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*The camera was a Canon 5D Digital SLR with a full 11 mm sensor. All of the above comparisons were taken using the original full frame images without any processing. The above images of M44 were taken by Jack Newton. See for yourself by downloading the two images and viewing them at 100% screen resolution from Meade.com.

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A Book Proposal of Universal Proportion

MICHAEL CHABIN

Writing the story of astronomy is what we all attempt to do, but how we do it is critical.

The Real Stars of Harry Potter

BY C. RENEE JAMES
ILLUSTRATIONS BY HEATHER CAMPBELL

Writer J. K. Rowling’s universe of Harry Potter and associates is colorful, complicated, and punctuated by some genuinely stellar characters.

Our Whirling World

JOEL MARKS

Talk of days and years is fine, but we cannot disentangle our world’s rotation and revolution.

Out of the Past: Astronomy Books for the Young, Then and Now

WAYNE WOOD

Most of the allure of astronomy and outer space has always been what is unknown, not what is known.

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Never Far From Home

The Grascals move me this chilly afternoon, their energy-infused bluegrass twangledang adding a cadence to my fingers. Outside my door, pumpkins—some with disguising faces of mirth and seemingly manic scarecrow companions—protect local homes and declare silently that autumn has arrived. Leaves are driven by cool nights to luminesce and fall, our fireplace sits empty yet awaiting bits of broken timber, and wool is again becoming my darling cloth.

Change in seasons as Earth whirls its way around Sol means we, too, change. Attitudes, moods, dress, even the manner in which we greet one another. Is it not wonderfully interesting how we humans respond to our reeling planet’s changing orbital circumstances?

What is inevitable in life, so remark the accountants or undertakers (or even the occasional francophile philosopher), are two things: taxation and death. But I think we should add change to the small list. It is essentially the ephemeral quantity by which we measure worth and means—things that change and pass away are imbued with less significance, yet those that resist the tugs of change, those that are “last,” they are important and eventually storied. Consider even time: is it not really nothing more than humans’ measure of the rate at which things change?

One tenth of a century ago, I was asked to become the editor of Mercury. I had been an occasional author and then regular author and columnist for the magazine for nearly five years before that invitation, and, save for a couple of years, I’ve been grooming, feeding, and loving this little beastie for the better part of that decade. In those years, I have changed—embarking on my forties with gusto and occasionally the ephemeral quantity by which we measure worth and means—things that change and pass away are imbued with less significance, yet those that resist the tugs of change, those that are “last,” they are important and eventually storied. Consider even time: is it not really nothing more than humans’ measure of the rate at which things change?

My family, my scholarship and writing, my life compel me forward, but I will remember my time tending to Mercury with satisfaction and tender emotion. The Society and its voice will remain strong, and this gives me profound comfort.

I wish you and our Society well. Clear skies for all, and may our children always look and find comfort.

James C. White II, Ph.D., Editor editor@astrosociety.org

The editor of Mercury and his wife, Lisa, and son, Sebastian.

The Grascals move me this chilly afternoon, their energy-infused bluegrass twangledang adding a cadence to my fingers. Outside my door, pumpkins—some with disguising faces of mirth and seemingly manic scarecrow companions—protect local homes and declare silently that autumn has arrived. Leaves are driven by cool nights to luminesce and fall, our fireplace sits empty yet awaiting bits of broken timber, and wool is again becoming my darling cloth.

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and its Janus sibling are ever-present partners in life—with Mercury feels full and complete, and I am looking beyond. The Astronomical Society of the Pacific, one of the lasting and storied institutions, is grand as ever and looks remarkably fit and polished after nearly 120 years of “bringing the heavens down to Earth.” Mercury, its voice since 1972, remains quietly sophisticated yet nagging in its insistence that two things are true: the heavens are there for us all, and children are the “we” to whom we will entrust our adult, celestial vigil. The magazine’s form may be transmuted, yet its messages will persist.

ON THE COVER: At the heart of a star-forming region in the Small Magellanic Cloud floats star cluster NGC 602. The cluster’s young, hot stars produce radiation that erodes the nebula surrounding them, a nebula made of a mix of primordial gas and newer dust created during the deaths of stars of earlier generations. Image courtesy of NASA, ESA, and the Hubble Heritage Team (STScI/AURA) — ESA/Hubble Collaboration.
Sizing up a Neutron Star

Astronomers are closer to cracking open a neutron star to reveal its exotic contents.

by Christopher Wanjek

Given the fact that a neutron star is merely a chunk of matter no wider than Washington, D.C., with contents perhaps equally as dense, and with the closest one at least 50 light-years away, it's no wonder astronomers have not determined the true size and mass of these objects.

Even the closest one, from our Earth-bound vantage point, would appear as the size of a bacterium on the Moon's surface.

In September, however, we got a little closer. Two teams of astronomers have established an upper limit on a neutron star diameter. They studied three neutron stars, and each one, they say, cannot be wider than about 30 kilometers, as detailed in separate articles in Astrophysical Journal Letters. A neutron star is the core remains of a star once at least eight times more massive than the Sun. The city-size sphere still contains over a solar mass, and a teaspoon of this packed matter would weigh as much as a mountain on Earth.

Scientists know that a neutron star is probably closer to 20 kilometers across. This first, well-established upper limit comes from observations of hot x-ray-emitting iron plasma orbiting above the neutron stars, about 30 kilometers from their centers. The measurements are as rock solid as a neutron star itself. More important, perhaps, is that the scientists are establishing a technique to calculate a neutron star's mass and diameter, among the most sought-after measurements in astrophysics.

Measuring mass and diameter would yield a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of matter inside a neutron star. Are they filled with a density and equation of state, the latter of which is a determination of the nature of materia...
The best evidence in answer to the age-old question, “Is a zebra a white animal with black stripes, or a black animal with white stripes?” comes in the form of abnormal zebras where the stripes form dots and blotches rather than lines. These appear as white blotches on a black background—most straightforwardly interpreted as a black animal with white stripes.

Based on the stunning new images from Cassini's September 10th close flyby of Iapetus, it looks to me like Iapetus may be Saturn's zebra moon.

It's been known (or at least strongly suspected) since the 1600s that Iapetus is a two-toned moon. Giovanni Cassini himself noted that he could only detect Iapetus in his telescopic observations when it was on one side of Saturn; he hypothesized that one hemisphere of the moon (its orbital trailing face) was much darker than the other (the orbital leading face). Voyager 2's close-up images in August 1981 finally revealed Iapetus's now familiar yin-yang appearance in some detail and nicely confirmed the conclusions of years of telescopic observations. But the mystery of the origin of the moon's surface personality split remained.

Iapetus's low density of about 1.1 grams per cubic centimeter and the reflectance spectrum of its brighter side lead to the rather unremarkable conclusion that it is an icy moon—not too surprising when you live in a system replete with other bright, icy moons and rings particles. We're, therefore, perhaps predisposed to think of the bright hemisphere as representing the native, underlying surface of the moon with the dark material viewed as some sort of surface contaminant.

But this then begs the questions: what is the nature of the dark material, and where did it come from? A number of dark-stuff-origin ideas have been proposed, some invoking delivery to the moon from the outside (impact of organic-rich meteoritic gunk, or contamination from other Saturnian satellites like Phoebe or Titan), while others look no further than Iapetus's own subsurface (blackening of erupted methane or ammonia-laced ice exposed to sunlight, or regional sublimation of a bright icy layer covering a globally dark basement).

Voyager's flyby images were just good enough to raise the interesting questions. It has been left for Cassini's orbital mission hopefully to answer them in detail, and the jaw-dropping images returned from Cassini’s closest pass to Iapetus promise finally to provide those answers.

It'll take a great deal of analysis to get at the full answer, and I'll bet that a number of doctoral theses will be generated from the Cassini Iapetus data, but I have to say that, after looking at just some of the highest-resolution images, it sure looks to me like we are looking at a dark underlying surface exposed after the removal of an overlying bright layer. The morphology of the contacts between the larger-scale bright-dark terrains looks for all the world like snow melting off a cratered asphalt driveway. It's a black animal with white stripes, folks.

Okay, maybe it's a white skinned animal with black fur and white stripes: at least one image shows very clearly a small, fresh, bright-rayed crater in the dark terrain where some cosmic projectile has punched through the dark material to a bright layer beneath. But I think it's going to be hard to escape the conclusion that the overall global pattern of dark and light that we've seen since Voyager is white on black, not the other way around.

Regardless of what the actual answer(s) ends up being, though, a great many people have thrilled to the joy of almost real-time planetary exploration as they pour through the raw images being displayed on the Cassini mission web site (saturn.jpl.nasa.gov). You can feel the genuine excitement of being a part of the exploration of the Solar System, and kudos to everyone on the Cassini team for helping to make that happen.

Daniel D. Durda is a Senior Research Scientist in the Department of Space Studies at the Southwest Research Institute in Boulder, Colorado.
Planetary Nebulae

More of the nature of planetary nebulae is discovered with every single observation.

by Katherine Bracher

S
ome of the most beautiful images taken by the Hubble Space Telescope have been of planetary nebulae: the Cat’s Eye Nebula, the Hourglass Nebula, the Egg Nebula, and many others. But planetary nebulae have been known for a long time, as Donald Menzel wrote in an A. S. P. Leaflet for November 1932. Among the first known was the Ring Nebula (M57; see “Echoes of the Past,” January 1994); other familiar ones are the Dumbbell Nebula (M27) and the Owl Nebula (M97).

Sir William Herschel, the discoverer of Uranus, observed several of these and thought that they looked like the small greenish disks of planets similar to his newly found one. But they did not move at all among the stars, so they must not be planets in our Solar System. He and his son John “were never sure but that some telescope, still larger than any they had used, would resolve the haziness into hundreds of faint stars, as their superior instruments had done to numerous star clusters that had previously been classed with the nebulae.”

Menzel described the discovery that they were true nebulae (clouds of gas): in 1864, “Sir William Huggins, pioneer spectroscopist, had directed his telescope with its prism attachment toward the bright planetary nebula in Draco… He was puzzled to find, instead of the customary rainbow hues of the stellar spectrum, several isolated bright green lines… Suddenly the significance of his discovery flashed upon him. Several years before, Bunsen and Kirchhoff had enunciated their famous laws of spectroscopic analysis. These stated that a bright-line spectrum could come only from an incandescent rarefied gas… Ergo, a nebula was composed of rarefied gas.”

Huggins knew that each gas generated its own unique pattern of colored lines, and he tried then to identify the gases in the nebulae. But he was disappointed: “A few of the colors were identified with hydrogen; several others, very faint, appeared to come from oxygen, but the majority of the radiations, including the most intense of all, the green lines that first attracted [his] attention…, could not be matched with any known terrestrial element. Accordingly, scientists provisionally postulated the existence of the hypothetical element, which they called ‘nebulium.’” But further work by chemists showed that there was no possibility of such an element, and astronomers then concluded “that the mysterious nebular constituents were not new elements, but very likely some familiar substance in an unfamiliar state of excitation.”

By Menzel’s time, some 150 planetary nebulae were known. The number is now over 1000. Each appears to have at its center a very hot blue star, and the nebula is like a bubble of gas surrounding the star. The density of this gas is very low, and it is expanding outward slowly from the star. The unexplained spectral lines arise from oxygen and nitrogen at very low density, under conditions that allow atoms to behave in ways that are impossible in laboratories on Earth.

Menzel went on to allude to “the interesting suggestion that the planetaries may be old novae; that the gaseous material is simply debris left over from an exploding star.” We know now that novae do throw off shells of gas; but a nova is a much more violent event, and their shells are very thin and move outward quickly, escaping the star in a short time and dissipating into space.

Astronomers now believe that most stars will produce planetary nebulae in their last stages of life. At this point, a star has expanded to become a red giant, and its atmosphere may continue to move out into space, exposing the star’s hot dense core, which will become a white dwarf. Ultraviolet energy from the hot star excites the gases in the nebula to glow. The gases move outward at about 25 km/sec, and at this rate, a typical planetary nebula may last for about ten thousand years.

The Hubble images give us a different picture, still not fully understood. Many planetary nebulae are not just spherical, but appear to have two lobes or streams of gas moving out from the central star in opposite directions. So it appears that material is not being ejected uniformly from the star; there may be a small equatorial belt, and gas is ejected perpendicular to this, from the poles. Perhaps the differences in appearance depend on the angle at which we are viewing these lobes of gas. The situation is certainly more complex than in Menzel’s day, and we await further discoveries.

KATHERINE BRACHER taught astronomy at Whitman College in Walla Walla, Washington, for 31 years. Retired in 1998, she currently lives in Austin, Texas. Her research focuses on eclipses and the astronomy of the ancient world; her other principal interest is early music. Her email address is bracher@whitman.edu.
The Missing Satellites Problem

Models predict many more Local Group satellites than are actually observed.

by Jennifer Birriel

The formation of structure in the Universe is one of the more pressing issues faced by modern cosmologists. According to cold dark matter models, galaxies formed in a hierarchical fashion by mergers and accretion of smaller satellite galaxies. The accretion process is not expected to have been one hundred percent efficient, and many small satellite galaxies are expected to have survived. A number of groups have used our own cosmic neighborhood to probe cosmological models of structure formation. The Local Group is currently known to have just over forty members; the majority of these are small, faint, dwarf galaxies that have only mild star-formation rates and a high concentration of dark matter. Many of these are satellites of the Milky Way and Andromeda (M31) galaxies. The existence of such satellite galaxies is, at least qualitatively, consistent with the models of galaxy formation.

There exists, however, a large quantitative discrepancy between theoretical predictions and the observed number of dwarf satellite galaxies in the Local Group. This discrepancy was first noted in the early 1990s and persists even in recent models. Models predict that the Milky Way should have some fifty dark matter satellites—significantly more than the dozen or so currently known. And the situation for the Local Group is worse—the number of predicted dark-matter satellites exceeds the observed number by nearly an order of magnitude! This disagreement between theory and observation has become known as the “missing satellites problem.”

Is this discrepancy real? On the one hand, several solutions have been proposed, most relating to physical processes that might hamper the formation of small galaxies from dark-matter halos. On the other hand, our picture of the Local Group is far from complete: despite years of study, the number of Milky Way and M31 satellite galaxies is still uncertain. While more and more are being discovered, most of these are small and faint. And small, faint galaxies are easy to miss, right?

Maybe these satellites are there but just too faint to see. Alan Whiting, an astronomer at the Cerro Tololo Inter-American Observatory, and his colleagues George Hau, Mike Irwin, and Miguel Verdugo, don’t think this is the case. The group used the results of an all-sky, deep optical survey for faint Local Group dwarf galaxies to investigate this possibility. Whiting and colleagues identified 206 candidate objects from the Palomar Observatory Sky Survey and the European Southern Observatory/Science Research Council Survey. They performed follow-up optical observations to determine distances to each object. Only two of the candidate objects were discovered to be dwarf galaxies belonging to the Local Group: Antlia and Cetus.

Are there not still Local Group dwarf galaxies to be discovered? Whiting and colleagues estimate that, at most, there may be a couple of still undiscovered dwarf galaxies in the Local Group. In addition, they estimate that perhaps as many as two dozen galaxies may be obscured from view by the Galactic plane.

It has been suggested that reionization hampered the conversion of dark-matter halos into visible galaxies. Models incorporating this mechanism produce a population of over 200 faint dwarf galaxies brighter than 26 magnitudes per square arcsecond. Whiting and colleagues point out that their survey is essentially complete for galaxies brighter than this limit over nearly three quarters of the sky. These results suggest that the large population suggested by such models simply does not exist. But does this finally put the “missing satellites problem” on firm observational footing? It has also been suggested that the small, dark-matter halos, unable to form a significant number of stars, retained most of their baryonic matter as atomic hydrogen and are actually observable as high-velocity clouds. Whiting and colleagues point out that no stars or any other optical signals have been detected with these clouds. Furthermore, they argue, these objects are too small and too nearby to be the missing dark halos.

This issue is still very much an open one. In just the past few months, two groups have identified a number of new objects that are both smaller and fainter than some of the previously detected dwarf galaxies. If these objects are numerous and dark-matter dominated, the “missing satellites problem” may yet be solved.

Astrophysicist JENNIFER BIRRIEL spends her free time poking around in stellar nurseries and stellar cemeteries. She is an assistant professor at Morehead State University in Kentucky.
Euler at 300

The famous and brilliant may pass away, but their ideas can become immortal.

by Clifford J. Cunningham

Get ready to blow out 300 candles! Leonhard Euler may not be a household name like Isaac Newton or Galileo Galilei, but his work in mathematics and astronomy laid the foundation for much of our modern understanding of the Universe.

Euler was born in Switzerland in 1707 and spent most of his professional life in St. Petersburg, Russia. Those two countries have commemorated him this year—Switzerland with a stamp, and Russia with a coin.

His first published foray into astronomy, in 1738, dealt with the solar astronomical year, but it was not until the 1740s that he turned his mathematical genius to problems that had dogged astronomers for years. As a measure of his success, consider the prize offered by the Paris Academy of Science. Each year the Academy would pose a question of amazing difficulty and expect someone in Europe to come up with the answer. It was the 18th-century’s equivalent to the Nobel Prize. Euler won it a dozen times, more than anyone else.

Several prize questions dealt with perturbation theory. The astronomer Pierre Le Monnier had presented evidence that Jupiter and Saturn were subject to observationally detectable inequalities that were attributable to the mutual gravitational attractions of the two planets. The prize, it was decided, should be offered for a “theory of Jupiter and Saturn explicating the inequalities that these planets appear to cause in each other’s motions, especially about the time of their conjunction.”

The prize in 1748 went to Euler, but he did not give the derivation of his differential equations. He was the first to use such equations to solve problems in trigonometry, which is key to understanding the motions of planets and satellites. The problem was posed again in 1752, and Euler won again.

Joseph-Louis Lagrange won the prize of 1766. In his memoir on celestial mechanics, he arrived independently at the conclusion Euler set forth in his still unpublished memoir of 1752: the discovery that the orbital elements of a perturbed planet, as determined by observation, include major components deriving from perturbation. Euler and his son, Johann, won half of the 1770 prize; the remaining half was reserved to be joined to the 1772 prize, when the same problem was posed for the third time.

In 1772 Lagrange won half, the other half being awarded once again to Euler for a more thorough development of his lunar theory—knowing the exact location of the Moon was a major problem then. Using the procedures developed by Euler, Tobias Mayer developed a lunar theory that established the standard terminology and techniques for dealing with the rotation of extended bodies.

The transit of Venus in 1769 gave Euler another opportunity to apply his skills at solving a major problem in astronomy—the determination of the solar parallax. Using observational results from astronomers all over Europe, he developed a method to calculate the parallax, and, thus, determine accurate distances to all the planets in the Solar System.

Euler continued to work even after he became blind in 1771. He communicated his ideas to his assistants by writing with chalk in large symbols on a blackboard. In his last session at the Academy in St. Petersburg, a few months before his death in 1783, the Russian Princess Dashkova said to him: “Sit where you want and the place you choose will naturally be the first among all.” Three centuries later we acknowledge his pre-eminence.

CLIFFORD CUNNINGHAM was recently photographed with Apollo 15 astronaut Alfred Worden during a visit to the Kennedy Space Center.
A popular Society program serves as the foundation for two new ones.

By Michael Gibbs

As the Astronomical Society of the Pacific continues to focus on the strategic direction of education and public outreach within the astronomy and space science community, the organization has been fortunate to receive several funding grants that allow us to implement our strategy. One example is the grant the Society received in 2005 from the National Science Foundation for a multi-year project titled Astronomy from the Ground Up (AFGU).

The AFGU program is designed to build the capacity of smaller, informal science education institutions—science centers, nature centers, and natural history museums—to more effectively present and interpret astronomy content to their visitors while increasing the public’s interest in astronomy. To accomplish this goal, the ASP, in collaboration with the National Optical Astronomy Observatory and the Association of Science-Technology Centers, is developing and testing new models of informal science education. In 2006, educators from across the country participated in AFGU workshops in Tucson, Arizona, and Boston, Massachusetts, along with online distance-learning opportunities. In 2007, workshops were held in St. Louis, Missouri, and, most recently, in Durham, North Carolina. More than 120 educators currently participate in the AFGU on-line learning community.

While a research effort is still underway to understand better the needs of the informal science education institutions and how best to provide them with professional development opportunities, it has become clear that there truly is a need within the informal science education community for continued support. In serving this need, the ASP applied for and received two new grants that will allow us to build upon the Astronomy from the Ground Up program.

The first new project is titled Astronomy Behind the Headlines, a two-year program funded by a NASA IDEAS grant. The goal is to enable informal educators to interpret confidently the latest astronomy and space science news and research for the public. This audience includes professional informal science educators, such as museum and planetarium educators and interpreters at nature centers. The secondary audience includes volunteers at these institutions, as well as amateur astronomers involved in public outreach.

Astronomy Behind the Headlines has three primary objectives:

- produce ten brief yet informative bi-monthly podcasts, with each episode highlighting one topic of particular current interest in the astronomy/space science field;
- provide interactive follow-up forum discussions and video chats to supplement the podcast by exploring the topic in greater depth; and
- create a website to host the podcast, including an archive of past episodes, provide a catalog of ideas for interpreting covered astronomy content for the public and a list of useful resources, and link to the related discussion fora.

Astronomy Behind the Headlines will provide innovative and timely astronomy and space science information primarily to informal science educators. The free professional development modules will assist them in responding quickly to and interpreting the latest astronomy/space science news and in incorporating results and data from NASA’s mission-based astronomy and space science research.

The second grant awarded to the ASP, which also builds on the success from the Astronomy from the Ground Up program, is the Brimstone Award given by the National Storytelling Network. The new project is titled, Sharing the Skies: Stories and Activities for Museum and Nature Center Educators and will begin in January 2008. The program will utilize storytelling and story-learning resources for professional development opportunities for informal educators at museums and nature centers through an on-line community.

Storytelling has certainly been used before as a tool for teaching in many cultures and for several different subject areas, including astronomy. The Sharing the Skies project is innovative—not necessarily because of the storytelling aspect, but because it incorporates a new medium, the internet, to teach story-telling techniques.

A professional storyteller, Lynn Moroney states, “storytellers have long held a high place in what is now called ‘informal education.’ We’ve been doing it for years! Communities will be enriched by this imaginative program that offers traditional stories and ‘science’ stories together to deepen our respect for, and knowledge of, the mystery of our universe.”

During the year to come, the education staff at the ASP, together with our project partners—such as the Association of Science-Technology Centers and Lynn Moroney—will be implementing these mission-based programs. As a member, friend, and benefactor of the ASP you too are a part of the cause of promoting science literacy through your active participation in the Society. Working together, we are making a difference.

MICHAEL GIBBS is the Chief Advancement Officer for the Astronomical Society of the Pacific. He can be reached by electronic mail at mgibbs@astrosociety.org.
Taking the Proof Out of Theory

A simple game demonstrates two important ideas of science.

by David Bruning

ne of our goals as science educators is to have students learn the process of science. Most of us confront students’ conceptions about the word theory and patiently explain that most scientists do not consciously define a hypothesis before they make observations. But even if we get students to understand a theory as an umbrella that collects facts and explanations into a cohesive structure, we are generally left with the lingering misconception that theories must be proven.

Prior to talking about cosmological theories in my astronomy course, I do a simple group activity. I write the sequence 2 4 6 on the chalkboard (the “observation”). The students’ goal is to determine the simple rule that these numbers obey (their “theory”). They cannot ask me to confirm their rule; rather, they must come up with another sequence of three numbers and ask me (humbly, the “omnipotent universe”) whether they, too, follow the rule. All groups get to hear the result to add to their collection of “data” and modify their “theory” accordingly.

A basic pattern of sequences repeats itself from term to term. The first volunteer will venture 4 6 8 (or 8 10 12). A second group will respond 12 14 16. Another group will try 20 22 24. Several additional, but similar, sequences follow. Around the fifth group, the sequence 1 3 5 will be proposed. This is cause for celebration because these students have broken the mold of even numbers. But only mild celebration is allowed because they are still increasing by twos. You might ask several groups to write their rule on the board now, with no comment. It usually takes eight to ten group responses before we get the desired result (so be patient): a group will suggest 3 2 1 (or better yet, 5 4 1). This group has stumbled onto the idea of trying to break their rule to test it.

At this point I usually tell the students that they have fallen into my trap, but I reassure them that they are completely human for doing so. What they have borne witness to is “confirmation bias,” a phenomenon well-known to psychologists. It seems that our brain is hard-wired to look for confirmation and that we feel rewarded when we find what we were looking for. Ask the students in the first group how they felt when they heard that their sequence “follows the rule.”

Despite discussions of falsification as an important process, students doggedly stick with confirmation as a tactic. But you can see a transformation as students get frustrated when, for sequence after sequence, it is pronounced that it “follows the rule.” It dawns slowly on them that confirmation is actually not particularly productive or illuminating. They realize that a positive result (“it follows the rule”) may not actually verify our rule—our idea can be wrong but the observation may incidentally confirm it. (The rules written on the board can be helpful in demonstrating this point.) But when we break the rule, we can learn more.

Even after this activity, some students hold onto the idea that proving theories is necessary. Why is proof so enticing to students? A simple reason is that many students are Dualists. Things must either be right or wrong in this framework, so, if you have a theory, the burden is on you to prove it correct. Having multiple theories and trying to falsify them requires greater academic maturity. “Proofs” also falsely build on students’ mathematics experiences where, especially in geometry, a theorem (that’s the same thing as a theory, right?) must be proven. And, of course, students are often taught that proving a theory is part of the scientific process by well-meaning but ill-informed teachers.

There is another aspect of confirmation bias of which educators should be aware.

Several years ago, UCLA researchers investigated confirmation bias in the context of political affirmation. MRI images of the brains of Republicans and Democrats were made as the subjects listened to statements made by political candidates. When a statement was made by a candidate from the subject’s party, the subject agreed. When the same statement was made by the opposing candidate, the subject disagreed. While the subjects would contend that their agreements were based in rational thought, the MRI scans showed that the “analytical portion” of the brain was quiet and that the “emotional part” was active. In other words, what the subjects perceived as logical thought was short-circuited by another part of the brain.

Our students provide us with many clues indicting their understanding of what we say: a head nod, a furrowed brow, a tilt of the head, a smile. But confirmation bias plays a role here and may wrongly convince student and instructor that they are getting it. Deeper questions may be needed to separate out confirmation bias, especially when we deal with complex and potentially emotional topics such as Big Bang creation, life in the Universe, and evolution.

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A BOOK PROPOSAL OF UNIVERSAL PROPORTION

By Michael Chabin
I want to write a book.

I want to tell the story astrophysics tells—not how we came to know it or who made which discovery but the story itself...

the beginning of time and space, the condensation of matter, and how that matter was processed into the stuff of which we, and even our dreams, are made. The story of simple rules and the even simpler objects they acted on and still act on and will act on, forever.

It should be engaging. After all, what mystery can be more baffling and fascinating than the concept of a field or the notion of flexible space?

It should be spare and beautiful and, most of all, it should convince. Astrophysics is one of the most compelling arguments ever made. To tell its story without changing the reader's mind is to fail to tell it at all.

Clearly, I’m going to need a model and, of course, everyone with whom I’ve talked expects a text but, at the moment, I’m leaning towards a children's book. They set a higher standard. After all, with so much to learn, children are unwilling to waste time on bad books.

A dull cover, an awkward first line, bland or empty prose, any of these will loose a child's attention instantly. That is why The Polar Express has such a beautiful cover, The Widow's Broom has one of the best first lines ever written, and the prose in The Little Prince is exquisite. That is why so many children's books are so good. With such a fastidious audience, they have to be.

Students, by contrast, have no choice. It doesn’t matter how the cover of a textbook looks, or how predictable its opening, or how pedantic and bland the prose. Texts are assigned by teachers, not chosen thoughtfully by students. Wit is not a consideration.

That's why so many textbooks are so awful.

So, I think my model will be a book for children instead, because at the very least, the story of astrophysics deserves a beautiful cover, great prose, and a memorable first line.

Joseph Campbell, I believe, once said that every myth was the best approximation of the truth when it was first told. In that sense all of them were the astrophysics of their times. But then, they aged, and, as they did, the facts marched on, leaving the stories open first to interpretation and eventually to ridicule. Still, they have one advantage over the modern version. Retelling a story over thousands of years tends to produce very good openings. Consider classical examples:

"Sing O muse, the anger of Achilles son of Peleus, that brought countless ills upon the Achaeans."

or

"In the Beginning, God created the Heaven and the Earth ..."

or

"He who has seen everything, I will make known to the lands ..."

or

"Arms and the man I sing, who, forced by fate, and haughty Juno's unrelenting hate ..."

As openings go, those are not bad.

Astrophysics is, of course, very different from the stories it replaced. On the one hand, it marches with the facts, and it is not open to much interpretation and even less ridicule. On the other hand, with so many authors and all their edits and footnotes and appendices, the story has never acquired much polish, and the first line...well, the first line is awful.

If ever there was an event we can call beautiful, surely it was that first wrenching of space and time that gave rise to everything we are and can ever be. One would think we could give it a worthy name.

We didn't. For the silliest of reasons, that splen-
did moment goes by a name that was given in sarcasm and intended to demean: “the Big Bang.”

Of course, it could be worse. One of the other great achievements of reason and evidence—natural selection—is widely doubted simply because it is called the theory of evolution—even by scientists who, for all their insight, have never understood the power of words and the profoundly subtle distinction in meaning to non-scientists between hypothesis and theory.

Still…Big Bang?
Not in my book!

But, then, how does one capture the essence of the Universe at that very earliest instant? I’ve heard it was hot, but what does that mean, if it is the only thing there was? Hot compared to what? I’ve heard it was massive, but what else would it be? It is all there was. It’s the fundamental unit of mass. The same is true of the suggestion that the Universe at time $t=0$ was infinitely small and dense. If it was all there was, could we not just as easily say it was infinitely large?

“So, if you aren’t using ‘the Big Bang,’” my editor asks, “how does it all begin?”

“Well, I thought maybe I would write: ‘In the time before time...’”

She smiles reassuringly.

“It does have a nice ring,” she says. “I like it. I really do. But does it mean anything?”

And, of course, it does not.

“Oh, that is nice!” she says, and this time she means it. “I especially like the idea of an edge to time. And, the word intolerable presages what is about to happen, doesn’t it? On the other hand, it suggests a human aspect, a kind of sympathetic fallacy of nature. Is that really what you want?”

It is not what I want.

“Well,” I offer, “we could try: ‘Unity...’”

“We could do that,” she says with a chuckle. “I’m not sure that qualifies as a first line, but as a first word it carries some weight. I remember reading a Hindu story that said the Universe began when Brahma first realized he was different from the rest...that he was unique and had an identity, and that all of history was the story of his effort to become one with the universe, again.”

That’s the trouble with editors. They’ve read everything.

“Then,” I try, a little desperately, “We could say, ‘The seed of the Universe had no measure...’”

“You could do something with ‘The seed of the Universe,’” she tells me. “It was a kind of seed. But I wonder if you’re stuck on the mathematics of singularities.”

Of course, she’s right. I am. But then, who isn’t hung up on singularities and their mathematical, uh, challenges?

“What if we leave the first bit for later,” she suggests. “What’s the rest? What happens next? Even great first lines with beautiful subjects have predicates.”

And there she has me.

“What does happen next? Every book I’ve ever read describes that first moment as an explosion, but every explosion I’ve ever seen explodes outward into the surrounding space. But at first, there was no surrounding space. Actually, there never has been. Correct me if I’m wrong, but it seems to me that space stretched inside the singularity...that if someone were standing outside, which I’ve been assured is impossible, they would have seen nothing at all. Because there was nothing to see. Because in all its lifetime the Universe hasn’t gotten any bigger on the outside. If it was infinitely small to begin with, it still is...on the outside.

What happened was that space gave way...on the inside. Nothing exploded. In fact, at first, not much moved and then only under the influence of gravity. Rather the distance between everything and everything else suddenly became great enough for there to be individuality. Room enough for Brahma to be able to distinguish himself from the rest. Room enough for matter to condense, for stars and galaxies to form, for us to descend from the primordial sludge.

“Tell astrophysics’s story without changing the reader’s mind is to fail to tell it at all.”
I'm not sure what you call an event like that—something stretching on the inside, but not the outside. It is certainly no explosion, though. An implosion maybe.

Suddenly my editor looks very tired.

I can't blame her. She works almost every hour she is awake in an endless and usually disappointing effort to nurse genius from the most unlikely sources—sources in which she may be the only one who truly believes. In my case she's often had to settle for less than genius. Still, she tries.

"It's a thought," she says. "Implosion is definitely one way to look at it."

Then she sighs.
"I'll tell you what. What if we come back to that, too? Let's talk about the story. If there's no story, no conflict, no journey, it won't be read, no matter how good the science is." Leave it to her to find the core of the issue. Story. That is the real question. How do you tell the story?

"Mommy, Mommy, where did I come from?"

"Well, let me think. It takes about four generations of stars to make a baby."

"Four?"

"About."

"Stars make a baby?"

"Well, not directly. But they make the stuff babies are made of, and until you have that... well, babies just aren't practical, are they? After all, you can't make a house without bricks."

"Babies are not made of bricks!"

"Certainly not! A brick baby would be very hard to handle."

"Mommy, apologize!"

"You're right, sweetheart. I'm sorry. That's a terrible joke, but babies do have parts, nonetheless. They have eyes, and hands, and hair, and even those parts have parts. Why, if we snipped off the tiniest piece of one of your hairs, we could take it apart just like a house and find out what it's made of."

"And what would we find?"

"Keratins!"

"Keratins?"

"That's right, keratins. They are proteins that happen to be long and fibrous, just the thing to make a hair."

"Well, then, what's a keratin made of?"

"I'm so glad you asked that question, because keratins are made mostly of alanine and glycine."

"Hmm. And what are they?"

"They are amino acids. All proteins are made of amino acids. And all people are made of proteins."

"Then what are mean old acids made of?"

"It's amino acid to you, dear! Well, they are made of tiny little particles called atoms. In particular they are made of hydrogen, oxygen, carbon, and nitrogen. And guess where those are..."
“Where?”

“In stars. So when I say it takes four generations of stars...”

That’s not a terrible way to introduce some science. It is actually kind of neat, but it does demonstrate the challenge of ensuring that the reader understands our words as we do. Ideas like “proteins are made of mean old acids” are generally harmless and tend to be self-correcting, but they can confuse the reader and waste time. Courteous writers avoid the problem by engineering their prose to exacting standards and testing it constantly and even then misunderstanding happens.

Still, carefully told and cleverly illustrated, this is a good story. Even so, it isn’t the story astrophysics tells, and listening isn’t the best way for a child to learn.

When my daughter was young I took her to the National Gallery of Art and the first place we went was the incredible collection of Impressionist paintings because, I thought, they were, well, more approachable than, say Goya. Besides, I knew all these swell stories about how Van Gogh shot himself and how Corot gave Daumier a house so he wouldn’t live in the streets—that sort of thing. Fascinating, I thought.

She wasn’t impressed. She wasn’t impressed at all. The broad-brush strokes and splashes of color seemed inept to her and she told me so. I swallowed hard but suggested maybe 17th-century Dutch paintings might interest her. After all, some of those are so real you can almost hear the tankards clank. So I showed her where to find them, sent her off, and went to collect my wife, Eileen.

Elizabeth never made it to the Dutch paintings. About half way there we found her up to her ears in a conversation with one of the guards about a small oval Italian Renaissance painting of a happy little putto. It was something I wouldn’t hang in the bathroom, but her conversation continued for five minutes or so, even after we arrived. Guards at the National Gallery are often extremely knowledgeable about the art in their care, and this one so fascinated my daughter that she talked about that little pink putto and all it meant well into dinner.

That’s when I realized what had happened. She wanted to do what I wanted to do.

I wanted to seem knowledgeable and introduce her to something new. I wanted to impress her and, to be honest, myself as well. That’s no sin, but she was an adolescent. Every cell in her body was devoted to becoming an adult. Of course she wanted to discover something wonderful on her own! Of course, she wanted to talk knowledgeably about it! That is the adult thing to do.

She wanted to give me a gift, and I’d been competing for center stage. It is still embarrassing.

She wasn’t alone. No one likes to be lectured to. Even Churchill complained that while he’d always loved learning, there were times when he resented being taught. Kids put up with it in a classroom because that’s what you have to do at school. Besides, some lecturers are storytellers of the first rank. But, while adults don’t seem to mind following the odd lady who holds her umbrella high, given a choice, kids will skip the tour every time. They’d rather explore on their own.

All of which suggests another way to tell the story:

The substitute teacher, Mrs. Pederson, had bright red hair, bright red lipstick, and a dress so purple it glowed in the dark. She also looked as if she meant business.

“Now for the roll,” she said brusquely. “Would
anyone who is not here kindly raise your hand?"
She looked around.

"Wonderful," she beamed. "All accounted for!"

Sam looked at his twin sister, who shrugged.

"Now today, we are visiting the Sun, and I need for all of you to get big, quite big, actually. Something like, oh, let's see, 100,000 kilometers tall will do."

Sam shook his head. So did his sister. They raised their hands.

"I'm sorry," said Sam.

"But did you say," said his sister.

"…get big?" asked Sam.

But there they stopped because both of them realized they were touching the ceiling. Mrs. Pederson couldn't hear anyway. Her head was already through the roof. She wasn't alone either. Half the class was on its feet in astonishment, and several of the taller kids were growing right through the ceiling as if it were no more substantial than fog.

"Sam?" said his sister. "Am I getting…"

"Bigger!" said Sam, just as his head passed through the ceiling on its way to 100,000 kilometers.

Kids are active in this story. They aren't sure what is going to happen, and neither is the reader. And, as it unfolds, they discover some interesting things about the Sun. It is a good story and works brilliantly in the classroom. I know, I've tried it.

Still, I'm bothered by something. I'm bothered because it was written with an unconscious assumption that readers need to be entertained first, and the science is secondary. It is the assumption that a simple story would be lost in a world of on-line games and YouTube and instant messaging and all the rest.

I'm not alone in making that assumption. But why do we do it? It isn't the kids. It is not Gameboys and Facebook. The problem, I think, lies with us and our lost perspective. The Astronomy Picture of the Day, adaptive optics, Google Earth, speculation on Larry King and Oprah about dark matter, quintessence, string theory, the accelerating Universe—all these may be wonderful but they make the extraordinary seem commonplace. We are so used to living with the weirdness of entangled pairs and the wonder of images from Gemini and Keck that we've lost our sense of scale. It is no wonder we don't think our simple story can compete.

But, what if modern astrophysics weren't so familiar? What would we think if we'd never heard it before, if we'd grown up on tales of Helios and stars attached to concentric spheres of sky? Eratosthenes lived 2,200 years ago and made some of the
earliest and best astronomical observations known. Though luck played a role in the accuracy of his results, his genius is beyond dispute. Of all the ancients, he and his close friend Archimedes would, I think, have been quickest to understand the story modern astrophysics has to tell and be the best judges of its merits. Think, for a moment, if we could bring those two forward in time and allow them to work through these incredible ideas until they understood them as we do. How would they react? What would they think of the details of the solar core or the way stars whip around massive black holes in the centers of galaxies or what we know of the beginning of everything? What would they think as they reasoned through the stretching of space and the meaning of spectra? What would they think of the manufacture of elements in the hearts of stars?

Give it a try. You’ll see as I did. Look through their eyes, and the magnitude of what has been accomplished stands out diamond-bright against the night of human history. What enlightenment, what epiphany could possibly compare?

There is no need to guild this story or dumb it down or reduce it to real-world examples and hands-on activities. It is best told simply, and if we can’t capture and hold a reader’s attention with it, the fault is ours. If we can’t move them with this story, we should find another line of work.

Because the real story of astrophysics is the reader’s story. It is the history of a universe that culminates, for now, in the person holding the book. The conflict? The struggle? That is what it has always been—our personal struggle to comprehend the extraordinary place in space and time we occupy, to revel in it, and to share it with the people we love.

That’s the book I’d like to write. Wish me luck.

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NU DRACONIS in the constellation Draco and Lambda Scorpii in Scorpius. Images courtesy of Michael Ragsdale and F.A. Ringwald, respectively. Draco Malfoy follows Black family tradition in naming his son Scorpius.
The **Real Stars** of Harry Potter

Writer J. K. Rowling’s universe of Harry Potter and associates is colorful, complicated, and punctuated by some genuinely stellar characters.

by C. Renée James

Illustrations by Heather Campbell
Sirius. Regulus. Bellatrix. Arcturus. Say these words to an astronomer, and you will likely trigger the memory of a bright star list, quite possibly with spectral types and apparent magnitudes thrown in for good measure. Say these words to a Harry Potter fan, on the other hand, and you will evoke a range of emotions, from sympathy for the affable but risk-taking Sirius to downright hatred for Bellatrix, from whom evil seemed to ooze from every You-Know-Who-loving pore.

What’s that? You’re not up on your Harry Potter? You might consider leafing through the four-thousand-page series sometime soon, especially if you want to draw serious crowds at your next star party or planetarium show. J. K. Rowling might not have known it, but she provided a vast new avenue for astronomy outreach by doing some good research into mythology and by naming plenty of characters after things you can find in the night sky.

Take Sirius in Canis Major, for example. We all know this is the brightest star visible at night and a vivid winter beacon for us in the northern hemisphere. We also know, as astronomers, that Sirius is not just a single star. Train a small telescope on that intense bluish-white dot and you’ll see that Sirius is leading a double life: an A-type main sequence star and its faint white dwarf companion truly makes up the “dog star.”

So what about Sirius, the character? Like his stellar namesake, he leads a double life as an animagus—a person who can transfigure her- or himself into an animal (unlike a werewolf, for example, who is basically a slave to the transfiguration process. But that’s another character…). It turns out that Sirius can transform himself into (you guessed it) a dog. Sirius also shares another quality with his star: he becomes the brightest spot in Harry’s life at the end of The Prisoner of Azkaban (book three).

If you are doing a winter star party, you might want to point out a star that is not too far (in terms of angular separation) from Sirius: Bellatrix. This “warrior woman” makes up Orion’s shoulder and is

For More Info…

One of the most popular sites for information on individual stars, James Kaler's STARS website contains lists of stars and associated details, constellation maps and photographs, and a plethora of other useful and informative elements. The site is located at www.astro.uiuc.edu/~kaler/sow/sowlist.html.

BELLATRIX (circled) forms Orion’s left shoulder. Image courtesy of Robert Gendler and Stéphane Guisard. A crazed warrior woman, Bellatrix Lestrange is one of Voldemort’s most feared Death Eaters.
quite an imposing figure as a B-type giant star. Hotter and larger and twenty-eight times more distant, Bellatrix produces fifty times the light of Sirius.

Meanwhile, in the Potterian universe, Rowling’s Bellatrix Lestrange is also an imposing warrior woman, basically the Dark Lord’s top “Death Eater” (read: evil person). With a quicker temper than Sirius Black and puffed up with pride, the character is the embodiment of a hot giant star. But proximity makes the star Sirius appear brighter to us earthlings. Sirius is less remote—both as a star and as a character—than Bellatrix, who cares nothing for humanity.

Regulus Arcturus Black gives us a double whammy, with two bright star names that might have simply been chosen for their poetic quality. But Regulus the star, the heart of the lion Leo, is a young, bright, B-type star that rotates so rapidly that it is virtually tearing itself apart. Regulus the character also shows us the heart of a lion. Having begun dabbling in his youth as a Death Eater, he makes a decision that virtually tears him apart (it certainly tears his family apart). Regulus Black ultimately dies young at the hands of Voldemort.

Arcturus, meanwhile, is a K giant star, very bright and very puffed up. In Greek mythology, Zeus placed Arcturus in the sky to protect other stars. In Rowling’s world, Regulus Arcturus offers his protection by being the first to strike a critical blow at Voldemort. Read the seventh book, The Deathly Hallows, to find out exactly how. And bright? The character most assuredly is: bright enough to be the first to locate one of Voldemort’s horcruxes. But puffed up? Regulus Arcturus possesses a trait shared by most of the Black family—a disproportionate pride being pureblood wizards (i.e., their

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**The Magic Above**

The fictional world of Harry Potter is filled with many types of magic: people who turn into animals, games played on broomsticks and plants that can attack. One type of magic that can be learned by Wizards and Muggles alike is Astronomy. Harry Potter and his friends take midnight lessons in one of the tallest towers at Hogwarts to learn the names of, and track the positions of, the stars and planets. After reading that the centaurs found Mars to be “quite bright tonight”, our daughters were curious to see what other heavenly bodies we shared with the Harry Potter universe. Tracking the phases of the Moon to watch for werewolves, finding the characters they loved (or loved-to-hate) in the sky, and learning that Europa is covered in ice, not mice, were adventures, not educational chores. With each star chart filled out, essay written and exam taken, they learned more about the world above us. To a parent, that is a magic in itself.

— M. H.

Meg Hove, Mercury Art Director Tom Ford, and their daughters Brigid and Mari read *Harry Potter and the Order of the Phoenix*. Photo by and courtesy of T. Ford.
heritage is not "tainted" with non-magical ancestors). In fact, all the star and constellation names in the Harry Potter series are reserved for the pureblood wizards.

Admittedly, you cannot fill an entire star party with just four stars. So how about some constellations? There’s Draco Malfoy, Harry’s peer rival at Hogwarts, a young man about whom volumes of character studies could be written. Draco ultimately fathers Scorpius, although all that is known of him is his name. Then there’s Andromeda Tonks, one of the “good guys.”

If you are still trying to scrape together enough material for a half-hour planetarium show or a decent star party, take a look at the Black Family Tree. There you will find Orion, Cassiopeia, and Cygnus, along with the stars Alphard and Pollux. Snippets of their “biographies” can be found mostly in book five, The Order of the Phoenix, but if you’re impatient, you can simply Google “Black Family Tree” and read what the more rabid fans have posted. Then you create some loose connections between the traits of the characters and the physical characteristics of the objects in the sky, and you have a program for the entire evening.

Be warned, though. While you can easily field questions about astronomical temperatures, sizes, and ages, you’ll want a Harry Potter fan on hand for the really tough questions.

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“All the star and constellation names in the Harry Potter series are reserved for the pureblood wizards.”

REGULUS in the constellation Leo and Arcturus in Boötes. Images courtesy of Jeraldo Martinez and F.A. Ringwald, respectively. Regulus Black, Sirius’s younger brother, proves he has a bright mind and the heart of a lion.
THE ANDROMEDA GALAXY is sister to our own Milky Way. Image courtesy of Robert Gendler. Sister of Bellatrix, Andromeda Tonks escapes the chains of the Black family and aligns herself with the good guys.
Everybody knows that Earth rotates 360 degrees each day, which is why the Sun comes back to the same place in the sky after 24 hours. Indeed, that is what makes a day a day. And everybody knows that Earth does this 365¼ times each year, which is why the Sun returns to the same place in the zodiac after 365⅓ days. Indeed, that is what makes a year a year (although we round them out to three of 365 days followed by a leap year).

Yes, everybody knows these things, but “everybody” is wrong.

No, I am not suggesting that we return to the days of stationary Earth at the center of a cosmos that revolves around us. The point is rather that Earth turns more than most people think it does.

To understand what is going on, it helps, first, to realize that we live in a whirling universe: everything turns! Every star, every planet, every rock in space is spinning; moons revolve around planets, planets revolve around suns, suns revolve around galaxies. It’s a dizzying fact of existence.

So our little Earth not only rotates on its axis, but also orbits old Sol, which in turn drags us in tow around the center of the Milky Way Galaxy. The latter motion normally escapes our notice because it is so slow by human standards; it takes 250 million years for the Solar System to go around the Galaxy once. Furthermore, what we see in the nighttime sky are the stars in our local neighborhood, so even if we were all traveling around the Galactic center at breakneck speed (which, actually, we are), the naked eye would just register the relative stability of the nearby, so-called “fixed” stars.

The temporal measure of our orbit around the Sun is, of course, well known to us, for it constitutes the year. It is instructive to recall, however, just how counterintuitive today’s commonplace knowledge seemed at first. Copernicus (1473-1543) famously proposed that Earth revolves around the Sun and not vice versa. Thus, Earth lost its place at the center of the scheme of things. But what really rattled people was a further implication, namely, that Earth moves. Commonsense rebelled at the idea that the very prototype of immobility, the ground beneath one’s feet, was in fact twirling on an axis and hurtling through space. The metaphor we use to describe this revelation indicates its emotional impact: revolutionary (that is, moving in an orbit).

Thus, we seem to have a neat division between the day determined by our axial rotation and the year set by our orbital revolution. But this is where the mistake lies, for these two motions are not entirely independent. One familiar way that their interaction intrudes upon our lives is during presidential election years, otherwise known as leap years. Why do we add a day to the calendar every four years? Because Earth does not return to the same point in its orbit around the Sun after exactly 365 days, but requires an additional quarter-day to complete the 360-degree circuit. Hence, adding one day every four years brings us back in sync. Of course it is only a coincidence that this correction coincides with our presidential elections, but maybe the United States should switch the date of the elections to February 29 just to press the point!

We now come to the moral of our little tale, for there is another interaction between diurnal rotation and annual revolution that goes largely unrecognized.

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**What Is a Day?**

The normal meaning of a day is technically the **solar day**. This is the time it takes a point on Earth’s surface to return by global rotation to the same place relative to the Sun (from point 1 to point 3 in the illustration).

But there is also the **sidereal day**. This is the time it takes a point on Earth’s surface to rotate 360 degrees relative to more distant stars (from point 1 to point 2 in the illustration). Because Earth is simultaneously orbiting the Sun, the sidereal day is shorter than the solar day. – J. M.
Although analogous to the leap year, it is completely distinct from it. There is, again, a misalignment between two measures that has to be made up by adding something; in this case, though, what needs to be set right is the number of degrees in Earth's daily rotation rather than the number of days in the year.

Let us consider the question: what is a day? Its normal meaning is the solar day. This is the time it takes a point on Earth's surface to return, by global rotation, to the same place relative to the Sun. For example, if we begin when the Sun is due south when viewed from Boston, then exactly one solar day will have elapsed by the time the Sun returns to that position in the sky. This is what we count as a 24-hour day. (We can ignore for the purposes of the present discussion that this is strictly speaking the mean solar day, since the eccentricity of Earth's orbit yields solar days of slightly differing lengths during the course of a year.)

But there is also a duration known as the sidereal day. This is the time it takes a point on Earth's surface to rotate 360 degrees relative to the more distant, "fixed" stars. If you think about the physical situation, you will realize that the sidereal day must be shorter than the solar day. This is because, while Earth is rotating at an approximately constant speed, it is also moving in its orbit around the Sun, and in the same direction as the rotation (counterclockwise as seen from the north). Hence, for Boston to come all the way back around to the same place relative to the Sun, it must travel more than 360 degrees.

“Copernicus proposed that Earth revolves around the Sun and not vice versa... But what really rattled people was a further implication, namely, that Earth moves.”

Author of De revolutionibus orbium coelestium (On the Revolutions of the Celestial Spheres), Nicolaus Copernicus (1473 – 1543) formulated a heliocentric cosmology that forever displaced Earth from the center of the Universe.
How much more? Well, the number of days in a year, approximately 365, is almost the same as the number of degrees in a full rotation, 360. This is surely not a coincidence but a Babylonian intention. *So Earth actually rotates an extra degree each day,* that is, around 361 degrees daily.

Furthermore, if you carry that through the whole year, you arrive at an even more surprising conclusion, to wit: *Earth rotates 366 times in a 365-day year!* This turns out to be a general rule of geometry: Any planet makes one extra rotation than there are days in its year. A limiting case, which can also help you to picture why this is so, would be a planet that has no day; it would rotate one time each year. This is because the planet would always present the same face to its sun; therefore its sun would always remain in the same place in the sky, so there would be no *return* to the same place to constitute a day. The situation is similar to the Moon’s motion relative to Earth. Because the Moon rotates once per revolution, Earth, on the Moon’s Earth-facing side, simply stays put in the lunar sky all the time.

If all that makes your head spin, it should!

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JOEL MARKS is professor of philosophy at the University of New Haven in West Haven, Connecticut, and an amateur astronomer. He enjoys indulging in what he has dubbed “philosophical astronomy,” which means arriving at new astronomical insights by reasoning about already known phenomena.
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OUT OF THE PAST:
ASTRONOMY BOOKS
FOR THE YOUNG, THEN AND NOW

by Wayne Wood
The day that Apollo 11 astronauts Neil Armstrong and Edwin "Buzz" Aldrin became the first humans to walk on the Moon, 20 July 1969, was a big one for two reasons: humans were landing on the Moon, and I got to stay up late. The whole extended family gathered around the black-and-white console set in my grandparents' living room and quietly watched as the grainy figure of Armstrong made its way down the ladder from the lunar module and onto the Moon's surface.

Being eleven years old at that moment meant that I had been almost three years old when Yuri Gagarin became the first man to fly into space and orbit Earth in April 1961. I can not remember a time when the current events of those days didn't include a regular diet of space shots and near-deification of astronauts.

There was a time in the summer and fall of 1969 when it was almost impossible to pick up a magazine or newspaper without seeing something about the astronauts who had landed on the Moon. Their faces looked down from a million bedroom walls of young dreamers who thought they were going to follow their trail to the stars. I was one of those dreamers, fueled in part by the books on astronomy that I was devouring at the school and public libraries.

What did those books say, and how is that different from the content of children's books on astronomy published now? The differences chiefly fall into three categories: advances in knowledge; cultural changes in depiction; and a less tangible attribute best described as a change in the "sense of wonder."

Two Moon Books
You Will Go to the Moon by Mae and Ira Freeman, illustrated by Robert Patterson, was published in 1959 as part of Random House's Beginner Books series—most famous for being the publishing home of Dr. Seuss. Despite its declarative title, the text of the book actually hedges on the promise of lunar vacations for all. It opens: "The moon is up there, far away. No one has been there yet. But some one will go there soon. Some day you may go there, too." Note the "may" of the text, as opposed to the "will" of the title. Curiously, the authors never give a name to the boy who is at the center of the book, and the story is, unusually, written in the second person—"you" will do this and that.

The book depicts an apple-cheeked red-headed boy as his well-dressed parents—dad in coat and tie, mom in heels and a matching skirt-and-jacket combination—take him to meet with "rocket men." Although the word astronaut had been coined in 1929, it was apparently not enough in the public mind in 1959 to have been used by the authors. The nameless boy, over the course of the book, flies to a space station orbiting above Earth and from there flies on to the Moon. He and his accompanying rocket men don space suits. The Moon has cars with large balloon tires waiting to transport the visitors around the lunar surface, and the boy and rocket men even visit a Moon city. The book ends with the young traveler standing on a mountain on the Moon gazing into the deep purple sky at the red disc of Mars. "What would you find on Mars?" the text asks. "No one knows yet. But some day you may go there, too! Then YOU will see."

Even though You Will Go to the Moon was written ten years before Apollo 11, much of what it depicts is broadly accurate with the realities of that mission: the boy takes off in a three-stage rocket; the lunar module pictured in the book is similar to the ones used by NASA teams; and the simple discussions of differences in gravity and climate between Earth and the Moon are realistic. Perhaps the most obvious difference between the boy's fictitious mission and the real United States missions to the Moon is the stop at the space station in between. Considering that the book was written two years before the first manned flight of any kind, (and, for context, only one year after regular trans-Atlantic jet flights began), it is a remarkably accurate depiction of what manned space travel became in the ten years after its publication.

What is striking to the modern eye about the book is the unintentional cultural messages in its pages. Of the fifteen characters depicted in the book, fourteen are male—the sole exception being the boy's mother. All are white. The opening scene in the boy's house, where he is seated at a window looking through a telescope at the Moon while his parents relax in the living room behind him, shows a nice suburban house of the 1950s. With the anachronistic "wasn't tomor-
The Graham book itself makes many of the same points as You Will Go to the Moon. Both deal with differences in gravity, temperature, and soil composition (summed up succinctly as “Dust, dust, dust” in the Freeman book). But, of course, the main difference in the two Moon books, even beyond the most obvious—that one has its information couched within a fictitious narrative, and the other is a nonfiction book—is that one was written ten years before the first Moon landing and the other was written thirty years afterward.

The Best Book of the Moon matter-of-factly discusses the Moon’s origins as inferred from analyses of Moon rocks brought back by astronauts. The book’s author notes: “The most accurate moon maps were made using photographs taken by space probes in the 1960s.” And the Apollo missions are summarized in this way: “Between 1969 and 1972, the Apollo space project landed twelve astronauts on the moon in seven separate moon missions.”

There is a striking difference in tone between the two books. In the 1959 book, a trip to the Moon is grand adventure, suffused with a sense of wonder about what is out there to be seen and discovered. By 1999, the Moon is a place where, a long time ago, a few people visited and learned some things. The achievement of space travel by humans is treated as ho-hum, not as an amazing feat of engineering, courage, and national will.

The Planets and Beyond

One of the most prolific of astronomy writers for children is Roy A. Gallant, who wrote a series of astronomy books beginning in the 1950s. His Exploring the Planets, published in 1958, neatly sums up the scientific knowledge of the time, but is also the font of great and fun speculation.

At the beginning of the book, Gallant notes that the advent of the telescope brought a wealth of astronomical knowledge, but also admits that, “[t]oday’s astronomers are still searching for answers to many of the same questions that baffled earlier men such as Ptolemy, Copernicus, Galileo, Huygens, and others.”

As Gallant wanders through the Solar System planet by planet, the relative paucity of knowledge from 1958 is evident. Cloud-shrouded Venus lends itself to speculation about what may be on the surface—with vivid illustrations of howling deserts and a boiling planet-wide sea. The knowledge of temperatures on Mars is dated: “During a Martian summer, at high noon along the equator you could bask in a comfortable 75-degree F. Temperature,” Gallant erroneously tells his young readers, and striking drawings show, for example, apparent lines on the surface of Mars that were not seen by planetary probes.

Despite the limitations in knowledge in this 49-year-old book, Gallant is still fun to read and a writer of clean, cheerful prose: “To the naked eye Saturn is a rather dull object in the heavens... But the invention of the telescope showed astronomers that Saturn was by no means a dull, uninteresting world. Seen in its full glory Saturn is the most beautiful object in the heavens.”

Naturally, limited to the Earth-bound perspective in 1958, Gallant’s arsenal of facts begins to run thin as he nears the outer edge of the Solar System. “As we work toward the ‘end’ of the Solar System, it becomes more and more difficult to paint a close-up view of the planets,” he writes in frustration.

What a difference several decades of planetary probes makes. By the time noted children’s author Patricia Lauber wrote her popular Journey to the Planets in 1987, the Mariner and Voyager spacecraft had sent back dazzling photographs and data on the planets through Uranus. (Voyager had yet to reach Neptune). While Gallant offered the best scientific knowledge and speculation from 1958, he was not able to declare flatly and memorably, as Lauber does, “Venus is hotter than a self-cleaning oven... On Venus, rocks glow red, like the coils on an electric range.” On to Mars, Journey to the Planets reproduces a dazzling Mariner close-up of Olympus Mons, the largest volcano in the Solar System, which was unknown in 1958.

In numerous examples throughout the book, Lauber draws on the advances in knowledge brought about by planetary probes to create a much more complete picture of our home planetary system than was possible through only telescopic observation. But, in an important distinction with the earlier discussion of Moon books, her book still succeeds in conveying a sense of the wonder of discovery. “Pinpoints of light in the night sky have become real places, where volcanoes erupt sulfur, where storms last hundreds or thousands of years, where the surface heat would melt tin and lead, where the sun appears as a flattened band,” she writes. “Yet
to the astronauts who have gone into space, the most wondrous sight of all is our small, blue and white, ever-changing planet—a glistering outpost of life in the black of space."

Fourteen years after Lauber’s popular book, Gallant, former Director of the Southworth Planetarium at the University of Southern Maine, and who is still active in the field of communicating science to children, wrote *The Planets*. This 2001 book is geared to a younger reading audience than his 1958 *Exploring the Planets* and has a much less sophisticated presentation of the material. Still, Gallant, to his great credit, is willing to let his readers in on controversies: “Although oddball Pluto is officially a planet, many astronomers think of it as a fake.” Perhaps this blunt approach could be expected from a writer who wrote an entire children’s book called *When the Sun Dies*.

Gallant also tells of scientific discoveries that likely seemed close to unimaginable in the 1950s when he began writing astronomy books for children: “So far, astronomers have discovered more than a dozen stars that have one or more planets orbiting them. In the years ahead, they will likely discover many more.”

### Constellations Are (Relatively) Forever

Given the breathtaking growth of knowledge about the Moon and planets in the span of years between publication dates of the books discussed so far, it is comforting to find at least one children’s book on astronomy from the 1950s that has aged very well: *The Stars: A New Way to See Them* by H. A. Rey. This elegant and attractive volume has changed little through six editions beginning in 1952. The esteem it had can be gauged by the fact that shortly after the publication of the first edition, Rey received a letter from Albert Einstein, who wrote, “Many thanks for your lucid and stimulating book. I hope it will find the interest it deserves.”

Rey, who is better known as the co-creator of Curious George, children’s literature’s favorite monkey, offers lucid explanations of what constellations are, explains how to identify them, and identifies by name the brightest stars in the night sky. The “new way to see them” of the title is a stick-figure-like connection of the stars in each constellation that, he argues, makes the shapes of the pictures in the sky easier to find and recall. That may be true, but the real riches of this book are the clear star maps and the discussions of subjects such as sidereal versus solar time, the precession of the equinoxes, and the ecliptic, zodiac, and seasons—discussions that are models of clarity and precision.

The book has sections that deal with the Moon and planets, and these have, of course, been updated since the early versions. Planetary tables have been updated in each edition. But the essential character of the constellations, and this book, have held up well for more than half a century.

### The Man in the Mall

The astronomy books of the 1950s and 1960s that I was checking out and reading under the influence of *Mercury* were artfully illustrated, colorful, and colorful.

The artist’s conception of Mars from 1958’s *Exploring the Planets* by Roy Gallant is colorful, eye-catching, fun, and wrong. Image courtesy of Doubleday & Company.
the covers with a flashlight when my parents assumed I was asleep were, of course, lacking all modern knowledge of the Moon and planets. They spoke of travel to the Moon as a wonder of the near future; today’s books speak of it as an historical event that is rapidly receding into the past. The older books offered artists’ conceptions of what the surface of Mars would look like up close; children’s books today offer photographs taken from the surface of Mars. There can be no argument that the books of today are vastly superior in the level of knowledge they confidently present. The interested ten-year-old of 2007 probably knows more about astronomy than the most learned astronomer of forty years ago! Today’s books also show that young astronomers can come in all colors and both genders. But as lacking in detail, sometimes inaccurate, and obviously culture-bound as the older books were, they served as an introduction to the Solar System, stars, and Universe, helping instill in young readers a sense of wonder that seems somewhat dimmed in some of the more knowledge-laden, modern books.

At least, that’s the subjective take of a middle-aged man who, in the 1960s, followed the Freemans, Roy Gallant, and H. A. Rey into space, and is still somewhat annoyed that the title of You Will Go to the Moon turned out to be a false promise.

As it turns out, I sort-of met Buzz Aldrin one time. One Saturday about ten years ago, I was at a mall in Nashville with my wife, and as we walked along I could hear somebody giving a speech in the mall’s stage area. The words grew more distinct as we drew nearer the center of the mall, and I could also see a sparse crowd sitting around listening to the speaker. He was a tall man with white hair and was dressed in a light blue sport coat; he looked more or less like the proprietor of a prosperous golf accessories shop. I heard him allude to the Apollo project. I looked closer, and I recognized him from all those magazine covers and wall posters from decades ago: Buzz Aldrin. His appearance was part of a promotion the mall was putting on that day in hopes of drawing in more shoppers.

He finished his speech to polite applause, and a few people came up and gathered around him to ask a question or shake his hand. It seemed difficult to reconcile this decidedly non-heroic looking man with the figure I remember from when I was eleven years old. Thinking about it later, I had to face the truth: he walked on the Moon, and I’m not going to. When Aldrin and I found ourselves at the same place, it wasn’t in a space capsule; it was at a mall. A long way from that summer night in 1969, when anything, anything, seemed possible.

WAYNE WOOD is the Director of Publications for the Vanderbilt University Medical Center in Nashville, Tennessee. He can be reached by email at wayne.wood@vanderbilt.edu.
**sky events**

by Richard Talcott

The longest nights of the year are now upon us. Although this may sound like good news, you don’t need a thermometer to know it’s cold outside. And, across much of the Northern Hemisphere, this time of year is also the cloudiest. When the skies do clear, however, the views can be spectacular. Add in several superb planets and a pair of bright comets, and this has the makings of a season to remember.

As the sky darkens in November, one object stands out above all others. Jupiter gleams at magnitude –1.8, noticeably brighter than any star. It pierces the south-western twilight with ease.

Its brilliance doesn’t translate into great telescopic views, however. Jupiter’s low altitude means its light travels through lots of Earth’s atmosphere, where turbulence blurs the image. Although Jupiter appears 32” across, you’ll have a hard time seeing much detail beyond its two dark equatorial belts. You’ll have an easier time spotting the four Galilean moons — Io, Europa, Ganymede, and Callisto — arrayed on either side of the planet’s disk. Jupiter will disappear into the Sun’s glare by mid-December, then reappear before dawn a month later.

What Jupiter lacks in visual appeal, Mars possesses. The Red Planet reaches the peak of its current apparition in December, when it lies opposite the Sun in our sky and closest to Earth. At opposition on December 24, Mars rises at sunset, passes nearly overhead around midnight, and sets at sunrise. It also shines brightest at opposition, at magnitude –1.6.

But the real treat comes when you turn a telescope on Mars. (For the sharpest views, wait until late evening when it climbs high in the sky.) Experienced observers know Mars shows the most detail when it appears 10” across or larger — and it’s that big from early October until mid-February. It’s at least 15” across throughout December.

The martian disk’s most obvious feature will be the north polar cap, a large expanse of white now near its maximum size as winter wraps up in the northern hemisphere. Subtle dark markings appear elsewhere across the ochre disk. If you observe Mars within a week of opposition, take a moment to scan 2.5” south of the planet. There you’ll find M35, Gemini’s finest star cluster.

The next planet to appear is Saturn. By late November, it rises in the east before midnight, and it comes up 30 minutes earlier every week after that. It appears highest in the south shortly before dawn. Unlike Mars and Jupiter, Saturn doesn’t stand out visually. It brightens from magnitude 0.8 in November to magnitude 0.4 in late January.

Saturn’s impact through a telescope more than atones for any naked-eye shortcoming. The planet’s disk grows from 17” to 20” across between November and January, while the ring diameter swells from 39” to 45”. With the rings tilted about 7° to our line of sight, you should easily make out the Cassini Division, which separates the outer A ring from the brighter B ring.

Once Venus rises, it dominates the sky. It comes up two hours before twilight begins in mid-November and nearly as early in December. Venus rises later by January, but it still rides high in the southeast during twilight. It shines around magnitude –4, some ten times brighter than the brightest star in the sky, Sirius.

Through a telescope during November’s first half, Venus shows a disk that’s more than 20” across and barely half-lit. By late January, its disk spans 13” and appears more than 80% lit. As January winds down, however, Venus impresses more by its proximity to Jupiter, now returning to view before dawn. The two brightest planets lie 1° apart on the 31st. They’ll be slightly closer the following morning.

In early November, Mercury puts on a good show in the east-southeast before sunrise. Then, after swinging around the far side of the Sun, it re-emerges in evening twilight during January’s second half. At greatest elongation on January 21/22, you can find the bright planet some 10° high in the southwest 30 minutes after sunset.

A trio of meteor showers should put on good shows in late autumn and early winter. First up: the Leonids, which peak before dawn on November 18. After the First Quarter Moon sets around midnight, you can expect to see up to 20 meteors per hour under a dark sky. That number jumps when the Geminids peak on the night of December 14/15. Perhaps 120 meteors per hour will streak the sky once the waxing crescent Moon sets in midevening. Our final meteor shower peaks before dawn on January 4. The Quadrantids also produce up to 120 meteors per hour, and the waning crescent Moon won’t interfere.

**A Tale of Two Comets**

Most meteors start life as dust grains locked in the rock-ice mixture of a comet’s nucleus. Not only do November, December, and January offer chances to view meteors from three debris trails, but two comets also should put on nice displays. First up is the surprising Comet 17P/Holmes. On October 21, this comet glowed inconspicuously at 17th magnitude. Less than a week later, an outburst propelled it to 2nd magnitude — a million times brighter than it had been.

A giant fissure presumably opened on the comet’s nucleus, exposing fresh ices to sunlight and powering the outburst. At first, the comet looked like nothing more than a bright point of light. Within a few days, however, binoculars and telescopes revealed it as a fuzzy ball of light. Because the comet lies nearly opposite the Sun in our sky, any tail that forms points mostly away from Earth and won’t appear lengthy.

No one knows how long this outburst will last. It was going strong two weeks later, and it could continue a couple of months. The comet remained bright for more than a month after amateur astronomer Edwin Holmes discovered it in November 1892, during a previous outburst. Try to look for the comet as soon as possible. It lies within the same binocular field as 2nd-magnitude Alpha (α) Persei, marked on the November all-sky map, for a week on either side of November 18.

The season’s second good comet is 6th-magnitude 8P/Tuttle. The highlight of Tuttle’s apparition comes on the evening of December 30, when it passes less than 1° from the Pinwheel Galaxy (M33) in Triangulum. They lie closest early in the evening, so be ready to observe as soon as the sky starts to darken. Tuttle is the parent comet of the Ursid meteor shower. Unfortunately, this year the shower’s December 22/23 peak coincides with Full Moon.

**RICHARD TALCOTT** is senior editor for Astronomy magazine. He is coauthor of the book *Chasing the Shadow: An Observer’s Guide to Eclipses.*
The all-sky star map shows the night sky as seen from about 35° north latitude at:
9 p.m. on November 1,
8 p.m. on November 15, and
7 p.m. on November 30.

To locate stars in the sky, hold the map above your head and orient it so that one of the four direction labels matches the direction you're facing. The all-sky map will then represent what you see in the sky.

1. Last Quarter Moon is at 2:18 P.M. PDT
2. The Moon passes 1.8° south of Saturn, 8 P.M. PDT
3. The Moon passes 3° south of Venus, noon PST
4. The Moon passes 7° south of Mercury, 3 A.M. PST
5. The Moon passes 1.8° south of Saturn, 8 P.M. PDT
6. The Moon passes 3° south of Venus, noon PST
7. The Moon passes 7° south of Mercury, 3 A.M. PST
8. Mercury is at greatest western elongation, 1 P.M. PST
9. The Moon is at apogee, 4:32 A.M. PST
10. Ceres reaches opposition, 7 A.M. PST
11. New Moon is at 3:03 P.M. PST
12. The Moon passes 5° south of Jupiter, 2 P.M. PST
13. The Moon reaches perigee, 4:13 A.M. PST
14. Full Moon is at 6:30 A.M. PST
15. The Moon passes 1.7° north of Mars, 10 P.M. PST
16. Mercury is at greatest western elongation, 1 P.M. PST
17. First Quarter Moon is at 2:33 P.M. PST
18. The Moon is at apogee, 4:32 A.M. PST
19. Ceres reaches opposition, 7 A.M. PST
20. New Moon is at 3:03 P.M. PST
21. The Moon passes 5° south of Jupiter, 2 P.M. PST
22. The Moon passes 1.7° north of Mars, 10 P.M. PST
23. The Moon is at perigee, 4:13 A.M. PST
24. Full Moon is at 6:30 A.M. PST
25. The Moon passes 1.7° north of Mars, 10 P.M. PST
26. Mercury is at greatest western elongation, 1 P.M. PST

The all-sky star map shows the night sky as seen from about 35° north latitude at:
9 p.m. on December 1, 8 p.m. on December 15, and 7 p.m. on December 31.

To locate stars in the sky, hold the map above your head and orient it so that one of the four direction labels matches the direction you're facing. The all-sky map will then represent what you see in the sky.

1 Last Quarter Moon is at 4:44 A.M. PST
   The Moon passes 2° south of Saturn, 5 A.M. PST
2 The Moon is at apogee, 8:53 A.M. PST
3 New Moon is at 9:40 A.M. PST
4 Geminid meteor shower peaks
5 First Quarter Moon is at 2:18 A.M. PST
6 Mercury is in superior conjunction, 7 A.M. PST
7 Winter solstice is at 10:08 P.M. PST
8 The Moon is at perigee, 2:14 A.M. PST
9 Jupiter is in conjunction with the Sun, 10 P.M. PST
10 Full Moon is at 5:16 P.M. PST
11 The Moon passes 0.9° north of Mars, 7 P.M. PST
12 Mars reaches opposition, noon PST
13 The Moon passes 3° south of Saturn, 2 P.M. PST
14 Last Quarter Moon is at 11:51 P.M. PST

January 2008

The all-sky star map shows the night sky as seen from about 35° north latitude at:
9 p.m. on January 1,
8 p.m. on January 15, and
7 p.m. on January 31.

To locate stars in the sky, hold the map above your head and orient it so that one of the four direction labels matches the direction you're facing. The all-sky map will then represent what you see in the sky.

Sky events

2 Earth is at perihelion, 4 p.m. PST
3 The Moon is at apogee, 12:06 a.m. PST
4 Quadrantid meteor shower peaks
  The Moon passes 7° south of Venus, 10 p.m. PST
6 Venus passes 6° north of Antares, 6 p.m. PST
8 New Moon is at 3:37 a.m. PST
10 The Moon is at perigee, 12:33 a.m. PST
12 The Moon passes 1.1° north of Mars, 4 p.m. PST
19 Mercury is at greatest eastern elongation (19°), 9 p.m. PST
21 Full Moon is at 5:35 a.m. PST
24 The Moon passes 3° south of Saturn, 10 p.m. PST
29 Last Quarter Moon is at 9:03 p.m. PST
30 The Moon is at apogee, 8:25 p.m. PST

ASP Welcomes Two New Members of the Board of Directors

Philip Sakimoto is an astrophysicist, E/PO and diversity specialist, and planetary scientist with the University of Notre Dame’s Department of Physics. He began his professional career teaching astronomy and physics at Whitman College in Walla Walla, Washington. He then moved to the East coast where he became Assistant Director of the newly formed Johns Hopkins Space Grant Consortium. In 1990, he joined NASA as University Affairs Officer for Goddard Space Flight Center in Greenbelt, Maryland. Four years later, he moved to NASA Headquarters in Washington, DC, where he served as a program officer for minority university programs, with specific responsibilities for managing NASA’s University Research Centers at Minority Universities Program and NASA’s Tribal Colleges and Universities Program. He was involved in the planning and implementation of the NASA Space Science Education and Public Outreach Program since its inception. In 2000, he formally joined the NASA Office of Space Science as program manager for the OSS EPO Program, the Broker/Facilitator Program, and space science diversity initiatives. He earned his B.A. in physics from Pomona College and his Ph.D. in astronomy from UCLA. During his student years he worked at the Griffith Observatory, taught astronomy at a community college and in a federal prison, and was an intern on the Viking Mission to Mars.

Edna DeVore is the Deputy CEO and the Director of Education and Public Outreach (E/PO) at the SETI Institute, and a science and astronomy educator. Her current E/PO projects involve the NASA Astrobiology Institute research program, NASA’s Stratospheric Observatory for Infrared Astronomy (SOFIA) with USRA, the Kepler Discovery Mission, and the NSF

NEW MEMBERS — The ASP welcomes new members who joined between 7 July 2007 and 26 October 2007

**Technical Membership**
- Mark G. Bailey, Kneeland, CA
- Joe DaSanto, Geneva, IL
- Craig E. DeForest, Nederland, CO
- Matthew M. Dennis, Bellingham, WA
- David G. Elliott, La Canada Flintridge, CA
- Linda D. Gray, Prescott, AZ
- Paul S. Hardersan, Grand Forks, ND
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- Thomas M. Nathe, Beaverton, OR
- Michael J. Pratts, Chicago, IL
- Glen A. Williams, Mount Pleasant, MI

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- Edwin L. Araza, Elk Grove, CA
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- Marsha Bednarski, New Britain, CT
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- Darwin Bohnet, Honolulu, HI
- Monica Brelsford, Bozeman, MT
- James Buchholz, Redlands, CA
- Leah Bug, University Park, PA
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- John C. Hamilton, Hilo, HI
- John R. Houghton, Paden City, WV
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- Amy D. Forestell, Austin, TX
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- Eddie V. Gonzales, Pasadena, CA
- Pamela J. Gonzales, Duarte, CA
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- Roy Gould, Cambridge, MA
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- Pamela Greyer, Chicago, IL
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- Brendan P. Noon, Summit, IL
- Tyler Nordgren, Redlands, CA
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- Bob Russell, Washington, DC
- Lanita J. Ruzhtskaya, Columbus, MO
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- Daniella Scalice, Moffett Field, CA
- Sharon Sleight, Phoenix, AZ
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- Anitha Soshu, Pasadena, CA
- Deanna Soper, Bloomington, IN
- Leonard Sparks, Columbus, OH
- Michael D. Stage, Anhester, NH
- Robert V. Steiner, New York, NY
- Travis F. Stenborg, Australia
- Denise C. Stephens, Orem, UT
- Frank Summers, Baltimore, MD
- Felipe J. Tapia, San Rafael, CA
- Vicky L. Teller, Diamond Bar, CA
- Kay W. Tobola, Pasadena, CA
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- Anthony J. Vanwissen, Boulder, CO
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- Daniel Werzel, Janesville, WI
- Ben R. Wiehe, Boston, MA
- Traci K. Wierman, Berkeley, CA
- Susan J. Williams, Kirkland, WA
- Michael D. Wolser, Ratharaf, TX
- Curtis Wong, Redmond, WA
- Charles Wood, Wheeling, WV
- Robert L. Youngken, Shoreline, WA
Research Experience for Undergraduates in Astrobiology, serving as Co-Investigator for the latter two. She was Co-I for "Voyages Through Time: An Integrated High School Science Curriculum" on the theme of evolution and published in 2003. DeVore serves on the Astronomy Education Board of the AAS, the Education Board for the Foundation for Microbiology, and has served on several advisory boards for NASA and NSF E/PO projects. Previously, she taught astronomy and directed planetarium programming for grades K-14. She has published more than 15 papers on science and astronomy education, and presented over 200 invited talks, teacher workshops, teacher short courses at science education conferences. She holds a B.A. degree from Raymond College at University of the Pacific, and a California teaching credential from San Jose State University (SJSU), with an M.A. in Instructional Technology/Education from SJSU and an M.S. in Astronomy from the University of Arizona 1992.

**Lynne Hillenbrand Is Re-elected**

Lynne Hillenbrand is an associate professor of astronomy at the California Institute of Technology. She received degrees in astrophysics from Princeton University (A.B.) and in astronomy from the University of Massachusetts (Ph.D.). Her postdoctoral work was conducted at the University of California, Berkeley, and at Caltech where she then joined the faculty. Her teaching includes undergraduate and graduate instruction as well as the research mentoring of undergraduate students, graduate students, and postdoctoral associates. Hillenbrand's research in the field of star and planet formation centers on studies of young stellar populations and the gas- and dust-rich circumstellar disks that surround them. In addition to the ASP Board of Directors, she has served on advisory committees for the National Research Council, the National Science Foundation, the National Aeronautics and Space Administration, the Association of Universities for Research in Astronomy, and various other science steering committees, users groups, telescope allocation committees, scientific organizing committees, and funding peer reviews.

**First SEED Grant Recipients Announced**

The ASP is pleased to announce the recipients of the first grant awards for the Simple Effective Education and Dissemination (SEED) Grants for astronomy researchers. The new grant program, made possible by an addition to the Society’s permanent endowment by an anonymous donor, provides small grant awards of up to $2,500 to enable active researchers in astronomy to engage in public outreach activities for K-14 formal education or informal education audiences.

The initial two years of the program have been supplemented by funds from the European Space Agency’s Planck Mission through a NASA contract with the Jet Propulsion Laboratory. The Planck Mission will map heat left over from the Big Bang with high sensitivity and angular resolution to add to human understanding of the early universe. The ASP acknowledges and sincerely thanks all of these supporters for their assistance with the Society’s mission to improve the understanding and appreciation of astronomy and to connect scientists and the public in the process.

The Society Awards Committee received many deserving proposals, of which it was able to fund nine. The recipient principal investigators include:

- **Sebastian Heinz** (University of Wisconsin) for "Spanish-Speaking Community Outreach at UW";
- **Marc Kassis** (Keck Observatory) for "Spectroscopy Activities for Middle- and High-School";
- **Ana Larson** (University of Washington) for "Bringing Hands-On Astronomy Lessons to Students at the Washington State School for the Blind";
- **Olga Panasenco** (Helio Research) for “Solar Astronomy in High School Science Education”;
- **Carl Pennypacker** (Space Science Lab, Berkeley) for “Internet All-Sky Camera”;
- **Pedro Sada** (Universidad de Monterrey, Mexico) for “Radio Kosmos—an Internet Radio Station for Spanish-Speaking Amateur Astronomers”;
- **James Sowell** (Georgia Tech University) for “Electronic Astronomical Education and Enticement”;
- **Ani Thankar** (Johns Hopkins University) for “Online Inquiry-Based Module on the Evolution of Galaxy Clusters”; and
- **William Welsh** (San Diego State University) for “Measuring the Invisible”

The ASP congratulates these recipients, and all those who submitted proposals for their efforts. Information on the grant program may be found at the Society’s website www.astrosociety.org/education/grants/grants.html.

**Federal Employees Contribute to the ASP via the Combined Federal Campaign**

Through the Combined Federal Campaign (CFC), federal employees can elect to make a charitable contribution to the ASP by payroll deduction. The ASP’s CFC number is 10651. Gifts to the ASP support the many educational and outreach activities of the Society. We welcome your support.

**ASP Awarded NASA IDEAS Grant**

"Astronomy Behind the Headlines: An Innovative Approach to Professional Development for Informal Science Educators" is a new program at the ASP with funding support from the NASA IDEAS Grant. This is a two-year collaboration project among the education departments of the Astronomical Society of the Pacific (ASP) and the Association of Science-Technology Centers (ASTC), that will provide informal..."
science educators with free online professional development modules, including podcasts, online resources, and interactive follow-up sessions to assist them in quickly responding to and interpreting the latest astronomy and space science news.

**ASP’s Recent Annual Conference in Chicago**

Attendees of this year’s Annual Conference were instrumental in creating workshop sessions where activities were shared and process was emphasized. Sessions and poster content were provocative, and the conference supported a wealth of networking. Conference highlights included keynote speaker George Nelson, ten exhibitors, more than 75 poster sessions, and 45 workshops. We thank the staff of co-host Adler Planetarium for their hard work in helping with the conference programming and logistics and with opening their doors to our attendees for a private evening at the planetarium. The ASP Annual Awards Banquet honoring eight individuals, including Bruce Gold Medal winner Martin Harwitt, and a trip to Yerkes Observatory capped off the week. We offer a big thank you to our sponsors for their support in helping us make this such a successful conference.

**Save the date!**

Don’t miss out on next year’s Annual Conference & International Year of Astronomy Symposium held 1-5 June 2008 in St. Louis, Missouri, in conjunction with the AAS summer meeting.

Join us on our exploration of Renaissance Italy 16-24 April 2008, as we celebrate four centuries of work with the telescope, and Italy’s unrivalled legacy of art, architecture, philosophy, and science. Astronomical lectures with astronomical historian William Sheehan and astronomer/photographer Dennis Mammana during this trip to Rome and Florence. Enjoy first class accommodations, sight seeing to such wonders as the Vatican Museum, St. Peter’s Basilica, the Colosseum, Arcetri Observatory, and, most of all, a visit to Galileo’s house and observatory. For a general interest form, and registration, please contact MWT Associates at tours@melitatrips.com.

For more information on the trip, “Galileo’s Tuscan Sky,” visit www.melitatrips.com/italy/index.html/.

**ASP Receives National Storytelling Grant**

The ASP recently received the Brimstone Award from the National Storytelling Network for a new project titled “Sharing the Skies: Stories and Activities for Museum and Nature Center Educators.” This grant will allow the ASP to provide online distance learning workshops for educators at museums, nature centers, and science centers who want to incorporate oral storytelling into their hands-on astronomy education programs. For additional information contact Anna Hurst (ahurst@astrosociety.org) at the ASP.

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**Galileo’s Tuscan Sky: 400th Anniversary of the Galileo Telescope**

Join us on our exploration of Renaissance Italy 16-24 April 2008, as we celebrate four centuries of work with the telescope, and Italy’s unrivalled legacy of art, architecture, philosophy, and science. Astronomical lectures with astronomical historian William Sheehan and astronomer/photographer Dennis Mammana during this trip to Rome and Florence. Enjoy first class accommodations, sight seeing to such wonders as the Vatican Museum, St. Peter’s Basilica, the Colosseum, Arcetri Observatory, and, most of all, a visit to Galileo’s house and observatory. For a general interest form, and registration, please contact MWT Associates at tours@melitatrips.com.

For more information on the trip, “Galileo’s Tuscan Sky,” visit www.melitatrips.com/italy/index.html/.

Mercury Art Director, Tom Ford, posing in front of Galileo’s residence in Florence, Italy.
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Growing into the New Century

Like all living things, an organization must develop and grow.

by James G. Manning

What's a fellow to do when he's newly located under the bubble of light pollution called the San Francisco Bay Area, and it's time for the Perseid meteors to flash in the sky? He seeks higher—and darker—ground.

That's just what I did this past August 12th with the Perseids peaking and needing a good place to observe. I traveled south at dusk through the light and congestion of the South Bay to the relative wilderness of Fremont Peak State Park, finding a perch below the summit along a narrow ridge aligned to the northeast. In the valley below twinkled the lights of Hollister, California, and those of San Juan Bautista to the west toward distant Monterey Bay. But they weren't enough to dim the Milky Way glittering overhead, or the stars of the summer/fall sky.

As Perseus rose through the mist, he cast shooting stars across the heavens—a sparkling white meteor across the Great Square of Pegasus, a pale blue rocket up the back of Cygnus the swan, a fireball dripping gold into the bucket of the Big Dipper, a rare magenta-colored spark streaking past the North Star. The shower performed more modestly than some years I've watched, but the display was colorful and satisfying.

If you watch a meteor shower often enough, you come to recognize its personality. For me, the Perseids are about "punctuated equilibrium." By that, I mean that the hourly rate can remain high and relatively constant over the best hours, but the shower manifests itself as a series of flurries and lulls—periods of higher activity separated by periods of less.

The lulls especially give you time to think, and the mind wanders. This particular night, mine wandered toward the notion of change and punctuated equilibrium.

The term is actually biological in origin, coined by Niles Eldredge and Stephen Jay Gould in the 1970s to describe their version of Darwinian evolution. Eldredge and Gould suggested that evolution isn't a process of smooth, constant change, but rather one in which species remained relatively stable for long periods of time, with periods of rapid speciation interspersed. Flurries and lulls, of a sort. Like the Perseids.

That's rather the way the sky works as well: unchanging or predictable for the most part, but counterpointed with changes—eclipses, the errant comet apparition, or a shower of meteors.

It's also the way organizations like the ASP tend to evolve.

If you read the history of the Society, it, too, has evolved over its lifetime in a kind of punctuated equilibrium as it has periodically outgrown its skin, or responded and adapted to a changing world and to new challenges and opportunities. We're in one of those "punctuated" stretches right now. One of the current changes, I guess, is me.

I come to the Society as its new executive director from an evolving background of my own, including more than thirty years in astronomy education. I've developed and run planetaria, curated exhibits, developed outreach programs, conducted classes and workshops, taught college-level introductory astronomy, and managed grant-funded projects. Most recently, I served as the head of the Office of Public Outreach at the Space Telescope Science Institute, the place that runs the science operations of the Hubble Space Telescope. I've had plenty of interactions with the ASP along the way as well, chairing the Board of Directors nominations committee, publishing in Mercury, partnering with the Society in support of the Night Sky Network, and serving as co-host for the annual meeting in Baltimore in 2006. And I'm pleased to be here, supporting an organization whose mission resonates strongly with my own.
But I'm not really the important new bit, for I walked in the door of an organization already on the cusp of change, in the process of evolving to meet both the challenges and opportunities of the new century—the third that the ASP has seen. The current strategic plan is reaching its culmination, and it's time to formalize some of the initiatives begun in 2003. There are economic challenges in this new century, and technological challenges, and some amazing new opportunities. It's time to grow into this shifting landscape or risk being left behind, and the ASP has always chosen the option to adapt and evolve.

What will this mean for the organization, and for you?

The mission of the Society will continue to be to increase the understanding and appreciation of astronomy, but with the endorsement of the Board of Directors in Chicago in September, we will articulate our mission as a means to a higher end. The ASP will work to increase public understanding and appreciation of astronomy through scientists, educators, enthusiasts and the public as a vehicle for advancing science literacy and exchange.

Advancing science literacy through engagement in astronomy is something the Society has talked about for years, and by formalizing this concept in our mission, we give ourselves a goal that's bigger than ourselves—and vitally important. Astronomy is appealing, accessible, and connectable to other science disciplines, all of which make it a wonderful avenue for introducing science as the adventure of discovery, encouraging the young to consider science careers, and helping the public to become more scientifically literate—and better able to make enlightened decisions about science and technology that will largely determine the future of our species on this planet. Nothing less.

And we can do it as we have for nearly 120 years: by bringing together the people who love the sky and want to share their passion for it with others.

Some of the most noticeable changes you'll see will involve *Mercury*. After a long stretch as editor, Jay White will be leaving the post to focus on his academic duties, his scholarship, and his family. He's done a superb job; we congratulate him on producing a magnificent vessel for advancing the Society's mission. And even as we make the transition to new editorial management, we will be transitioning the journal from print to digital form.

*Mercury* is costly to produce as a hard-copy publication at a time when it is essential for the Society to maintain a solid financial base from which to advance its mission and take advantage of the opportunities we see ahead. Like many other non-profit organizations in our position, the inescapable conclusion is to take our publication online. We see this as the best way to preserve the quality and content that members have come to appreciate and expect in their journal as we marshal and deploy our resources to meet the challenges of the future. *Mercury* will be accessible to members through the ASP website via an exclusive password; we'll provide details as the transition proceeds.

Other changes are afoot as well. We'll be simplifying our membership structure as befits an organization that is not just a Society, but a Society with a cause. Look for details via the mail. We're developing plans for a new member-exclusive feature called "Astronomy Beat," a weekly online posting giving an insider's view on the joys of doing astronomy—a chance to rub virtual elbows with scientists, educators, and amateur astronomers engaged in the work they love. We'll continue to develop our networks of astronomy clubs, formal educators and museum professionals, produce our technical publications for the science community, and develop partnerships with other organizations to advance our astronomy and science literacy goals. And we'll be helping to lead the charge for the International Year of Astronomy in 2009, using the 400th anniversary of Galileo's first telescopic peep at the heavens (and the 120th anniversary of the Society) as a way to focus public awareness on astronomy and to create a legacy of sustained interest for the future.

This isn't about the new guy walking in and deciding to rearrange the furniture. It's about the new guy walking into an organization already in the process of change and buying into that process because it's the right thing for the Society to do in the scheme of its continued and punctuated evolution. It's about growing into the new century, and recognizing that a vital organization is one that embraces change as a revitalizing force.

There are challenges ahead, and some exciting times as well. We invite you to join us in our efforts, and we appreciate and count on your support to see us through. Contact us at ed@astrosociety.org with your comments, your ideas, and your suggestions. We want to hear from you and want you to share in our exciting goals.

Together, doing what we love, we can shape the future even as we celebrate the sky!

JAMES G. MANNING is the Executive Director of the Astronomical Society of the Pacific. He can be reached by email at jmanning@astrosociety.org.
The Astronomical Society of the Pacific Invites Nominations for the Society’s 2008 Awards

AMATEUR ACHIEVEMENT AWARD
significant observational or technological contributions to astronomy by an amateur astronomer

THOMAS J. BRENAN AWARD
dedication to teaching astronomy at the high school level

RICHARD H. EMMONS AWARD
dedication to teaching introductory astronomy at the college level

KLUMPKE-ROBERTS AWARD
contributions to the public understanding and appreciation of astronomy

LAS CUMBRES AMATEUR OUTREACH AWARD
educational outreach by an amateur astronomer

MARIA & ERIC MUHLMANN AWARD
innovative advances in astronomical instrumentation, software or observational infrastructure

ROBERT J. TRUMPLER AWARD
PhD research considered unusually important to astronomy

Further details, submission information, and past recipients can be found on our website:
http://www.astrosociety.org/membership/awards/awards.html