled, "Math education system is broken, Bush panel says,” the National Mathematics Advisory Panel (convened by the President in April 2006), states that students in pre-school to middle school need to master their math skills. When examining math test scores of 15-year-olds in the US compared to students the same age in 23 other industrialized countries, the US students trail. The reason for this, according to the panel, is that elementary and middle schools do not provide enough depth within their math curriculum for students to receive the necessary foundation needed to understand higher math.

Clearly, there are problems. But what are the solutions? What is being done to support teachers to encourage our children to develop the science, technology, engineering, and math (STEM) skills necessary for our future workforce in the global marketplace?

If you have ever interacted with young children (and even those who are a little older), there are consistently two areas they find fascinating — stars and dinosaurs. When I talk with these children, I’m amazed at how much they know about the various dinosaurs and the different constellations. So, how can we expand and grow this passion and encourage more students to become interested in science?

The Astronomical Society of the Pacific, with its cause of improving science literacy through the appreciation of astronomy, is one of the nation’s leading nonprofit organizations working directly with formal and informal science educators to use astronomy as a key to engage students in science. The intended result is to improve science literacy and therefore provide for a strong economy and a well-educated society.

The ASP and you — as a member, benefactor, and friend — are part of a national effort that directly supports both formal and informal science education. We focus on astronomy and use this as the spark to generate an interest in science and the STEM field.

Through the ASP’s various networks, we have a national effort with the goal of improving science literacy. These networks exist thanks to amateur astronomers and their clubs taking part in the Night Sky Network; informal science educators participating in Astronomy from the Ground Up; in-service science teachers and volunteer astronomers contributing to Project ASTRO and Family ASTRO; and those teaching undergraduate astronomy classes who take part in the Cosmos in the Classroom conference. Individuals involved in any of these national networks directly interact with our children or the public, and we make it one of our goals to provide them with the resources and support necessary to utilize astronomy as a way of generating interest in science.

Your partnership with the ASP allows us to implement our mission, advance the cause of science literacy, and support these national networks. It is only through our continued focus and commitment to the cause — to improve science literacy through astronomy — that we can begin to stem the tide and ensure our country is able to compete in the global marketplace of the future.

MICHAEL G. GIBBS (mgibbs@astrosociety.org) is the Chief Advancement Officer for the Astronomical Society of the Pacific.
Regardless of our beliefs, we all share the same sky.

by Mike Simmons
Away from city lights, beneath a blanket of stars, the child in all of us comes alive. Something basic, perhaps primitive, beckons our gaze skyward. After a lifetime spent in the fog of light pollution, a glimpse of the stars as our ancestors knew them evokes awe at their beauty and grandeur. It’s the same wherever, or whoever, we are. A fascination with astronomy connects us in a way no other science can.

Connecting the World
Astronomers Without Borders (AWB) draws on this common interest to link astronomy enthusiasts worldwide. Sharing is an integral part of appreciating the cosmos. It shows up on a local level when amateur astronomers take their telescopes to public sites and invite others to explore the sky with them. AWB extends this concept to people around the world. After all, we share the same sky.

In isolated countries, contact with fellow astronomers in the West is often nothing short of a miracle. When the Amateur Astronomers Association of Kurdistan (AAAK) in northern Iraq heard that I would be visiting them to research an article for a US publication, the bold headline of their newsletter read, “WE ARE NOT ALONE ANYMORE!” The visit of a lone American astronomer was historic for this active local group. The amateur astronomer who first befriended the group also cherishes the relationship that allows him to talk directly with his new friends in Iraq.

Presentations to amateur-astronomy groups in the US about astronomy in remote lands elicit more questions about the people and their culture than the ways they practice astronomy. Seeing the plight of those in less fortunate circumstances often leads to donations of unused telescopes and other surplus resources. A plea for surplus instruments for the AAAK produced a heartwarming response. One hundred and fifty pounds of equipment made its way halfway around the world, but several cast-offs were left behind. This inspired AWB’s Sharing Telescopes and Resources (STAR) program, one of several projects managed, assisted, or planned by AWB. Woodland Hills Telescopes has provided warehouse space, and sponsors are being sought for shipping telescopes abroad. When distribution funds become available, the project will be launched in earnest. In the meantime, AWB has expedited direct connections between donors and recipients. Such basic contributions reap tremendous returns.

A WB Activities
Amateur astronomy clubs in most of the developing world emphasize education over private observing. For example, “Einstein’s Mind Lesotho” conducts numerous school programs in their poor South African nation and has support for ambitious plans that would be the envy of any Western country. For the AAAK, the donations not only initiated school and public observing programs but also prompted the government to recognize the AAAK’s activities and provide a meeting place and other resources. This, in turn, built their reputation and improved the AAAK’s ability to do even more. A connection with the West can sometimes bring recognition and opportunities in an upward spiral that begins with a simple and (from a Western perspective) seemingly insignificant contact.

Thanks to the Internet, there is even more to be gained through distant contact. The idea of bringing people together through a common interest in astronomy — and sharing telescopes as a result — has given rise to new ideas that have become the larger vision for Astronomers Without Borders. The Internet offers the potential for a global “club” of enthusiasts, and the AWB website provides the necessary meeting place and tools. A growing array of projects (club activities) presents numerous opportunities for participation. The online Community Center (the club meeting place) is being built to offer forums and special programs.

But the foundation of Astronomers Without Borders is the network of member organizations of all types (affiliates). Affiliates include astronomy clubs, magazines, advocacy groups, equipment manufacturers and retailers, and others interested in astronomy and space science. A searchable database of affiliates allows groups to find and contact others based on common activities, interests, or
geography. This is comparable to one of the most important functions of any club — the socializing that takes place in meeting rooms and coffee shops before and after club gatherings. This sharing can now be extended worldwide, through the Internet, to groups with similar interests. The response so far has been tremendous.

The affiliate network will also foster new types of programs. Pairing clubs for specific projects or adding programs that promote collaboration will occur on a regular basis. For example, sharing observations of a new comet from northern and southern locations or measuring the parallax of the Moon or Mars takes advantage of large distances between clubs. Ideas for programs come mostly from the affiliates themselves.

Cosmic Vistas, Earthly Scenes

The project with the highest profile to date is one that demonstrates, in spectacular fashion, the connection between Earth and sky. The World at Night (TWAN) combines astro-imaging and landscape photography to create a unique collection of stunning celestial scenes above the world's greatest natural, cultural, and historic sites. TWAN reveals the unified nature of Earth as a planet rather than an amalgam of human-designated territories by showing that the stars are the same, regardless of which national or regional symbol they're drifting over.

Babak Tafreshi, a well-known landscape astrophotographer and science journalist in Iran, conceived TWAN and inaugurated the project under the AWB umbrella. The photographers Tafreshi has invited to join the effort are widely published and skilled in this particular type of astrophotography.

All the continents are already represented in the image bank, but...
many important sites remain inaccessible or closed to the public and individual photographers. TWAN will help photographers gain access to these locations and support travel to these prime spots. A survey of significant sites is underway, with priority given to UNESCO’s 851 World Heritage Sites. About 100 will eventually be chosen but many personal favorites of team members will also be included.

**AWB and the IYA**

Led by the International Astronomical Union and UNESCO, the *International Year of Astronomy 2009* (IYA2009) is a yearlong initiative that will convey, to the public around the world, the importance of astronomy and its impact on our daily lives. There are a broad array of projects and activities planned for IYA2009, and Astronomers Without Borders is deeply involved.

AWB has been designated an Organizational Node, making it a partner in this unprecedented effort. AWB will work through its network of affiliates to extend IYA2009’s educational programs to remote locations and will take a lead role in other IYA2009 projects. TWAN has been designated as a Special IYA2009 Project, and planning for several major TWAN exhibitions around the globe is now underway.

AWB is leading the sidewalk astronomy component of IYA’s Global Cornerstone Project: *100 Hours of Astronomy*, which could be the high-profile event of the IYA. This global effort, from April 2 through April 5, 2009, will encourage all amateur astronomers to take their telescopes to the people — not just on public sidewalks but also to schools, science centers, and other venues. A 24-hour global star party (described on the next page) will be the project’s peak event, while 24 hours of live webcasts from research observatories will give the public a look into the professional arena.

**A Messier Marathon star party at Bahram Palace, a 400-year-old caravanserai in Kavir National Park, Iran.**

**Gernot Meiser, TWAN photographer and AWB Regional Coordinator for Europe, shares a telescopic view of the sky in Egypt.**
Internet-Based Programs

The Internet will be utilized in a number of innovative AWB programs that are now being conceived and tested. A network of schools, using remotely operated telescopes to bring together students from around the world, has been discussed. Gathered in their classrooms during daytime school hours, students will connect with telescopes (in darkness) in other parts of the world. Motivated by common objectives, observations and experiences would be shared in a worldwide community of schools.

There are many remotely operated telescopes available, and some networks have already been created. AWB will not attempt to duplicate the work being done by others, but will instead focus on the international educational aspect that serves the AWB mission of connecting people across borders, and partner with others to expedite these programs.

Another way to reach distant destinations is via a global star party that brings affiliates and others together to share the sky. Connected by live chat, image uploads, and, in some cases, live streaming video, observers can take part from any location where an Internet connection exists. As the Earth rotates, observers in successive time zones will have one hour to scrutinize a list of objects. But this isn’t a competition and there are no goals other than those shared by any other star party — to observe together and share views, thoughts, and experiences. Before or after their observing hour, clubs will add comments and information to AWB’s star party website, assist novice observers, teach new telescope owners how to better use their equipment, and interact with each other and their members — just as at any star party.

A program of astro-tourism — international tours to countries with dark skies and fellow astronomy enthusiasts — will help foster more direct contact between observers. Admittedly, this program is similar to other already popular types of guided travel such as solar eclipse tours or ecotourism. But in this case a dark night sky, and the element of visiting with local astronomy enthusiasts who host the travelers, are the primary attractions. While the expense and rigor of international travel will always limit participation in this program, the relationships and understanding that result will be invaluable, and a cadre of cross-border astronomy advocates will be one lasting outcome.

Goodwill Through Astronomy

Astronomers Without Borders is not the only astronomy or science program with an international reach. What differentiates AWB is its focus on sharing and collaboration. The goal is not to directly educate people about astronomy or recruit them into the field. Instead, AWB concentrates on bringing together members of its worldwide community to share resources. In the end, this improves education and outreach in all regions, and even turns some local visions into global realities.

It also links previously isolated world citizens — in the East and West, in developed and developing countries — to learn about each other through the sharing of a common interest. As a bonus, these interactions foster an understanding of people beyond local and regional borders and highlight the things they have in common in addition to astronomy.

Modern technology has separated many people from the night sky of their ancestors. But technology has also given us the tools to discover lands and peoples our ancestors never knew. Our primal connection to the night sky combined with modern technology can now bring us together, meeting beneath the stars we all share.

MIKE SIMMONS has been an amateur astronomer for more than 35 years and loves sharing the sky with others. His outreach efforts in astronomy broadened in 1999 when he traveled to Iran for a total solar eclipse. Seeing astronomy as a universal interest that transcends cultural differences, Mike founded Astronomers Without Borders in 2006.
Explore the Universe...

Master of Education with a Specialization in Astronomy (Online)

- Innovative partnership between Northeastern University in Boston and Australia’s Swinburne University, the leading international astronomy program.
- Earn a Master of Education (MEd) from Northeastern and a Graduate Certificate of Science (in Astronomy) from Swinburne—entirely online!
- Ideal for science teachers or career changers.
- Courses in the solar system, galaxies, astrobiology, and more.

APPLY TODAY
Northeastern classes begin July 7 • Swinburne classes begin August 18
www.spcs.neu.edu/astronomy
GLAST: EXPLORING THE EXTREME UNIVERSE

A new gamma-ray observatory will expose the violent and unruly side of the cosmos.

by Robert Naeye and David J. Thompson

Courtesy General Dynamics
A long time ago, in a galaxy far, far away, the core of a massive star implodes under the crushing force of gravity. As the core scrunches down into a black hole, magnetic fields channel infalling gas into two blazing jets of subatomic particles. As the beams punch out of the dying star, protons collide at incredible speeds, generating shock waves that send a burst of gamma rays screaming through the universe.

Fast forward 10 billion years. The photons from this gamma-ray burst have raced across immense tracts of mostly empty space. Cosmic expansion has literally stretched their wavelengths, sapping their energy. But they still pack a powerful punch. Just one of these gamma-ray photons carries a billion times more energy than the light we see with our eyes.

Eventually, the photons smack into the thin atmosphere of planet Earth. The photons have traversed an unfathomable distance unscathed. But when they smash into gas molecules, they go splat and decay into a shower of particles and photons. It’s a pity for Earth’s astronomers that the information carried by those photons is lost forever.

But soon that situation will change. Later this year, NASA will launch the Gamma-ray Large Area Space Telescope, or GLAST for short. This $690 million mission will catch some of these gamma rays, revealing cosmic behavior at its most extreme and unruly. GLAST will give scientists an unprecedented look into the workings of active galaxies, neutron stars, supernova shock waves, and solar flares. And if Mother Nature is generous, GLAST might even discover the nature of dark matter and unveil new laws of physics.

Unique Partnerships
GLAST is an international mission involving NASA, the US Department of Energy, and more than a dozen institutions in France, Germany, Italy, Japan, and Sweden. Without the indispensable contributions of each of these partners, the spacecraft never would have made it to Cape Canaveral, Florida, for launch.

The mission also represents a partnership between particle physicists and astronomers — two distinct communities that rarely interact because of the modern-day specialization of science. But the two cultures joined forces to make GLAST a reality, with the particle physicists bringing their expertise in building particle detectors, and astronomers contributing their experience in building spacecraft.

Particle physicists are interested in GLAST because gamma rays are the most energetic form of light on the electromagnetic spectrum. They pack so powerful a punch that they behave more like particles than waves. In fact, they are so energetic that Einstein’s famous equation $E = mc^2$ comes into play. When two gamma-ray photons collide, their energy converts into particles: an electron and its antimatter counterpart (a positron). Likewise, when matter and antimatter meet, they annihilate each other and produce a shower of particles and radiation that includes gamma rays. Thanks to these energetic interactions, GLAST will probe fundamental physics under conditions far beyond anything we humans can attain in particle accelerators.

For their part, astronomers are tantalized by the prospect of seeing where the universe’s most extreme action is taking place. GLAST will reveal new insights into black holes, neutron stars, and supernova shock waves: places where particles are accelerated to near-light speed. GLAST will catch gamma rays from objects near and far — from flares on our Sun to gamma-ray bursts (GRBs) toward the edge of the visible universe.

The Instruments
GLAST will be renamed after its successful launch and deployment, with the name chosen from thousands of entries submitted by the public. One of the authors (RN) hopes the new name will include the word “observatory” rather than “telescope,” because GLAST does not operate like a conventional tele-

Two jets shoot out of the center of the active galaxy Cygnus A. Courtesy NRAO.
A gamma ray from deep space (1) enters the LAT. It first passes through the anticoincidence detector (2) without producing a signal. The gamma ray interacts with one of 16 thin tungsten sheets (3). This interaction converts the gamma ray into an electron and a positron. The tracker (4) uses silicon strips to measure the paths of the electron and positron, allowing the LAT to pinpoint the arrival direction of the gamma ray. The electron and positron enter the calorimeter (5), which measures the energies of the particles, and therefore the energy of the original gamma ray. Unwanted cosmic-ray particles produce a signal in the anticoincidence detector, which tells the data acquisition system to reject the signal.

The LAT will build upon the success of its predecessor, the EGRET instrument on NASA’s Compton Gamma Ray Observatory. The LAT greatly improves upon EGRET in every conceivable aspect of scientific performance: sensitivity, field of view, angular resolution, time resolution, and energy coverage. With its huge leap in capabilities over all previous gamma-ray observatories, GLAST will break new ground, and can be anticipated. But with a huge leap in capabilities over all previous gamma-ray observatories, GLAST will break new ground, and will address questions that nobody has yet thought to ask.

The LAT is managed at the Stanford Linear Accelerator Center (SLAC). The principal investigator is Peter Michelson, the great nephew of America’s first Nobel laureate in physics: Albert A. Michelson. The GBM is managed at NASA’s Marshall Space Flight Center in Alabama. The P.I. is Charles “Chip” Meegan, with Jochen Greiner of the Max Planck Institute of Extraterrestrial Physics serving as co-P.I. The GLAST project as a whole is managed at NASA’s Goddard Space Flight Center in Maryland.

Science with GLAST

GLAST is a multi-purpose observatory that will study a multiplicity of phenomena. Like any good experiment, the mission was designed to achieve certain observational and technical goals, so some results can be anticipated. But with a huge leap in capabilities over all previous gamma-ray observatories, GLAST will break new ground, and will address questions that nobody has yet thought to ask.

By giving scientists their first clear view of a broad swath of the gamma-ray spectrum, GLAST is effectively opening a new window on the universe. The history of astronomy has shown that whenever scientists have peered into the unknown, major discoveries followed, most of which were unanticipated. Following are some of the objects that GLAST will study, but stay tuned; probably no one has predicted GLAST’s most exciting discoveries.

- **ACTIVE GALAXIES.** In the words of GLAST project scientist Steve Ritz of NASA Goddard, “The study of active galaxies will be GLAST’s bread and butter. There are guaranteed results.” With the LAT’s high spectral resolution, GLAST stands poised to reveal the composition of jets that shoot out from the cores of massive galaxies at near-light speed. GLAST observations may also explain how the supermassive black holes that lurk in galactic cores accelerate the jets. GLAST will also discover a thousand and perhaps many thousands of new active galaxies, particularly those belonging to the class known as blazars. These beasts beam their powerful, gamma-ray-emitting blowtorches directly at Earth.

### How the LAT Works

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anticoincidence detector</td>
<td>Rejects 99.97% of unwanted signals produced by cosmic rays that enter the LAT.</td>
</tr>
<tr>
<td>Conversion foil</td>
<td>Measures the gamma-ray's energy.</td>
</tr>
<tr>
<td>Particle tracking detectors</td>
<td>Measures the paths of the particles and resolves the gamma-ray source locations.</td>
</tr>
<tr>
<td>Calorimeter</td>
<td>Measures the energy of the original gamma ray.</td>
</tr>
</tbody>
</table>

![Diagram of the LAT](image)

---

D.T.

---

22 Mercury Spring 2008
**GAMMA-RAY BURSTS.** Since GRBs were discovered in the 1960s, these explosions from deep space have remained one of the most enigmatic phenomena in astrophysics. Working in tandem with other observatories, GLAST will help crack some of the remaining mysteries. Thanks to missions such as Swift and BeppoSAX, astronomers have come to realize that most bursts are triggered by the death of massive stars, with much of the energy beamed in two narrow jets. But others are probably caused either by neutron-star mergers or giant flares on highly magnetized neutron stars known as magnetars. The GBM should catch about 200 GRBs per year, greatly increasing the burst-detection rate.

**NEUTRON STARS.** With magnetic fields billions or even trillions of times stronger than Earth’s, neutron stars are among nature’s most prolific particle accelerators. And whenever particles are accelerated to high speeds, gamma rays are a natural byproduct. GLAST has the potential to discover hundreds of neutron stars that shine brightly in gamma rays but weakly at other wavelengths. It may provide key data that will reveal how neutron-star magnetospheres accelerate particles, and it may help scientists better understand what makes pulsars pulse. By catching neutron stars at different ages, GLAST might also shed light on the largely unknown life cycle of neutron stars.

**COSMIC RAYS AND SUPERNova REMNANTS.** The origin of cosmic rays has been an enduring mystery ever since their discovery in 1912. Recent X-ray observations strongly suggest that most low-energy cosmic rays are accelerated in shock waves generated inside supernova remnants. The LAT’s high spatial resolution will enable scientists to pinpoint the telltale spectral signature of accelerated particles. If, as expected, this emission coincides with individual supernova remnants, GLAST will seal the deal. On the other hand, the LAT cannot detect ultra-high-energy cosmic rays (UHECRs), whose origin is one of the great, unsolved mysteries in astrophysics. (For more about UHECRs, see Christopher Wanjek’s column in the Winter 2008 issue of Mercury.)

**SOLAR FLARES.** Working with NASA’s RHESSI satellite, GLAST could help solar physicists piece together the story of how the Sun shoots out high-speed particles in sporadic outbursts known as flares. RHESSI is providing data on lower-energy gamma rays, but the LAT will extend this range into the upper end of the gamma-ray spectrum. The GBM will assist by catching flares, and by providing energy coverage that overlaps that of RHESSI and the LAT. The timing of the GLAST mission is ideal since solar maximum will occur in 2011 or 2012.

**DARK MATTER.** For decades astronomers have known that the universe contains more matter than they can see in their telescopes. The nature of this “dark matter” is one of the most profound unsolved mysteries of modern science. Though not one of GLAST’s primary objectives, the mission has the potential to crack the mystery if a leading theory of particle physics is correct. Known as supersymmetry, this theory predicts that every familiar particle has a heavier superpartner. Such particles would be, by their very nature, exceedingly difficult to detect, since they’d only interact with familiar atomic matter through the two weakest forces of nature: gravity and the weak nuclear force.

Supersymmetry predicts that when two superpartners interact, they will annihilate each other and produce a shower of particles and radiation, including gamma rays of particular energies. The LAT has the sensitivity to see patches of sky glowing from dark-matter annihilations. In conjunction with experiments on the ground, GLAST might resolve this mystery once and for all.

**FUNKY PHYSICS.** GLAST also has the capability to make spectacular discoveries in fundamental physics, though deputy project scientist Julie McEnery of NASA Goddard cautions, “This is not guaranteed science; this is somewhat speculative.”

By studying the arrival times of gamma rays of different energies from distant GRBs, the LAT might be able to determine that very-high-energy gamma rays, which have wavelengths smaller than an atomic nucleus, travel faster or slower than the speed of light. The LAT might also pick up “Hawking radiation” from exploding or accreting substellar-mass black holes that formed in the early universe. That of course, depends on whether these primordial black holes actually exist.

**UNIDENTIFIED SOURCES AND THE UNKNOWN.** The EGRET instrument on the Compton Gamma Ray Observatory picked up 271 gamma-ray sources. But more than half of these objects remain unidentified. The LAT’s superior spatial resolution will allow astronomers to make follow-up observations with other instruments to nail down the identity of most of these objects, which could yield major surprises.

In addition, the LAT’s greatly improved sensitivity should allow it to see thousands of new sources during the spacecraft’s five-year nominal mission, though GLAST science-team members can only venture guesses of the exact number of sources that the LAT will see. Who knows what surprises nature has in store among these new objects?

ROBERT NAEYE and DAVID J. THOMPSON both work at NASA’s Goddard Space Flight Center in Greenbelt, Maryland. Former Mercury editor Naeye of SP Systems is senior science writer for Goddard’s Astrophysics Science Division. Thompson is a GLAST deputy project scientist.
SO YOU WANT TO BE A PROFESSIONAL ASTRONOMER!

Exotic workplace locales, amazing discoveries, and fame (but probably not fortune) await those who persevere on the path leading to a career as a professional astronomer.

by Duncan Forbes

Courtesy Gemini Observatory
In many ways, professional astronomers are very fortunate. They have an opportunity to continue their passion (one that many people share) and they're paid to do it. Some of the reasons given by PhD students for becoming an astronomer include: it’s fun and exciting, there are great opportunities for travel, it’s a cool job, and it’s possible to make significant discoveries.

Universities, observatories, government organizations, and industry employ astronomers who, contrary to popular belief, don’t spend all their waking hours at a telescope. Instead, most of their time is spent teaching, managing projects, providing support services, and performing administrative duties. A typical astronomer might spend just a week or two a year on an observing run, following by months of data analysis and article writing.

If you’re going after a career in astronomy, be warned: It is extremely competitive! There are many very smart, hard working people seeking a limited number of positions. The worldwide community of professional astronomers is only about 10,000; most are located in the US (with about 1,000 in the UK and 250 in Australia).

Under the heading of “astronomy” there are many fields (and sub-fields) of research. But if research isn’t your thing, there are other options, including Support Astronomer and Telescope Operator, which will let you spend a lot of time around telescopes all over the world. The American Astronomical Society (AAS) has a useful guide that describes various careers in astronomy.

So how do you join the elite ranks of professional astronomy? Here are some suggestions for how to get a job in astronomy.

First, Get that PhD!

All professional research astronomers have a PhD in astronomy or a related field. Use the web and talk to people about the best places to do your PhD. Be bold and choose a different university for your PhD than your undergraduate degree. This exposes you to different ideas and broadens your horizons. It also looks better to a potential employer. You may even consider doing your PhD overseas. Advantages could include a shorter program (three to four years in the UK and Australia vs. five to six years in the US) and no Graduate Record Examination (GRE) required.

Attributes of a good PhD student include a passion for research, a high level of motivation, well organized, and good verbal and written skills. As a student you will probably be working more than 40 hours a week (think apprentice), so it’s important to work efficiently.

The old mantra “work smarter, not harder” is very relevant here, especially as data volumes continue to grow at an exponential rate. Two good articles on what it’s like to be a PhD student and how to obtain a PhD are “How to be a Good Graduate Student” and “So Long, and Thanks for the PhD!”

Choose your PhD supervisor carefully. They will be your guide and mentor for the next few years. It’s a good idea to check out their publication record to see where their recent interests lie, and ask current students what they think of their supervisor and the research group/department. There is a wide range of supervisory styles from the “Hi, here is a research topic. Come back and see me in three years time.” to “I want updates of your progress every five minutes.”

Some supervisors can be quite demanding, which likely stems from two factors — their research reputation is at stake, too, and they want to prepare you for the ‘real world’ of independent research. Richard Reis has written several interesting articles in the Chronicle for Higher Education including “Choosing the Right Research Advisor”.

While working on your PhD, you should aim to write papers (and publish them!) as you go. This will make the actual writing of your thesis a much easier task. I suggest you try for one published paper for each year of full-time research. Some students manage more than a half dozen papers during their PhD program. The bad news is that you have to compete with them in the job market! And
don't forget to read other people's papers, because 'knowing the literature' is very important.

It's also a good idea to discover the 'big picture' beyond your narrow sub-field, I suggest spending about 10% of your week attending seminars and chatting with colleagues outside your field about their work. Some collaboration work done outside of your department will look good when it comes time for letters of reference and job applications.

Warning: Too much time spent observing or writing computer code can adversely affect your chances of acquiring a PhD! While this work might form the basis of your project, be careful it doesn't become all-consuming — you still need to prepare and present a thesis to be awarded a PhD.

Networking is important for your career, so hone your skills during your time as a PhD candidate. Give research talks. Being able to present your research can be crucial to your career prospects, so get plenty of practice. Finally, consider applying for small grants and awards as these can help improve your CV.

**Becoming a Postdoc**

At some point toward the end of your PhD work, it'll be time to apply for a postdoctoral research position. The best place to look for a postdoc or staff position at a university or observatory is the monthly AAS Job Register. Each year some 200 short-term postdoc (and about 80 permanent staff) positions are advertised worldwide, with peak activity occurring in November.

Postdocs can be divided into 'named' and 'unnamed' positions. The named positions include Hubble and Chandra Fellowships in the US, and Fellowships funded by the national research councils in the UK and Australia. These positions generally offer freedom to explore your own research direction, a (reasonably) generous research budget, and a decent salary. As such they are prestigious and highly competitive. Unnamed positions are typically with individual astronomers or university departments that have generated funds for the position via a research grant, and the research topic is likely predetermined.

In either case, you may be invited to join a large team. Being a member of a large research group can allow you to tackle major scientific questions and work with top people in your field. However, it can also make it difficult for people outside the team to evaluate your contribution to the project.

**First the good news!** Although most countries overproduce astronomy PhDs relative to their job market, the number of postdoc positions worldwide roughly matches the demand for positions (after excluding people who don't wish to continue in astronomy or are unwilling to live abroad). In the most recent decadal report of Australian astronomy, some 70% of PhD recipients obtained a postdoc (mostly abroad), 20% obtained a job in industry, and 10% don't respond to questionnaires.

So generally speaking there is a postdoc position in astronomy for you if you want it. Postdocs are the key period in which you show what you're made of in terms of the quality and quantity of your publications. The average academic astronomer in the UK produces 4.4 papers a year. Ambitious young postdocs should be looking to match or exceed that level with quality papers. A typical research career involves two to three postdocs each lasting two to three years. The next step is an application for an entry-level Lectureship or an Assistant Professor job.

**Now the bad news.** It's tough to get a permanent job in astronomy. It is not unheard of for a university department to receive more than 100 applications for a single position. Although the numbers vary over the years, a recent report by the UK's Royal Astronomical Society concluded that only one in five students with a PhD in astronomy obtained a permanent job in the field in the medium term — meaning by the time the "student" is about 40 years old!

It's also worth bearing in mind that the popularity of sub-fields in astronomy, and hence the number of related jobs that are available, changes with time. For example, in a survey of Australian astronomers (covering the period 1995 to 2000), the percentage who said that they were working in galactic astronomy declined from 41% to 24%, while the fraction of those exploring extragalactic topics rose from 26% to 42%.

**Movin' On Up**

If you want to move up the job ladder, you'll have to evolve from an apprentice-like PhD student to a research leader or manager. You will find yourself making smaller contributions to more papers.
You’ll have a better grasp of the big picture but probably at the expense of the technical details. Choosing your collaborators well is an important aspect of ongoing research success. You will increasingly multi-task, juggling teaching, community service, administration, management, personnel, and finance issues along with your research and that of your students.

Your first step in this evolution is to leave the world of the postdoc and acquire that full-time position. You’ll need to apply, of course, and the better your résumé, the better your chances. Your written application (including cover letter, CV, research interests, and letters of reference) is key to getting a job interview. Give considerable thought as to whom to ask to write those reference letters. It’s obviously good if the writers are well regarded by your potential employer, but it is equally important to get a strong letter from someone who knows you well.

When you get a job interview, be prepared and do your homework. Think about why you want the job — it’s probably the first question you’ll be asked. You may also be asked potentially tricky questions like: “What are your career plans?” and “If offered this job today, would you accept it?” It’s also a good idea to have some questions of your own lined up. There are plenty of websites and books with strategies on how to interview well — look at a few beforehand.

Speaking of the Web, astronomy job webpages with the latest rumors and gossip about positions (and what it’s like to work at various institutions) have added an interesting new dimension to the application and hiring process. On the flipside, an employer may Google you. Consider cleaning up your personal web page, includ-

You’ll have a better grasp of the big picture but probably at the expense of the technical details. Choosing your collaborators well is an important aspect of ongoing research success. You will increasingly multi-task, juggling teaching, community service, administration, management, personnel, and finance issues along with your research and that of your students.

Your first step in this evolution is to leave the world of the postdoc and acquire that full-time position. You’ll need to apply, of course, and the better your résumé, the better your chances. Your written application (including cover letter, CV, research interests, and letters of reference) is key to getting a job interview. Give considerable thought as to whom to ask to write those reference letters. It’s obviously good if the writers are well regarded by your potential employer, but it is equally important to get a strong letter from someone who knows you well.

When you get a job interview, be prepared and do your homework. Think about why you want the job — it’s probably the first question you’ll be asked. You may also be asked potentially tricky questions like: “What are your career plans?” and “If offered this job today, would you accept it?” It’s also a good idea to have some questions of your own lined up. There are plenty of websites and books with strategies on how to interview well — look at a few beforehand.

Speaking of the Web, astronomy job webpages with the latest rumors and gossip about positions (and what it’s like to work at various institutions) have added an interesting new dimension to the application and hiring process. On the flipside, an employer may Google you. Consider cleaning up your personal web page, includ-

There are a number of new major observatories being planned or currently under construction, including the Atacama Large Millimeter/submillimeter Array (ALMA) in the Atacama Desert of northern Chile. While astronomy isn’t a growth industry, there are still plenty of opportunities for eager researchers.

---

**What Not To Do**

When it comes time to apply for a permanent position, you’ll likely be inundated with advice and suggestions. So let me tell you what you **shouldn’t** do.

- **Use the ‘shotgun’ approach of applications: many and wide.**
- **Don’t read the application instructions.**
- **Write it on the last possible day.**
- **Fail to run the spellchecker.**
- **Fail to include a well-directed cover letter.**
- **Don’t get a senior colleague to read your application.**
- **Don’t tell your referees you have put their names forward.**
- **Or tell them, but not until the day before the deadline.**

— D. F.
ing any publicly accessible MySpace or Facebook entries.

If you’re invited to visit your potential employer, you may be asked to give a seminar on your research. This will form a crucial part of your job interview, but how not to give a research talk is a topic for another time.

**Publications: Quantity and Quality**

Once you acquire that coveted permanent position, your life will revolve around teaching, doing research, and publishing your results. Why do we publish? As scientists we need to communicate the results of our research, a published paper is our ‘product,’ and (like it or not) these papers are a measure of our productivity. Not publishing your results will result in a remarkably short astronomical career!

The number of papers posted to the [astro-ph preprint server](http://arxiv.org) has risen steadily since 1992, and this increase shows no sign of abating. One reason for astro-ph’s popularity is that if you publish only in a journal and do not post your paper online, you may decrease its citation rate by half.

In 2007, the number of papers posted to astro-ph exceeded 10,000. This translates to more than 40 new papers each working day! Even if you select only the papers in your sub-field, it’s still very difficult to keep up. Some astronomers don’t even try.

While many funding agencies and employers look only at the quantity of your papers, the quality of your publications is arguably a much more important measure. Quality in this context is often taken as the impact of your publication on other astronomers and for that we use the number of citations to your paper.

With so many papers appearing daily, how do you make other astronomers aware of your work and get them to cite it? One solution is to tell them what you do by presenting seminars in their departments and by giving talks/posters at conferences. You should also give careful thought to the words contained in the paper’s abstract so your paper is easy to find by someone doing an abstract-based search.

Although [Scopus](http://www.scopus.com) and [Thomson Scientific](http://www.thomsonreuters.com) track citations, the most up to date source for astronomers is the [Astrophysical Data Service (ADS)](http://adsogle.org), which gives both raw citations and citations normalised by the number of authors. In 2004 Frazer Pearce compiled the relative distribution of all raw and normalised ADS citations for astronomers (“Citation Measures and Impact Within Astronomy”) and found that the top 10% of active astronomers worldwide typically have 382 raw and 74 normalised citations in the previous five years.

**Just Do It**

In summary (with apologies to Nike), the three steps to job success in astronomy are:

1. Research it.
2. Publish it.
3. Talk about it.

Repeat steps 1 to 3 several times a year, and a long career in professional astronomy awaits you. In the process, if you discover something significant and become famous, then so much the better. Don’t forget to network, always keep the big picture in mind, and enjoy yourself.

This article is based on discussions with PhD students, postdoctoral researchers, and senior colleagues I have worked with over the years, particularly in the US, UK, and Australia. I hope it sheds some light on the process of landing a job in astronomy and is useful to anyone seeking a long-term research career in astronomy.

DUNCAN FORBES certainly made some mistakes when in the astronomy job market but he survived and is now a Professor at Swinburne University in Australia, after a Lectureship in the UK and a postdoc position in the US. His research interests include globular clusters and galaxy formation.

He thanks everyone who has contributed to the discussions that helped crystallize this article. He particularly thanks Anna Russell, Alister Graham, Frazer Pearce, and Jay Strader for their input. This article was written under cloudy skies at the Siding Spring Observatory in Australia.
Flowing Liquid Water on Mars? Not Yet
University of Arizona

Liquid water has not been found on the Martian surface within the last decade after all, according to findings by a University of Arizona researcher and his colleagues.

The finding casts doubt on the 2006 report that the bright spots in some Martian gullies indicate that liquid water flowed down those gullies sometime since 1999.

"It rules out pure liquid water," said lead author Jon D. Pelletier, an associate professor of geosciences at the University of Arizona.

Pelletier and his colleagues used topographic data derived from images of Mars from the High Resolution Imaging Science Experiment camera, known as HiRISE, on NASA's Mars Reconnaissance Orbiter. Since 2006, HiRISE has been providing the most detailed images of Mars ever taken from orbit.

The researchers applied the basic physics of how fluid flows under Martian conditions to determine how a flow of pure liquid water would look on the HiRISE images versus how an avalanche of dry granular debris such as sand and gravel would look.

"The dry granular case was the winner," Pelletier said. "I was surprised. I started off thinking we were going to prove it's liquid water."

More information: http://uanews.org/node/1855

---

Organic Material at Saturn's Geyser Moon
NASA / ESA / JPL

NASA's Cassini spacecraft tasted and sampled a surprising organic brew erupting in geyser-like fashion from Saturn's moon Enceladus during a close flyby on March 12. Scientists are amazed that this tiny moon is so active, "hot," and brimming with water vapor and organic chemicals.

New heat maps of the surface show higher temperatures than previously known in the south polar region, with hot tracks running the length of giant fissures. Additionally, scientists say the organics "taste and smell" like some of those found in a comet.

"A completely unexpected surprise is that the chemistry of Enceladus, what's coming out from inside, resembles that of a comet," said Hunter Waite, principal investigator for the Cassini Ion and Neutral Mass Spectrometer at the Southwest Research Institute in San Antonio. "To have primordial material coming out from inside a Saturn moon raises many questions on the formation of the Saturn system."

"Enceladus is by no means a comet. Comets have tails and orbit the sun, and Enceladus' activity is powered by internal heat while comet activity is powered by sunlight. Enceladus' brew is like carbonated water with an essence of natural gas," said Waite.

New high-resolution heat maps of the south pole by Cassini's Composite Infrared Spectrometer show that the so-called tiger stripes, giant fissures that are the source of the geysers, are warm along almost their entire lengths, and reveal other warm fissures nearby.


---

This HiRISE image shows a partial view of a high latitude pit. These polar pits contain gullies, small-scale slope features that are proposed to require some amount of liquid water to form.

This temperature scan shows that at least three of the south polar fractures are active along almost their full lengths (the yellow stars are plume jets). Remarkably high temperatures of 180 Kelvin (-135°F Fahrenheit) were registered along the brightest fracture, named Damascus Sulcus, in the lower left portion of the image. For comparison, surface temperatures elsewhere in the south polar region of Enceladus are below 72 Kelvin (-330°F Fahrenheit).
**Does Alpha Centauri Have Planets?**

*University of California, Santa Cruz*

A rocky planet similar to Earth may be orbiting one of our nearest stellar neighbors and could be detected using existing techniques, according to a new study led by astronomers at the University of California, Santa Cruz.

The closest stars to our Sun are in the three-star system called Alpha Centauri, a popular destination for interstellar travel in works of science fiction. UCSC graduate student Javiera Guedes used computer simulations of planet formation to show that terrestrial planets are likely to have formed around the star Alpha Centauri B and to be orbiting in the “habitable zone” where liquid water can exist on the planet’s surface. The researchers then showed that such planets could be observed.

To study planet formation around Alpha Centauri B, the team ran repeated computer simulations, evolving the system for the equivalent of 200 million years each time. Because of variations in the initial conditions, each simulation led to the formation of a different planetary system. In every case, however, a system of multiple planets evolved with at least one planet about the size of Earth. In many cases, the simulated planets had orbits lying within the habitable zone of the star.

**More information:**


---

**Organic Molecule on an Exoplanet**

*NASA / JPL / STScI*

NASA’s Hubble Space Telescope (HST) has made the first detection ever of an organic molecule in the atmosphere of a Jupiter-sized planet orbiting another star. The molecule found by Hubble is methane, which under the right circumstances can play a key role in prebiotic chemistry — the chemical reactions considered necessary to form life as we know it.

This discovery proves that Hubble and upcoming space missions, such as NASA’s James Webb Space Telescope, can detect organic molecules on planets around other stars by using spectroscopy, which splits light into its components to reveal the “fingerprints” of various chemicals.

“This is a crucial stepping stone to eventually characterizing prebiotic molecules on planets where life could exist,” said Mark Swain of NASA’s Jet Propulsion Laboratory (JPL), Pasadena, Calif., who led the team that made the discovery.

The discovery also confirms the existence of water molecules in the planet’s atmosphere, a discovery made originally by NASA’s Spitzer Space Telescope in 2007. “With this observation there is no question whether there is water or not — water is present,” said Swain.

The planet now known to have methane and water is located 63 light-years away in the constellation Vulpecula. Called HD 189733b, the planet is so massive and so hot it is considered an unlikely host for life. HD 189733b’s atmosphere swelters at 1,700 degrees Fahrenheit, about the same temperature as the melting point of silver.

Though the star-hugger planet is too hot for life as we know it, “this observation is proof that spectroscopy can eventually be done on a cooler and potentially habitable Earth-sized planet orbiting a dimmer red dwarf-type star,” Swain said.

**More information:**

**Embryonic Planet Found**  
*Jodrell Bank Centre for Astrophysics*

Using radio observatories in the UK and US and computer simulations, a team of astronomers has identified the youngest forming planet yet seen.

Taking advantage of a rare opportunity to use the Very Large Array (VLA) of radio telescopes in the US with the special addition of an extra telescope 50 km away, the team studied the disk of gas and rocky particles around the star HL Tau. This star is thought to be less than 100,000 years old (by comparison the Sun is 4,600 million years old) and lies in the direction of the constellation of Taurus at a distance of 520 light-years. The disk around HL Tau is unusually massive and bright, which makes it an excellent place to search for signs of forming planets.

The big surprise was that, as well as detecting super-large dust in the disk around HL Tau, an extra bright ‘clump’ was seen in the image. It confirms tentative ‘nebulosity’ reported a few years earlier at around the same position. The new image shows the same system in much greater detail.

Team leader Dr Jane Greaves of the University of St Andrews comments, “We see a distinct orbiting ball of gas and dust, which is exactly how a very young protoplanet should look.”

More information:  
www.jb.man.ac.uk/news/embryonic

---

**Light Echoes Whisper the Distance to a Star**  
*European Southern Observatories*

Taking advantage of the presence of light echoes, a team of astronomers have used an ESO telescope to measure, at the 1% precision level, the distance of a Cepheid — a class of variable stars that constitutes one of the first steps in the cosmic distance ladder.

“Our measurements with ESO’s New Technology Telescope at La Silla allow us to obtain the most accurate distance to a Cepheid,” says Pierre Kervella, lead-author of the paper reporting the result.

Cepheids are pulsating stars that have been used as distance indicators for almost a hundred years. The new accurate measurement is important as, contrary to many others, it is purely geometrical and does not rely on hypotheses about the physics at play in the stars themselves.

The team of astronomers studied RS Pup, a bright Cepheid star located towards the constellation of Puppis. RS Pup varies in brightness by almost a factor of five every 41.4 days. It is 10 times more massive than the Sun, 200 times larger, and on average 15 000 times more luminous. RS Pup is the only Cepheid to be embedded in a large nebula, which is made of very fine dust that reflects some of the light emitted by the star.

Because the luminosity of the star changes in a very distinctive pattern, the presence of the nebula allows the astronomers to see light echoes and use them to measure the distance of the star.

More information:  

“The light that travelled from the star to a dust grain and then to the telescope arrives a bit later than the light that comes directly from the star to the telescope,” explains Pierre Kervella. “As a consequence, if we measure the brightness of a particular, isolated dust blob in the nebula, we will obtain a brightness curve that has the same shape as the variation of the Cepheid, but shifted in time.”
Smallest Known Black Hole
NASA Goddard Space Flight Center

Using a new technique, two NASA scientists have identified the lightest known black hole. With a mass only about 3.8 times greater than our Sun and a diameter of only 15 miles, the black hole lies very close to the minimum size predicted for black holes that originate from dying stars.

“This black hole is really pushing the limits. For many years astronomers have wanted to know the smallest possible size of a black hole, and this little guy is a big step toward answering that question,” says lead author Nikolai Shaposhnikov of NASA’s Goddard Space Flight Center in Greenbelt, Md.

The tiny black hole resides in a Milky Way Galaxy binary system known as XTE J1650-500, named for its sky coordinates in the southern constellation Ara. NASA’s Rossi X-ray Timing Explorer (RXTE) satellite discovered the system in 2001.

Astronomers realized soon after J1650’s discovery that it harbors a normal star and a relatively lightweight black hole. But the black hole’s mass had never been measured to high precision.


Black Hole Found in Globular Cluster
European Hubble Space Telescope

Omega Centauri has been known as an unusual globular cluster for a long time. A new result obtained by the NASA/ESA Hubble Space Telescope and the Gemini Observatory reveals that the explanation behind Omega Centauri’s peculiarities may be a black hole hidden in its centre. One implication of the discovery is that it is very likely that Omega Centauri is not a globular cluster at all, but a dwarf galaxy stripped of its outer stars, as some scientists have suspected for a few years.

“This result shows that there is a continuous range of masses for black holes, from supermassive, to intermediate-mass, to small stellar mass types”, explained astronomer Eva Noyola of the Max-Planck Institute for Extraterrestrial Physics in Garching, Germany, and leader of the team that made the discovery.

Omega Centauri is visible from Earth with the naked eye and is one of the favourite celestial objects for stargazers from the southern hemisphere. Although the cluster is 17,000 light-years away, it appears almost as large as the full Moon when the cluster is seen from a dark rural area.

Omega Centauri has several characteristics that distinguish it from other globular clusters: it rotates faster than a run-of-the-mill globular cluster, its shape is highly flattened and it consists of several generations of stars - more typical globulars usually consist of just one generation of old stars.


Globular clusters, like Omega Centauri, consist of up to one million old stars tightly bound by gravity and are found in the outskirts of many galaxies, including our own.
**A Galaxy Ablaze with Starbirth**

*NASA Goddard Space Flight Center*

Combining 39 individual frames taken over 11 hours of exposure time, NASA astronomers have created this ultraviolet mosaic of the nearby “Triangulum Galaxy.” “This is the most detailed ultraviolet image of an entire galaxy ever taken,” says Stefan Immler of NASA’s Goddard Space Flight Center in Greenbelt, Md. Immler used NASA’s Swift satellite to take the images, and he then assembled them into a mosaic that seamlessly covers the entire galaxy.

The Triangulum Galaxy is also called M33 for being the 33rd object in Charles Messier’s sky catalog. It is located about 2.9 million light-years from Earth in the constellation Triangulum. It is a member of our Local Group, the small cluster of galaxies that includes our Milky Way Galaxy and the Andromeda Galaxy (M31). Despite sharing our Milky Way’s spiral shape, M33 has only about one-tenth the mass. M33’s visible disk is about 50,000 light-years across, half the diameter of our galaxy.

Individual star clusters and star-forming gas clouds are clearly resolved, even in the crowded nucleus of the galaxy. The image also includes Milky Way foreground stars and much more distant galaxies shining through M33.

“The ultraviolet colors of star clusters tell us their ages and compositions,” says Swift team member Stephen Holland of NASA Goddard. “With Swift’s high spatial resolution, we can zero in on the clusters themselves and separate out nearby stars and gas clouds. This will enable us to trace the star-forming history of the entire galaxy.”

More information:
[www.nasa.gov/mission_pages/swift/bursts/m33.html](http://www.nasa.gov/mission_pages/swift/bursts/m33.html)

---

**Cosmic Engines Surprise XMM-Newton**

*European Space Agency*

XMM-Newton has been surprised by a rare type of galaxy, from which it has detected a higher number of X-rays than thought possible. The observation gives new insight into the powerful processes shaping galaxies during their formation and evolution.

Scientists working with XMM-Newton were looking into the furthest reaches of the universe, at celestial objects called quasars. These are vast cosmic engines that pump energy into their surroundings. It is thought an enormous black hole drives each quasar.

As matter falls into the black hole, it collects in a swirling reservoir called the accretion disc, which heats up. Computer simulations suggest that powerful radiation and magnetic fields present in the region eject some of gas from the gravitational clutches of the black hole, throwing it back into space.

This outflow has a profound effect on its surrounding galaxy. It can create turbulence in the gas throughout the galaxy, hampering star formation. Thus, understanding quasars is an important step to understanding the early history of galaxies.

However, the structure surrounding a quasar is difficult to see because they are so distant. The light and X-rays from them takes thousands of millions of years to reach us.

About 10-20% of quasars are of a special type called BAL quasars. The BAL stands for ‘broad absorption line’ and seems to indicate that a thick cocoon of gas surrounds the quasar.

More information:
[www.esa.int/esaSC/SEMDHJXMMEF_index_0.html](http://www.esa.int/esaSC/SEMDHJXMMEF_index_0.html)
New Light on Dark Energy
European Southern Observatories

Astronomers have used ESO’s Very Large Telescope to measure the distribution and motions of thousands of galaxies in the distant Universe. This opens fascinating perspectives to better understand what drives the acceleration of the cosmic expansion and sheds new light on the mysterious dark energy that is thought to permeate the Universe.

“Explaining why the expansion of the Universe is currently accelerating is certainly the most fascinating question in modern cosmology,” says Luigi Guzzo, lead author of a paper in which the new results are presented.

“By measuring the apparent velocities of large samples of galaxies over the last thirty years, astronomers have been able to reconstruct a three-dimensional map of the distribution of galaxies over large volumes of the Universe. This map revealed large-scale structures such as clusters of galaxies and filamentary superclusters,” says Olivier Le Fèvre, member of the team. “But the measured velocities also contain information about the local motions of galaxies; these introduce small but significant distortions in the reconstructed maps of the Universe. We have shown that measuring this distortion at different epochs of the Universe’s history is a way to test the nature of dark energy.”

Within current uncertainties, the measurement of this effect provides an independent indication of the need for an unknown extra energy ingredient in the ‘cosmic soup’, supporting the simplest form of dark energy.


Snapshot from a computer simulation of the formation of large-scale structures in the Universe, showing a patch of 100 million light-years and the resulting coherent motions of galaxies flowing towards the highest mass concentration in the centre.

THE ASP’S 2008 MEETING WILL FEATURE:

- A symposium for education and outreach professionals.
- Discussions of international, regional, and local programs for the International Year of Astronomy (IYA) in 2009.
- Two days of hands-on demonstration workshops for diverse audiences.
- The annual awards banquet and members meeting.

Co-sponsored with, and part of, the 2008 Summer Meeting of the American Astronomical Society

For more information visit the ASP Web Site: www.astrosociety.org/2008meeting
News and information for Society members

The 2008 ASP Award Recipients

Catherine Wolfe Bruce Gold Medal
Sidney van den Bergh, Researcher Emeritus, Dominion Astrophysical Observatory, Victoria, BC, Canada

The ASP’s 2008 Catherine Wolfe Bruce Gold Medal, awarded since 1898 for a lifetime of outstanding research in astronomy, is presented to Sidney van den Bergh—a world-renowned astronomer and a leader in Canadian (and world) astronomy. While he is best known for his distinguished and inspirational work on galaxies and their stellar contents, he is a strikingly prolific writer with more than 500 refereed publications covering a vast array of astronomical subjects. He has also authored more than 250 conference proceedings.

He has made fundamental contributions to studies of local group galaxies (including dwarf galaxies), galactic morphology, and the extragalactic distance scale. Sidney’s work on galactic morphology probes how galaxies change both along the Hubble sequence and as a function of intrinsic luminosity. His research has also had a major influence on our understanding of globular and open star clusters, supernovae, and metal abundances and the chemical evolution of the universe.

Sidney’s long and distinguished career began as an assistant professor of physics and astronomy at Ohio State University. In 1958 he moved to Toronto, Ontario, where, for the next 19 years, he taught at the University of Toronto, worked at the nearby David Dunlap Observatory, and inspired and supervised many students who have since become leaders in the fields of stellar and galactic research.

In 1977 he was appointed Director of the National Research Council’s Dominion Astrophysical Observatory (DAO) located outside Victoria, British Columbia. As director (1977-86), he orchestrated an era of dramatic increases in staff levels as well as research and technical productivity.

He has continued to be active since his retirement as director, and he remains a Researcher Emeritus with the DAO. Sidney served as President and Chairman of the Board of the Canada-France-Hawaii Telescope Corporation, President of the Canadian Astronomical Society, and Vice-President of the International Astronomical Union. He was inducted into the Royal Society and is an Officer of the Order of Canada. Asteroid van den Bergh 4230 is named in his honor.

Very few individuals during the past half-century can boast of such a sweeping impact on international astronomy and astrophysics. The Astronomical Society of the Pacific is honored to add the Bruce Medal to the long list of Sidney van den Bergh’s other important awards in astronomy.

Richard H. Emmons Award
Chris Impey, University of Arizona, Tucson, Arizona

Students who have had the pleasure and privilege of experiencing a course with Chris Impey will not be surprised to learn that he is the recipient of ASP’s 2008 Richard H. Emmons Award for excellence in college astronomy teaching.

Innovation is certainly a hallmark of Chris’s approach to teaching astronomy. He is ever thought provoking and engaging; students benefit from his refreshing methods that use interactive techniques and a blend of online and classroom teaching. His approach to education is much broader than simply providing a professionally constructed course for non-science majors. He has taken book publishers to task to get them to change their marketing techniques and improve their wares, worried over the use of mobile technologies and the Internet for educating our ever-plugged in youth, and wondered about his contribution to the future lives and careers of his students.

Chris Impey has not restricted his passion for sharing astronomy to the classroom. In addition to his exemplary research, he is a prolific writer — having penned several books — and is a relentless blogger. He has a wealth of experience to share and fortunately, he shares it freely. He is serious and thoughtful about education but also wants to entertain and make us all laugh while we learn.

Amateur Achievement Award
Steve Mandel, Soquel, California

The ASP is honored to present Steve Mandel with the 2008 Amateur Achievement Award. Initiated in 1979 by the ASP, its purpose is to recognize significant contributions to astronomy by an unpaid amateur.

A successful entrepreneur, author, and expert communications coach for professional executives, Steve is equally accomplished as an astrophotographer and amateur research scientist. In 2004, he started an amateur research project, the Mandel-Wilson Unexplored Nebulae Project, to discover, catalog, and image unexplored nebulae of the Milky Way, particularly high-latitude interstellar clouds. This project led to the realization that small-aperture amateur telescopes, equipped with CCD cameras, were...
uniquely suited to detect large nebular clouds high above the galactic plane. He photographed, mapped, cataloged, and labeled these nebulae as Integrated Flux Nebulae (IFN).

Steve coordinates the annual Advanced Imaging Conference in San Jose, California, which brings together astrophotographers from around the world to discuss CCD imaging techniques and share ideas for projects that involve amateurs working with professionals. In addition, he has nurtured and sustained amateur-professional collaboration with Kitt Peak National Observatory’s Public Outreach Department by training their staff, creating policies, and loaning and procuring equipment. Steve Mandel’s vision and hard work have resulted in the creation of a world-class outreach program at Kitt Peak, where people not only look through telescopes but have the unique opportunity to experience astrophotography and image processing in a hands-on environment within one of the great astronomical research centers in America.

Las Cumbres Amateur Outreach Award
Gary Fujihara, University of Hawaii Institute for Astronomy

For his work in advancing science literacy, the ASP is proud to present Gary Fujihara with the Las Cumbres Amateur Outreach Award for outstanding outreach by an amateur astronomer to children and the public.

Gary is the Science Education and Public Outreach officer for the University of Hawaii Institute for Astronomy. He spends much of his spare time providing informal education to the general public, and is a JPL/NASA Solar System Ambassador. He draws on his experiences in the musical and graphic arts, software development, and as a former telescope operator for Japan’s Subaru Telescope. His programs include lectures, hands-on education, and amateur telescope observing. It’s a blend of cutting-edge science and ancient Hawaiian culture.

AstroDay, established in 2002, is Gary’s signature amateur event held on the Big Island of Hawaii. This free, award-winning celebration of astronomy and science draws more than 10,000 people each year. They come to see exhibits and learn directly from professional researchers, science educators, and amateur astronomers. AstroDay educates the public about astronomy, space science, the sacred connection of Mauna Kea, and the importance and impact of astronomy in Hawaiian culture.

It was Gary Fujihara’s hope that his work in outreach would inspire local youth to pursue an education and career in science and astronomy while sustaining Hawaii’s rich cultural heritage. But his influence extends far beyond the islands to everyone who has been enriched by his enthusiastic teaching style.

Klumpke-Roberts Award
Dava Sobel, East Hampton, New York

This year the ASP presents the Klumpke-Roberts Award for outstanding contributions to public understanding and appreciation of astronomy to Dava Sobel, whose successful and highly regarded books on astronomical themes and figures have drawn worldwide acclaim.

Galileo’s Daughter explores the context in which Galileo made and defended the crucial astronomical observations that we celebrate in the upcoming International Year of Astronomy. Longitude (the basis for one of her PBS NOVA shows) shows how the problem of determining longitude at sea was solved — not by astronomers but by clock-makers. Other books include Is Anyone Out There? (with Frank Drake), Letters to Father, and The Planets. She has written about science for numerous magazines including Audubon, Discover, and The New Yorker, and previously worked the science beat for The New York Times.

In 2006, Dava was the Robert Vare Nonfiction Writer-in-Residence at the University of Chicago. She received the 2001 Public Service Award of the National Science Board for fostering public awareness of science. She is now at work on a play about Copernicus, and her third PBS program is in the works.

The popularity of her books (coupled with the strong reviews they have received from historians and critics), and her generosity in sharing her knowledge and craft with colleagues and the public, make Dava Sobel eminently qualified to join the long list of astronomy popularizers who have won this award.

Robert J. Trumpler Award
Anjum Mukadam, Hubble Post-doctoral Fellow, University of Washington at Seattle

Astronomers owe a huge debt to the builders of the instruments they use, from the VLA to the Chandra X-ray Observatory and the Sloan camera. It is therefore particularly fitting that Anjum Mukadam is the recipient of the 2008 ASP Robert J. Trumpler Award, which is for a recent PhD thesis considered unusually important to astronomy. This award is in recognition of both her skill in helping construct a fast and versatile photometer
and her success in using that instrument to study pulsating white dwarfs and other stellar phenomena.

As a graduate student at the University of Texas and in collaboration with Ed Nather, Anjum assisted with the construction of Argos, a fast, time-series CCD photometer for use at the prime focus of the 2.1-meter McDonald telescope. She then used Argos to probe stars, including white dwarfs, using the technique of asteroseismology. Just as helioseismology has enabled us to study the physics of the solar interior, the asteroseismology of white dwarfs is opening up the possibility of studying the physics of condensed matter using stars as laboratories. More than a dozen scientific papers have resulted from her graduate work, and as a bonus, Argos is useful for the detection of extrasolar planets that transit their parent star.

After her graduate work at the University of Texas, Anjum Mukadam won a Hubble Fellowship, which she took to the University of Washington.

Thomas J. Brennan Award
Wil van der Veen, New Jersey Astronomy Center for Education at Raritan Valley Community College, Somerville, NJ

The ASP is delighted to present the 2008 Thomas J. Brennan Award for exceptional achievement related to the teaching of astronomy at the high school level to Wil van der Veen, who has had a profound impact on the teaching of secondary-level astronomy in New Jersey.

Wil has developed 16 different astronomy workshops to provide training for New Jersey teachers, workshops that are regularly described by the teachers as “wonderful and awesome.” His 200-plus sessions have resulted in the training of more than 4,000 New Jersey teachers. These teachers, who have been introduced to his excellent and enthusiastic teaching, now are requesting more extensive trainings for entire groups of grade-level teachers. This growing movement has initiated many partnerships with school districts.

He also created a new Project ASTRO and Family ASTRO site in New Jersey, housed at the New Jersey Astronomy Center at Raritan Valley Community College. He has received numerous IDEAS and EPA grants to support these programs.

Among his many other commitments to teacher training and development, Wil van der Veen is the lead science educator on a NASA grant with NJIT, which provides a website and a series of workshops to help high school teachers integrate astronomy content into biology, chemistry, and physics curriculums. He is also the lead on a grant with Princeton University to develop a “Gravity and Orbital Motion” teacher’s guide.

Maria and Eric Muhlmann Award
Joss Bland-Hawthorn, School of Physics, University of Sydney, NSW, Australia
Karl Glazebrook, Swinburne University of Technology, Hawthorn, Victoria, Australia
Jean-Charles Cuillandre, Canada-France-Hawaii Telescope Corporation, Kamuela, Hawaii

The Maria and Eric Muhlmann Award is presented for important research results that are based upon the development of groundbreaking instruments and techniques. In modern astronomy, improvements in instrumentation and observing techniques have often been more important for enhancing the sensitivity of our observations than increases in telescope size. Modern electronic detectors, coupled with novel approaches to background-noise subtraction, have paved the way for the study of the distant universe. The “Nod and Shuffle” technique, developed by this year’s ASP Muhlmann awardees — Joss Bland-Hawthorn (top), Karl Glazebrook (center), and Jean-Charles Cuillandre (bottom) — is one of these remarkable developments.

This technique has already enabled the Gemini Deep Deep Survey to produce the deepest spectroscopic survey of the sky to date, resulting in breakthroughs centered upon precision measurements of the stellar mass function, star-formation history, and metal abundance of galaxies in the “redshift desert.” Twenty percent of the local stellar mass density was in place by a redshift of 1.8, rising to almost 50% by redshift 1. Even more interesting, nearly half of the massive “red-and-dead” galaxies were present by redshift 1.8. This pushes back the time at which these galaxies must have been born in the early universe and suggests that galaxy formation proceeds from larger to smaller sizes — contrary to expectations.

Inventing techniques such as Nod and Shuffle that can have wide ramifications for the
sensitivity of all telescopes is one of the most important ways to advance astronomy. It is for this singular achievement that the ASP is pleased to present its 2007 Maria and Eric Muhlmann Award to the Nod and Shuffle team.

**ASP’s Spring Fund Drive**

One of the key ways the ASP advances the cause of science literacy is by providing professional development training and resources for those engaging in astronomy and space science education and public outreach. The ASP is at the intersection of multiple networks, such as amateur astronomers, scientists, and formal and informal educators. Consider making a gift today to support these networks and the ASP. We invite you to read the 2008 Spring Fund Drive letter from the ASP executive director, Jim Manning.

**AAS Education Prize to ASP’s President**

The American Astronomical Society’s Education Prize for 2008 was awarded to Dr. James B. Kaler of the University of Illinois, in Urbana, Illinois. The Prize recognizes outstanding contributions to the education of the public, students, and/or the next generation of professional astronomers.

Jim is cited for significant contributions to many aspects of astronomy education throughout his entire career, for his inspired teaching and mentorship of graduate and undergraduate students (many of whom have gone on to noteworthy careers in the field), and for his wider contributions to introductory astronomy education through his textbooks and many engaging astronomy books. He is also cited for maintaining a popular website with a wealth of useful material that is regularly consulted by astronomy teachers and students.

He has made numerous contributions to the public understanding of astronomy through his prodigious number of public lectures; his work with planetarium, television, and radio programs; and for his numerous books and articles for amateur astronomers as well as the general public. Previous recipients of the Education Prize include Frank D. Drake, Owen Gingerich, and Jay M. Pasachoff.

**ASP’s Founder Still in the News**

Scientists studying images from the University of Arizona-led High Resolution Imaging Experiment (HiRISE) camera on NASA’s Mars Reconnaissance Orbiter have discovered never-before-seen impact “megabreccia” and a possibly once-habitable ancient lake on Mars at a place called Holden Crater.

The crater on Mars is named after Edward S. Holden (1846-1914), the founder of the Astronomical Society of the Pacific and the first Director of the Lick Observatory. There is also a Crater Holden (29 miles across) on the Moon. More about the role of Edward Holden in the founding of the ASP can be found in ASP’s Centennial History.

“Holden Crater has some of the best-exposed lake deposits and ancient megabreccia known on Mars,” said HiRISE’s principal investigator, professor Alfred McEwen of the University of Arizona’s Lunar and Planetary Laboratory. "Both contain minerals that
formed in the presence of water and mark potentially habitable environments. This would be an excellent place to send a rover or sample-return mission to make major advances in understanding if Mars supported life.”

Holden Crater is an impact crater that formed within an older, multi-ringed impact basin called Holden Basin. Before an impact created Holden Crater, large channels crossed and deposited sediments in Holden Basin. For more about the discoveries at Holden Crater, see the press release.

Former Mercury Editor to Head Sky & Telescope

Sky & Telescope magazine, the iconic publisher of astronomy periodicals and books, announced today that it has appointed Robert P. Naeye to the position of Editor-in-Chief, succeeding Richard Tresch Fienberg, PhD, who will retire from the magazine this summer.

Mr. Naeye joins Sky & Telescope from NASA’s Goddard Space Flight Center, where he has been serving as Senior Science Writer in the Astrophysics Science Division since February 2007. In accepting the position, Mr. Naeye becomes only the fifth Editor-in-Chief of the magazine in nearly 70 years. Dr. Fienberg has spent nearly 22 years with Sky & Telescope, serving in various positions, including 8 years as Editor-in-Chief.

“This is a highly successful magazine and a brand that is recognized by serious amateurs and professionals in astronomy throughout the world, so this change is important, particularly after the successful and stable leadership Rick Fienberg has provided,” commented Stephen Kent, the CEO of New Track Media, which owns Sky & Telescope. “Bob Naeye is without question the right choice because, in addition to his qualifications as a writer and editor, he has worked with our team in the past, which means he knows the magazine and its people. He is at the same time someone who brings the perspective of an ‘outsider,’ which means he can respect the traditions of this great title without being hidebound to them and he sees the opportunities we have going forward. We get freshness in a package that is familiar, and that doesn’t happen often in this business.”

Mr. Naeye added, “It’s a tremendous honor to be hired as Editor-in-Chief of Sky & Telescope. The magazine has a longstanding tradition of excellence and integrity. Working with S&T’s outstanding staff, we will build on that tradition and carry the magazine and website to new heights.”

Mr. Naeye worked as a Senior Editor at Sky & Telescope from 2003 to 2007 and earlier in his career had served as Editor of Mercury magazine. He has authored two books and contributed to two others. In 2002, Mr. Naeye won the David N. Schramm Award for Science Journalism from the American Astronomical Society’s High-Energy Astrophysics Division, and he received the Professional Astronomer of the Year Award from the Astronomical Association of Northern California the same year.
by Paul Deans

The Skies of May

Spring evenings are a perfect time to spot the two brightest stars of the season: Arcturus and Spica. Both are easy to find in the south-southeast; Arcturus, the dominant star in the kite-shaped constellation Boötes, the Herdsman, is the brighter of the two stars and is noticeably golden yellow. Whitish Spica is the prime star in Virgo, the Maiden — the second-largest constellation in the sky.

If you’re uncertain as to their location, use the Big Dipper (below) as your guide; you’ll find it overhead these evenings. Extend the curve of the Big Dipper’s Handle down and away from the Bowl and you’ll soon come to Arcturus. Continue the curve toward the south and you’ll easily spot Spica. There’s a handy little saying that’ll help you remember this: Arc to Arcturus, then Speed on to Spica. And if you’re still unsure about Spica’s location, the Moon will help by being nearby on May 16th (as well as June 12th and July 9th and 10th).

Early in May, seek out Mercury low in the western twilight. On the 6th it shines just below the crescent Moon. Your best views will come about 50 minutes after sunset.

Two other planets are prominent this month. Saturn is just east of Regulus, the brightest star in Leo, the Lion. Both appear in the southwest as twilight fades. At dusk on the 12th, the 8-day-old Moon meets them. Jupiter rises after midnight and is a fine sight in the predawn sky. It’s joined on the 24th by the waning gibbous Moon.

This year Astronomy Day falls on Saturday May 10th, with the 6-day-old Moon standing next to the Beehive Star Cluster (M44). Mark the location of the Beehive because on May 22nd and 23rd, you can watch the red planet Mars drift through M44 (right). This is a sight best viewed in binoculars or a small telescope.

As for Venus, it’s too close to the Sun to be seen this month.

The Skies of June

If you look toward the east as darkness falls, you’ll see three bright stars rising. The brightest and highest, already more than halfway up from the horizon to the zenith (overhead), is Vega. Together with the other two (Deneb and Altair), it forms the gigantic Summer Triangle. The Triangle will be higher after sunset in the coming months, so more on it another time.

Draw a line southwestward from Vega to Arcturus (in Boötes). About one-third of the way toward Arcturus you’ll reach the four-star Keystone of the sprawling constellation of Hercules, the Strongman (below). Although dim, the Keystone’s nearly square shape is makes it reasonably obvious, especially since it’s nearly overhead.

Above: Although none of its stars are bright, the shape of the Keystone of Hercules helps them stand out, even in a city sky.

Below: The path of Mars through the Beehive Cluster, May 21 to 23. The location of Mars on each date is for approximately 8 pm EDT.
If you have binoculars, use them to scan the western side of the Keystone. Can you find a faint, fuzzy spot? That's actually a huge sphere of stars — the globular cluster M13 (right). In a telescope, M13 becomes a luminous glow of hundreds of thousands of stars, with a bright center surrounded by numerous sparkles of light.

The motions of the planets are rarely obvious; last month’s passage of Mars through M44 being a notable exception. But during June and July you can easily track Mars as it catches up to, and passes, Saturn and Regulus. All the action takes place in the west after sunset.

Start in early June. On the 7th, the 5-day-old Moon sits just below Mars, while a day later it passes beneath Regulus (Saturn is to the pair’s upper left). All three will fit nicely into the field-of-view of binoculars. Follow Mars as it drifts westward during the month. The red planet catches Regulus on the 30th; this evening the two are less than 1° apart.

Jupiter is now rising in the east-southeast less than two hours after sunset. Unfortunately, it’s in the constellation Sagittarius, which means the planet will never be very high in the sky this summer.

Venus continues to hide in the Sun’s glare, but by month’s end Mercury is a morning object. Can you find it in late June, rising in the east-northeast about 70 minutes ahead of the Sun? Far above it on the 30th, the 26.5-day-old lunar crescent sits next to the Pleiades.

The Skies of July

• Go to Sky & Telescope’s July 2008 Sky Chart
• How to use S&T’s Interactive Sky Chart

Swinging low across the southern horizon during the night is the reddish star Antares, the heart of Scorpius, the Scorpion (right). The 11-day-old Moon is near Antares on the 13th.

When the Moon is out of the way, find a dark-sky sight and explore Scorpius with binoculars or a small telescope using low power. In the process, you’ll be exploring the hazy glow of the Milky Way. This glow is invisible to city stargazers; you’ll need a light-pollution-free night sky to see it.

Near the tail of the Scorpion are two beautiful open clusters: M6 and M7. The bigger and brighter of the two is M7 and is a fine sight in binoculars. In a small telescope, M6 is a pretty stellar gathering of stars often called the Butterfly Cluster. Can you picture the outline of a butterfly with its wings spread?

If you have a clear (and low) eastern horizon, try to spot Mercury on the morning of July 1st. Look for it about 30 minutes before sunrise and use the very thin crescent Moon as your guide; the planet will be some 7° (that’s 14 Moon diameters) to its lower right. Mercury remains visible in roughly the same place, at the same time, for the first two weeks of the month.

Then on the evening of the 1st, look low into west shortly after sunset. There will be the red planet Mars sitting just above Regulus, with Saturn to the pair’s upper left. By the time the Moon arrives in the neighborhood on the 5th and 6th, Mars is already halfway to Saturn. Finally, on the 10th, Mars slides less than 1° below the ringed planet. Since the best views are about 45 minutes after sunset, you may need binoculars to help you see all the action this month.

The bright object rising in the east-southeast around sunset is giant Jupiter. The nearly full Moon passes nearby on the night of the 16th/17th. And after several months of invisibility, Venus finally puts in an appearance…but not until early next month.

August Preview

On August 2nd, about 30 minutes after sunset, grab your binoculars, head outside, and look into the west. If you have a clear, low western horizon, you’ll see a very thin crescent Moon just above the horizon, with brilliant Venus to its right. Both will be difficult to see. One evening later, the Moon sits below Mars and to the left of Saturn.

During the next two weeks Venus will crawl slightly higher as Saturn sinks into the murk of twilight. On the 13th, Saturn will be about ½° right of Venus. Then between the 14th and 16th Mercury joins the scene and creates a short-lived planetary trio until Saturn vanishes into the twilight glare.

Finally, don’t forget the Perseid meteor shower, which peaks during the morning hours of August 12th. The best observing window is after the 10-day-old Moon sets (around 1:30 a.m.) and before dawn. Under a clear, dark sky, you might see up to 60 meteors every hour.
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 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 (page 40), 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 90° west longitude (which makes it useful throughout the continental US) at 10 pm daylight-saving time at midmonth. The chart can be used at 11 pm (DST) at the start of each month, and 9 pm (DST) 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.
Sir Arthur C. Clarke: The Quiz

On March 19, 2008, Sir Arthur C. Clarke passed away at the age of 90. How much do you know about his life and work?

Q1 Arthur C. Clarke was born in Somerset, UK, but which nation’s capital served as his adopted home?
   A. Vientiane, Laos  B. New Delhi, India  C. Dhaka, Bangladesh  D. Colombo, Sri Lanka

Q2 For a useful plot device, Clarke created the famous “three laws of robotics.”
   True or False?

Q3 In the October 1945 issue of Wireless World, Clarke introduced which scientific concept (that became a reality 12 years later)?
   A. Laser  B. Microchip  C. Geostationary orbit  D. Docking module

Q4 The Rama series features a gigantic spacecraft capable of supporting a biosphere within: rivers, flora, and cities. What shape was it?
   A. Helix  B. Cylinder  C. Monolith/rectangle  D. Sphere

Q5 Which of Clarke’s short stories was noted as the seminal basis for the film 2001: A Space Odyssey?

Q6 Which of the following about 2001: A Space Odyssey is false?
   A. HAL isn’t derived from “IBM.”  B. The book was released after the film.  C. Stanley Kubrick wanted to insure the production in case aliens were found.  D. One working title for the film was “From Luna With Love.”

Q7 Many asteroids that are named for people carry both numerical and verbal titles. Asteroid number 2001 is named for Clarke.
   True or False?

A1 D. Clarke had lived in Sri Lanka since 1956, but retained two citizenships (Sri Lankan and UK). When asked why he chose the island, he joked, “30 English winters.” But he loved the culture, people, and mostly the water; he was an avid scuba diver.

A2 False. Isaac Asimov created these laws; Clarke formulated the three laws of prediction:
   1. When a distinguished, but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.
   2. The only way of discovering the limits of the possible is to venture a little way past them into the impossible.
   3. Any sufficiently advanced technology is indistinguishable from magic.

A3 C. While John L. Pierce headed the development of the communications satellite in 1954, Clarke’s earlier paper presented a “geostationary” model. The geostationary orbit is sometimes referred to as the “Clarke Orbit” in his honor.

A4 B. It was a 50-kilometer-long cylinder. “Rama” can be etymologically traced to Rigveda and the Atharvaveda as alluding to “darkness,” a fitting contrast to its living interior.

A5 A. Clarke drew much inspiration and direction from several of his own works but selected “The Sentinel” as the starting point for 2001. The 1948 story, written for a BBC competition, failed to grab a winning place. The magazine 10 Story Fantasy finally published it in 1951.

A6 D. At least three working titles were set for the film, including “How the Solar System Was Won” (more of a mock-title), “Journey Beyond the Stars,” and “A Space Odyssey.” And in case you’re wondering, here’s the scoop on the other answers.
   A: A common misconception is that “HAL-9000” is a conversion of “IBM,” as moving each letter up one spot creates the acronym. Clarke emphatically denied this derivation, explaining HAL stood for “Heuristically-programmed Artificial Computer.”
   B: The book was developed concurrently with the film, but released slightly later. Although the screenplay credits were shared, the novel was attributed to Clarke alone.
   C: Kubrick attempted to secure an insurance policy from Lloyd’s of London to protect himself against losses, in case extraterrestrial intelligence was discovered before the movie was released. Coverage was refused.

A7 False. Asteroid 2001 had already been assigned to Albert Einstein. Clarke was understandably disappointed. Clarke’s asteroid, discovered in 1981, carries the designation of “4923 Clarke.”

Simon Winston-Macauley is a perpetual student who devours science, science fiction, and journalism. He is currently pursuing a PhD in neuropsychology. His father, Ian T. Macauley, was a lifelong friend of Sir Arthur’s and edited “Greetings, Carbon-Based Bipeds!” Simon has known Arthur since childhood and personally mourns the passing of “Uncle Arthur.”