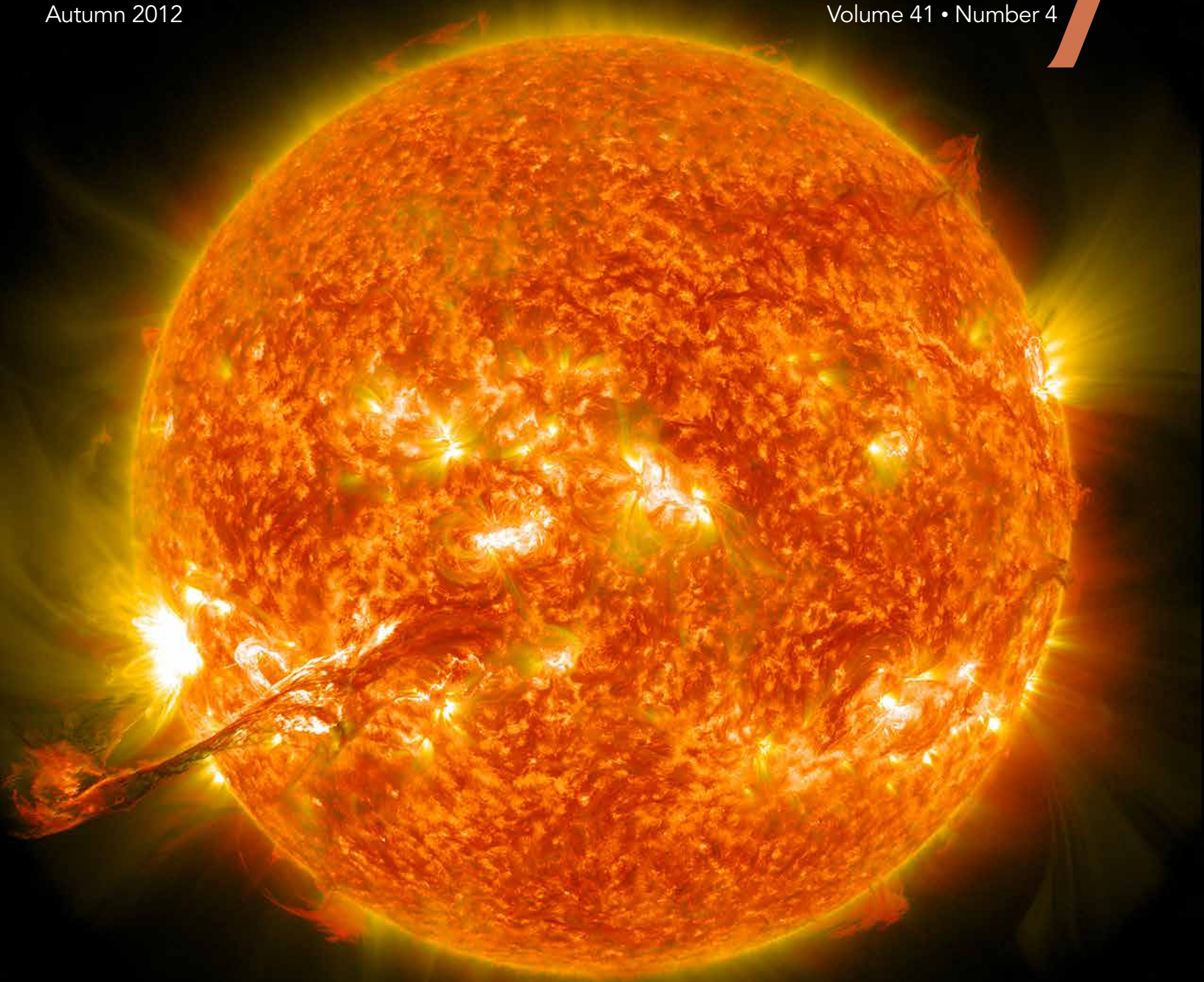


Mercury

Autumn 2012

Volume 41 • Number 4



Astronomical Society of the Pacific
An International Organization www.astrosociety.org

Thank you!

In this season of gratitude and reflection, the ASP wishes to thank our many friends whose membership dues help us deliver on our mission every day. Your support results in our being able to:

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- Provide professional development to K-12 educators to improve science literacy in the classroom, and
- Mentor amateur club activities to instill a grassroots interest in astronomy

... and so much more. This is where you make a difference!

As the calendar turns its pages toward December 31st, won't you please consider making an additional difference with a year-end gift to the ASP? Every donation matters, regardless of size. Should you prefer to set up a recurring gift, the ASPs' new online portal makes it easy — astrosociety.org/support — and you can extend your spirit of giving all year long.

Thank you again for helping the ASP to advance science literacy through astronomy!



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ASP Posters from Tucson: A Sample

Here are eight of the 85 posters that were presented at the 2012 ASP Conference in Tucson. All the conference posters, oral presentations, and workshops will appear in the *Conference Proceedings*, available by mid-2013.

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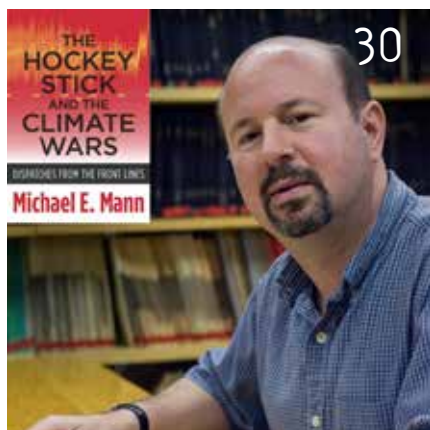
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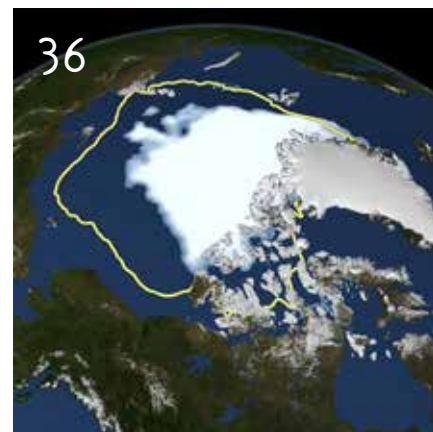
The truth about that infamous hockey stick diagram,
and how I became entangled in the global warming
controversy.

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Astronomy in the News

A link between cold European winters and solar
activity, Opportunity and Curiosity at work on Mars,
and a planet circling Alpha Centauri B — these are
some of the discoveries that recently made news in
the astronomical community.



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Coming Soon: A New Look for *Mercury*

Once upon a time, if you were a publisher of books, magazines, or newspapers, you had four major expenses to deal with. Known as the four Ps of publishing, they were People, Paper, Printing, and Postage. Failure to successfully deal with these costs might lead to the fifth 'P' of publishing — Perish. But by the start of this century, another option was available — electronic publishing, where four Ps were reduced to one.

Those of you who have been with the ASP for a while know whereof I speak. Almost five years ago (after the departure of *Mercury's* previous editor), Jim Manning, the ASP's executive director, hired me to embrace the inevitable future and move the magazine from the printed page to electronic format — which took the form of a PDF e-zine.

Full disclosure: I've always disliked publishing PDF *Mercury* in vertical (portrait) format. It's a hangover from its days as a print publication, and it just doesn't read well on a computer screen. (Somebody once commented that reading vertical-format magazines...not just *Mercury*...on a computer screen made them seasick from having to scroll up and down and up and down and....) We tried to minimize this problem in *Mercury* via the design of the PDF pages, but we weren't always successful.

This summer the ASP undertook a member's survey. There were a couple of questions that related to *Mercury*, and here's one that's particularly relevant:

When you read Mercury, how do you read it? Please check all that apply.

I read it on a computer screen: **72.4%**

I read it on a tablet (iPad, etc.) screen: **12.1%**

I print the entire document and read the hard copy: **5.3%**

I print pages of interest and read the hard copy: **9.6%**

I do not read *Mercury*: **14.9%**

Even though the total adds up to more than 100% (114.3% to be precise, because more than one answer was allowed), it's clear that the vast majority of respondents say they read it in electronic format (on a computer screen or a tablet).

And now, to the point. Because so many of you read *Mercury* on a computer screen, we're changing to a horizontal (landscape) format, which will make the e-zine much easier to read on your (horizontal) computer screen. Format doesn't matter quite as much for a tablet, but if the content is already horizontal, there's a good chance that you won't have to expand it to read it. In this new format, a single page will fill your screen, making scrolling a thing of the past (except to move from page to page).

The change will take place with the next issue (Winter 2013). For those of you who want to read it in print, the e-zine will still be easily printable in its new format. And for those 14.9% who indicated that they don't read *Mercury* — well, perhaps the news of a new, computer-screen-friendly format will cause them to at least take another look at this membership benefit.

Paul Deans
[Editor, Mercury](#)

ON THE COVER

Front: On August 31, 2012, a long filament of solar material that had been hovering in the Sun's atmosphere erupted out into space. The coronal mass ejection, or CME, traveled at more than 900 miles per second and struck Earth a glancing blow four days later. This visual is a combination of two images, both in extreme ultraviolet. You can see a movie of the eruption [here](#) and [here](#). Courtesy NASA/GSFC/SDO.

Back: A beautiful blue 'butterfly' flutters towards a blue nest of warm dust and gas above an intricate network of cool, dusty filaments in this image of the Vela C region by ESA's Herschel space observatory. The two blue regions stand out from their surroundings because their dust has been heated by imbedded young, hot stars. Courtesy [ESA/PACS](#) and SPIRE Consortium.

Mercury

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



by James G. Manning

Living History

Today's history was once somebody's current event.

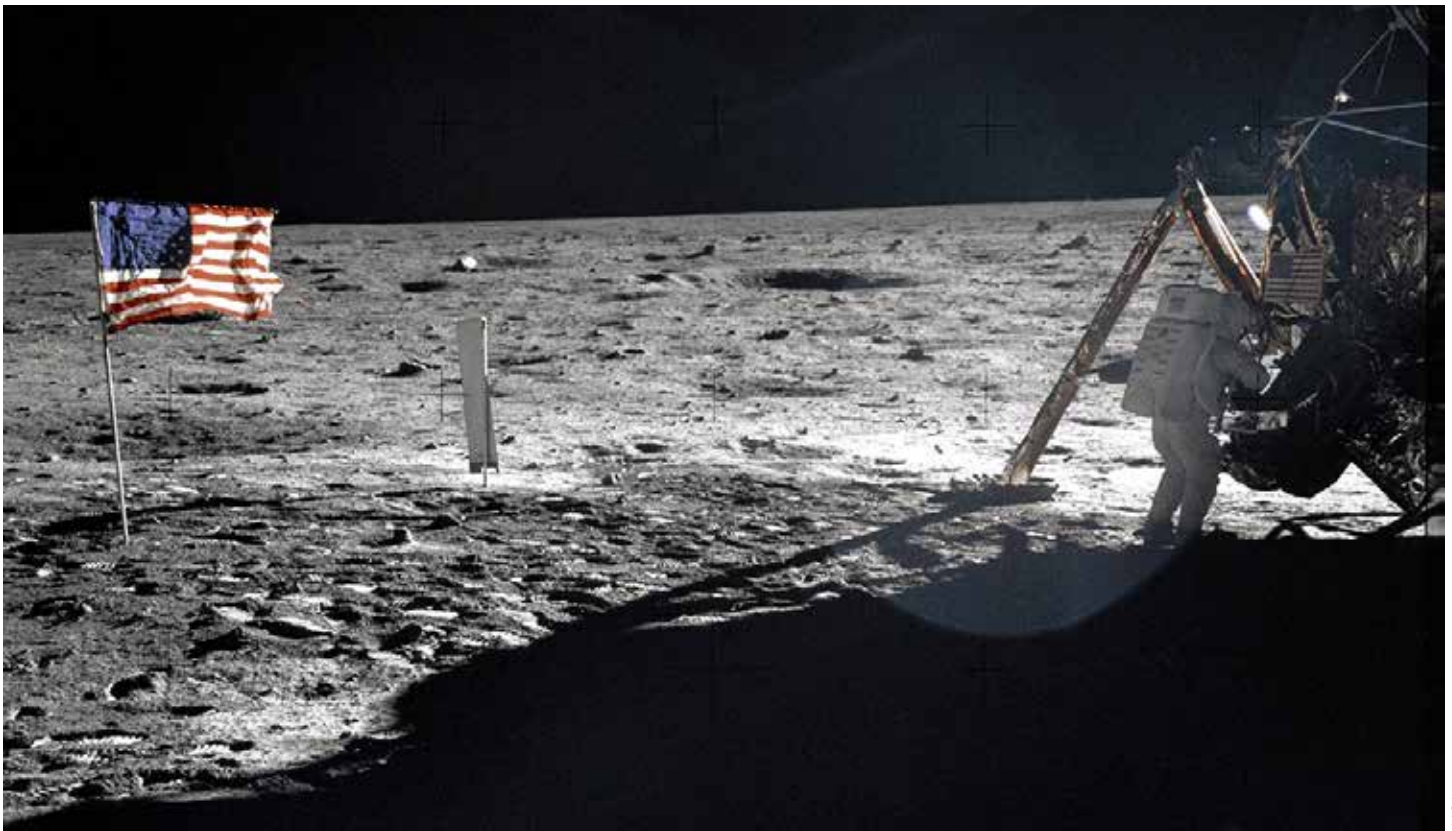
One of the important things to remember about history is that every bit of it started, for someone, as a current event. I was reminded of this when I heard the news that Neil Armstrong, the first human being to plant a footprint on the Moon, [had passed away](#) on August 25 at the age of 82. Other moonwalkers still survive, so it's not quite the end of an era, but this particular current event prompted not only sadness, but also nostalgia for the era Armstrong represents — an era that is certainly more than a historic book entry, a picture, or a vintage video to me.

As I grow longer in the tooth, I find increasingly that one of the most remarkable facts about the 1969-72 flurry of Moon landings is that for the majority of the world's present population, they are and always have been history — that most of the people alive today were either too young to remember or had not yet been born. How does that change their perspective from those of us for whom the landings are not mere history, but something we lived as a current event?

I remember well living that particular July 20, 1969, when I was in my teens. I actually missed witnessing the Moon landing that afternoon, for I was busy earning money at the local canning factory for my first year of college. Vegetable canning is emphatically seasonal work, dictated by the vegetable. Julys were ruled by the pea, and when the pea crop was ready, we canned — for long hours and often late into the night.

And so, while NASA sweated out the landing of the lunar module that summer afternoon in Mission Control, I was sweating in the cook room of Our Best Canning Company, mixing, and bringing to the boil, vast vats of brine to be squirted into cans of raw peas before they were sealed, cooked, cooled, labeled, and shipped. We must make sacrifices for our craft!

But then, something amazing happened. We ran out of peas. As luck would have it, the final fields were harvested that day, and we finished processing the summer's pea crop by suppertime, allowing



This frame, from Buzz Aldrin's panorama of the Apollo 11 landing site, shows Neil Armstrong working at an equipment storage area in the Lunar Module.



first word

me to rinse out my vats and scurry home to the family farm in time for the main event that night.

It was an insect-thrumming evening, sultry and starry. The Moon, two days from first quarter, hung low in the southwest, alongside Jupiter against the stars of Virgo. Mars beat as a second heart in Scorpius, and the Milky Way was a star-shot arch across the sky. I peered at the Moon across the fields and farms and woodlots of northeastern Wisconsin, marveling that at that very moment, for the first time ever, there were two of us on that plaster of Paris ball, looking back at all the rest on the blue-white Earth.

As the Moon prepared to set, I went inside to my huddle of family around the TV, and a few minutes before ten in the evening, we watched as Neil Armstrong clambered down the ladder on the leg of the lunar module and made his simultaneous small step and giant leap. Fifteen minutes later, Buzz Aldrin climbed down to join him, and for two hours, we sat enraptured, watching two ghostly figures float about on the surface of another world.

A little after midnight, the first lunar excursion was over. The astronauts crawled back into the lunar module, taking bits of the Moon with them, and we all crawled off to our beds, drifting into sleep with the knowledge that the world had changed forever.

With the passing of Neil Armstrong (and of [Sally Ride](#), first American woman in space, a month earlier), even I must conclude — inescapably — that the Space Age is aging, and its early, pioneering years are solidifying into history. But I remember how living those moments made such a difference for those of my generation who watched and were inspired to go into fields of science and science education as a result.

There's another important thing to remember about history—more of it gets made every day, and living it provides opportunities for new generations to be inspired. And we can leverage those current events in our work.



Neil Armstrong, Apollo 11 Commander, inside the Lunar Module as it rests on the lunar surface after completion of his historic moonwalk.

Just this year we had the opportunity to share the rare transit of Venus. We have a brand spanking [new rover](#) on Mars, ready to discover. In 2015, the [Dawn](#) spacecraft will give us our first ever close-up view of the giant asteroid Ceres (as it has Vesta during the past year), and [New Horizons](#) will zip past Pluto, providing us with the first good look in all of history at this remote body. There are eclipses to witness, big auroral displays that may happen, and inevitably, another bright comet is on its way to a striking apparition sometime in the future. And one day, we may see new manned spacecraft carrying new Neil Armstrongs and Sally Rides and astronauts of many countries to places we've never been before.

There will be all kinds of history to live in the form of current events in space and in the sky. And your Society will continue to take full advantage, to move forward our mission of advancing science literacy through astronomy, and to help inspire the next generations of scientists, educators, and enlightened citizens.

With your partnership, we will continue to take those small steps, as Neil Armstrong did that sultry summer night so long ago, which can lead to giant leaps for mankind! [\[RETURN\]](#)

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



There are no good photographs of Neil Armstrong on the Moon. That's because for most of their EVA, Neil had the camera, so Buzz Aldrin is the astronaut pictured in all the Apollo 11 photos taken on the lunar surface. Here is one of the few: a frame from the time-lapse video of Neil and Buzz erecting the American flag. According to Charles Apple, a writer who covers journalistic visuals, this is the only picture we have of Neil Armstrong's face while he was outdoors on the Moon.



by Katherine Bracher

50 Years Ago: Radio Galaxies

Radio galaxies are a subset of active galaxies that happen to be radio emitters.

In October 1962, Otto Struve published an ASP Leaflet titled “Radio Galaxies,” describing what was then known and theorized about these objects. Since that time much new work has been done on them, beginning less than a year later with the identification of quasars by Maarten Schmidt. But even in Struve’s day, some of the theories were on the right track.

The term “radio galaxy” was used to describe a galaxy with very strong radio emission. Some of these had been discovered in the 1950s, and Struve pointed out that: “all strong radio galaxies are very massive, but the reverse is not true.” He noted that the Andromeda galaxy (M31) and our Milky Way galaxy are very massive, but emit radio waves only weakly. He also commented that some, but not all, Seyfert galaxies (those with very bright nuclei) are strong radio sources. We now know that only some five percent of these galaxies are strong radio emitters.

Struve credited the Russian astronomer I.S. Shklovsky with the recognition that the radio emission from galaxies is due to “the non-thermal synchrotron radiation of relativistic electrons (very fast electrons in a magnetic field).” This radiation is characterized by increasing intensity with increasing wavelength, unlike thermal emission. But the origin of this synchrotron emission was still unknown.

It was known that supernova remnants in our galaxy, like the Crab Nebula and Cassiopeia A, are sources of non-thermal emission. Hence G.R. Burbidge suggested that perhaps supernovae could explain the radio galaxies. But this would require many more supernovae (about a million per year) than occur in any galaxy, as Struve pointed out.

Many of the very large elliptical galaxies have a huge cloud of invisible, high-speed electrons on either side of the nucleus, about 100-150 kiloparsecs from the galaxy itself. Shklovsky suggested that these clouds of ionized gas had been “ejected by an unknown mechanism from the nuclear regions of the optical galaxies, and that these clouds carry with them their magnetic lines of force.” To replenish the ejected gas, he proposed that intergalactic gas was falling into the galaxy from outside. This theory concerning the intergalactic gas is no longer current.

Today we describe radio galaxies as a subset of active galaxies that happen to be radio emitters. Active galaxies have highly luminous nuclei, which are believed to eject beams of high-speed particles; in some cases these form two lobes on either side. The lobes are driven outward, and the intergalactic medium limits how far they go. Sometimes we observe the emitted particles in narrow jets, as in the giant elliptical galaxy M87.

The high luminosity of the nuclei of these galaxies is now attributed to the presence of a supermassive black hole in the galaxy,



This image is a composite of optical, radio, and X-ray data of the giant elliptical galaxy M87. Bright jets moving at close to the speed of light are seen at all wavelengths coming from the massive black hole at the center of the galaxy. Credit: X-ray: NASA/CXC/CfA/W. Forman et al.; Radio: NRAO/AUI/NSF/W. Cotton; Optical: NASA/ESA/Hubble Heritage Team (STScI/AURA), and R. Gendler.

which is accreting mass and forming an accretion disk around itself. This accretion disk heats up, and its radiation excites the surrounding gas. But we are still not sure how the jets are produced.

Quasars are another type of radio galaxy of exceedingly high luminosity, and hence visible at great distances. They are believed to be an extreme example of the supermassive black hole at a galaxy’s core forming an accretion disk, perhaps accreting hundreds of solar masses per year to generate their high luminosity. Not all quasars are radio emitters, however, though the first ones to be identified were strong radio sources. So the whole picture has become much more complicated than fifty years ago when Struve wrote his Leaflet, though synchrotron radiation is still understood to be the principal cause of the radio emission. [\[RETURN\]](#)

KATHERINE BRACHER taught astronomy at Whitman College in Walla Walla, WA, for 31 years. Retired in 1998, she currently lives in Brunswick, Maine. Her research focuses on eclipses and the astronomy of the ancient world; her other principal interest is early music.



by Jennifer Birriel

Kepler's Supernova Remnant

New research converges on a distance to this 1604 supernova and the nature of its progenitor star.

Kepler's supernova was not actually discovered by Johannes Kepler. Upon learning of a "new star" in the constellation Ophiuchus, Kepler carried out a yearlong, intensive observing campaign of the supernovae. He published his results in a book entitled *De Stella nova in pede Serpentarii* (or "On the new star in Ophiuchus's foot") in 1606. Thus, the object became linked to Kepler by virtue of his dedicated study of it, and hence Kepler's name was also attached to the supernova remnant (SNR) when it was found.

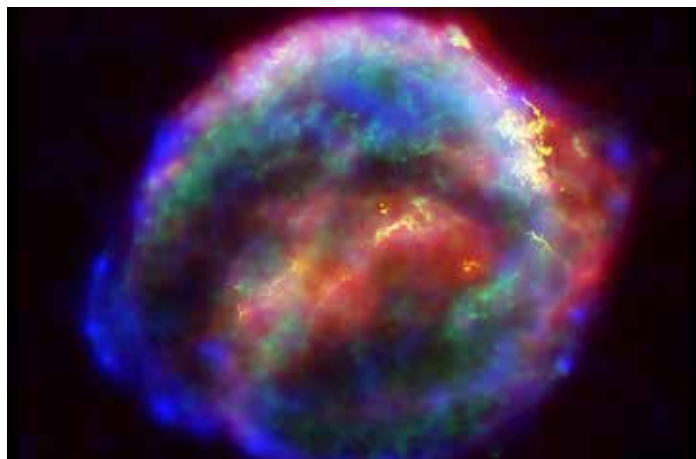
There are many questions about Kepler's SNR. The nature of the supernova explosion and the progenitor system has been a matter of debate. The SNR distance is uncertain, with estimates anywhere between three and seven kiloparsecs (kpc). In addition, it has a large asymmetric shell containing about one solar mass of material composed of solar metallicity but with enhanced nitrogen. This shell, or bubble, sits two to three parsecs from the center of the explosion in the northern region of the remnant.

It is now generally accepted that Kepler's (SNR) was the result of a Type Ia supernova explosion. A Type Ia supernova is the detonation of a carbon-oxygen white dwarf when its mass reaches the Chandrasekhar limit due to accretion from a companion star. There are two competing scenarios for such an explosion. In the single degenerate (SD) scenario, a white dwarf star accretes material from a less evolved companion, whereas in the double degenerate (DD) series, the explosion occurs when two white dwarf stars merge.

Kepler's SNR has several properties suggestive of a SD progenitor system. Its circumstellar medium (CSM) is very dense and rich in hydrogen. A DD progenitor system can also produce a CSM, but it would not be rich in hydrogen. In addition, Kepler's CSM contains dust that can only have been produced by an asymptotic giant branch star prior to the supernova explosion.

Early this year, astronomers A. Chiotellis, K.M. Schure, and J. Vink [posited](#) that the progenitor of Kepler's supernova was most likely a symbiotic binary consisting of a carbon-oxygen white dwarf and a red giant. The nitrogen-enhanced shell results from the nitrogen-rich stellar winds emanating from the red giant star with a mass of four to five times that of the Sun. Because Kepler's SNR resides well above the galactic plane and has a high spatial velocity, the team thinks it likely that the progenitor system resulted from the collision of two runaway stars that were ejected from the galactic center or galactic disk.

Chiotellis and colleagues used model simulation that suggests a combination of the red giant wind and the motion of the binary system created the nitrogen-rich bubble in the northern region. At the same time, the white dwarf accreted mass from the red giant's wind. The current radius of the SNR combined with its velocity and other model parameters indicated a distance of about six kpc.



NASA / ESA / JHU / R. Sankrit & W. Blair

This [multi-color image](#) is a combination of observations by the Hubble and Spitzer Space Telescopes, and the Chandra X-ray Observatory.

In a [more recent article](#), D.J. Patanude, C. Badenes, J. Park, and J.M. Laming examined subenergetic and energetic models. Sub-energetic models would suggest distances less than about six kpc while energetic models favor distances in excess of about seven kpc. They point out that the observed X-ray spectrum of Kepler's SNR rule out a subenergetic explosion.

B. Williams and six colleagues used infrared spectra from the Spitzer Space Telescope to [examine the dust](#) in Kepler's SNR. Two strong, broad features at 10 and 18 micrometers suggest the presence silicate dust formed in the wind of an oxygen-rich, red giant star prior to the supernova. They found a near-infrared excess that cannot be accounted for by silicates, but can be explain by the additional presence of graphite dust or metallic iron inclusions in the silicate grains.

Understanding the nature of Type Ia SN is crucial given that they are used as standard candles for cosmological distance determinations. But is Kepler's SN typical of Type Ia SN? Chiotellis and colleagues point out that the progenitor of Kepler's SN would have been a rare object as only about one in ten runaway stars are binaries. In addition, Kepler's Type Ia SN exhibits an unusual bilateral symmetry not found in other Ia remnants. Our understanding of Kepler's SNR is an important step, but we also need to identify progenitors of other Type Ia SN. [\[RETURN\]](#)

JENNIFER BIRRIEL is Associate Professor of Physics in the Department of Mathematics, Computer Science, & Physics in Morehead KY. Her doctoral thesis involved studies of symbiotic stars, and she maintains a strong interest in the potential evolutionary link between these binary stars and Type Ia supernovae.



by Daniel D. Durda

Farewell Vesta, Onward to Ceres...

After a year exploring Vesta, Dawn departs for the largest asteroid.

It's one of those baseball aficionado-type of trivia-level facts to keep track of, but this fall NASA's [Dawn](#) mission did something that's never been done before in planetary exploration. For the first time a spacecraft has left orbit around an object outside the Earth-Moon system and departed for another — in order to enter orbit around that one too! (Okay, JAXA's [Hayabusa](#) spacecraft left Itokawa for Earth, but it's hard to describe Hayabusa's proximity operations around that tiny asteroid as an 'orbit.' I know, I know, but I did qualify this as trivia-level stuff!) On September 4th Dawn gently slipped the bounds of Vesta and began its three-year journey to Ceres.

Dawn was launched in July 2007 to orbit and survey two of the largest asteroids in the main asteroid belt — Vesta and Ceres. Ceres is, in fact, *the* largest asteroid. Although we've seen several asteroids close up with other spacecraft before, these two targets of the Dawn mission offer planetary scientists a unique opportunity to learn about the inner workings of transition-size planetary embryos — objects not quite large enough to be considered full-fledged terrestrial planets, but worlds far bigger than their debris-like cousins strewn across the rest of the asteroid belt. And even better, Vesta and Ceres each represent complementary end-member compositional and structural bookends within this important planetesimal-to-planet story. Why is one a differentiated 'mini-planet' with a distinct core-mantle-crust structure while the other is an apparently undifferentiated icy rock ball?

Answers to these primary questions of the mission began with the first stop at Vesta in July 2011. We already knew that Vesta was going to present a geologically complex and fascinating face. Even before Hubble Space Telescope images showed there to be an immense, impact basin-like feature across Vesta's south polar region, we knew the asteroid had undergone some sort of giant, cratering impact at some point in its past. Vesta has a 'family' of smaller asteroids associated with it that spectroscopic observations show to be composed of the same basaltic rock as Vesta's bright and mineralogically distinct surface. Long before this family of debris was discovered, Vesta had been linked as the parent object for the so-called [HED complex of meteorites](#), a group of igneous rock meteorites whose collective geochemical properties show to have originated from a differentiated parent body.

Determining the detailed characteristics of Vesta's differentiated internal structure was high on the Dawn mission's list of objectives. Getting a good look at that south polar impact basin was icing on the impact specialists' cakes! An equator-ringing band of grooves and a central peak higher than Mt. Everest are important structural clues that will help us decipher some of the mysteries of basin-scale impact processes so important on many terrestrial worlds, our own Moon included.



NASA / JPL-Caltech / UCL / MPS / DLR / IDA

This mosaic synthesizes some of the best views Dawn had of the giant asteroid Vesta. The towering mountain at the south pole — more than twice the height of Mount Everest — is visible at the bottom of the image. The set of three craters known as the “snowman” can be seen at the top left. A full set of Dawn data is in the process of being [archived](#).

After waiting with so much anticipation for those first detailed views of Vesta, it's hard to believe that slightly more than a year of orbital operations are now over. With the mission science team only beginning to dig into the real meat of the tens of thousands of images, millions of visible and infrared spectra, and thousands of hours of neutron and gamma ray spectra and gravity measurements, Dawn has begun its gentle, ion-thruster-powered trajectory to Ceres.

There are challenges ahead for the mission, since one of its attitude-controlling reactions wheels developed a bit of gyroscopic 'arthritis' during the gradual spiral out of Vesta's gravity well, but nothing that will impact the overall science goals at Ceres in any significant way. The team will be doing a bit of observation sequence reshuffling during the cruise to Ceres in order to accommodate more gentle demands on the sticky reaction wheel's systems, but come early 2015 the veil will begin to be parted on the largest 'mini-planet' in the main asteroid belt.

Even though Ceres is larger than Vesta, it appears that Ceres hasn't differentiated into a core-mantle-crust structure. Why not? There are suggestions that Ceres may be an ice-rich object. Did the presence of that ice somehow 'buffer' the asteroid's interior from heating to the point of differentiating? Did it only partially differentiate? Once in orbit in just a few years, Dawn will help answer these questions, teaching us just a little bit more about the way terrestrial planets work. [\[RETURN\]](#)

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



by Christopher Wanjek

Hydrogen Signal Reveals First Stars

A relatively straightforward radio technique could map when and where the first stars formed.

When, where, and how did the first stars form? The answer is blowing in the wind — a hydrogen wind. The very first stars heated this hydrogen wind, which then emitted a unique signal that now should be detectable as a 21-centimeter spectral line at radio wavelengths.

An international team of scientists led by Rennan Barkana of Tel Aviv University has taken the first step in observing this long-sought-after signal. As reported this summer in the journal *Nature*, [Barkana's group](#) created 3D computer models of how this wind literally blew the structure of the universe into place.

The simulations suggest that careful observations with next-generation radio telescopes now being built could detect the 21-cm hydrogen line, allowing for precision mapping of the first stars and galaxies and the dark voids between them.

Let There be Hydrogen

Perhaps surprising, scientists know more about the first moments after the Big Bang 13.8 billion years ago than they do about the era when stars are thought to have turned on, approximately 100 million years after the Big Bang.

The Big Bang produced mostly hydrogen, with some helium and a sprinkling of lithium thrown in for good measure. For the first 300,000 years or so, the universe was opaque, filled with ionized gas. Light continuously scattered off of electrons and could not break through this primordial fog.

Then the universe cooled to the point at which hydrogen could bind with electrons, forming neutral hydrogen. The universe was now transparent but quickly grew dark with no light source other than the Big Bang's fading glow. This was the beginning of the so-called Dark Ages.

Eventually, hydrogen began to fall into gravity wells created by dark matter. As a critical mass formed, hydrogen gas clouds became dense and hot enough to form stars. Little is known about how or when this happened. But Barkana's group said that radio telescopes tuned to the right frequency could map this era.

21st-century 21-centimeter Cosmology

Theorists have speculated on 21-centimeter cosmology for decades. All that neutral hydrogen would make a telltale signal when smacked by photons from the first stars. The problem, however, is that this signal is buried in the foreground emission from the Milky Way and nearby galaxies.

But a theoretical breakthrough came in 2010 in a paper in *Physical Review D* by Dmitriy Tselikhovich and Christopher Hirata of Caltech, who are co-authors on the new *Nature* report. They realized that, in the early universe, ordinary matter moved faster than

dark matter, sped by collisions with photons. This velocity imbalance had a momentous effect on evolving structure.

Some ordinary matter moved so fast that it would escape dark matter's pull, leading to less clustering and less star and galaxy formation in certain regions. Barkana said this velocity differential should imprint a large-scale fluctuation signal of about 10 milli-Kelvin in the 21-cm hydrogen spectral line associated with stars at redshift 20, or from when the universe was about 180 million years old. The fluctuation should stand out easily against foreground radiation, he said.

"It is quite remarkable that such a large effect would remain unnoticed for so long, given that all the ingredients to calculate it were in place decades ago," said Matias Zaldarriaga, a professor at the Institute for Advanced Study in Princeton, NJ, not associated with the study. "This theoretical insight [from 2010] is very solid and widely agreed upon, but what is not yet clear is how to best observe the effects of this."

Several groups are building arrays of radio telescopes to detect 21-cm radiation from the early universe, albeit focused around redshift 10. "The antennas and instruments would have to be slightly redesigned in order to focus on redshift 20 and our predicted signal," Barkana said. "Going earlier should not be much harder. But until our prediction, there was no known signal out there that would motivate this. Our predicted signal is easier to observe than previously thought because it is both stronger and occurs on larger angular scales than previously expected."

The maps of first stars and galaxies would complement [WMAP's](#) map of temperature fluctuations in the cosmic microwave background that revealed the seeds of structure. On the other side of reionization, the planned [James Webb Space Telescope](#) would image the brightest first galaxies.

Zaldarriaga said that the 21-centimeter hydrogen line could allow us to peer back as far as the dark ages, an era that until recently many cosmologists thought was out of reach. "The entire field is interesting although in a very early stage, so how much we will ultimately be able to get from it is hard to predict," he said. [\[RETURN\]](#)

CHRISTOPHER WANJEK is based in Baltimore. His first novel, *Hey Einstein!*, is a comical tale of nature and nurture and cloning Albert Einstein...poorly...five times.



by David Bruning

What Purpose Reading?

Paper texts, not electronic, provide the quietude needed to foster deep thinking about astronomy.

What is the role of reading in your astronomy class? Is the text just a backstop for your lectures or is it a workshop in which to synthesize ideas? To me, reading equals thinking. A well-written astronomy text enables one to be privy to the thoughts of generations of astronomers before us. But I am not a hapless passenger on the wings of the author's words; indeed, I shape the ideas within the text to take me where I want to go.

On the other hand, my students appear to be passive recipients of the written word; they memorize sentences as if they were oracle bones. They do not participate in the give-and-take between author and reader that I have come to expect. Instead of wishing to be challenged by ideas strewn through the pages, they wish to be assured that the manipulation of the electronic file is tantamount to education.

Yet, when I read digital media, I commonly enable the same mindset as my students. I skim through the pages and look for prominent words or facts. Electronic alerts scream for attention. Millions of pages demand that I sip at knowledge, flitting from flower to flower like a hummingbird. But books — they require that I slow down and drink deeply.

Rarely does the reader of electronic files become lost in the words. While one can argue that electronic connectivity is a useful and powerful tool, I contend that we are doing the wrong thing — we should be thinking about what we read and not be distracted with tasks such as clicking on references. As you read a digital publication, ask yourself “Is what I am doing ‘reading’?”

Others, such as David Ulin in *The Lost Art of Reading*, have described the loss that occurs when “reading” literature from a screen rather than the physical page. In the electronic world of blogs and wikis, Ulin observes that: “distraction masquerades as being in the know.” The Twitterverse revels in minimalist or superficial reading of long, detailed works. Lewis Lapham in *Gag Rule* (2004) says that the electronic landscape has produced a “vocabulary better suited to the sale of products than the articulation of thought”

Even the brain does different things when engaged with electronic media. A [study](#) by Gary Small of the UCLA Memory and Aging Center shows Net-savvy people demonstrate stronger brain activity than Net novices, but the area of the brain utilized is different than for normal reading. Savvy Google searchers [studied](#) by Betsey Sparrow of Columbia University utilize stronger information retrieval pathways; the downside is that they remember where to find the information better but fare less well in recalling the actual information. Overall effects on cognition are uncertain in most of these studies.

What we mean by reading will certainly have to evolve as digital media become more commonplace. But redefining “reading” begs the question of what has really changed and that may be deeper thinking and assimilation of conceptual ideas. Is it *what we do* with



iStockPhoto.com / frankreporter

Digital media triggers different parts of the brain than do print media, suggesting that the act of learning will become different.

text rather than the *act of viewing* text the characteristic that should define “reading”?

Print books aid concentration, as Ulin says, “by offering to do nothing.” They require the reader “to be patient, to take each thing in its moment, to let the narrative prevail.” In a world of competing distractions, students have become increasingly impatient; they want knowledge now and are reluctant to till the soil of printed words out of which true knowledge will grow. Even the act of taking reading notes has morphed into a flurry of electronic underlining and tagging; do students no longer make reflective notes?

I confess that I have tried different course policies attempting to engage students in reading. I have experimented with and without a text, required reading quizzes, posed just-in-time questions, and provided credit for error sleuthing. But what do I do to promote the effort needed in reading to elicit the give-and-take between author and reader? In my effort to make learning easier for students, do I rob them of the sublime labor needed to understand the concepts I so much want them to discern? If I don't hold my students responsible for reading, do I limit their ability to think deeply about the course? [\[RETURN\]](#)

DAVID BRUNING teaches astronomy at a Midwestern state university. He fears that misuse of electronic media will complete the transformation of the university into a place of commerce rather than scholarship. He also recognizes the irony of writing this article, complete with distracting links, for an electronic publication.



by James Lochner

Outreach vs. Engagement

The words we use are important.

The same word can have a different meaning denotation depending on context. For example, “dough” can be something from which you make bread, or, using its slang synonym for money, what you use to buy the bread. The same word can also have different connotation to different cultures. For example, a sports team “mascot” has a fairly innocuous meaning to Caucasian Americans, but to Native Americans it may denigrate them into offensive caricatures. A word in one language may not translate well into another language. Or a word in one language may require a lengthy explanation in another.

Public “Outreach” seems to be one of those words that require lengthy explanation, partly because it has become overused so as to become ambiguous. NASA has used this word in conjunction with “Education” since at least the late 1990s. It has come to signify the catch-all of what is done outside of education. Distinctions have been made between formal and informal education, carefully delineating the latter on the side of education rather than outreach, though the boundary can still be fuzzy. The intent of education is to “increase learning,” whereas the intent of outreach is to “raise awareness...and to develop an appreciation.” On the face of it, we “reach out” to our audiences.

Salvatore Acevedo, an expert in linking organizations with multicultural communities, brought up this topic during the recent Tucson ASP meeting in the “Engaging and Supporting Culturally Diverse Audiences” session. He characterized the attitude behind outreach as: “The audience needs us, but they don’t know it,” and “The audience needs to change its behavior.” So it’s a one-way communication. Keep in mind that our audience interprets what we mean by “outreach” based on our actions. We might not have meant to do this, but this may be how it has been perceived.

The community of E/PO practitioners has evolved away from that. We now seek to determine the needs of the audience. But this still leaves the E/PO practitioner in the role of the “great provider.”

Acevedo advocated that we get away from “outreach” and think more about “engagement.” NASA is certainly doing this, though whether “E/PO” will ever become “E/PE” remains to be seen.

But what is meant by engagement? What does it look like when it happens?

In the interpretive methodology used by the National Park Service, the aim is to help park visitors discover their own meaning in the place, people, or history of the park. This method, used by park rangers in their presentations, helps visitors to make an intellectual and emotional connection. To some degree, the visitors care about it.

For us, we want our audience to care about our science, technology, discoveries, and/or achievements. For NASA, 50 million viewers certainly seemed to care about the outcome of the Mars



NASA / Christopher Christosimos

The NASA Village science tents featured many hands-on demonstrations, activities, and handouts to illustrate the capabilities of Earth Science Research during Earth Day celebrations in 2010.

Curiosity landing in early August 2012.

So I’ve begun thinking of engagement as the conscious and deliberate exercise of thoughts or emotions on the part of the audience. The audience actively participates in something they are interested in and has meaning to them. It involves more mental or emotional effort on the part of the audience than an audience to whom we are just outreaching. As such, it has a potentially greater impact.

There are a number of projects that engage their audience by involving them in planning and development, and some also include members of the audience in their evaluation plan. The latter is particularly important when working with underserved audiences and there are number of outstanding examples of E/PO practitioners working with Native American communities.

But in turning toward “engagement,” Acevedo additionally challenges us to fully embrace the two-way communication between the practitioner and the audience. So the attitude of the practitioner becomes: “We need/want the audience, but we don’t know how to communicate,” and “We need to change *our* behavior.” The practitioner enters into a relationship, listening, sharing, respecting, and being open to change. So engagement also has an impact on the E/PO practitioner.

As far as replacing Outreach with Engagement, “Engaging Out” doesn’t have the same ring for this column, and I’m not sure our dear editor will go for it. [\[RETURN\]](#)

JAMES LOCHNER is the Program Manager for the Science Mission Directorate’s Education and Public Whatever-you-want-to-call-it programs at NASA Headquarters.



by Andrew Fraknoi

Resources for Addressing Fears About Astronomical Causes for the End of the World in 2012

If you need to debunk this hoax, here are some useful responses.

As students return to school this fall, and the media and web hype about Doomsday 2012 reaches a final, fevered pitch, all of us in science education will need to be prepared to respond to concerns from those who are genuinely worried or confused.

Two new resources are now available for educators, parents, youth group leaders, and science communicators to address fears that worldwide disaster is coming on Dec. 21, 2012.

A free guide to accessible written and audio-visual materials (most of them freely available on the Web) has just been published in the journal *Astronomy Education Review*. The easiest way to see the entire article is to click on the “Download PDF” link under the author’s name.

A video recording of the plenary session “Doomsday 2012 and Cosmophobia” at this summer’s meeting of the Astronomical Society of the Pacific has [now been posted](#) by NASA’s Lunar Science Institute. The panel, held August 7, 2012, in Tucson, Arizona, which I had the pleasure of organizing, featured David Morrison (Director of the Carl Sagan Center for the Study of Life in the Universe at the SETI Institute and Senior Scientist at the NASA Lunar Science Institute), Kristine Larsen (Professor of Physics and Astronomy at Central Connecticut State University), Bryan Méndez (an Astronomer and Education Specialist at the Center for Science Education at the UC Berkeley Space Sciences Laboratory), and Mark Van Stone (an autodidact calligrapher who earned his doctorate in Maya hieroglyphs in 2005 and currently teaches at Southwestern College).

Panelists examine some of the key claims about end-of-the-world predictions and the more general idea of “cosmophobia” — fear of celestial events and phenomena. They also answer questions from educators in the audience. The website also includes an overview letter from David Morrison and links to a number of useful resources.

Finally, here are two quick links from the ASP to get you started if you need answers in a hurry.



Paul Deans

Panelists for the session “Doomsday 2012 and Cosmophobia” at the ASP’s 2012 conference in Tucson are, from left to right, Mark Van Stone, Bryan Méndez, Kristine Larsen, and David Morrison. Standing is moderator Andrew Fraknoi.

David Morrison’s *Astronomy Beat* article “[Doomsday 2012, the Planet Nibiru, and Cosmophobia](#)” (free to all) discusses the supposed end of the world in December 2012, and a planet whose approach is supposed to cause it. And the [79th issue](#) of *The Universe in the Classroom* newsletter from the ASP, by Alice Enevoldsen (Pacific Science Center), is about responding in the classroom to various doomsday 2012 scenarios.

Best of luck in helping people understand that there is nothing more to be nervous about this winter than any other year, and that our students will be taking exams and we will be paying taxes in 2013.

[Editor’s addendum. Ed Krupp, noted expert in archaeoastronomy and Director of Los Angeles’s Griffith Observatory, explained the details and history of this 2012 mania in the November 2009 issue of *Sky & Telescope*. Since the issue is no longer on newsstands, *S&T* has kindly made [Krupp’s article](#) available as a PDF. Also, on November 4, 2009, Krupp presented an [hour-long lecture](#) on the topic for Distinctive Voices @ The Beckman Center, a public science program of the National Academy of Sciences. It’s a very entertaining video.] [\[RETURN\]](#)

ANDREW FRAKNOI is the Chair of the Astronomy Program at Foothill College, the former Senior Educator at the Astronomical Society of the Pacific, and the Founding Co-editor of *Astronomy Education Review*. In honor of his 39 years of service to the Society, the ASP recently announced a new award — the Andrew Fraknoi Supporter’s Award — that will be presented annually to an individual in recognition of his or her exceptional support of the ASP.



2012hoax.org contributor "PashNinja"



ASP 2012 Tucson

This special section of *Mercury* features reprints of eight poster papers plus a transcript of the majority of Michael Mann's plenary talk "The Hockey Stick and the Climate Wars" — all part of the ASP's Communicating Science conference held in Tucson, AZ, August 2012.

Images courtesy Paul Deans (x6).





There and Back Again in the Classroom and in Outreach: Astronomy and *The Hobbit*

by [Kristine Larsen](#), Central Connecticut State University

Originally published in 1937, J.R.R. Tolkien's *The Hobbit* features the adventures of the diminutive, furry-footed hobbit Bilbo Baggins and thirteen dwarves in a quest to regain the dwarves' ancestral treasure from the dangerous dragon Smaug. Considered more of a children's tale than the later trilogy *The Lord of the Rings*, *The Hobbit* garnered twenty-fifth place in a 2003 BBC poll of the best-loved novels (right behind several *Harry Potter* books), with *The Lord of the Rings* capturing the top position.

Now, a decade after the record-breaking release of director Peter Jackson's film trilogy of *The Lord of the Rings*, fans of Middle-earth are anxiously awaiting the release of Jackson's three-part treatment of *The Hobbit*. Given that the first trilogy raked in nearly \$3 billion worldwide (according to [imdb.com](#)) and that interest in the films is high, both online and at conventions such as the 2012 San Diego Comic Con, *The Hobbit: An Unexpected Journey* (release date December 14, 2012) and its sequels (release dates December 13, 2013 and summer 2014) promise to introduce a whole new audience to the wonders of Middle-earth. Therefore now is the time to prepare to exploit the astronomy of *The Hobbit* in our classrooms and outreach programs.

J.R.R. Tolkien utilized a great deal of astronomy in crafting his Middle-earth novels, from inventing his own constellations to utilizing a detailed lunar chronology to coordinate the parallel adventures of a number of characters in *The Lord of the Rings*¹. The astronomy of *The Hobbit* focuses on the Moon's phases, a topic that is a central part of any school's science curriculum, and also a topic about which many students (and pre-service teachers) hold stubborn misconceptions.

On Midsummer's Eve, the elvish lord Elrond of Rivendell holds up dwarf lord Thorin Oakenshield's map, and when the light of a "broad silver crescent" Moon passes through it, once-invisible letters are seen. These "moon-letters" are special runes that can only be

seen when light of the same "shape and season" of the Moon as the time of their writing passes through them.

The runes reveal that if someone stands "by the grey stone when the thrush knocks" the last ray of the setting Sun of "Durin's Day will shine upon the key-hole" (Tolkien 2007, 50).

The reader then learns that the dwarves follow a luni-solar calendar, with their New Year's Day falling on the "first day of the last Moon of Autumn." Furthermore, if the Moon and Sun are seen in the sky together on that date, it is given the special designation "Durin's Day" (named for the first king of the dwarves). In other words, it occurs if a slender crescent Moon can be seen within one day (or 24 hours) of new Moon.

Thorin is alarmed that he and his companions will fail at their quest to find the key-hole (and access the treasure within The Lonely Mountain), because "it passes our skill in these days to guess when such a time will come again" (Tolkien 2007, 51). As readers of *The Hobbit* well know, Bilbo Baggins and the baker's dozen of dwarves arrive at mountain in time for the dwarvish New Year, and the location of the long-hidden key-hole is, as had been predicted, revealed by the light of the setting Sun while the newborn Moon is seen nearby in the sky.

We can turn these important vignettes from the book into lesson plans. Students can investigate the difference between lunar and lunisolar calendars (such as the Islamic versus the Jewish, Chinese, and Tibetan calendars) and the inherent difficulties in using the Moon's 29.5-day Moon cycle in developing a calendar for a 365.25-day year (McCluskey 2000). Students can investigate the various methods that cultures use to create intercalary months in luni-solar calendars in order to prevent their holidays from drifting too far relative to the seasons. Such lessons integrate multicultural themes as well as mathematics into the science curriculum.

As an extension, students can develop their own calendars based on the periods of rotation and revolution of other planets in our solar system, including the periods of revolution of various moons around their planets (in order to have "months" as well as days and



New Line Cinema



Kristine Larsen



ESO / B. Tafreshi

The thin crescent Moon setting over ESO's Paranal Observatory in Chile. This picture was taken on October 27, 2011, and also shows the planets Mercury and Venus as well as Earthshine on the crescent Moon.

years). While Tolkien does not explain details of the dwarvish luni-solar calendar, he does detail a number of other Middle-earth calendars in Appendix D of *The Return of the King* (the third of *The Lord of the Rings* trilogy). Students can compare these to the standard Gregorian calendar as well as a number of proposed permanent calendars, such as the Hanke-Henry, in which a given date always falls on the same day of the week (Pappas 2011).

While today the Tibetan, Chinese, and the vast majority of Jewish luni-solar calendars strictly rely on calculations to determine the beginnings of their months, the Islamic and Karaite Jewish calendars rely on the actual sighting of the New Moon to determine the start of a month (and hence the beginning of important holidays and festivals)². Since the New Moon technically cannot be seen, it is actually a very young (and slender and dim) waxing crescent Moon that is observed.

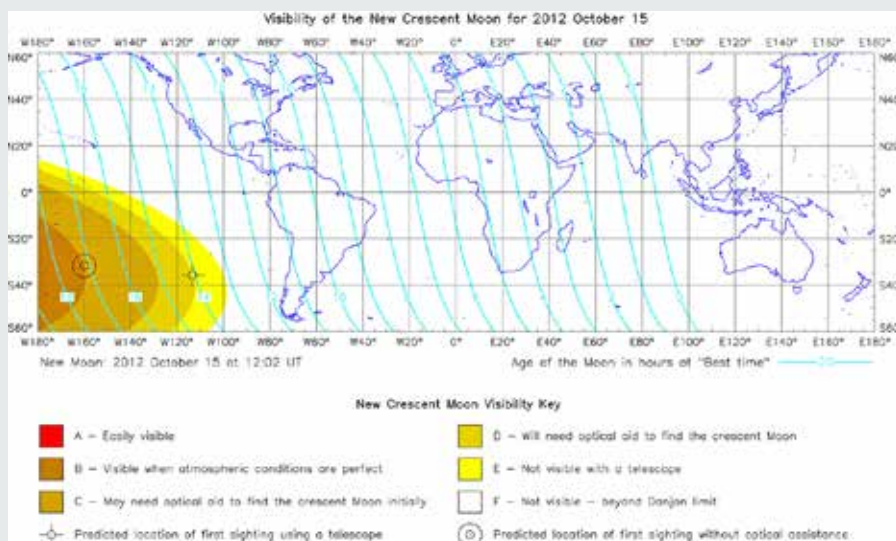
Although one can calculate the actual time of new Moon with precision, the earliest possible sighting of a waxing crescent Moon is more difficult to predict, as it depends on a number of factors including the location of the Moon relative to the Sun (itself dependent on a number of factors including time of the year and distance of the Moon from the Earth) and the observer's experience, visual acuity, and location (USNO "Crescent Moon"). The current record for youngest crescent Moon seen with the unaided eye is 15.4 hours by J. Schmidt and 15.5 hours by S.J. O'Meara (Schaefer 1988, 511).

Thanks to the accumulation of thousands of observations of young crescent Moons (both historical and modern), various computational models have been developed to predict the likelihood of an individual observer being able to view a young crescent of a given age. The Moon Watch program of the Nautical Almanac Office in England (HMNAO) collects observations of the young crescent Moon (less than 24 hours old) and continues to refine its computational models. The program also publishes tables of the predicted earliest visibility of the young Moon for various cities around the world³. The United States Naval Observatory has an

online application that allows you to input your location and get back the apparent heights of the Sun and Moon above the horizon for any given time, from which you can estimate whether they are theoretically far enough apart to possibly be observed⁴.

The magic number here is seven degrees, called the Danjon limit; the Moon cannot be observed if it is closer than this value to the Sun (Doggett and Schaefer 1994, 398). Students can use these websites to estimate the likelihood of their celebrating Durin's Day in 2012 or 2013. Interestingly, the dwarvish New Year of 2012 occurs tantalizingly close to the release date for the first *Hobbit* film. I leave it as a homework assignment for you to figure out just how close.

Even a null observation of a young crescent Moon is valuable information to astronomers, and therefore Moon Watch encourages the submission of such results. Likewise, we can learn from several mistakes that Tolkien made in *The Hobbit* concerning the phases of the Moon. Having students pick out and explain these errors can be used as a final assessment to determine whether or not students truly understand the cycle of the Moon's phases. In the famous scene where Bilbo encounters the three trolls, Tolkien describes a "waning Moon" (i.e. a Moon after full) already visible in the sky during evening twilight. This is clearly impossible, and in later editions the phase is vaguely described as "wandering" (Ratcliffe 2007b, 829).



The visibility of the new crescent Moon on October 15, 2012.

Another problem with the troll-scene Moon being a waning phase is that the moon-letters scene with Elrond (in which the Moon is clearly a broad waxing crescent a few days before first quarter) occurs some three weeks after the troll scene. Another important gaff is made by Tolkien in the scene in which the dragon Smaug destroys Laketown. Although it occurs a few days after the new Moon, in this scene the thrush tells Bard to look for a weakness in the dragon's armor using the Moon then rising in the east (Tolkien 2007, 228). Clearly this is also impossible. Students who can explain these errors have achieved some mastery of the Moon's phases⁵.

As 2012 draws to a close, calendars are very much in the public



imagination, thanks to the 2012 Maya calendar/apocalypse hoax. In addition, the Moon's phases will soon play an important role in what promises to be three blockbuster films. Now is the time to

capitalize on both interests, and help our students understand the relation between astronomy and timekeeping, and perhaps even interest them in actually observing the night sky for themselves. ■

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1. For an overview of the astronomical references in Tolkien's works, see http://www.physics.ccsu.edu/larsen/astronomy_of_middle.htm.
2. The Karaite Korner Yahoo Group posts visual sightings reports for its members each month at www.groups.yahoo.com/group/karaite_korner_news/messages. There are a number of Islamic websites for first crescent sightings, including <http://moonsighting.com>.
3. Tables are found at <http://astro.ukho.gov.uk/moonwatch/background.html>. There is also a world map showing the probability of viewing the next month's young crescent available at <http://astro.ukho.gov.uk/moonwatch/nextnewmoon.html>.
4. <http://aa.usno.navy.mil/data>
5. Tolkien is right far more often than he is wrong, in terms of his usage of the Moon's phases. For a classroom exercise utilizing his lunar chronology in *The Lord of the Rings* see Larsen (2004). For a more extensive discussion of the Moon in *The Hobbit* see Schaefer (1994).
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Why Color Matters: The Effect of Visual Cues on Learner's Interpretation of Dark Matter in a Cosmology Visualization

by [Zoë Buck](#), University of California – Santa Cruz

The research I present here investigates the effect of color on learners' interpretation of dark matter in a cutting edge visualization produced by the University of California High Performance Astro-Computing Center (HiPACC) for the Adler Planetarium. The visualization, known as the Constrained Local Universe Simulations (CLUES), reproduces the formation of dark matter structure of our local universe over time.

Introduction and Problem

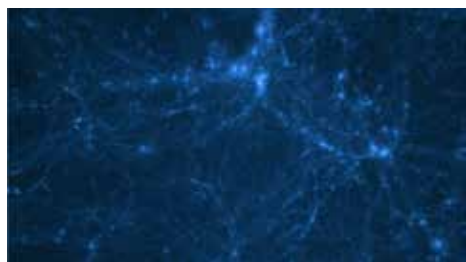
- Visualizations are cutting-edge learning tools with low linguistic demand and high information content.
- Dark matter is vital to our understanding of the universe (Primack & Abrams, 2011) and yet we do not know how to present dark matter visually to support learning.
- Learners bring a lifetime of experience and knowledge to the table (Piaget & Inhelder, 1969), which makes a profound impact on how they interpret their world — for example learners

will take blue to mean cold and red hot, even after being taught otherwise (Carvalho & Sampaio, 2006).

- I am interested in better understanding visualizations as tools that mediate cosmology learning (Engeström, 1987), especially around dark matter.

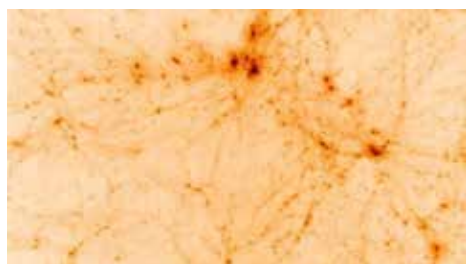
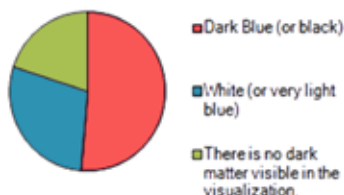
Methods

- Treatment variable: CLUES simulation of the evolution of dark matter.
- "Interpretation index": Aggregate of number of correct responses to questions about the interpreting the visualization.
- "Expertise index": Level of prior science knowledge assessed using 6 general science questions.
- Alternative treatment post-test only experimental design (Creswell, 2003).



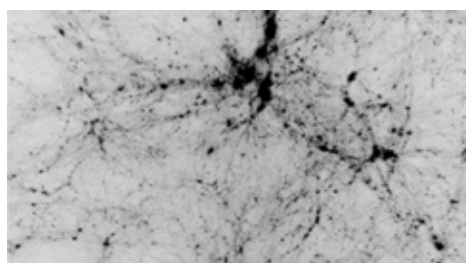
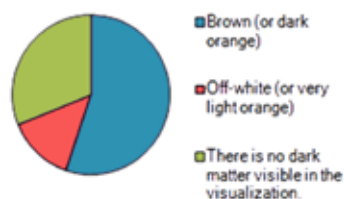
CLUES "blue" (the original version)

Using what you remember from the cosmology presentation, what color is the dark matter in the image above?



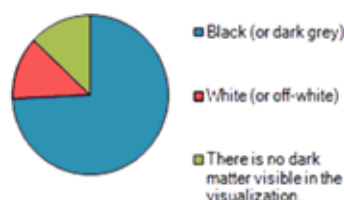
CLUES "peach" (color inversion)

Using what you remember from the cosmology presentation, what color is the dark matter in the image above?



CLUES "b&w" (color inversion)

Using what you remember from the cosmology presentation, what color is the dark matter in the image above?



The pie charts above indicate what percentage of respondents in each treatment group correctly identified the dark matter in the images beside each one. In order, the dark matter (in the simulated images) is visualized in white, brown, and black. Those participants who identified the dark matter correctly are shown in the pie charts in blue.

Sample

- Recruited from classes at UCSC (4 year university, urban, undergraduate) and Hartnell (community college, rural) (n=150).
- Linguistic demographics: ~2/3 language minority.
- Racial/ethnic demographics: 40% White, 27% Latino, 14% Multiracial, 13% Asian, 2% Black.

Results

- Chi squared testing indicates significant correlation ($p < .05$) between treatment variable and survey responses around interpreting the visualization.
- Participants who saw the original version of CLUES (white dark matter, blue space) were significantly more likely to misidentify various aspects of the visualization than those who saw a version of CLUES where dark matter was indicated by a color that was darker than the background.
- Having "high scientific expertise" (as indicated by an expertise index of 5-6, $n=29$) cancels out the color effect.
- For those without "high expertise," there is not a significant correlation between level of expertise and ability to correctly explain the visualization.

Implications

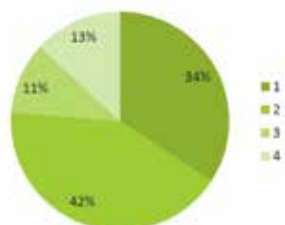
- Color variations in visualizations can have a profound effect on audience interpretation.
- This effect is significant regardless of the learner's scientific knowledge background until she or he reaches the very highest levels of expertise.
- Visualizations have the potential to be an effective medium for communicating cosmology.
- Decisions should be guided by research that includes the voices of diverse learners. [m](#)

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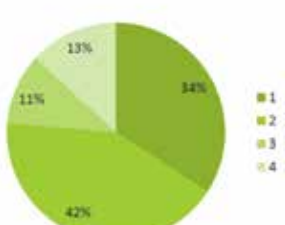
CLUES "blue"



CLUES "peach"



CLUES "b&w"



The pie charts represent the interpretation indices for each treatment group. 'One' represents respondents who interpreted the visualization with the least accuracy, 'four' with the highest.



The Priscilla and Bart Bok Award

by [Katy Garmany](#), National Optical Astronomy Observatory

Bart Bok was an outstanding research astronomer who made important contributions to our understanding of the Milky Way and of star formation. Much of his work was done in collaboration with his wife, astronomer Priscilla Fairfield Bok. He received the [Bruce Medal](#) of the ASP for lifetime achievement and the Klumpke-Roberts Award for the popularization of astronomy.

Throughout his life, and especially as an ASP Board member, Bok was a strong advocate for outreach and education in astronomy. Upon his death in 1983, the Society established the Bart Bok Memorial Fund to support educational projects. At the suggestion of the American Astronomical Society, the activities supported by the Bok Fund were expanded to include the joint sponsorship of an astronomy award at the Intel International Science and Engineering Fair, called the Priscilla and Bart Bok Award.

The [Intel International Science and Engineering Fair](#), a program



Bart and Priscilla Bok

AAO

of Society for Science & the Public, is the world's largest pre-college science competition, and every year includes more than 1,500 high school students from approximately 70 countries, regions, and territories. Awards include both the grand prizes, awarded in each of 17 different categories, and special awards, presented by more than 60 different professional and educational organizations. Projects in astronomy are judged in the category physics. The Bok prize is the only special award in astronomy. Currently the award is given annually to two students: a first (\$1,000) and second (\$500) place. The award is supported by a grant from the NSF to provide travel for three judges to the annual Intel fair, and support for the two winners to attend the AAS winter meeting. I've been one of three judges for six of the last eight years.

Since 2000, the Bok winners have included 17 young men and 9 young women, all between their sophomore and senior year in high school. In a typical year, there are about 100 projects in the category physics: in the past few years this category has included about 15 to 20 astronomy projects. The number of astronomy projects is a bit lower than 10 years ago, when the total number, as reported by the lead judge, was more than 30. Are fewer high school students choosing to do astronomy projects in recent times? This is a trend that bears watching.

Some Recent Award Winners

2012: *Piper Michelle Reid* of Dripping Springs, TX, "Photometric and Spectroscopic Analysis for the Determination of Physical Parameters of an Eclipsing Binary Star System."

2012: *Henry Wanjune Lin*, Shreveport, LA, "A Generalized Holographic Model of Cosmic Accelerated Expansion."

2009: *Caroline J. von Wurden*, Los Alamos, NM, "Determining the Orbital Elements of Minor Planet 23265."

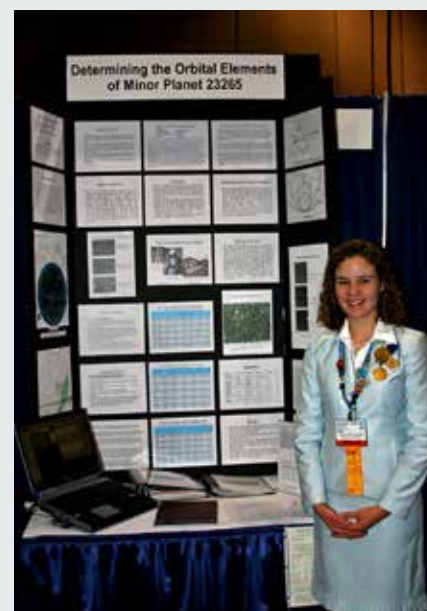
2007: *Temple Mu Troy*, MI, "Period Analysis of Cataclysmic Variable X10 and its Implication on the Origin of Low States."

2009: *Keith Austin Hawkins*, Canton, OH, "A Time-dependent Impact Parameter Model Sheds Light on the Evolution of Galaxy Morphology in Compact Clusters of Galaxies" (update: Keith has



Henry Wanjune Lin (2012)

Katy Garmany



Carolyn J. von Wurden (2009)

John Glaspey



completed two astronomy summer research programs while in college: NOAO and Hawaii).

2007: *Emily Brook Petroff*, Portland, OR, "Variation in Star Formation Rate From Galaxy Cluster Center for c11037."

2006: *Hsin Yu Chen*, Taipei, Taiwan, "Magic Mirror for Galaxy Clusters."

2006: *Philip Mocz*, Mililani, HA, "Group Analysis to Pattern Discovery in Stellar and Galactic Distributions."

2005: *Gabrielle Alyce Gianelli*, Orlando, Florida, "Fractal Dimension



Keith Austin Hawkins (2009)

John Glaspey

Analysis of Putative Martian Coastlines" (update: Gabrielle is now a software engineer at Etsy).

2005: *Anand M. Palaniappan*, Columbia, Missouri, "A New Algorithm for Multiple Hypothesis-based Tracking and Discovery of Potentially Hazardous Near Earth Objects."

2000: *Daniel Alan Perley*, Socorro High School, Socorro, New Mexico, "Dynamic Formation of Tidal Structure in Interacting Galaxies as Determined by Newtonian

Model Computer Simulations" (update: Daniel is now a graduate student at Berkeley, and a judge at the 2009 Intel ISEF). [\[RETURN\]](#)



Gabrielle Alyce Gianelli (2005)

Katy Gamary

Developing Leaders in STEM: Assessing Success to Make a Difference

by **Michael G. Gibbs** and **Dianne Veenstra**, Capitol College

Capitol College established a comprehensive outreach program engaging students through the Center for Space Science Education and Public Outreach. This is a summary report regarding the assessment of the science, technology, engineering, and math (STEM) outreach programs. Capitol College thanks the Maryland Space Grant Consortium for their continued support.

The STEM Leaders Program

The STEM Leaders Program was a spring 2012 semester-long educational effort consisting of high-impact science, technology, engineering and math (STEM) workshops to advance Capitol College undergraduate students, in particular women and traditionally underserved populations. The 2012 STEM Leaders Program consisted of two-hour workshops geared toward Capitol College undergraduate students in collaboration with Prince George's Community College. One of the program goals was to provide hands-on learning experiences. Based on recommendations received from prior STEM programs, a group of STEM Leaders (those who participated in prior years) had routine meetings in which they assisted with the planning and implementation of the program workshops (e.g. project management.) A total of 120 individuals

participated with the STEM workshops.

The 2012 program also included a VelcroSAT program. The Maryland Space Grant Consortium financially supported this program. Funding supported Capitol College undergraduate students studying:

- The feasibility of using one or more picosatellites (small 1-kg CubeSat) to tackle the orbital debris problem.
- Assess the feasibility regarding the removal of hazardous space debris on a collision course with spacecraft between 100 and 500 km from the surface of the Earth.

Workshop #1: Careers in Space Science

"The Colorful Moon: Exploring Mineralogy and Water/OH on the Lunar Surface" was presented by Dr. Rachel Klima from Johns Hopkins University Applied Physics Laboratory and discussed NASA missions Space Advancements. Dr. Klima discussed Lunar Moon technology specifications and various STEM occupational options. She also provided the audience with critical key information for obtaining college internships and entry-level opportunities at APL discussed immediately within lecture along with literature about other career opportunities.



Workshop #2: STEM Management

This workshop was presented with the Prince George's Community College students. Mr. Frank Culbertson, a former astronaut of NASA and currently Senior Vice-President of Orbital Sciences, lectured on "Program and Operations Management in the International Space Station Era" discussing his personal mission experiences with visual enhancements.

Dr. Dalia Bach Kirschbaum, Research Physical Scientist at NASA's Goddard Space Flight Center, presented a discussion on "NASA's Global Precipitation Measurement (GPM) Mission: Science, Technology, and Project Management." Dr. Kirschbaum discussed her expertise on STEM management and its relation to her specialty, which is advancing empirical and physical approaches to landslide modeling and forecasting using remote sensing information in relation to GPM missions.



Capitol College

Workshop #3: Cyber Awareness and Exploration

Dr. Jason Pittman, Capitol College faculty member, presented the workshop titled, "Emerging Cyber Security Trends — the Cloud and Beyond" and emphasized Cyber threats and awareness. This workshop was also combined with Prince George's Community College students. Dr. Pittman touched on the areas of Cyber Security management, data encryption review, risk management and analysis in cloud computing with practical solutions.

Workshop #4: Professional Career Workforce Development

This workshop was a collective effort of Capitol College faculty presenting the participants with concepts and information targeting professional development in the 21st-century employment industry. This workshop was also combined with the participants of Prince George's Community College and guests.

Workshop #5: Virtual Reality

This workshop, presented by Mr. Justin Brown, Deputy Program Manager for the Ground/Air Task Oriented Radar (G/ATOR) program at Northrop Grumman, was entitled "Soft Skills in Relation to Reality." It discussed identifying what soft skills are used in the workplace, the value of soft skills, and how to develop soft skills while in college and relate them to success in STEM fields.

Workshop #6: Putting it All Together

The final workshop was a recognition workshop honoring the participants that met the minimum requirements in attendance. There was a workshop held at Prince George's Community College with Dr. Anna Borovikov, a scientist for NOAA CPC. Dr. Borovikov presented a lecture on "My Journey: Mathematician working with climate data and Arabic manuscripts." She provided the participants detailed analysis of climate data on a global scale and incorporated her Arabic manuscripts within the lecture.

Assessment Information

- 95% of the participants rated the overall Emerging Stem Leaders Program workshop series with a 5 or above with the highest level being a 7.

- 90% of the participants rated the overall presentations regarding career opportunities in a STEM field with a 5 or above with the highest level being a 7.
- 90% of the participants rated the overall presentations provided regarding leadership with a 5 or above with the highest level being a 7.
- 100% of the participants would recommend the workshops to others if they were to be offered again.
- Requests for the upcoming workshops included: String Theory, Nuclear Power, Thermodynamics, Biotechnological fields, Computer Science, Cryptology, and Quantum Computing.
- Comments from the participants were as follows:
 - Great event, well organized.
 - I believe this program event can be really big when enough advertisement or marketing is made.
 - Record the events and upload to the Internet.
 - Awesome overall.
 - A lot of fun.
 - Keep the flame on. It's changing lives.

Demographics

- Females, 30, Males, 65.
- Ages ranged from 17 to 56.
- Average participant age was 21 years old.
- Out of the students that chose to respond to the race/ethnicity question, 90% were from an under-represented population. [\[RETURN\]](#)



Three Years After the IYA: An Update on the Galileoscope Project

by [Richard Tresch Fienberg](#) (AAS) and Douglas N. Arion (Carthage College)

What Is the Galileoscope?

The Galileoscope is a high-quality, low-cost telescope kit developed by a team of astronomers, optical engineers, and science educators for the 2009 International Year of Astronomy (IYA). It's a 50-mm (2-inch) diameter, 25- to 50-power achromatic refractor designed to be put together by students. Assembly takes only minutes and requires no tools, tape, or glue.



In contrast to other inexpensive telescope kits, the Galileoscope can be used effectively both in the classroom to investigate how lenses make images and outside under the stars as a tool for cosmic exploration. Even from brightly lit cities, with the Galileoscope anyone can see the celestial wonders that Galileo first glimpsed 400 years ago and that still delight stargazers today: lunar craters and mountains, four moons circling Jupiter, the phases of Venus, Saturn's rings, the Pleiades star cluster, sunspots (with a safe solar filter covering the aperture, of course), and more.

Sales to Date

To date nearly 190,000 Galileoscope kits have been delivered to recipients in 106 countries. About one-third of the units were sold via 30,000 small orders from individuals, and about two-thirds were sold via 500 large orders from institutions. More than 20,000 kits were donated to schools, some in the U.S. and some in poorer countries, chiefly in Africa and the Middle East.

Throughout the IYA kits were sold direct to individual and institutional customers via our website, priced in bulk at \$12.50 (later \$15.00) plus shipping, and individually at \$15 (later \$20) plus shipping. The prices are higher today, as noted on the next page, because of increased costs and the requirement from retailers that they get a markup (i.e., profit margin). Total sales to date have exceeded \$4.5 million.

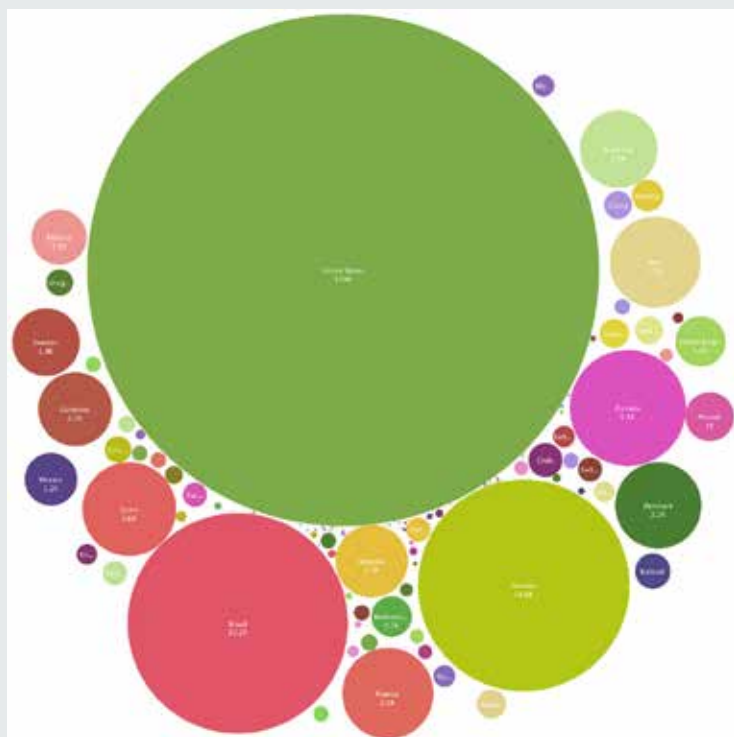
A Difficult Birth

Our team worked hard to develop, produce, and distribute Galileoscopes so that people everywhere can experience the thrill of observing the cosmos through a telescope that they will be proud to own and that offers superior optics and mechanics, as well as demonstrable educational value, at the lowest possible cost.

It wasn't easy, and it almost didn't happen. The global economic meltdown occurred during the peak of IYA planning. This doomed our original plan to finance the design and manufacture of the Galileoscope with donations and/or loans. We had to spend personal funds to produce tooling for the molds, and we had to collect advance order revenue to pay for the initial manufacturing run. Days before unveiling the Galileoscope website, we became embroiled in a trademark dispute that delayed the launch. And the lengthy period between receipt of the first orders and delivery of the first telescopes from our factory in China created a customer-service nightmare that our volunteer staff was ill-equipped to handle.

Still Here & Going Strong

Nevertheless, we did it. And three years after the IYA, the Galileoscope is still available (we currently have about 8,000 of them in





inventory). Sales of individual kits are now made through a growing network of retailers who typically charge from \$50 to \$60 per kit plus shipping. We continue to sell Galileoscopes in bulk (by the case, 6 kits per case) direct to EPO professionals via our website: <http://galileoscope.org>.

The bulk price is \$150 per case (\$25 per kit) plus shipping. This approach facilitates the continued use of the kits in formal and informal educational venues, where budgets are often tight.

Education & Activity Guides

Teaching materials developed for the Galileoscope are available for free. On our own website, we have two educational guides adapted from the Hands-On Optics educational program, courtesy of our partners at the National Optical Astronomy Observatory (NOAO). One is on optics and how refracting telescopes work, and the other is on observing with the Galileoscope.

Galileo's Classroom

Galileo's Classroom: Activities & Materials for Teaching Astronomy is a coherent set of educational materials that provide both content knowledge for classroom teachers and classroom-ready materials suitable for use with the Galileoscope in a variety of formal and informal settings. The activities have been selected from among thousands of available astronomy-related activities, based upon their utility in modeling Galileo's findings and on our current understanding of exemplary classroom practices. Each activity has been rewritten into the natural language of classroom teachers and has been field tested in schools. *Galileo's Classroom* is available in [PDF format online](#) from the CAPER Science and Mathematics Teaching Center at the University of Wyoming.

Teaching With Telescopes

[Teaching With Telescopes](#), a new website from the science educators at NOAO, is designed to help teachers bring small telescopes into the classroom. The program naturally focuses on the Galileoscope. On the Teaching With Telescopes website you'll find information

about the Galileoscope, extensive assembly directions, an observing guide, and classroom activities. Teachers can take an online course on using the Galileoscope and participate in the discussion forum.

Telescopes4Teachers

We have recently entered into a partnership with the Astrosphere New Media Association, a 501(c)(3) nonprofit organization dedicated to improving science literacy and education. Astrosphere has created the [Telescopes4Teachers](#) program, through which supporters in the U.S. can make tax-deductible donations of Galileoscopes to teachers and schools of their choosing. This is in response to numerous requests from teachers for donated telescopes, and to equally numerous requests from customers for a way to donate telescopes to their local schools.

U.S. teachers: To receive free Galileoscopes for your classroom, you'll need to find a donor or donors willing to contribute \$50 (1 kit) or \$200 (1 case of 6 kits) and to specify your school as the recipient. We do not maintain a list of educators seeking donations.

For those outside the U.S.: You can contribute any amount (not tax-deductible) toward the purchase of Galileoscopes to be shipped to underserved schools throughout the world. In partnership with the Galileo Teacher Training Program (GTTP) and the CosmoQuest citizen-science project, Astrosphere will identify teachers in financially struggling regions and provide them not only a case of Galileoscopes for their class, but also the training they need to teach astronomy effectively.

Whither Galileoscope?

To guarantee the long-term availability of the Galileoscope, we need to find a telescope or science-kit manufacturer willing and able to take over the project and fund another production run. We have met with numerous companies and organizations but have yet to find any takers. If you have ideas or suggestions, we're eager to hear them! (Please contact Rick Fienberg by clicking on his name at the start of this article.) In the meantime, we have enough inventory to fill orders at the current rate for another year or so. [\[RETURN\]](#)



Left: Young science enthusiasts looked through Galileoscopes at an outreach event in Flagstaff, Arizona, in 2011. (Courtesy S. Pompea, NOAO.)

Right: Educators learned how to assemble and use Galileoscopes at a GTTP workshop in Thailand in 2011. (Courtesy P. Pop, Thai Astronomical Society.)



Investigating Where Students Get Their Information About Science

by [Sanlyn Buxner](#), Chris Impey, Kitina Tijerino, and The Collaboration of Astronomy Teaching Scholars (CATS); all Steward Observatory, University of Arizona

Introduction

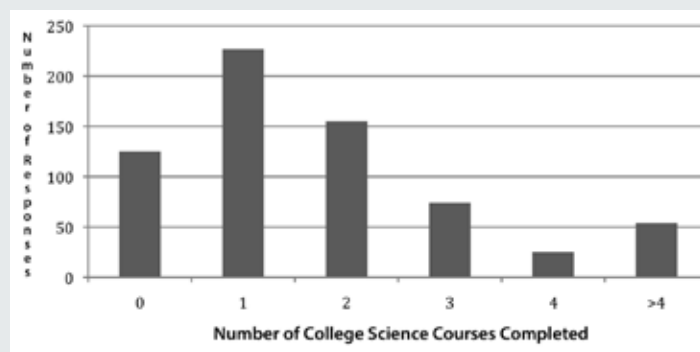
As educators and outreach professionals, we spend our careers trying to influence students' and the public's understandings about science as well as influence attitudes toward science and technology. The National Science Foundation is deeply invested in knowing more about where members of the public get their information about science and publishes its findings in the biennial National Science Board Report *Science and Engineering Indicators* (NSB, 2012). Little research has been conducted to investigate this topic with undergraduate non-science major students specifically. Aside from instructors' experience, little is known or documented about where students get information about science or what sources of information they find credible in informing their understandings about science.

The Survey

Data was collected through an online survey, which included both open-ended and forced choice questions asking students to report their interest, understanding and engagement in science and technology and STEM related activities. The survey was completed by 660 undergraduate students enrolled in introductory astronomy courses at the University of Arizona during the spring of 2012. 91% of participants were traditional college aged students (18-22 years of age), 44% were male and 56% were female.

Not surprisingly, completion of more college science courses was related to a stronger reported interest in science overall. Those who reported having completed four or more science courses also reported the greatest interest in science. Additionally, those who reported having completed more college science courses were more likely to report greater knowledge about science in general.

When asked how their interest in science has changed over time, 53% of students reported that it had increased, 36% reported that it stayed the same, and 12% reported that it had decreased since the middle of high school.



Sources of Science Knowledge

In their open-ended responses, a majority of respondents (58%) reported the Internet as the first place they used when they wanted to learn about a topic in science (8% mentioned Wikipedia specifically). Fewer (46%) students reported consulting knowledgeable people (professors, parents and friends) and less than 2% would look in a book. More than 70% of respondents reported getting most of their information about science online, 40% reported getting it from their courses, and 7% reported getting information from books and TV.

When asked to judge the importance of different resources in informing them about science, teachers were reported as the most important source (90%), followed by the Internet (80%), Wikipedia in particular (50%), TV shows (60%), books and magazines (50%), and science centers (50%). Scientists, professors and scientific journals were reported as the most reliable sources of scientific information. (The charted results appear on the next page.)

Future Work

We will be conducting individual interviews with students to gain greater insight into their understanding about science. Additionally we will pair their responses with how they answer the open-ended question: "What does it mean to study something scientifically?"

Acknowledgements

This material is based in part upon work supported by the National Science Foundation under Grant No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

We would also like to thank Michael Greene and the NASA JPL Exoplanet Exploration Program (ExEP) for the continued support of the research, professional development, and curriculum development efforts of the Center for Astronomy Education (CAE) and our broader CAE community. [RETURN](#)



How interested are you in:		Not at all interested	A little interested	Moderately interested	Very interested
Science in general (n=659)	N	236	196	150	78
	%	36%	30%	23%	12%
Technology in general (n=659)	N	22	120	285	232
	%	3%	18%	43%	35%
Astronomy (n=658)	N	35	139	274	210
	%	5%	21%	42%	32%
The Space Program (n=657)	N	70	193	233	161
	%	11%	29%	35%	24%
Computers and information technology (n=660)	N	95	199	233	133
	%	14%	30%	35%	20%
Physics (n=660)	N	236	196	150	78
	%	36%	30%	23%	12%
Biology (n=655)	N	156	265	168	66
	%	24%	40%	26%	10%
Chemistry (n=659)	N	233	250	137	39
	%	35%	38%	21%	6%
Geology (n=659)	N	194	257	165	43
	%	29%	39%	25%	7%
Environment Science (n=653)	N	130	248	203	72
	%	20%	38%	31%	11%

		Not at all	A little	Moderately	Very
How knowledgeable are you about science in general? (n=659)	N	11	191	399	58
	%	2%	29%	61%	9%
How well informed are you about recent scientific advances? (n=659)	N	79	327	217	36
	%	12%	50%	33%	6%
How important is science for your likely career path? (n=657)	N	184	236	146	91
	%	28%	36%	22%	14%

In the past year roughly how many times have you:	> 10 times	6-10 times	3-5 times	1-2 times	none
Been to a science center or museum, nature center, or planetarium (n=656)	41	73	146	288	108
	6%	11%	22%	44%	16%
Watched a science show on TV (n=657)	203	133	157	124	40
	31%	20%	24%	19%	6%
Watched a movie that was about science (n=655)	113	124	193	186	39
	17%	19%	30%	28%	6%
Read a science story in a printed newspaper or magazine (655)	104	110	201	183	57
	16%	17%	31%	28%	9%
Read a book (not a textbook) about science (n=655)	32	53	90	219	261
	5%	8%	14%	33%	40%
Read about science or watched a science video anywhere on the Internet (n=652)	196	143	156	136	21
	30%	22%	24%	21%	3%
Read about science on the Wikipedia web site (n=649)	177	126	154	129	63
	27%	19%	24%	20%	10%
Talked to a scientist or science teacher about a science topic of interest to you (n=656)	70	77	127	211	171
	11%	12%	19%	32%	26%



NASA's Space Forensics: Solving Cosmic Mysteries with Crime Scene Narratives

by [Sara Mitchell](#) (NASA GSFC) and Sarah Eyermann (Syneren Technologies)

Explosions, collisions, births, and deaths — the universe presents astronomers with an abundance of puzzles to analyze. Scientists are keen to solve the mysteries of these events and explore the origins, evolution, and mechanics of our universe. But these events may have happened millions or billions of years ago, and trillions of kilometers from Earth. The primary evidence astronomers can collect is electromagnetic radiation — light. The NASA Space Forensics project, funded by NASA's Physics of the Cosmos (PCOS) and Cosmic Origins (COR) projects, takes audiences through astronomy problem-solving narratives that parallel crime scene forensics. The “corpse” could be a massive star that ended its life in a brilliant supernova explosion. The “theft” might involve stellar material, swirling into an unseen singularity at the center of a galaxy.



Space Forensics is an expansion of a successful pilot teacher's workshop, which took teachers and students through the “crime scene” left after the supernova explosion of Cassiopeia A. Throughout 2012, we are developing several Space Forensics cases with educational activities and guides to accompany each narrative. Beginning in 2013, we will produce an interactive website to make these cases and activities available to wider audiences, challenging armchair crime-solvers to explore the mysteries of the universe. The Space Forensics project will allow teachers, students, and the public to engage in the science of PCOS/COR missions and interact with authentic data, imagery, and problem-solving techniques used by NASA scientists.

As Space Forensics cases and activities are developed, we will be assembling a network of formal and informal education partners to review and pilot test these resources. In addition, we are seeking partners for future Space Forensics cases — got a mystery for us?

Why Teach Space Forensics?

- Tells the story of doing science — science as a cycle of questions and answers.
- Shows the links between topics in science and technology instead of standalone concepts.
- Overlap of science, technology, engineering, and mathematics — plus history and language arts.
- Presents real science in the context of compelling human stories.

The Case of the Wanted Waves

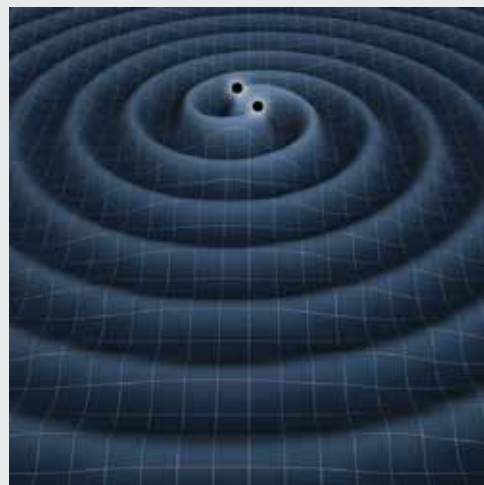
Just like real criminal cases, not all astronomical mysteries are solved the first time around. Some remain cold cases for years until new technology breaks the case. The search for gravitational waves

is one such case. First theorized in 1916, this enigmatic phenomenon is still at large. Astronomers have become bounty hunters, always looking for new breakthroughs in technology to help them in their search.

Forty years ago, crime scene technology was much more primitive than it is today. The crime scene specialists may have collected both fingerprints and blood from the scene, but at that time there was no extensive database of fingerprints, and no way to analyze DNA. As decades passed, resources such as a fingerprint database and DNA testing allowed cold cases to be reopened. Similarly, scientists have been looking for new technologies that will detect and analyze the hidden gravitational effects of objects throughout the universe.

The Case of the Galactic Kingpin

What if at the heart of our galaxy — the Milky Way — was a giant crime organization? We can see that many stars are involved, and they're very influential in the galactic community. We can observe many aspects of the group, and with the help of informants within the organization and a sketch artist, we



Artist's impression of gravitational waves from two orbiting black holes. Courtesy K. Thorne (Caltech)/T. Carnahan (NASA).



Artist's impression of a stellar-mass black hole. Courtesy ESA/NASA/Felix Mirabel.



can get a good sense of what the structure of the organization looks like. We can see that all these stars revolve around a central figure, but all attempts to observe the center of this organization — the kingpin — fail.

The identity of this galactic kingpin is a closely protected secret. No direct information is ever leaked. Everything we know has to be learned by indirect means. It takes a lot of influence to control such a large organization. Satellites perform surveillance, and we hope to intercept communications in the form of gravitational waves (once we have the technology to detect them). But who is this kingpin, how has he gained so many members, and what are they up to?

The Case of the Exploding Star

Ka-boom! Here today, gone tomorrow — astronomers have discovered that a star they've been watching for years has suddenly exploded. And it isn't the first time it's happened to a star, either. Is there a pattern? Who is the culprit?

Astronomers study the still-smoldering remains of the star with a variety of techniques, utilizing the light that can be collected from the star and the space around it. They can determine the approximate time of the star's death, and analyze the patterns in evidence left behind to find out more about how the star exploded and what its final moments were like.



The Cassiopeia A supernova remnant seen at X-ray, optical, and infrared wavelengths. X-ray courtesy NASA/CXC/SAO; optical courtesy NASA/STScI; infrared courtesy NASA/JPL-Caltech/Steward/O.Krause et al.

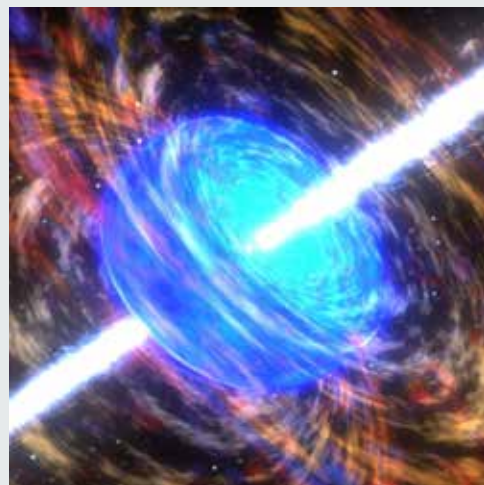
Comparing this star to cold cases of other stars that have exploded, astronomers look for common traits among the “victims.” Using the evidence collected, astronomers can determine whether these stars exploded due to natural causes — or whether something more sinister is at play.

The Case of the Fleeting Flashes

Something is setting off blinding flashes in the night sky, but astronomers haven't been able to catch the culprit! Surveillance catches a glimpse of these cosmic fireworks, but we're having trouble collecting enough evidence to know what's behind them. We're discovering that they're happening more often than we thought — but until scientists can collect more evidence, the investigation remains unsolved.

There's a break when improved surveillance catches a new bit of evidence — the flashes are followed by a lingering afterglow that

wasn't spotted during initial examination of each scene, providing an immense trove of information to analyze. Astronomers are still always on the chase, racing to the scene after a flash has been spotted and often just catching the afterglow...but they're getting closer. This case isn't closed yet — we've narrowed down the list of suspects, but we're still rushing to collect evidence from the scene of each event, hoping to get the clues that'll help identify the culprit.



Artist's impression of a gamma-ray burst destroying a star. Courtesy NASA/SkyWorks Digital.

How Can You Get Involved?

- Help us find pilot-testing sites for our first four cases! We'll be rolling these cases out throughout the fall and winter of this year.
- Share the science and technology of your mission, and help us accurately portray the real scientific process behind astronomical research.
- Do you have a mystery that would be a great fit for Space Forensics? We're always interested in hearing about prospective cases that could be a part of the next batch! To contact us, click on Sara Mitchell's name at the start of this paper. [\[RETURN\]](#)

ASP Annual Meeting: Ensuring STEM Literacy

July 20-24, 2013 • San Jose, CA

in partnership with San Jose State University

[Sign up to receive more information at the ASP website](#)





Introducing the AAS Astronomy Ambassadors Program

by [Suzanne Gurton](#) (ASP), Richard Tresch Fienberg (AAS), Andrew Fraknoi (ASP/Foothill College), and Edward Prather (CAE/Univ. of Arizona)

Introduction

The [American Astronomical Society](#) (AAS), in partnership with the [Astronomical Society of the Pacific](#) (ASP), members of the [Center for Astronomy Education](#) (CAE), and other organizations active in science education and public outreach (EPO), is creating a new program for young astronomers just starting their careers. The project involves a series of professional-development workshops and a community of practice designed to help improve participants' communication skills and effectiveness in doing outreach to students and the public. Called Astronomy Ambassadors, this new program will provide mentoring and training experiences for new members of our profession, from advanced undergraduates to post-docs, providing access to resources and a network of contacts within the astronomy EPO community.



Scene from an education workshop organized by the Center for Astronomy Education (CAE) at a recent AAS meeting.

By learning how to implement effective education and outreach strategies, Astronomy Ambassadors will become better teachers, better presenters at meetings, and better representatives of our science to the public and to government. And because young astronomers are a more diverse group than older ones who currently do the majority of outreach, they will help the astronomical community present a more multicultural and gender-balanced face to the public and enable members of underserved groups to see themselves as scientists.

Since "random acts of EPO" have been shown to have no lasting effect, the emphasis of the Astronomy Ambassadors program will be on helping participants set up ongoing, sustainable partnerships

with schools or other organizations. Wherever in their community they choose to do their outreach, Astronomy Ambassadors will be provided with a range of effective activities, templates, and resources. Rather than reinvent the wheel, we will start by using materials that the ASP, CAE, and other science organizations have already developed for their outreach programs. The library of outreach opportunities and materials will grow with time and the number of Ambassadors.

Putting a Face on Science

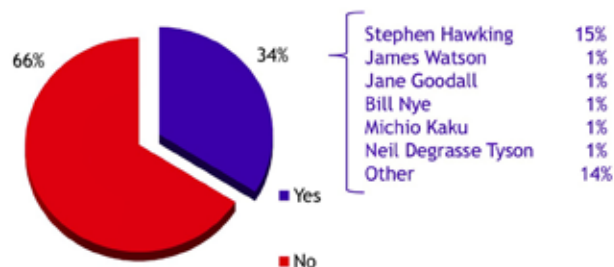
The Astronomy Ambassadors project was the brainchild of then-AAS President (now Past-President) Debra M. Elmegreen. Among other motivations, she was alarmed at the results of Research!America's 2009 "[Your Congress—Your Health](#)" poll, in which 66% of Americans said they couldn't name a living scientist and another 14% tried but failed, either naming dead scientists or nonscientists. In other words, only about 1 in 6 Americans can name a living scientist; undoubtedly, the fraction of our citizens who know a scientist *personally* must be far smaller. The AAS Council agreed with Elmegreen that we should take action to address this problem.

The AAS mission statement includes two key statements that explains why the Society is investing in communication and outreach training:

- "The Society, through its members, trains, mentors and supports the next generation of astronomers. The Society supports and promotes increased participation of historically underrepresented groups in astronomy."

Most Americans Can't Name a Living Scientist

Can you name a living scientist? (first volunteered responses)



Source: Your Congress - Your Health Survey, March 2011
Charlton Research Company for Research!America





- **“The Society assists its members to develop their skills in the fields of education and public outreach at all levels.** The Society promotes broad interest in astronomy, which enhances science literacy and leads many to careers in science and engineering.”

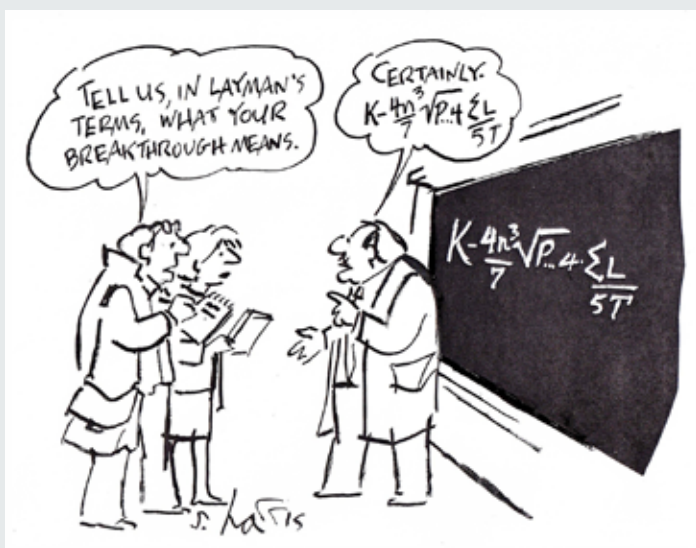
One of our goals is to put a young, enthusiastic, and diverse face on the science of astronomy. Accordingly, the primary candidates for Astronomy Ambassadors training are early-career AAS members: advanced undergraduates, graduate students, and first-time post docs.

We hope to include Ambassadors of both genders, from a variety of cultural backgrounds, from institutions large and small and urban and rural, and to encourage Ambassadors to seek out venues with diverse audiences.

In partnership with the AAS, the ASP has a goal of 25 to 30 participants for the first Astronomy Ambassadors workshop to be held at the [221st AAS meeting](#) in Long Beach, California, in January 2013.

Whom Will Ambassadors Serve?

The opportunities for outreach are many, both in and out of the classroom. Adults and family groups flock to community centers, science museums, planetariums, nature centers, national and regional parks, fairs and festivals, science-institution open houses, etc., where they can be engaged in science, technology, engineering and mathematics (STEM) activities. And students can be found not only in formal classrooms, but also in after-school programs and summer camps. The tools emphasized in the workshop will be most appropriate for the general public and middle- and high-school students.



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A Community of Practice

A new section on the AAS website will be dedicated to tools for, and communication among, Astronomy Ambassadors. Participants will become part of an online community that can exchange ideas, resources, and experiences through their own dedicated forum. The site will be populated with a menu of opportunities for doing outreach in Ambassadors' own communities as well as numerous age- and venue-appropriate hands-on resources.

As the program grows — as new cohorts of Ambassadors “graduate” from training and get involved with outreach — there will be an increasing number of participants in the online forums and more opportunities for sharing of successes and challenges and for group problem solving.

Workshop at AAS Long Beach

The workshop content will balance skill building with a deeper understanding of outreach. The website will have general tips for finding existing programs and materials for astronomy and science outreach, but the workshop will help participants learn how to identify specific opportunities in their own communities.



Workshop sessions also will assist young scientists in gaining a better understanding of how people learn and what makes outreach to nonscientists effective. By building on participants' existing communication skills and natural enthusiasm for science, workshop activities will build confidence in the participants for doing public outreach.

Evaluation Plan

Since the Long Beach workshop is a pilot, evaluation will be limited to the impact of the training and its tools on the participants, with additional information gathered to document the outreach that they do. Participants will log their activities, and those logs, along with follow-up interviews, will help gauge the impact of the Astronomy Ambassadors' outreach efforts. We'll also implement a set of pre- and post-workshop surveys, observations of the workshop, lunch-time focus groups with participants, and later telephone interviews with a subset of initial participants, all as part of a formative evaluation plan. These efforts will help refine our planning for future workshops.

How Can You Become Involved?

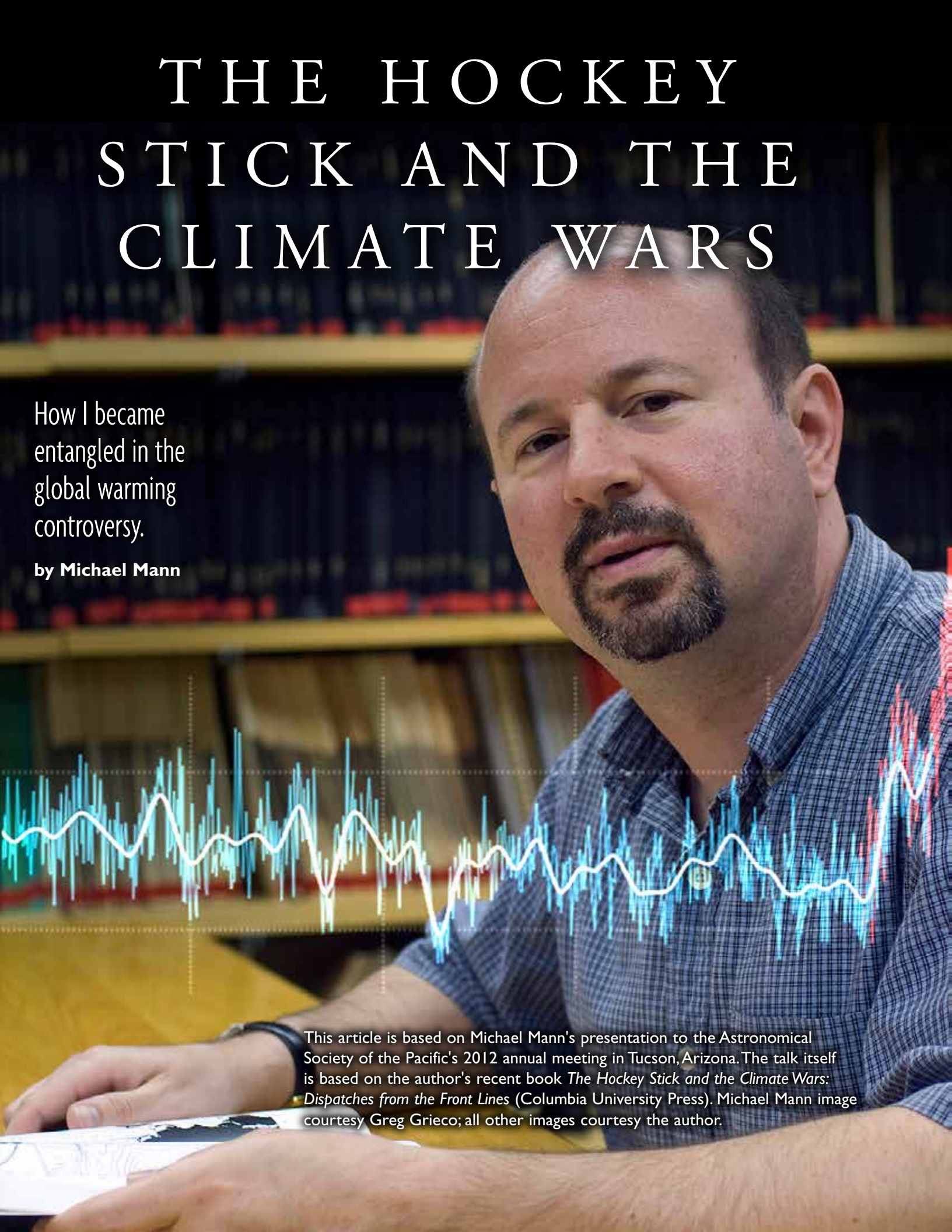
If you're part of our target audience to become an Astronomy Ambassador, watch the announcements from the AAS for the January 2013 meeting — they'll contain instructions for applying to attend the inaugural workshop. The AAS expects to provide successful applicants with modest travel stipends to help defray the cost of coming to Long Beach two days early to attend the workshop.

If you're an experienced EPO professional and are interested in contributing outreach materials or techniques that you have developed and that could be featured on the Astronomy Ambassadors website and/or our workshops, please contact [Suzanne Gurton](#), Education Manager at the ASP. [\[RETURN\]](#)

THE HOCKEY STICK AND THE CLIMATE WARS

How I became
entangled in the
global warming
controversy.

by Michael Mann



This article is based on Michael Mann's presentation to the Astronomical Society of the Pacific's 2012 annual meeting in Tucson, Arizona. The talk itself is based on the author's recent book *The Hockey Stick and the Climate Wars: Dispatches from the Front Lines* (Columbia University Press). Michael Mann image courtesy Greg Grieco; all other images courtesy the author.

As part of this presentation [to the ASP], I'd like to discuss my experiences as a reluctant and accidental public figure in the debate over human-caused climate change. But I'll start by simply pointing out that human-caused climate change is not controversial scientifically. The scientific case is relatively straightforward.

Two Centuries of Greenhouse Effect Science

The greenhouse effect is basic physics and chemistry that we've known for nearly two centuries. Early 19th-century scientists such as Joseph Fourier understood the existence of the greenhouse effect — the fact that certain gases have heat-absorbing properties, and that they warm a little part of Earth's atmosphere.

We know that we're increasing the concentration of greenhouse gases, CO₂ in particular, through fossil fuel burning. We can measure that buildup, and the concentration is now 392 parts per million (ppm). If we continue on the course we're on, we'll hit 450 ppm of CO₂ in the atmosphere within a matter of decades. I'll come back to this later, because 450 ppm is our best estimate of what level of CO₂ would likely commit us to a 2°C warming of the planet relative to pre-industrial times.

We can use ice cores to extend that record back in time so we know that today's CO₂ levels are higher than anything we've seen in at least 700,000 years. We can look at the isotopic composition of the CO₂ that's building up in the atmosphere and see in it the fingerprint of fossil fuel burning. The CO₂ buildup isn't natural; it's due to us.

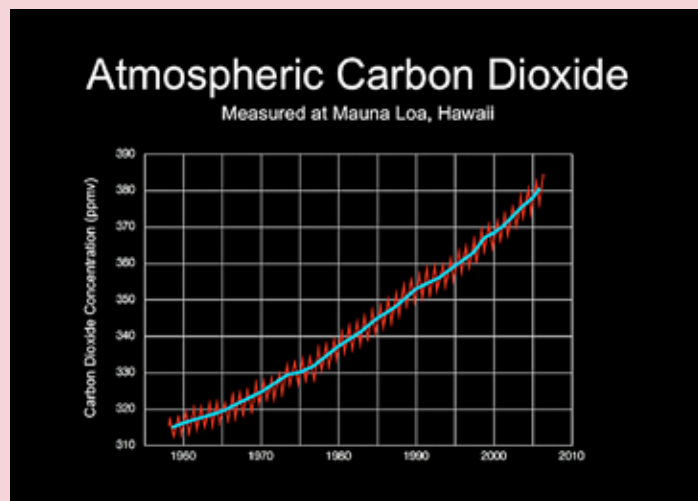
So we have nearly two-century-old physics and chemistry that tells us there's this greenhouse effect. We have irrefutable measurements that tell us we're increasing the greenhouse effect through fossil fuel burning and other activities. It would be remarkable if the planet *wasn't* warming. That would defy our understanding of basic physics and chemistry. But of course it is warming, and it has warmed a little less than 1°C in the last century.

The Deniers

I don't call the people who deny the reality of climate change "skeptics," because what they're doing isn't practicing skepticism. In my view, one-sided skepticism isn't skepticism; it's contrarianism or in its severest form, denial. But if you're a critic, you might say: "Well, I don't trust those thermometer measurements that tell us the planet has warmed up a degree."

If you don't trust those, you could throw them out entirely. There are dozens of other lines of evidence (*right*) that tell us the planet is warming and the climate is changing in much the way we expect it to as we increase greenhouse gas concentrations.

We will sometimes hear from the critics: "Well,

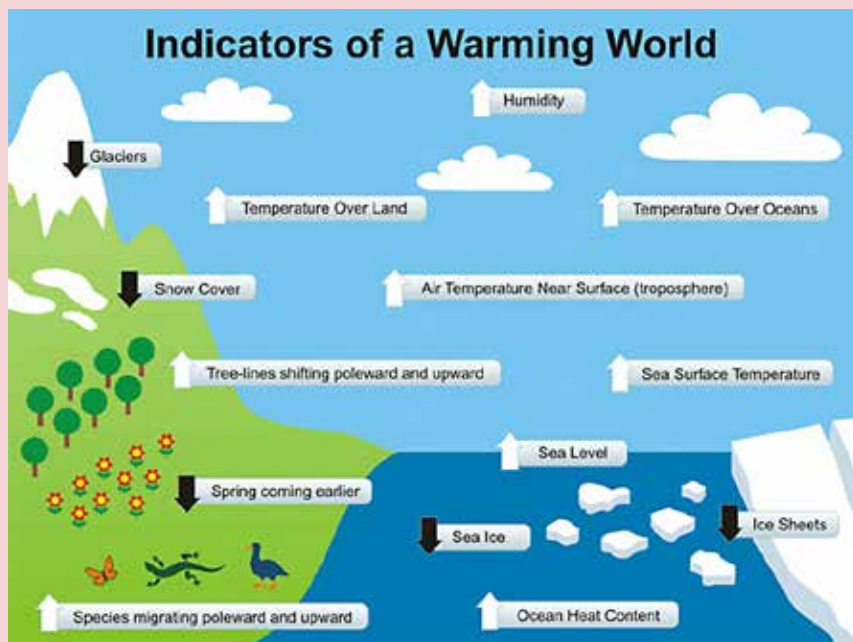


Carbon dioxide data (red curves) and the seasonally corrected data (blue line) as measured at Mauna Loa, Hawaii. While this chart ends in 2006, the level of atmospheric CO₂ has continued to climb; data to 2012 is available [here](#).

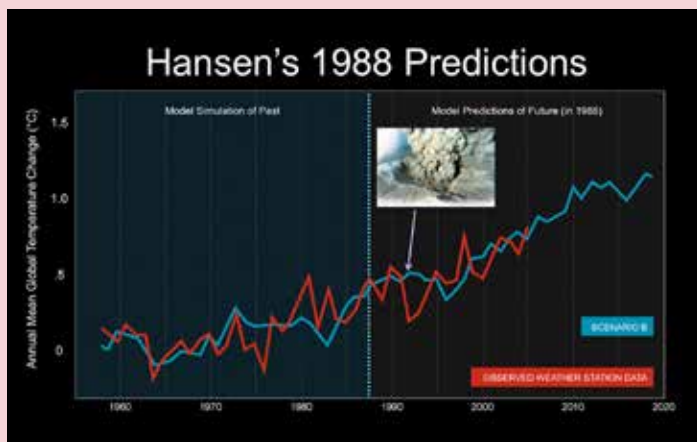
this is all based on these untested, speculative climate models." But nothing of what I've told you so far is based on climate models.

Critics are more than happy to rely on weather forecasts made from essentially the same models, but somehow, when it comes to climate, these models are unvalidated, untested, and unreliable. And even if that were true, it would still be the case that we know, with a great deal of confidence, that we are warming the planet by increasing greenhouse gas concentrations. That doesn't rely on climate models.

Of course we do use climate-change models. They are quite useful for asking certain questions or testing hypotheses. They represent a formalization of our best understanding of the underlying physics, chemistry, and biology that governs Earth's systems. They embrace our understanding of atmospheric physics; the fluid dynamics that governs the behavior of the oceans, atmosphere, and ice sheets; and the interactions with incoming and outgoing sources of radiation.



Even if we throw out all the land and ocean temperature measurements, there are still plenty of indicators telling us that the global temperature is rising.



Prediction is Hard

Danish physicist Niels Bohr once said: “Prediction is very difficult, especially if it’s about the future.” In 1986, James Hansen (NASA Goddard Institute for Space Studies) made a prediction. He took his climate model, one that was quite primitive by today’s standards, and subjected it to several possible future scenarios. He created three different simulations with different initial conditions, so they don’t show the same trajectory, but they all did a pretty good job of capturing the overall modest warming that had been seen to that time (*the line in red in the chart at the top of the page*).

Next he projected forward several decades, based on several possible assumptions as to what we would do. After all, predicting human behavior is probably the most complicated part of the problem, so he considered three different scenarios. The low scenario (pink line) shows what would happen if we tailed off our burning of fossil fuels fairly dramatically. A scenario where we dramatically accelerated our burning of fossil fuels is the high scenario (green line). And then there is the middle-of-the-road scenario (blue line).

Adjusting a Model

It turns out that the middle-of-the-road scenario corresponds more-or-less to the one we’ve actually pursued in our various practices that have led to increasing greenhouse gas concentrations. In the chart above, we see the prediction that Hansen made (in blue) for the scenario that it turns out we followed (red line). And more than two decades into the future from Hansen’s work, I would argue that’s a pretty darn good prediction.

Similar models have been used to make all sorts of predictions that have been validated. But this is perhaps the most impressive example of how these models aren’t untested.

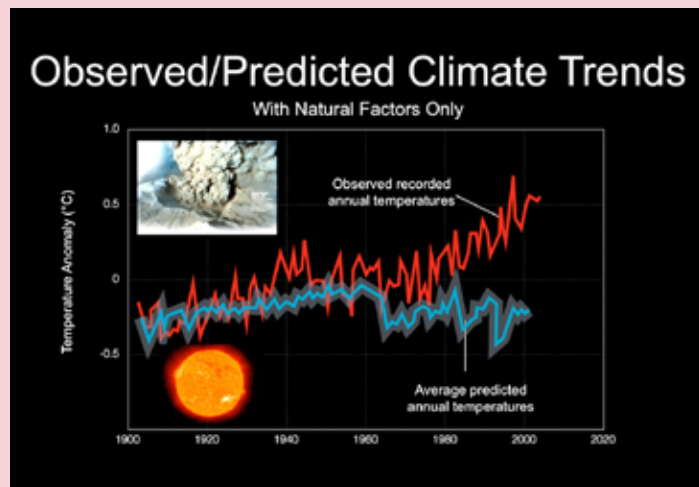
But if you’re a critic you might say: “Okay, you caught the overall warming, but what happened here? Look at that huge cooling dip in the chart. If your model is so good, how come it couldn’t predict something like that? It’s such a big signal.”

Of course Hansen didn’t know in 1988 that in 1991, Mount Pinatubo would erupt (*left, lower image*). It put large amounts of sulfate aerosols into the stratosphere where they reflected a certain amount of solar radiation back to space and cooled the planet for several years until they fell out of the atmosphere.

But what he did realize, as soon as Pinatubo went off, is that it would take about six months for that aerosol cloud to spread around the globe in the stratosphere and begin to have a really prominent radiative impact on the climate. So he had six months to put in the estimated aerosol loading associated with the eruption and run his climate model to see what it predicted. It turned out that the model predicted more-or-less what was seen — a $\frac{1}{2}^{\circ}\text{C}$ or so cooling for several years. So what might look like a problem with model predictions actually turned out to be another very successful test — using a model that’s primitive by today’s standards.

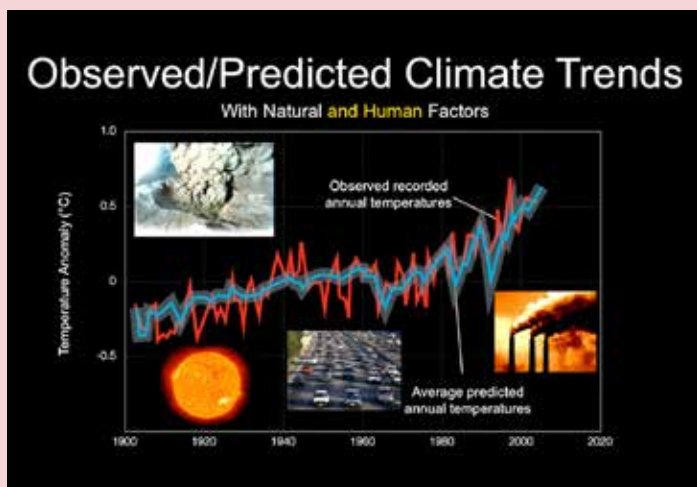
Is the Warming Human Caused?

Now let’s look again at that global temperature curve (*left*) and again, if you’re a critic, you might still say: “Well, maybe you could explain that warming with increasing greenhouse gases, but how do we know that’s the culprit? Maybe it’s something natural. Maybe it’s those volcanic eruptions that change the climate over time, or maybe it’s the measureable change in solar output — small, a fraction of a percent variation over timescales of a decade or longer, but maybe it’s those natural factors that are responsible for the warming.”



Well, we actually know, with some degree of precision, what the history of explosive volcanic radiative forcing of the climate has been throughout the past century. We have satellite records that tell us how solar output has changed during the past decades, and we have indirect information from things like sunspots that can be used to try to infer how solar radiance changed further back in time. So we can put these natural factors into the models, and maybe they’ll explain the warming.

Actually, no. In fact, if it were the natural factors alone that were at work, we would have expected a cooling during the past few decades (*above, blue line*). That’s because solar output has basically been flat. Also we’ve had a number of large volcanic eruptions that have a cooling effect, and if you put them together, the models predict a cooling. So the warming has happened in spite of a natural



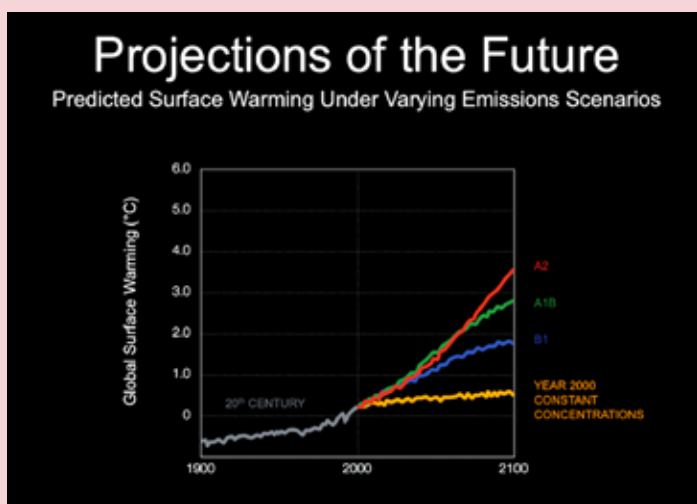
trend that should have been in the opposite direction.

In addition to greenhouse gases, there's another important anthropogenic forcing that has to do with coal burning and other industrial activities that put sulfate aerosols into the lower atmosphere. They don't stay for years but they're constantly produced. So in those regions of high industrial activity, there has actually been a modest cooling effect due to these anthropogenic aerosols. And that's our best explanation for why global temperatures experienced a stasis in the middle of the last century.

Slowing the Rise

So what about predictions? To some extent, we hold the future in our hands. If we had a magic switch that could turn instantly off fossil-fuel emissions and freeze the CO₂ concentrations at their current levels, then we would hold warming to well below 2°C.

If we froze CO₂ concentrations at their current levels, we would still get a warming of about ½°C or so (*below*). Why? Well, it turns out there's a certain amount of warming that's in the pipeline because of thermal inertia of the climate systems. The oceans are slowly absorbing a lot of the heat that they have received at the surface and will continue to do so for decades. So surface temperatures will continue to increase by a certain amount — we call that the



On this chart, the zero represents the end of the 20th century. Earth was at about -0.6°C at the beginning of the 20th century, and the temperatures up the left-hand side represent the warming relative to the end of the 20th century.

committed warming — and that gives us another ½°C. So we've warmed about 1°C since the start of the 20th century, and we've got another ½°C in the pipeline.

The European Union has defined, based on an assessment of climate change impacts, a 2°C warming of the planet relative to pre-industrial time as the limit beyond which we get into the danger zone — dangerous anthropogenic interference with the climate. That means we've got only about ½°C to work with if we're going to avoid reaching the 2°C limit that I talked about before. And we could do it if we could freeze CO₂ at the current levels. On the other hand, if we pursue even one of the relatively low fossil-fuel scenarios where we end up increasing CO₂ concentrations to only 550 ppm by the end of the century (that's twice pre-industrial levels), then we will most likely exceed that 2°C limit.

The Denier's Agenda

So if the science is this clear, and the impacts are this threatening, why has there been no action to combat climate change? To understand that, we need to delve into the politics of this issue and look at the fact that there are vested interests who profit greatly from our current reliance on fossil fuels and don't want to see that change. In many cases they have chosen to engage in a disinformation campaign to try to discredit the science linking our burning of fossil fuels to climate change.

In fact, their agenda was betrayed in a memo by Republican pollster Frank Luntz that was leaked in 2002. What he basically said was that the fossil-fuel industry needed to manufacture doubt and confusion among the public and convince the public that the science is grossly uncertain. The public was becoming increasingly convinced that human-caused climate change was real, and if they became convinced of the science, they would demand action of their policy makers. But according to Luntz, there was a narrow window of opportunity to reframe the discussion to emphasize uncertainty, debate, and controversy to try to cloud the public's understanding. And if this sounds familiar to you, it may be because this was the same tactic used by the tobacco industry decades ago to try to discredit the science linking the use of tobacco to human health issues.

Following the lead set by Luntz, powerful US Senators such as Republican James Inhofe made statements such as: "With all of the hysteria, all of the fear, all of the phony science, could it be that man-made global warming is the greatest hoax ever perpetrated on the American people? It sure sounds like it." [Senate Floor Statement by US Sen. James M. Inhofe (R-Okla) Chairman, Committee on Environment and Public Works, July 28, 2003.]

Now I'm giving this talk to a room full of scientists. You know that if we get two or three of us into a corner and we start talking about some scientific topic or issue in our field, it's unlikely that the three of us will agree on just about anything. Good-faith skepticism is the self-correcting machinery, as Carl Sagan liked to describe it, which leads science toward a better understanding of the way the world works. So the idea that thousands of scientists around the world could conspire to create this hoax of climate change, and somehow get the ice sheets and global temperatures and everything else to play along with the hoax is really quite remarkable.

A Long Look-back Time

So how, you might ask, did I get entangled in all of this? Back in the late 1990s, my coauthors and I were attempting to extend the temperature record back in time. As you know, we have only about a century of widespread thermometer measurements. We know the globe has warmed during that period of time, but with just 100

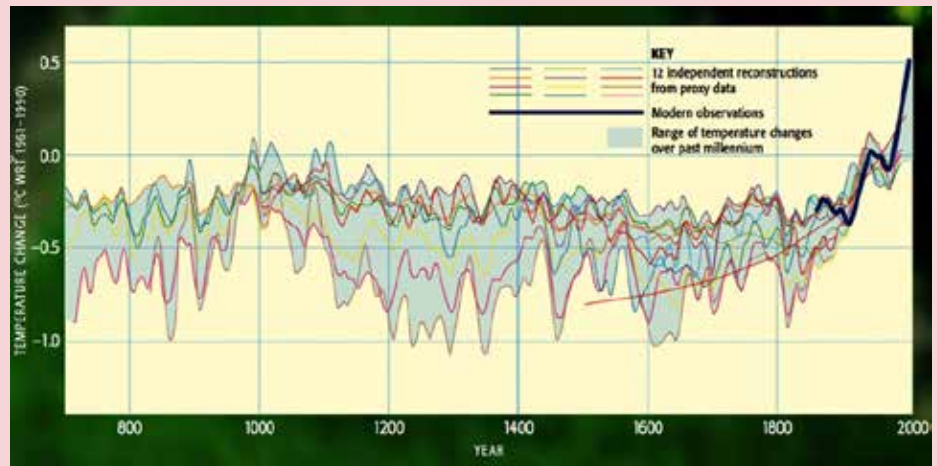
years of data, it's hard to say how unusual that sort of warming might be. Maybe it happens every few centuries or so.

One of the ways to try to frame our understanding of modern climate change is to place it in the context of climate changes over longer time frames. Unfortunately we don't have thermometers centuries back in time, so we have to turn to imperfect thermometers that we call proxy records, such as tree rings, corals, ice cores, and sediments that tell us how the climate changed in the distant past.

In the late 1990s my coauthors and I published reconstructions of temperatures based on these sorts of proxy data. The questions that drove this work actually had very little to do with climate change. We were interested in looking at how things like El Niño had changed in the past, the patterns of responses to large volcanic eruptions and what that could tell us about the dynamics of the climate system, and how things like volcanic eruptions could change phenomena like El Niño and the pattern of the jet stream.

It was almost as an afterthought that we did, what might be argued, the least interesting thing you can do with these spatial patterns and just averaged them to get a single number. So we averaged away all that interesting spatial information to get one number that, if plotted back in time, looks like this graph (*below*).

There's a fair amount of uncertainty here, though it's not visible. But one of the conclusions of this work — though it wasn't what we had set out to investigate — was that the recent warming really was unprecedented as far back as we could go. We said that the recent warmth was *likely* to have exceeded anything we have seen during the past 1,000 years. And "likely" had attached to it a probability of about 67 percent.



Twelve independent reconstructions from proxy data of temperature changes going back more than 1,000 years shows the same "Hockey Stick" curve that my colleagues and I noticed, along with the same conclusion: the recent warming is unprecedented.

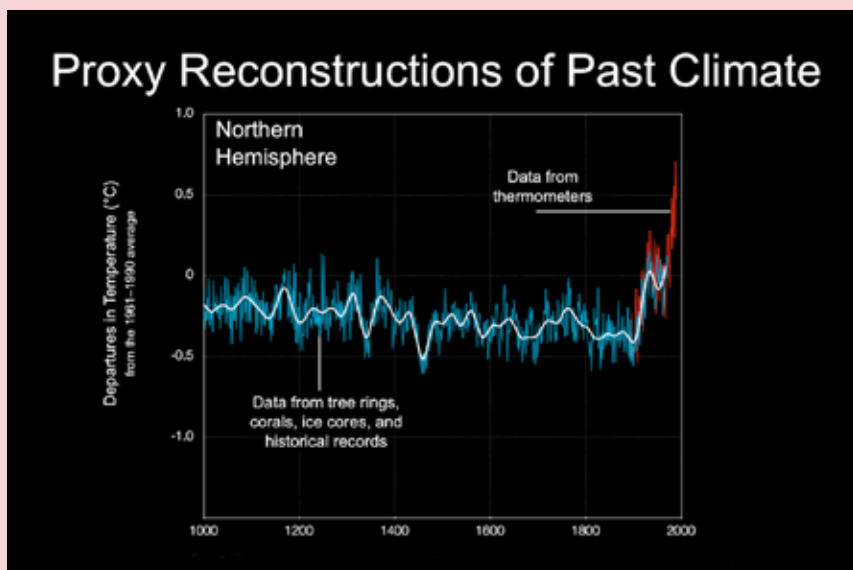
The Hockey Stick

The curve on the chart got a name from a colleague of mine, Jerry Mahlman from NOAA's Geophysical Fluid Dynamics Laboratory in Princeton. It was never meant to be a derogatory term, but it was simply describing the pattern. Moving from left to right on the chart below, we see 1,000 years ago relative warmth, which descends into the colder temperatures of the Little Ice Age (and then recovery) — think of that as a handle. Then there is the abrupt warming of the past century — think of that as a blade. Put them together and we get something that looks sort-of like a hockey stick. The curve was featured in the *Summary for Policy Makers* in the 2001 Third Assessment Report of the Intergovernmental Panel on Climate Change.

This curve that we almost accidentally produced suddenly became an icon in the climate-change debate, at a time when the critics were really ramping up their rhetoric and attacks against the science. I came into it right at that time, and my work became an icon in the climate-change debate. As happens to icons in such a debate, they get attacked.

It didn't matter that a decade later, there's no longer a hockey stick — there's a hockey league! There are literally dozens of different reconstructions (*above*) that have been done, using different types of data and different statistical methods. And they all come up with the same answer: the recent warming is unprecedented as far back as these reconstructions go, which is now actually more than 1,000 years. So this does appear to be a robust conclusion. It doesn't just depend on the "Mann Hockey Stick," as the deniers like to call it — according to them it's just that curve and me (they like to leave off my co-authors!), and all of our understanding of human-caused climate change rests precariously on this hockey stick.

It's a caricature of the science. The modus operandi among those looking to discredit the science is to create a straw man — to make it seem as though all of our scientific understanding rests not just on one body of work but one study by one scientist. If you can bring that study and that scientist down, then the entire case collapses like a house of cards. It's a very



Here it is: the infamous Hockey Stick graphic. Going back 1,000 years, the faint blue lines show our estimates of what temperatures looked like, and there's a whole lot of interesting stuff going on. The climate is very dynamic; the globe doesn't warm or cool uniformly from year to year. Source: *Climate Change 2001: The Scientific Basis*, Houghton, J.T. et al (eds), Cambridge University Press, Cambridge, 2001.



This is my daughter underneath a polar bear at the Pittsburgh Zoo, where you can walk through a Plexiglas tunnel that goes under the polar bear's feeding pool. If you happen to be involved in an NSF-funded climate change outreach program and you know the manager of the zoo, then you might be able to get him to throw the fish into the pool when your daughter's underneath!

cynical way of looking at it, but it's very important to understand that that's the way those looking to discredit the science see it.

A Point of Ethics

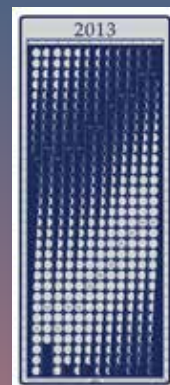
Finally, I want to end this with more of a personal note. So often climate change is framed as a scientific issue, a policy issue, or an economic issue. But to me, it's more a case of intergenerational ethics.

For instance, it's not just about polar bears and whether we're going to have Arctic sea ice and whether polar bears will still exist in the wild — it's what that represents. If we don't confront this problem quickly, then we are committing future generations to a fundamentally different and degraded planet. For me, that's a deeply ethical issue, and you can't just resolve it by framing it terms of cost-benefit analysis, because those who are going to receive the costs — our children and grandchildren — are not the ones who got the benefit of cheap energy in the first place.

So there's this intergenerational disparity as well as regional disparity. Many of those who are going to experience the most severe impacts of climate change — the low-lying island nations and the developing world where agriculture is already running into climate change impacts — had nothing to do with the creation of the problem in the first place. So this is really a matter of ethics as much as it is a matter of science and policy and economics, and that's the notion I'd like to leave you with. Thank you. [\[RETURN\]](#)

MICHAEL E. MANN is a member of the Penn State University faculty, holding joint positions in the Departments of Meteorology and Geosciences, and the Earth and Environmental Systems Institute. His research involves the use of theoretical models and observational data to better understand Earth's climate system. He shared the 2007 Nobel Peace Prize with other Intergovernmental Panel on Climate Change authors and is a co-founder of the award-winning science website RealClimate.org.

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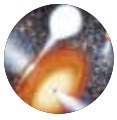
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Excerpts from recent press releases that describe an assortment of astronomical discoveries.

Link Between Cold European Winters and Solar Activity

Johannes Gutenberg University, Mainz, Germany

Scientists have long suspected that the Sun's 11-year cycle influences climate of certain regions on Earth. Yet records of average, seasonal temperatures do not date back far enough to confirm any patterns. Now, armed with a unique proxy, an international team of researchers shows that unusually cold winters in Central Europe are related to low solar activity — when sunspot numbers are minimal. The freezing of Germany's largest river, the Rhine, is the key.

"The advantage with studying the Rhine is because it's a very simple measurement," said Frank Sirocko, professor of Sedimentology and Paleoclimatology at the Institute of Geosciences of Johannes Gutenberg University in Mainz, Germany. "Freezing is special in that it's like an on-off mode.

Either there is ice or there is no ice."

From the early 19th through mid-20th centuries, riverboat men used the Rhine for cargo transport. And so docks along the river have annual records of when ice clogged the waterway and stymied shipping. Sirocko and his colleagues found that between 1780 and 1963, the Rhine froze in multiple places 14 different times. The sheer size of the river means it takes extremely cold temperatures to freeze over, making freezing episodes a good proxy for very cold winters in the region, Sirocko said.

Mapping the freezing episodes against



A frozen river with skaters. Oil painting by Esaias van de Velde (1619).

the solar activity's 11-year cycle, Sirocko and his colleagues determined that ten of the fourteen freezes occurred during years when the Sun had minimal sunspots.

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Arctic Sea Ice Hits Smallest Extent In Satellite Era

NASA / GFSC

The frozen cap of the Arctic Ocean appears to have reached its annual summertime minimum extent and broken a new record low on Sept. 16, the National Snow and Ice Data Center (NSIDC) has reported. Analysis of satellite data by NASA and the NASA-supported NSIDC at the University of Colorado in Boulder showed that the sea ice extent shrunk to 1.32 million square miles (3.41 million square kilometers).

The new record minimum measures almost 300,000 square miles less than the previous lowest extent in the satellite record, set in mid-September 2007, of 1.61 million square miles (4.17 million square kilometers). For comparison, the state of Texas measures around 268,600 square miles.

Arctic sea ice cover naturally grows during the dark Arctic winters and retreats when the Sun reappears in the spring. But the sea ice minimum summertime extent, which is normally reached in September, has been decreasing during the last three decades as Arctic Ocean and air tempera-

tures have increased. This year's minimum extent is approximately half the size of the average extent from 1979 to 2000. This year's minimum extent also marks the first time Arctic sea ice has dipped below 4 million square kilometers.

"Climate models have predicted a retreat of the Arctic sea ice; but the actual retreat has proven to be much more rapid than the predictions," said Claire Parkinson, a climate scientist at NASA Goddard Space Flight Center, Greenbelt, Md. "There continues to be considerable inter-annual variability in the sea ice cover, but the long-term retreat is quite apparent."

The thickness of the ice cover is also in decline. "The core of the ice cap is the

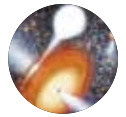


An image of the Arctic sea ice on September 16, 2012, the day the National Snow and Ice Data Center identified to be the minimum reached in 2012. The yellow outline shows the average sea ice minimum from 1979 through 2010.

perennial ice, which normally survived the summer because it was so thick," said Joey Comiso, senior scientist with NASA Goddard. "But because it's been thinning year after year, it has now become vulnerable to melt." [\[RETURN\]](#)

[➔ More information](#)

NASA / GFSC Scientific Visualization Studio



Opportunity Working at Matijevic Hill

NASA / JPL

NASA's Mars rover Opportunity, well into its ninth year on Mars, will work for the next several weeks or months at a site with some of the mission's most intriguing geological features.

The site, called "Matijevic Hill," overlooks 14-mile-wide Endeavour Crater. Opportunity has begun investigating the site's concentration of small spherical objects reminiscent of, but different from, the iron-rich spheres nicknamed "blueberries" at the rover's landing site nearly 22 driving miles ago.

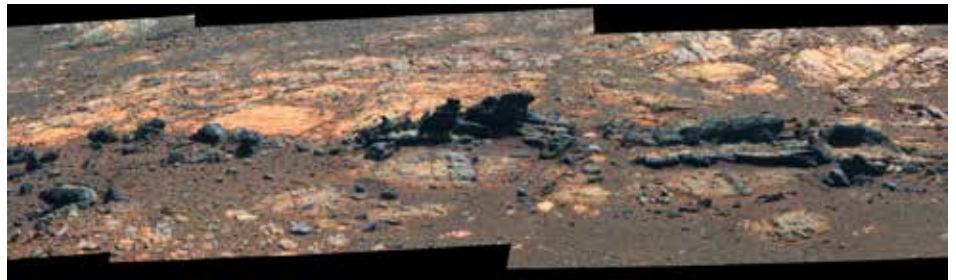
The small spheres at Matijevic Hill have different composition and internal structure. Opportunity's science team is evaluating a range of possibilities for how they formed. The spheres are up to about an eighth of an inch in diameter.

The "blueberries" found earlier are concretions formed by the action of mineral-laden water inside rocks, but that is only one of the ways nature can make small, rounded particles. One working hypothesis is that the newfound spherules are also concretions but with a different composition.

"Right now we have multiple working hypotheses, and each hypothesis makes cer-

tain predictions about things like what the spherules are made of and how they are distributed," said Opportunity's principal investigator, Steve Squyres, of Cornell University, Ithaca, N.Y. [\[RETURN\]](#)

 [More information](#)



Rock fins up to about one foot (30 centimeters) tall dominate this scene from the panoramic camera on NASA's Mars Exploration Rover Opportunity. The image is in false color to make some of the differences between materials easier to see.

NASA / JPL-Caltech / Cornell U. / Arizona State U.

Curiosity Finds Old Streambed on Mars

NASA / JPL

NASA's Curiosity rover mission has found evidence a stream once ran vigorously across the area on Mars where the rover is driving. There is earlier evidence for the presence of water on Mars, but this evidence — images of rocks containing ancient streambed gravels — is the first of its kind.

Scientists are studying the images of stones cemented into a layer of conglomerate rock. The sizes and shapes of stones offer clues to the speed and distance of a long-ago stream's flow.

"From the size of gravels it carried, we can interpret the water was moving about three feet per second, with a depth somewhere between ankle and hip deep," said Curiosity science co-investigator William Dietrich of the University of California, Berkeley. "Plenty of papers have been written about channels on Mars with many different hypotheses about the flows in them. This is the first time we're actually seeing water-transported gravel on Mars. This is a transition from speculation about the size

of streambed material to direct observation of it."

The finding site lies between the north rim of Gale Crater and the base of Mount Sharp, a mountain inside the crater. Earlier imaging of the region from Mars orbit allows for additional interpretation of the gravel-bearing conglomerate. The imagery shows an alluvial fan of material washed down from the rim, streaked by many apparent channels, sitting uphill of the finds.

The rounded shape of some stones in the conglomerate indicates long-distance transport from above the rim, where a channel named Peace Vallis feeds into the alluvial fan. The abundance of channels in the fan between the rim and conglomerate suggests flows continued or repeated over a long time, not just once or for a few years.

The discovery comes from examining two outcrops, called "Hottah" and "Link," with the telephoto capability of Curiosity's mast camera during the first 40 days after landing. [\[RETURN\]](#)

 [More information](#)



It may look like a broken sidewalk, but this geological feature on Mars is actually exposed bedrock made up of smaller fragments cemented together, or what geologists call a sedimentary conglomerate. Scientists theorize that the bedrock was disrupted in the past, giving it the titled angle.

NASA / JPL-Caltech / MSSS



astronomy in the news

Planet Found in Nearest Star System to Earth

European Southern Observatory

European astronomers have discovered a planet with about the mass of the Earth orbiting a star in the Alpha Centauri system — the nearest to Earth. It is also the lightest exoplanet ever discovered around a star like the Sun. The planet was detected using the HARPS instrument on the 3.6-metre telescope at ESO's La Silla Observatory.

Alpha Centauri is one of the brightest stars in the southern skies and is the nearest stellar system to our solar system — only 4.3 light-years away. It is actually a triple star — a system consisting of two stars similar to the Sun orbiting close to each other, designated Alpha Centauri A and B, and a more distant and faint red component known as Proxima Centauri.

"Our observations extended over more

than four years using the HARPS instrument and have revealed a tiny, but real, signal from a planet orbiting Alpha Centauri B every 3.2 days," says Xavier Dumusque (Geneva Observatory, Switzerland and Centro de Astrofísica da Universidade do Porto, Portugal). "It's an extraordinary discovery and it has pushed our technique to the limit!"

Alpha Centauri B is very similar to the Sun but slightly smaller and less bright. The newly discovered planet, with a mass of a little more than that of the Earth, is orbiting about six million kilometers away from the star, much closer than Mercury is to the Sun in the solar system. The orbit of the other bright component of the double star, Alpha Centauri A, keeps it hundreds of times further away, but it would still be a very brilliant object in the planet's skies. [\[RETURN\]](#)



ESO / L. Calçada

This artist's impression shows the planet orbiting the star Alpha Centauri B, a member of the triple star system. Alpha Centauri B is the most brilliant object in the sky; the other dazzling object is Alpha Centauri A.

[More information](#)

NASA's Kepler Discovers Multiple Planets Orbiting a Pair of Stars

NASA

Coming less than a year after the announcement of the first circumbinary planet, Kepler-16b, NASA's Kepler mission has discovered multiple transiting planets orbiting two suns for the first time. This system, known as a circumbinary planetary system, is 4,900 light-years from Earth in the constellation Cygnus.

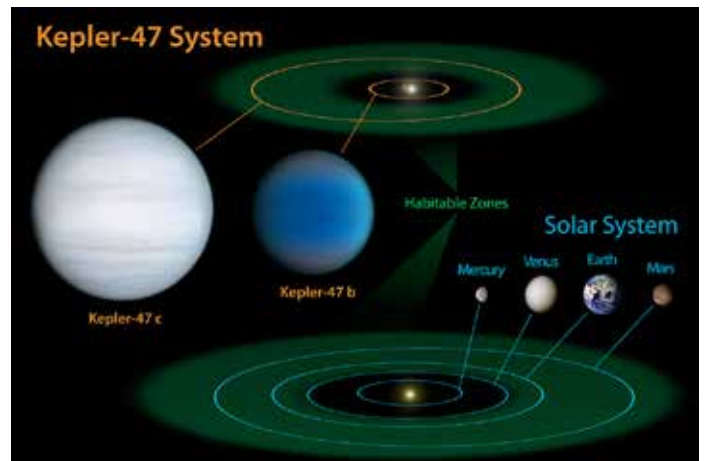
This discovery proves that more than one planet can form and persist in the stressful realm of a binary star and demonstrates the diversity of planetary systems in our galaxy.

Astronomers detected two planets in the Kepler-47 system, a pair of orbiting stars that eclipse each other every 7.5 days from our vantage point on Earth. One star is similar to the Sun in size, but only 84 percent as bright. The second star is diminutive, measuring only one-third the size of the Sun and less than 1 percent as bright.

The inner planet, Kepler-47b, orbits the pair of stars in less than 50 days. While it

cannot be directly viewed, it is thought to be a sweltering world, where the destruction of methane in its super-heated atmosphere might lead to a thick haze that could blanket the planet. At three times the radius of Earth, Kepler-47b is the smallest known transiting circumbinary planet.

The outer planet, Kepler-47c, orbits its host pair every 303 days, placing it in the so-called "habitable zone," the region in a planetary system where liquid water might exist on the surface of a planet. While not a world hospitable for life, Kepler-47c is thought to be a gaseous giant slightly larger than Neptune, where an atmosphere of thick bright water-vapor clouds might exist.



NASA / JPL-Caltech / T. Pyle

This diagram compares our own solar system to Kepler-47, a double-star system containing two planets, one orbiting in the so-called "habitable zone." This is the sweet spot in a planetary system where liquid water might exist on the surface of a planet. As the stars are smaller than our Sun, the systems habitable zone is closer in.

[More information](#)



Large Water Reservoirs at the Dawn of Stellar Birth

European Space Agency

ESA's Herschel space observatory has discovered enough water vapor to fill Earth's oceans more than 2000 times over, in a gas and dust cloud that is on the verge of collapsing into a new Sun-like star.

Stars form within cold, dark clouds of gas and dust — 'pre-stellar cores' — that contain all the ingredients to make solar systems like our own.

Water, essential to life on Earth, has previously been detected outside of our solar system as gas and ice coated onto tiny dust grains near sites of active star formation, and in proto-planetary discs capable of forming alien planetary systems.

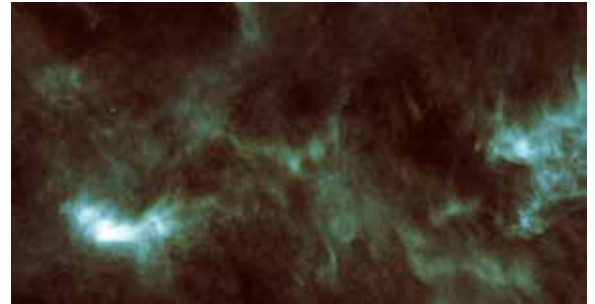
The new Herschel observations of a cold pre-stellar core in the constellation of Taurus known as Lynds 1544 are the first

detection of water vapor in a molecular cloud on the verge of star formation.

More than 2000 Earth oceans-worth of water vapor were detected, liberated from icy dust grains by high-energy cosmic rays passing through the cloud.

"To produce that amount of vapor, there must be a lot of water ice in the cloud, more than three million frozen Earth oceans' worth," says Paola Caselli from the University of Leeds, UK.

"Before our observations, the understanding was that all the water was frozen onto dust grains because it was too cold to be in the gas phase and so we could not measure it. "Now we will need to review our understanding of the chemical processes



ESA / Herschel / SPIRE

Herschel's infrared view of part of the Taurus Molecular Cloud, within which the bright, cold pre-stellar cloud L1544 can be seen at the lower left. It is surrounded by many other clouds of gas and dust of varying density.

in this dense region and, in particular, the importance of cosmic rays to maintain some amount of water vapor." [\[RETURN\]](#)

[More information](#)

New Observations Reveal the Secrets of a Dying Star

European Southern Observatory

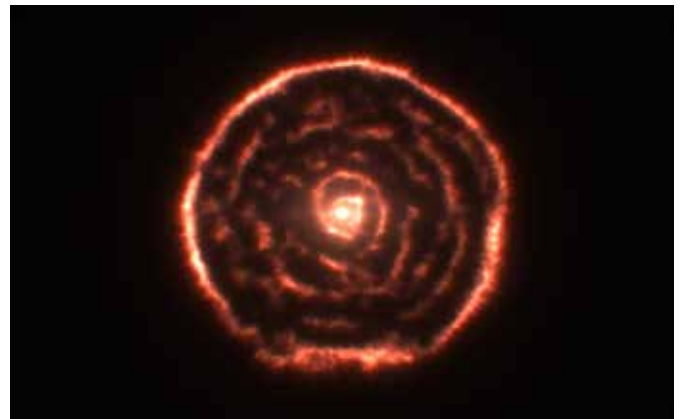
A team using the Atacama Large Millimeter/submillimeter Array (ALMA), the most powerful millimeter/submillimeter telescope in the world, has discovered a surprising spiral structure in the gas around the red giant star R Sculptoris. This means that there is probably a previously unseen companion star orbiting the star. The astronomers were also surprised to find that far more material than expected had been ejected by the red giant.

"We've seen shells around this kind of star before, but this is the first time we've ever seen a spiral of material coming out from a star, together with a surrounding shell," says Matthias Maercker (ESO and Argelander Institute for Astronomy, University of Bonn, Germany).

Because they blow out large amounts of material, red giants like R Sculptoris are major contributors to the dust and gas that provide the bulk of the raw materials for the formation of future generations of stars, planetary systems, and subsequently for life.

Late in their lives, stars with masses up to eight times that of the Sun become red giants and lose a large amount of their mass in a dense stellar wind. During the red giant stage stars also periodically undergo thermal pulses. These are short-lived phases of explosive helium burning in a shell around the stellar core. A thermal pulse leads to material being blown off the surface of the star at a much higher rate, resulting in the formation of a large shell of dust and gas around the star. After the pulse the rate at which the star loses mass falls again to its normal value.

Thermal pulses occur approximately every 10,000 to 50,000 years, and last only a few hundred years. The new observations of R Sculptoris show that it suffered a



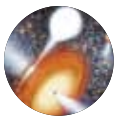
ALMA (ESO / NAOJ / NRAO)

Observations using ALMA have revealed an unexpected spiral structure in the material around the old star R Sculptoris. This slice through the new ALMA data reveals the shell around the star, which shows up as the outer circular ring, as well as a very clear spiral structure in the inner material.

thermal pulse event about 1800 years ago that lasted for about 200 years. The companion star shaped the wind from R Sculptoris into a spiral structure.

[\[RETURN\]](#)

[More information](#)



astronomy in the news

Cause of SN 1006 Revealed

University of Barcelona, Spain

Between April 30 and May 1 of 1006, the brightest stellar event ever recorded in history occurred: a supernova, or stellar explosion, that was widely observed by various civilizations from different places on the Earth. More than a thousand years later a team led by researchers from the University of Barcelona, the Instituto de Astrofísica de Canarias (IAC) and the CSIC has found that the supernova of 1006 (SN 1006) probably occurred as a result of the merger of two white dwarfs.

Different communities of astronomers all over the world observed the supernova of the year 1006. Some of them, including Chinese astronomers, highlighted the fact that the astronomical event was visible for three years. The most explicit record, made by the Egyptian doctor and astronomer Ali

ibn Ridwan (988-1061), notes that the phenomenon was about three times brighter than Venus, and it emitted light of a quantity equivalent to almost a quarter of the Moon's brightness.

As co-director of the work, Pilar Ruiz-Lapuente, a researcher at the Institute of Cosmos Sciences (ICCUB) explains, "In this work the existing stars in the area have been studied, regarding distance and possible contamination by elements of the supernova, and the results show that there is no star that could be considered the progenitor of this explosion".

IAC researcher Jonay González Hernández adds, "We have conducted an exhaustive exploration of the area around where the explosion of the supernova of 1006 occurred and have found nothing, which invites us to think that this event was probably the result of a collision



This is a composite image of the SN 1006 supernova remnant. Shown here are X-ray (blue), optical (yellow, orange, and light blue), and radio data (red). Credit: X-ray: NASA/CXC/Rutgers; Radio: NRAO/AUI/NSF/GBT/VLA; Optical: Middlebury College/NOAO/AURA/NSF/CTIO Schmidt & DSS.

and merger of two white dwarf stars of similar mass." [\[RETURN\]](#)

[➔ More information](#)

Surprising Black Hole Discovery Changes Picture of Globular Star Clusters

National Radio Astronomy Observatory

An unexpected discovery by astronomers using the National Science Foundation's Karl G. Jansky Very Large Array (VLA) is forcing scientists to rethink their understanding of the environment in globular star clusters, tight-knit collections containing hundreds of thousands of stars.

The astronomers used the VLA to study a globular cluster called Messier 22 (M22), a group of stars more than 10,000 light-years from Earth. They hoped to find evidence for a rare type of black hole in the cluster's center. They wanted to find what scientists call an intermediate-mass black hole, more massive than those a few or more times the Sun's mass, but smaller than the supermassive black holes found at the cores of galaxies.

"We didn't find what we were looking for, but instead found something very surprising — two smaller black holes," said Laura Chomiuk, of Michigan State University and the National Radio Astronomy

Observatory. "That's surprising because most theorists said there should be at most one black hole in the cluster," she added.

Black holes are left over after very massive stars have exploded as supernovae. In a globular cluster, many of these stellar-mass black holes probably were produced early in the cluster's 12-billion-year history as massive stars rapidly passed through their life cycles.

Simulations have indicated that these black holes would fall toward the center of the cluster, and then begin a violent gravitational dance with each other, in which all of them or perhaps all but a single one would



Artist's concept of black holes in a globular star cluster.

be thrown completely out of the cluster.

The two black holes discovered with the VLA were the first stellar-mass black holes to be found in any globular cluster in our Milky Way galaxy. [\[RETURN\]](#)

[➔ More information](#)



Ultra Distant Galaxy Spotted

Space Telescope Science Institute

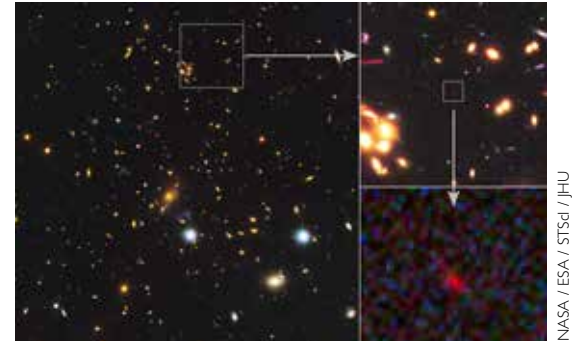
With the combined power of NASA's Spitzer and Hubble space telescopes, as well as a cosmic magnification effect, astronomers have spotted what could be the most distant galaxy ever seen. Light from the young galaxy captured by the orbiting observatories first shone when our 13.7-billion-year-old universe was just 500 million years old.

The far-off galaxy existed within an important era when the universe began to transit from the so-called cosmic dark ages. During this period, the universe went from a dark, starless expanse to a recognizable cosmos full of galaxies. The discovery of the faint, small galaxy opens a window onto the deepest, most remote epochs of cosmic history.

"This galaxy is the most distant object

we have ever observed with high confidence," said Wei Zheng, a principal research scientist in the department of physics and astronomy at Johns Hopkins University in Baltimore. "Future work involving this galaxy, as well as others like it that we hope to find, will allow us to study the universe's earliest objects and how the dark ages ended."

Light from the primordial galaxy traveled approximately 13.2 billion light-years before reaching NASA's telescopes. In other words, the starlight snagged by Hubble and Spitzer left the galaxy when the universe was just 3.6 percent of its present age. Technically speaking, the galaxy has a redshift, or "z," of 9.6. The term redshift refers to how much an object's light has shifted into longer wavelengths as a



NASA / ESA / STScI / JHU

In the big image at left, the many galaxies of a massive cluster called **MACS J1149+2223** dominate the scene. At upper right, a partial zoom-in shows **MACS 1149-JD** in more detail, and a deeper zoom appears to the lower right. In these visible and infrared light images from Hubble, **MACS 1149-JD** looks like a dim, red speck.

result of the expansion of the universe. Astronomers use redshift to describe cosmic distances. [\[RETURN\]](#)

[➔ More information](#)

Climbing the Cosmic Distance Ladder

NASA / JPL

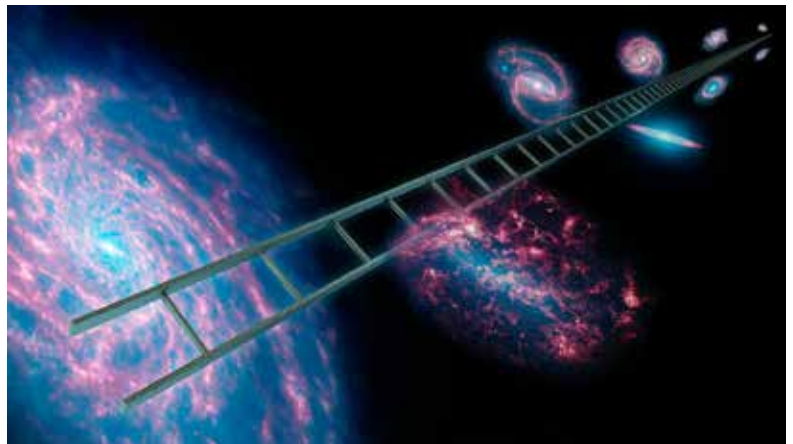
Astronomers using NASA's Spitzer Space Telescope have announced one of the most precise measurements yet of the Hubble constant, or the rate at which our universe is stretching apart.

The Hubble constant is named after the astronomer Edwin P. Hubble, who astonished the world in the 1920s by confirming our universe has been expanding since it exploded into being 13.7 billion years ago. In the late 1990s, astronomers discovered the expansion is accelerating, or speeding up, over time. Determining the expansion rate is critical for understanding the age and size of the universe.

Unlike NASA's Hubble Space Telescope that views the cosmos in visible and short-wavelength infrared light, Spitzer took advantage of long-wavelength infrared light for its latest Hubble constant measurement of 74.3 kilometers per second per megaparsec. A megaparsec is roughly three million light-years. This finding agrees with an independent supernovae study conducted

last year by researchers primarily based at the Space Telescope Science Institute in Baltimore, Md., and improves by a factor of three on a seminal 2001 Hubble Space Telescope study using a similar technique as the current study.

"This is a huge puzzle," said the lead author of the new study, Wendy Freedman of the Observatories of the Carnegie Institution for Science in Pasadena. "It's exciting that we were able to use Spitzer to tackle fundamental problems in cosmology: the precise rate at which the universe is



NASA / JPL-Caltech

Astronomers using NASA's Spitzer Space Telescope have greatly improved the cosmic distance ladder used to measure the expansion rate of the universe, as well as its size and age. The cosmic distance ladder, symbolically shown here in this artist's concept, is a series of stars and other objects within galaxies that have known distances.

expanding at the current time, as well as measuring the amount of dark energy in the universe from another angle." [\[RETURN\]](#)

[➔ More information](#)



News and information for Society members.

Meet Your New Board Members

The following individuals were recently elected to the ASP's Board of Directors for a three-year term.

William Cochran is a Senior Research Scientist with McDonald Observatory of The University of Texas at Austin. He received his PhD in astrophysics from Princeton University. His astronomical research has focused on searching for and characterizing extrasolar planets. He is a Co-Investigator on the NASA Kepler Mission, and has been involved in the Kepler project since its inception in the early 1990s. He was elected Chair of the Division for Planetary Science of the American Astronomical Society in 2003, and has also served on numerous NASA and National Research Council committees including the Committee on Planetary and Lunar Exploration (COMPLEX).

In recent years he has become increasingly active in educational and public outreach activities. For example, in 2010 and 2011 he worked with Prof. David Slavsky of the Loyola University Center for Science and Math Education on an intensive month-long summer program in astronomy for students and teachers in the Chicago Public Schools. This program used data from the NASA Kepler spacecraft to give the students and teachers unique insights into the nature of NASA data and what it tells us about our world and beyond. He has also been very active in obtaining Education/Public Outreach supplements to NASA research grants, and has used these to help support the McDonald Observatory [“What Are Astronomers Doing?” website](#) and summer teacher workshops at McDonald Observatory.

Noelle Filippenko has held positions as the VP of Operations, Director of Meeting & Incentives, and Director of Marketing for an established international planning company. Clients have included Google, Microsoft, Apple, and Oprah, as well as numerous nonprofits. She has been advising organizations with strategic planning in marketing, fundraising, partner collaboration, and membership retention and expansion for more than 25 years. She has served four years as a VP on the Board of the Northern California Chapter of the International Special Events Society, and was one of the first in the hospitality industry to earn both a CMM (Certified Meetings Manager – Director Level) and a CMP (Certified Meeting Professional).

She joined the ASP in 2000 and has attended five of their conferences. She assisted in the design, budgeting, planning, and operations of two of them; each successfully achieved its marketing and financial goals. She has also worked with the ASP's outreach to arrange for hands-on activities and star parties for children with special needs. Understanding membership and attendees' interests is a priority. In 2010, she coordinated a sold-out event for The Planetary Society and the Chabot Space & Science Center that sought to increase visibility and outreach for both groups. The evening also featured an Astro Expo with involvement from the ASP, SETI, Kepler, SOFIA, AANC, and others. This type of alliance is essential in bringing together science organizations to better serve their membership and conduct public outreach. She has been Co-Chair for the gala opening of the Bill Nye Climate Lab at Chabot, is

involved with SETIcon II, and will assist in the opening of the Exploratorium in 2013. She has a passion for connecting the individual to the organization, by increasing their participation and support of the organization's vision.

Christine Jones is the Director of the Smithsonian Institution Consortium for Unlocking the Mysteries of the Universe, a Senior Astrophysicist at the Center for Astrophysics, and a Lecturer in the Harvard Astronomy Department. Her research interests are focused on understanding the formation and evolution of galaxies and clusters of galaxies and the roles that supermassive black holes play in galaxy evolution.

Jones received her undergraduate and graduate degrees in astronomy from Harvard and was a Harvard Junior Fellow before joining the Smithsonian. She has more than 200 refereed publications. In recognition of her research and contributions to NASA X-ray emissions, she was awarded the Ninner Meteorite Award, the Bart J. Bok Prize, the Bruno Rossi Prize and the Marcel Grossmann Prize, as well as seven NASA awards and medals. She is a Fellow of the American Association for the Advancement of Science and an Honorary Fellow of the Royal Astronomical Society. Jones has served twice on the Council of the American Astronomical Society, first as a Councilor and recently as Vice-President. She is currently the President of Division XI Space and High Energy Astrophysics for the International Astronomical Union. Recognizing the need to help educate both students of all ages and the public, Jones worked to develop [“Everyday Classroom Tools”](#) science curriculum materials for elementary grades, a multi-wavelength slide set of the full sky that was available through the ASP, and a video workshop for K-5 teachers “Shedding Light on Science” produced by the Annenberg Foundation. She also serves as an AAS Shapley Lecturer. Finally, for more than 15 years, she has been director of the NSF supported Research Experiences for Undergraduates program, which brings interns to the Center for Astrophysics to carry out ten weeks of astronomical research.

Chris Ford is RenderMan Business Director at Pixar Animation Studios, whose photorealistic rendering software technology is used to create the stunning visuals in the majority of today's visual effects and animation feature films. As a Product Manager, Chris has also been responsible for many of the most notable computer graphics (CG) software tools used in contemporary feature film production, broadcast, game development, and cinematic-quality astronomical visualization. Prior to Pixar, he was Director of Product Management at Autodesk for all CG entertainment software (between 2002 and 2005), and between 1997 and 2002 Senior Product Manager at Alias|Wavefront (Silicon Graphics) for Maya, the world's dominant professional digital media content creation application. Software solutions managed by Chris have received two Academy Awards for technological innovation, and he is credited in seven feature films. A long-time amateur astronomer, Chris is both a visual observer and an astrophotographer with a specific interest in applying contemporary media production technologies to visualizing astronomical data in the cause of public outreach. Chris is currently President of the Mount Diablo Astronomical Society.



2012 Fall Fund Drive

From the desk of James Manning, Executive Director, Astronomical Society of the Pacific:

Dear Friend of the ASP:

What would life and learning be like without the stars? They inspire us, and they help us to understand this world and the worlds around us. At the Astronomical Society of the Pacific (ASP), we leverage this inspiration to advance science and science literacy. I'm writing to ask for your support in helping us deliver on our mission.

Every day, the ASP works with people across the country to bring our mission to life. Consider, for example, the story of Anne Wilson, park ranger at Agate Fossil Beds National Monument near Harrison, Nebraska. Prior to 2010 and Anne's participation in the ASP's Astronomy from the Ground Up (AFGU) workshop, the park had no astronomy program. But now, using the training and materials she received and continues to augment via ASP's AFGU "Sky Rangers" companion program, Anne incorporates astronomy into her outdoor interpretation. The Monument boasts a telescope, regular star parties, and interactive sky programs to the delight of its visitors, including families and school children. Anne even finds time to conduct popular astronomy programs at neighboring parks.

You can download the PDF of Jim's complete message [here](#).

P.S. Astronomy is the gateway to science literacy; your donation will help inspire the next generation as they look to the stars. Please give a gift today!



LEGACY GIVING

Astronomy compels the soul to look upwards and leads us from this world to another
— Plato

Leave a universal legacy...

Astronomy shows us that we are part of something much greater than ourselves, and that our actions on Earth have a lasting impact. A legacy gift to the ASP as part of your estate plan reflects this understanding, and will support future generations as they reach for the stars.

astrosociety.org/donate
or (415) 337-1100 x106

ASP Annual Awards: Call for Nominations

The Astronomical Society of the Pacific honors special accomplishments in astronomy research, technology, education, and public outreach by giving eight annual awards. Nominations are open for the 2013 Awards. Nominations for these Awards (excluding the Catherine Wolfe Bruce Medal) may come from ASP members and members of the astronomical community. Descriptions of the awards and links to the nomination pages are listed [here](#). The deadline for nominations is January 1, 2013.

Save the Date

Even as you read about the 2012 Tucson conference elsewhere in this issue of *Mercury*, we are excited to announce that our next conference, celebrating our **125th Annual Meeting**, will be held in San Jose, CA — the nation's center of gravity for STEM literacy and industry. The conference will run from **July 20 to 24, 2013**, with the theme "Ensuring STEM Literacy."

We also wish to thank San Jose State University for their support of our **2013 Cosmos in the Classroom** conference, which will run in conjunction with our Annual Meeting.

You can sign up [here](#) for more information and updates as they become available.

NEW MEMBERS — The ASP welcomes new members who joined between July 1 and September 30, 2012.

Technical Membership

Duane A. Dedrickson, Springfield, OR
Roy Kilgard, West Hartford, CT
Whit Ludington, Elizabeth City, NC
Joseph Round, APO, AP

General Membership

Jeff Adkins, Antioch, CA
Linda M. Alviti, Alhambra, CA
Tony Berendsen, Reno, NV
James M. Burke, San Francisco, CA
Tracy Carvajal, Deltona, FL
Whitney H. Cobb, Englewood, CO
David Crown, Tucson, AZ
Ross A. Dubois, Tucson, AZ
Michael P. P. Finerty, Tucson, AZ
Miriam Fuchs, San Francisco, CA
Sandy L. Gottstein, Anchorage, AK
James L. Green, Silver Spring, MD
Sally A. Harper, Honolulu, HI
Patricia Higgins, Frankfort, KY
Terrance Hourihan, Gaithersburg, MD
Inese I. Ivans, Salt Lake City, UT
Heather Jones, Diamond Bar, CA
Ashish Joshi, San Mateo, CA
Eduard Kuznetsov, Ekaterinburg, Russia

Henry W. Lin, Shreveport, LA
Robert Martino, Tucson, AZ
Charles Miller, Las Cruces, NM
Kathleen T. Morrison, Novato, CA
Leslie W. Proudfoot, Santa Clara, CA
Piper M. Reid, Austin, TX
Sara G. Roberts, Cardiff, United Kingdom
Paola Rocamora Sila, Santiago, Chile
Susan R. Rolke, Fitzwilliam, NH
Cia Romano, Tucson, AZ
Jude S. Sabato, Buffalo, NY
Robert Schultz, Santa Rosa, CA
Juan Seguel, La Serena, Chile
Arfon Smith, Chicago, IL
Rachel Smith, Raleigh, NC
Tim Spuck, Shipperville, PA
Laura N. Stewart, Delta, BC, Canada
Christopher B. Stringer, Salt Lake City, UT
Stewart Tait, Balgownie, NSW, Australia
Hao Thai, Stanford, CA
Sheila Tobias, Tucson, AZ
Sybil B. Vasche, San Jose, CA
Richard J. Zagozeski, Pense, SK, Canada

Family Membership

Hector L. Rodriguez, Morovis, Puerto Rico



sky sights

by Paul Deans

The Skies of November

- [Go to Sky & Telescope's November 2012 Sky Chart](#)
- [How to use S&T's Interactive Sky Chart](#)

Please note that S&T's Interactive Sky Chart does not work on the iPad. I suggest iPad users download the SkySafari 3 app (through iTunes). Here is a [review](#). If ASP iPad users have another favorite, tell me about it.

This month, only one planet is visible in the western sky at twilight. **Mars** hovers low in the southwest at dusk, setting about two hours after the Sun. The crescent Moon passes by the dim red planet on the 15th and 16th.

As Mars sets, giant **Jupiter** rises in the east-northeast. Opposition is early next month, so Jupiter is visible pretty much all night long for the next three months. Make the most of this late autumn viewing opportunity, before the cold weather sets in. The Moon visits this giant world twice this month — on the 1st and 28th. On each evening Jupiter sits above the Moon as both rise; on the 28th, the Moon is full.

During the last week of the month, **Mercury** pops up about an hour before the Sun and is visible the east-southeast at dawn, but this planet is better seen early next month.

Venus is bright but low in the east-southeast at dawn. On the

11th, the brilliant planet is to the upper left of the crescent Moon; Spica is to the Moon's lower left. The next morning, **Saturn** is immediately left of the thin lunar crescent.

On the mornings of the 16th to 18th inclusive, watch Venus slide past Spica — the dimmer star is about 4° to the right of the bright planet. But this is just a warm-up for a more interesting planetary gathering. On the mornings of the 26th and 27th, Venus and Saturn are a mere ¾° apart. Make sure you have a peek through a telescope; it's rare to have two planets in the same telescopic field of view.

Finally, the morning of November 14 will see thousands of eclipse chasers in northeastern Australia and on ships off the continent's northeast coast hoping for clear skies as a **total eclipse of the Sun** passes their way. None of this eclipse is visible from North America.

The Skies of December

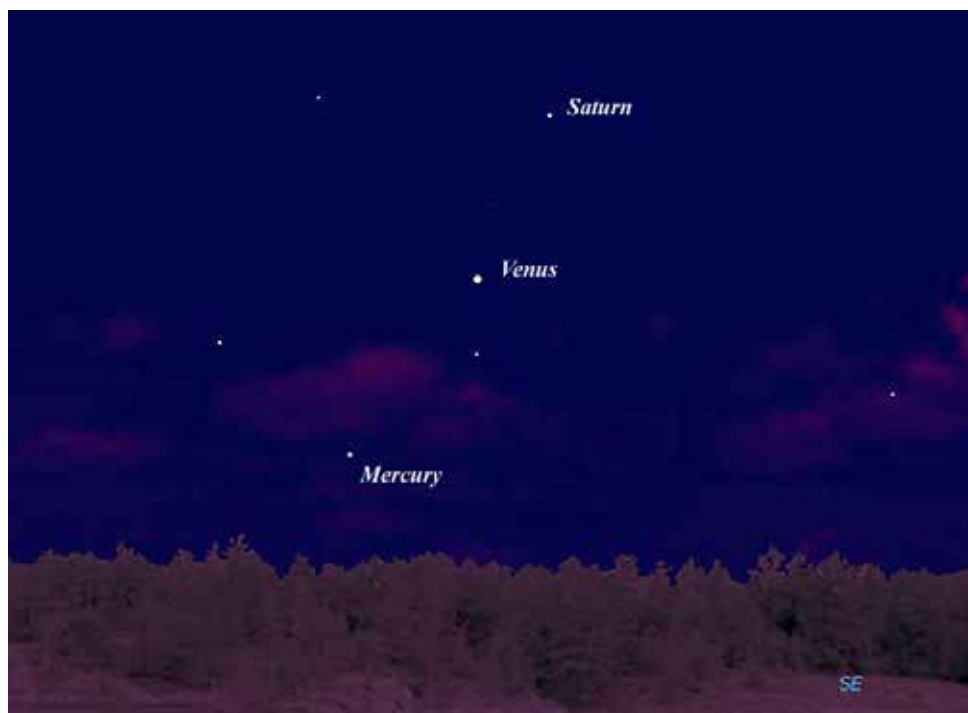
- [Go to Sky & Telescope's December 2012 Sky Chart](#)
- [How to use S&T's Interactive Sky Chart](#)

Mars continues to keep pace with the Sun. It appears low in the southwest at dusk and sets about two hours after sunset. On the 15th, the crescent Moon sits well above the red planet at dusk. On the opposite side of the sky, **Jupiter** blazes as twilight falls. On Christmas Day evening, Jupiter sits about 1° above the nearly full

Moon as both rise. Using binoculars, can you spot this giant planet above the lunar limb even before the Sun sets?

During the first half of the month, **Mercury** puts in a fine appearance in the dawn sky. About 90 minutes before sunrise on the 2nd, find **Venus** in the south-east. Then look for **Saturn** about 8° to its upper right and Mercury 8° to its lower left (8° is slightly less than the width of your fist held at arm's length; see the diagram below). The planets keep this straight-line formation as they move along the *ecliptic* (the apparent path of the Sun, Moon, and planets through the sky), but by midmonth Mercury rapidly sinks toward the rising Sun, with Venus in slow pursuit. On the 10th Saturn appears to the upper left of the crescent Moon; the next morning Venus is to the upper left of the lunar crescent while Mercury is to its lower left.

The **Geminid meteor shower** peaks during the night of the 13–14. There will be no moonlight to interfere with the show as new Moon falls on the 13th. When viewed from a dark-sky site, an



Looking southeast about one hour before sunrise during the first few days of December.



average of 100 meteors per hour may be spotted radiating from near the bright star Castor in Gemini, the Twins. And since the radiant is well up in the east by 9:00 pm, you don't have to stay up all night to watch for them.

The **Winter Solstice** arrives on the 21st at 6:12 am Eastern time, 3:12 am Pacific time. At this moment the Sun reaches its most southerly declination of -23.5° , and then proceeds to slowly head north. And contrary to the doom-mongers, no astronomical catastrophe will occur today, so don't cancel those New Year's Eve plans.

The Skies of January

- [Go to Sky & Telescope's January 2013 Sky Chart](#)
- [How to use S&T's Interactive Sky Chart](#)

Mars continues to be the only planet in the western sky at sunset, but at magnitude 1.2, it's not exactly a beacon of reddish light. It still sets more than an hour after the Sun, but by the end of March it will be lost in the solar glare. The 13th might be your easiest evening to spot it; the red planet sits some 10° below the crescent Moon (that's the width of your fist held at arm's length).

Meanwhile, **Jupiter** is a beacon, high in the east after sunset. It's well placed for viewing until the early morning hours. After sunset on the 21st, look for Jupiter about 1° to the left of the 10-day old Moon. Using binoculars, can you spot Jupiter beside the Moon before sunset?

Rising during the morning hours, **Saturn** is well up in the south by dawn. The ringed world appears to the left of the crescent Moon on the morning of the 6th.

Meanwhile, **Venus** is beating a hasty retreat from the morning skies. At the start of the month it rises 90 minutes before the Sun, but by month's end it rises a mere 30 minutes prior and is low in the southeast. By late February Venus will be lost in the solar glare, which is where **Mercury** is hiding this month.

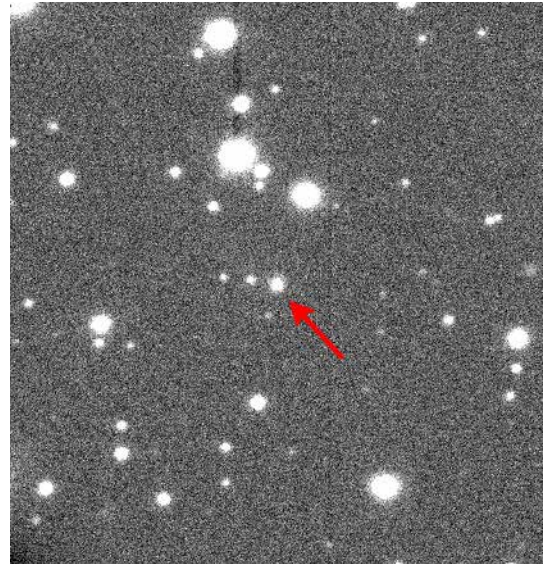
The **Quadrantid meteor shower** is expected to peak during the morning hours of the 4th. Despite showing off upwards of 40, 50, or more meteors per hour, this shower lacks the popularity of the Perseids or Geminids. That's because its peak is sharp and short (a few hours at most) and unlike other showers, there's little activity during the nights before and after the Quadrantid's peak. The radiant lies between Boötes and the Big Dipper and rises in the northeast around 1:00 am. Unfortunately the last quarter Moon rises before the radiant, and its light will obscure the fainter meteors.

The Comets Are Coming

Although this segment takes us well into 2013, I would be remiss if I didn't mention two *potentially* bright comets that will grace our skies in 2013. The key word is "potential."

The first is **Comet Pan-STARRS (C/2011 L4)**. Based on recent observations, it's still on track for a nice display in the northern skies next March. But even though it might reach a magnitude of 0, it'll do so at perihelion when it's on the far side of the Sun from us.

The graph at the bottom of this [webpage](#) shows observed magni-



From small beginnings great things sometimes grow. This is the Pan-STARRS discovery image of Comet C/2011 L4. The comet is shown by the red arrow. A current image of Comet ISON would look about the same.

tudes plotted against the predicted brightness, so you can see right away if the comet is still 'on track' to reach its predicted perihelion brightness. Bright or not, Comet Pan-STARRS will appear low in the western evening sky shortly after perihelion on March 9. It'll move north through Pisces, along the eastern edge of the Great Square of Pegasus, and up into Andromeda.

The second has the potential to be even brighter, but it won't reach perihelion until late November, so there's plenty of time for predictions to deviate from reality. Discovered by two amateur astronomers (Vitali Nevski of Belarus and Artyom Novichonok of Russia), the comet is designated **C/2012 S1** and is called **Comet ISON** (the acronym for the Russian observatory where it was discovered). At perihelion on November 28, 2013, Comet ISON passes within just 725,000 miles (1.2 million km) of the solar surface and could put on quite a show.

But beware. Some sites are claiming Comet ISON may be as bright as the full Moon as it passes perihelion. That may well be true, but at the time the comet will be a mere 2° from the Sun (about the width of two fingers held at arms' length) and so impossible to see. And it'll be at its brightest for just a few hours. The graph at the bottom of this [webpage](#) shows observed magnitudes plotted against the predicted brightness, so you can track the comet's measured brightness and compare it to the predictions.

Once it emerges from the solar glare, and assuming it survives its close encounter with the Sun, Comet ISON heads due north. Passing through Ophiuchus and Hercules, the comet will be well placed for viewing after sunset by northern observers in early December.

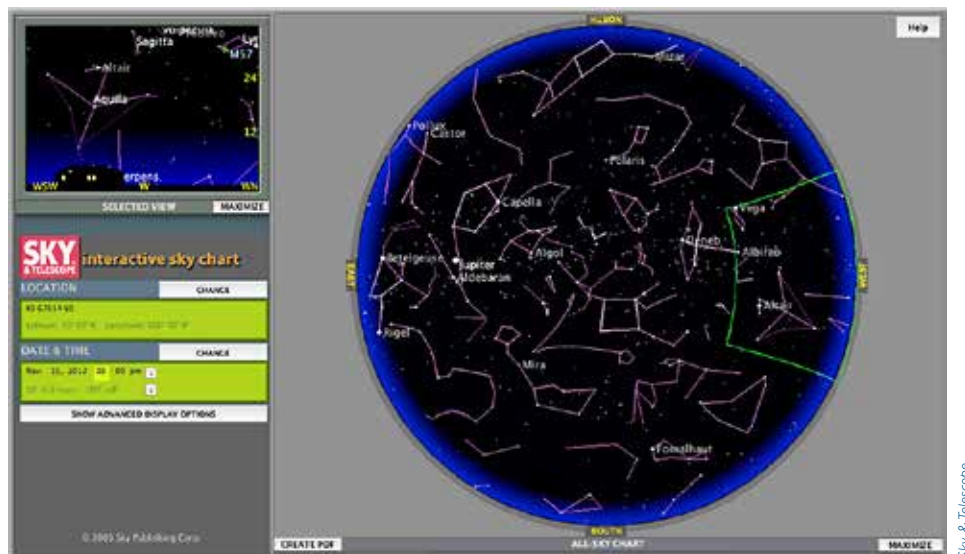
But remember — predicting the brightness of incoming comets is a bit of a mug's game. And as well-known amateur astronomer David Levy has often commented: "Comets are like cats. They both have tails and they do what they want." [\[RETURN\]](#)

Using Sky & Telescope's Interactive Sky Chart

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.

Please note that the *S&T* Interactive Sky Chart does not work on the iPad.

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 view of the sky in the upper left and a large circular all-sky chart on the right. If the star charts do not appear, refer to the "Tech Talk" section at the end of this article.

For instance, when you click on the link for the [November Sky Chart](#), you should see, in a new window, a screen that looks like the image above. Each of the monthly links in Sky Sights will take you to a chart set for 40° north latitude and 100° west longitude (so it's useful throughout the continental US) at 9:00 pm local time at midmonth in November, December, and January. The chart can be used one hour later at the start of each month and one hour earlier at month-end.

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

But Sky's Interactive Chart offers much more. Click on any area of the circular All-Sky Chart that you'd like to see in more detail. The green frame will jump to where your cursor is pointing, and the scene in the Selected View window will now show this area. Or click and hold down your mouse button within the green frame on the All-Sky Chart, then drag the frame around the sky. The scene in the Selected View window will change as the location of the green rectangle on the All-Sky Chart changes. Finally, click and hold down your mouse button in the Selected View window, then drag the cursor to move to another part of the sky. The green frame in the All-Sky Chart will follow your movements.

Changing the Chart

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

To alter the **date and time**, click on the month, day, year, hour, or minute in the display at lower left, which will become highlighted. (You can change only one parameter at a time.) Then use the + or – button to increase or decrease the value you've selected. Each time you change a quantity, both the Selected View and All-Sky Chart will be updated instantly. If you'd rather do a wholesale change, click the large "Change" button in the Date & Time display area. A pop-up window will appear. Here you can choose any date between January 1, 1600, and December 31, 2400, using the day and month pull-down lists and the year text-entry box.

To alter the **location**, you'll need to click the large "Chance" button in the Location display area. A pop-up window will appear that will let you select a new location. Use either the "USA or Canada" or the "World by City" box and your time zone will be automatically selected, but don't forget to check the Daylight Saving Time box if appropriate. **Do not use the "Worldwide by Latitude & Longitude" option — there are problems with its functionality** (among other things; here's an [update from S&T](#)).

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. [RETURN](#)

An eXtremely Deep Field

Called the eXtreme Deep Field (XDF), this photo was assembled by combining 10 years of Hubble Space Telescope photographs taken of a patch of sky at the center of the original Hubble Ultra Deep Field. The XDF is a small fraction of the angular diameter of the full Moon, and contains about 5,500 galaxies. Magnificent spiral galaxies similar in shape to our Milky Way are visible, as are large, fuzzy red galaxies where the formation of new stars has ceased. Peppered across the field are tiny, faint, more distant galaxies. The history of galaxies — from soon after the first galaxies were born to the great galaxies of today — is laid out in this one remarkable image.

You can read more about the XDF in this [press release](#) (where you'll find a [zoomable image](#)), and you can watch [six videos](#) related to this image.

Image courtesy NASA / ESA / G. Illingworth, D. Magee & P. Oesch (U. of California, Santa Cruz); R. Bouwens (Leiden U.) / the HUDF09 Team. [[RETURN](#)]

