On a chilly February evening in 1889 in San Francisco, astronomers from Lick Observatory and members of the Pacific Coast Amateur Photographic Association — fresh from viewing the New Year’s Day total solar eclipse north of the City — met to share pictures and experiences. Edward Holden, Lick’s first director, complimented the amateurs on their service to science, and proposed to continue the good fellowship through the founding of a Society “to advance the science of astronomy, and to diffuse information concerning it.”

Thus the Astronomical Society of the Pacific was born.

Boasting a diverse, loyal, and enthusiastic legion of employees, boards, supporters, members, donors, subscribers, program participants, and volunteers during the past 125 years, the ASP looks back with great pride and looks ahead with great excitement.

THANK YOU ALL!

www.astrosociety.org/support
Celebrating the ASP’s Past Quarter Century
ANDREW FRAKNOI
A long-time ASP staff member (and former Executive Director) recalls some of the Society’s activities during the past 25 years.

Discovering the Universe at Astronomy Camp
ELENA SAAVEDRA BUCKLEY
Research and fun go hand-in-hand during Kitt Peak’s nine-day Advanced Teen Summer Astronomy Camp.

Seasons Greetings
EMILY JOSEPH
Earth isn’t the only planet that goes through a change of seasons. From little Mercury to the distant gas giants, there’s a reason for their seasons (or not).

Astronomy in the News
Water vapor venting from Europa, a planet around a solar twin in a star cluster, and Hubble’s new perspective on the remote universe — these are some of the discoveries that recently made news in the astronomical community.
One evening at the beginning of October last, I found myself in the Icelandic countryside gazing at a sky full of light. I was in Iceland with a group of travelers keen to explore the geologic wonders of this island nation by day and hopeful of seeing a display of the northern lights at night. Neither disappointed. It was my fifth trip to Iceland, and I was as enchanted by the volcanoes, lava flows, waterfalls, and various geologic delights as those in the group, all of whom were seeing everything for the first time.

Meanwhile, the Sun had done its part. On September 30th, our star hurled a coronal mass ejection in Earth’s general direction. Estimated date of impact: October 2nd.

It was windy, cloudy, and rainy much of that day, and the evening didn’t look promising. Between dinner courses, I stepped outside and gazed skyward… just in case. There were heavy cloud bands to the east and west, with bands of thin cloud overhead. But the overhead clouds were not aligned with those on the horizon, and after a moment of observation, it was clear those thin cloud bands were moving in a very uncloudlike manner.

When dining with a group of aurora chasers, it’s easy to clear the room. Simply indicate that the northern lights are dancing overhead and only the wait staff will be left inside. And so we poured outside, cameras firing, fingers pointing, and exclamations of joy filling the air. It was a fine display, certainly one of the best I’ve seen in a number of years. The biggest problem? Not knowing where to look as the dance of these celestial lights literally filled the sky.

Three hours later, the clouds closed in, ending the show. But Iceland had fulfilled its promise of volcanic “fire” frozen on the ground and celestial “fire” flickering in the sky.

The ASP is pleased to partner with MWT Associates in their astronomy-focused tours and expeditions. This coming March, you can join us for Iceland: Northern Lights, Glaciers, and Volcanoes. For more details, see the ASP’s Astronomy Travel webpage.
Hyperbolic. That’s what the orbit of Comet ISON may have been, for orbital calculations wiggled tightly around its trajectory being barely open or barely closed.

But hyperbolic most certainly characterizes the speculation about it in many camps, from the time this sunward vagabond from the Oort Cloud got noticed back in September of 2012.

Last November 17th, just 11 days prior to its perihelion passage, I drove out from under the coastal marine layer in the wee hours of the morning to the Bay side of the San Francisco peninsula to see what all the hype was about. There I found a bayside park with a good view east under a clear if moonlit sky, pulled out my binoculars, and searched.

By then, the speculation had changed from wondering about how big and bright the comet would be to whether it would survive perihelion at all. A couple of outbursts in the days just proceeding had finally raised its brightness to just naked-eye level, but fueled frets that it was beginning to break apart. And so I roused and went off to see it, since there were no guarantees it would come out the other side.

In the days leading up to my early morning search, spectacular images of ISON had been posted online, showing a well-developed comet with a streaming tail — as photographed through telescopes that must have used filters to remove the moonlight. But when I looked, in a sky made brilliant by the light of the full Moon, it was not so easy to see, its head looking like a faint, out-of-focus star about a degree and a half above Spica low in the east; its tail rendered invisible in the wash of moonlight on the edge of dawn.

Hyperbolic, hyperbole, hyper, hype. The words all derive from the Greek root huperballein or thereabouts, meaning literally “to throw beyond” — to exceed, to exaggerate. Gazing at the comet that chilly morning, I found that all of those words applied to the feverish prose and depictions of many concerning the chance to see a “Comet of the Century” come the end of 2013. As it turned out, I felt fortunate to have seen it at all.

For we all know what happened. The comet turned out to be too small, too weakly put together, and too close to the Sun. It turned into Brünnhilde from Wagner’s Ring Cycle and was consumed in its own immolation scene, brought to us in graphic detail courtesy of the Sun-gazing spacecraft SOHO, STEREO, and SDO. Such are the
whims of the universe, and we learn our lesson once again.

Still, it would have been glorious to see a prominent naked-eye waft of outbound comet in a dark December morning sky. It would have been an early party favor — a celestial milestone event — for the Astronomical Society of the Pacific’s own milestone as we prepare to celebrate the Society’s 125th birthday on February 7th.

The sky has always been good for that: offering signs and wonders that help cement and gild our memories of earthbound happenings. Comets, of course, were almost always thought to be up to no good in the old days, and it took more modern eras to rehabilitate their image and make them more desirable celestial heralds. But really, the ASP needs no such assistance, for the Society has served as a sort of celestial herald all its own, communicating and educating about a universe that has changed dramatically during the last 125 years in terms of our understanding.

Consider. In 1889, the electron had yet to be discovered, and people didn’t understand how the Sun was able to shine for its presumed lifetime. Astronomers were still finding canals on Mars, and they still debated whether the Milky Way was it or whether there were other “island universes” in space. In the ensuing century and a quarter, the ASP grew up amid a revolution in cosmic understanding, as new technologies and insights cleared our eyesight to reveal the amazing universe we see today, still ripe with mysteries. The lists of ASP Boards and Board presidents and award winners read like a Who’s Who of the movers and shakers in astronomical discovery who have shaped this new view.

And the ASP was there every step of the way — marveling, informing, teaching, inspiring, and bringing countless young minds and hearts (and older ones, too) to the adventure of science and the excitement of discovery.

Like little ISON, the Society has undergone its own sungrazing milestones — events such as the 1906 San Francisco earthquake and fire that destroyed its offices, library, and many of its early records; the Great Depression and a couple of World Wars; the more recent Great Recession and little crises of its own during the years. But unlike ISON we survive and go on — publishing, educating, forging networks and connections, striving ever to make the world safe for science and science literacy.

So it seems to me that in this case, a little hyperbole is warranted — for one of the oldest, biggest, most distinguished, most accomplished, and coolest astronomical societies in history. Exaggeration? Not much, from my perspective.

Cometary gilding or no, the Society’s 125th anniversary is a true milestone, and we couldn’t have gotten here without superlative staffs, boards, members, and supporters. Thank you all for making the ASP what it was, what it is, and what it will become in the future. Let us raise a glass to the ASP on its 125th birthday. Long may it continue to make a difference in the world, using the sky we all love!

On the day of the Society’s 125th anniversary, JAMES G. MANNING bids adieu as the Executive Director of the Astronomical Society of the Pacific.
Comets a Century Ago

Back then, there were some unusual ideas regarding the origin and nature of comets.

With all the recent fuss about Comet ISON, this is a good time to look back a century to see what was known—or not known—about comets.

In the 1890s, Isaac W. Heysinger of Philadelphia wrote about the unsolved problems of astronomy. When he turned to comets, several questions arose including:

• Why do some comets split, while others show multiple tails?
• Why do some comets appear dim after reappearing from behind the Sun, while others have their splendor greatly enhanced?
• Where do comets come from; where is their permanent abiding place?

The second question is particularly pertinent in the case of Comet ISON, which some expected to be a spectacular comet after its passage behind the Sun. Instead it fell apart. Dean Pensell of NASA’s Solar Dynamics Observatory was quoted as saying that what was left after perihelion was “not a big chunk of material, but more like a bee swarm.” The reason for such an event, which was queried a century ago? It seems that all of the water in Comet ISON evaporated. “The ice is the cement that holds the comet together,” said Pensell.

At the time of Comet Halley’s passage around the Sun in 1910, the problem of the origin and nature of comets was a widely discussed topic. In what was termed the “golden age of comet discovery” by William W. Campbell, Director of Lick Observatory, 100 comets were discovered between 1888 and 1908. Four American observers—Lewis Swift, William Brooks, Edward Emerson Barnard, and Charles Perrine— took the laurels as the best comet hunters, having bagged 37 of those 100.

Three theories competed to explain the origin of comets. One was called the solar origin theory, which postulated that expulsions of matter from the Sun became comets. It was thought that solar prominences were the mechanism by which this happened, and spectroscopic evidence was used to bolster the idea as both comets and meteors revealed the presence of large amounts of hydrogen—the prime element of the Sun’s atmosphere. Doubters of this theory pointed to the fact that whatever was thrown off the Sun would consist of minute particles that could hardly coalesce into solid matter.

The second theory posited the giant planets as the producers of comets. Disturbances in the atmospheres of Jupiter and Saturn, notably the Great Red Spot on Jupiter and white spots on both planets, were fingered as possible places where matter could be expelled into space. Proponents of this theory likened such events to the giant volcanic events of recent times, especially Krakatoa in 1883, which sent a cubic mile of solid matter to a height of many miles.

The third theory, and the one accepted today, is that comets are distant fragments of the nebula that formed the solar system, making many of them pristine objects billions of years old.
There was a variation of this third theory, formulated shortly before Halley’s 1910 appearance, by Forest Moulton, Professor of Astronomy at the U. of Chicago, and geologist T.C. Chamberlain. Their so-called planetesimal theory invoked the passage of a star near our Sun. This caused a fraction of the solar mass to be ejected into space, forming the planets and comets. It required the implausible notion that the Sun had cooled to form a solid crust on its exterior before the passage of this other star, and combined with the extreme improbability of the close approach of two stars, the theory had few adherents.

Where comets abide is, of course, tied to their orbital properties. In the 1890s Louis Fabry established the true significance of the parabolic orbit that most comets exhibited. While many comets appeared to be on parabolic or hyperbolic orbits, it was shown that planetary perturbations were the cause, and that the original, undisturbed orbits were all elliptical. This meant that they were not interstellar interlopers but were all under the gravitational influence of the Sun.

Our modern knowledge about comets is based on two landmark scientific concepts of the 1950s. Fred Whipple elucidated the nature of the cometary body itself by thinking of it as a dirty snowball, and Jan Oort gave form to the place where comets reside when they are not heading inwards for a meeting with the Sun. This is the famous Oort Cloud that surrounds the solar system at an average distance of 50,000 astronomical units. Yet no matter how much we know, their appearance in the sky still evokes a sense of wonder that a mere dirty snowball can be so beautiful.

CLIFFORD J. CUNNINGHAM was recently seen chatting about astronomy with America’s most famous artist, Peter Max.

A New Cosmological Tool

Extragalactic proper motions could help us measure the Hubble constant and much more.

Ever since the discovery of the expansion of the universe in 1929, astrophysicists have been on a quest to determine the value of the Hubble constant. The Hubble constant is the ratio of an object’s recession velocity (along our-line-of-sight) to its distance; the Hubble flow refers to the cosmological expansion. Determining the Hubble constant has been done by using the Doppler shift to determine galaxy recession velocities plus independent distance measurements using certain celestial objects as a bright “standard candle.”

One classical observational test of cosmology involves plotting the angular diameter of a “cosmic ruler” as a function of redshift. The cosmic ruler must have a standard length for this to work; standard cosmic rulers include the first rank (or brightest) galaxies in a cluster and galaxy clusters themselves. This method requires knowledge of both the orientation and size of the “ruler.”

Objects subject to local gravitational forces, such as a galaxy in a cluster, have motion in addition to the Hubble flow. This additional
motion is called the object’s “peculiar velocity.” The portion of the object’s peculiar velocity along our line-of-sight will show up as a deviation from the expected Hubble recession velocity. However, we need an independent measurement of the object’s distance to determine its peculiar velocity from the observed Doppler shift.

The portion of an object’s peculiar velocity perpendicular to our line of sight is referred to as its proper motion. Because the cosmological expansion is homogeneous, there should be no proper motion associated with the Hubble flow. Therefore, argues Jeremy Darling of the University of Colorado at Boulder, precise astrometric measurements revealing the proper motions of structures can simultaneously confirm that the structure is decoupled from the Hubble flow and confirm that the Hubble expansion is, in fact, homogeneous on large scales.

The angular size of an object depends on the ratio of its physical size to its distance. So, the time rate-of-change of the angular size will depend on both the rate of change of its distance, which is directly related to the Hubble expansion, and the rate of change of the physical size of the object. The fractional change in angular size is zero if the object is not a gravitationally influenced structure. On the other hand, a gravitationally bound object will appear to “shrink” as it recedes. Angular size is measured in the direction perpendicular to the Hubble flow and therefore is directly measured by the proper motion between any two objects that are gravitationally coupled.

Individual galaxies and clusters do not change size measurably on the time scale of human observations. So, the time rate of change of the angular size depends only on the angular size, the Hubble constant, and the redshift. This eliminates the need to know the size or orientation of the “ruler.” Darling points out that measuring the real-time rate of change in the angular size of gravitationally bound objects such as galaxies or clusters of galaxies can provide a direct, geometric measurement of the Hubble constant and the object’s distance.

Darling applied his technique to 284 radio quasars with known redshifts observed with the Very Long Baseline Interferometer (VLBI) from 1990-2010. He examined the proper motions of quasar pairs with both large and small separations. Large separation pairs (200-1500 megaparsecs — Mpc), which should not be gravitationally associated, showed zero proper motion as expected. However, the proper motion results for small separation pairs (less than 200 Mpc), which should be gravitationally interacting, were inconclusive: but the sample size was small, only seven pairs.

Where does this leave this promising new technique? Present instrumentation has sufficient astrometric and proper motion sensitivity, and angular resolution. The sample size of small-separation quasar pairs needs to be larger, and Darling expects that small-separation pairs will show significant deviation from the Hubble flow. Improved VLBI astrometry would be helpful. Optical proper motions determined by the recently launched Gaia spacecraft, which will have access to close to 500,000 quasars, will prove critical.

JENNIFER BIRRIEL is an Associate Professor of Physics in the Department of Mathematics, Computer Science & Physics at Morehead State University in KY.
Seasons Greetings

Earth isn’t the only planet that goes through a change of seasons.

It’s winter here in Tucson as I write this, so we’re experiencing shorter days, colder weather, and more frequent rain. We tend to think of seasons in terms of local weather or the months of the year, but they’re actually caused by certain characteristics of the planet we live on in relation to the Sun it orbits.

Two features of a planet’s orbit cause seasons: obliquity (the amount of tilt of its rotational axis), and eccentricity (how far off its orbit is from a perfect circle). All worlds have these characteristics, and their variation from planet to planet results in quite a disparity in what we call “winter.”

Mercury and Venus both have very small obliquities — their poles are almost perfectly perpendicular to their orbits. Also, Venus’ orbit is almost perfectly circular, and when you add in its runaway greenhouse effect, the planet has pretty much no seasonal variation. The thick carbon dioxide atmosphere keeps the entire planet at virtually the same temperature — day or night, summer or winter. The only possible relief from the toasty 867°F weather is to climb a mountain, and even that won’t help very much.

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Mercury, on the other hand, has extremely bizarre seasons despite its small obliquity for two reasons. It has the largest orbital eccentricity of any of the planets — when it’s nearest the Sun, it’s about 1.5 times closer than when it’s farthest. It’s also in what’s known as a 3:2 orbital resonance — for every two Mercurian years, there are only three Mercurian days. So when it is “summer noon” on a certain part of Mercury, the temperature rises to more than 800°F, but during “winter night” at that same location, it drops to –279°F.

Earth’s axis is tilted by 23.4°, but it has an almost perfectly circular orbit. So our seasons are dictated mainly by the axial tilt.

Mars has a similar obliquity, about 25°, but it has a very eccentric orbit, so the seasons are not equal in length. The planet is much closer to the Sun during its northern winter (and therefore moving faster in its orbit), which results in a winter that’s shorter and warmer than its southern counterpart. Winter in either hemisphere causes dry ice to form at the winter pole, as a portion of the carbon dioxide in the Martian atmosphere freezes to the ice cap. But, because of the different lengths of the seasons, more CO₂ freezes out during the northern winter than the southern one — so much so that the atmosphere of Mars is actually thinner when it’s winter in the north.
Gas giants generally demonstrate their change of seasons via thermal changes in their clouds — colder in winter, warmer in summer, and often brighter or with different colors depending on the season. But this doesn’t hold for Jupiter. Its obliquity is only marginally greater than Venus’, and there’s a similar lack of seasonal variation. Currently the northern hemisphere of the largest planet is enjoying spring, but you won’t notice much difference between the local equivalents of “April” and “November.”

Saturn follows the typical gas giant pattern, with an interesting extra factor — its rings. This famous conglomerate of rock and ice casts a shadow on the planet, and the shadow’s location changes with the seasons. Now, during Saturn’s northern spring, the northern hemisphere is getting warmer, but the change is particularly acute in the region currently emerging from 15 years of ring-shadow darkness. In the depths of winter, parts of the visible northern clouds are actually blue, as the colder weather thins the upper clouds. Now that it’s late spring, the clouds have resumed their “classic” yellow-brown appearance. We’ve learned all these details from the Cassini spacecraft, which arrived in 2004, just two Earth years after the northern winter solstice. If the mission is maintained as planned, it will last until Saturn’s northern summer solstice in 2017, and for the first time we’ll have witnessed, close up, all the seasons on a gas giant.

Uranus is famous for being the “sideways” planet. Its axis is tilted 97°, so it appears to be laying on its side. A consequence of this is extreme seasons — winter for one pole means a decades-long night, as the Sun shines almost directly on the other pole. As spring arrives, and parts of the atmosphere are touched by the Sun for the first time since the previous fall, huge storms are triggered, some nearly the size of North America. We’re still learning about the seasons on Uranus, because its year is 84 times longer than ours, and we’ve been peering at this planet with large scopes for only a few decades.

A season on Neptune lasts 40 Earth years. It was discovered in 1846, so we’ve barely been aware of it for a full Neptunian year, let alone acquiring good data on all its seasons. We do know that its obliquity is about 28°, in the same neighborhood as ours, so it will theoretically experience similar amounts of seasonal change. It had its northern winter solstice in 2003, and as the southern hemisphere slowly moves through spring and into summer, its clouds have brightened as it receives more sunlight. We’ll have to wait another 20 or so years to be sure this is a seasonal change, but for now it seems likely.

Pluto — leaving aside the question of its planetary status — has a highly eccentric orbit. Its axial tilt is even more extreme than Uranus’ so it, too, is literally rolling sideways around the Sun. This leads us to believe it will have similarly extreme seasons, but we really won’t have good data until the New Horizons spacecraft flies by in 2015.

We now know that our planetary system is only one of many. With new planets constantly being discovered in orbit around distant stars, we’re sure to come across many more fascinating variations on what we think of as “traditional” seasons.

Emily Joseph is a Research Assistant, with an emphasis on Mars studies, at the Planetary Science Institute. You can find her on Twitter @EmExAstris.
String theory — what many physicists call the best promise for a unified “theory of everything” to describe all known physics — is not without its knots.

For one thing, there’s that requirement for extra dimensions: a 10-, 11-, or even a 26-dimensional universe is required to make the math work out correctly. And then there’s the paucity of practical tests to confirm string theory’s predictions. The energy level and size scale to see the effects of string theory are too extreme.

Thought it was hard to find the Higgs boson? Ha! Energies needed to see the effects of strings are millions of times higher.

“Scientists have joked about how string theory is promising…and always will be promising, for the lack of being able to test it,” said James Overduin of the Department of Physics, Astronomy, and Geosciences at Towson University.

But inspired by Galileo and Newton and their work on gravity, Overduin and his students have stumbled upon a possible test for string theory relying on free-falling bodies in the solar system. The work is featured in the journal Classical and Quantum Gravity.

String theory posits that all matter and energy in the universe is composed of one-dimensional strings, thought to be a quintillion times smaller than the already infinitesimal hydrogen atom and thus too minute to detect indirectly. String theory hopes to provide a bridge between two well-tested yet incompatible theories: Einstein’s general relativity, our reigning theory of gravity, and the standard model of particle physics, or quantum field theory, which explains all the forces other than gravity.

Overduin and his group — Towson University undergraduate students Jack Mitcham and Zoey Warecki — expanded on a concept proposed by Galileo and Newton to explain gravity. Fable has it that Galileo dropped two balls of different weights from the Tower of Pisa to demonstrate how they would hit the ground simultaneously. Years later Newton used telescopic observations to conclude that Jupiter and its moons fall with the same acceleration toward the Sun.

The same test could be used for string theory, Overduin said. The gravitational field couples to all forms of matter and energy with precisely the same strength, an observation that led Einstein to his theory of general relativity and is now enshrined in physics as the equivalence principle. String theory predicts violations of the equivalence principle, because it involves new fields that couple differently to objects of different composition, causing them to accelerate differently.

Building on work done by Kenneth Nordtvedt and others beginning in the 1970s, Overduin’s group considered three possible signatures of equivalence principle violation: departures from Kepler’s Third Law of planetary motion, drift of the stable Lagrange points, and orbital polarization (the Nordtvedt effect) whereby the distance...
between two bodies such as the Earth and Moon oscillates because of differences in acceleration toward a third body such as the Sun. No evidence for these effects has been found, but all observations in science involve some degree of experimental uncertainty. Overduin's team suggests using these experimental uncertainties themselves to obtain upper limits on possible violations of the equivalence principle.

“The Saturnian moons Tethys and Dione make a particularly fascinating test case,” said Warecki, who presented the work at the January 2014 meeting of the American Astronomical Society. “Tethys is made almost entirely of ice, while Dione possesses a significantly rocky core. And both have Trojan companions,” essentially mini-moons in Lagrange points that lead or follow these larger moons.

The limits obtained in this way are not as sensitive as those from dedicated torsion-balance or laser-ranging tests, but they are uniquely valuable as potential tests of string theory nonetheless, because they cover a much wider range of test-body materials.

Stacy McGaugh, Professor of Astronomy at Case Western Reserve University and an expert on dynamical astronomy, maintains guarded optimism about the Overduin team’s work, calling it “a very neat concept. Looking for such effects has a huge potential payoff even if the odds seem long,” he said.

Best yet, in Overduin’s opinion, this test is almost free. “We are already monitoring these objects; we only have to analyze the observations.”

Science writer CHRISTOPHER WANJÉK maintains a three-dimensional existence in Baltimore.

Grail Quest

Are learning and problem solving in Astro 101 transferable skills for students?

Many of us have course goals that state: “Students will learn how to learn and develop stronger problem-solving skills.” We trust that, if students can learn how to problem solve in one environment, they can transfer those principles to a variety of environments. But experience has shown that students have trouble adapting their learning to similar concepts within Astronomy 101, much less extend their learning to other disciplines. Can Astro 101 instructors effect transfer of learning?

Transfer of learning takes many forms. Near transfer applies knowledge or skills to a very similar situation (for instance, applying the experience of using Kepler’s law to find a star’s mass to the task of finding a galaxy’s mass). Far transfer employs knowledge or skills to an apparently dissimilar situation (e.g., using the luminosity and temperature of the Sun to find the temperature of a planet). Researchers disagree as to the distance between near and far but agree that there is a continuum between these types of transfer.
In addition, cognitive psychologists speak of lateral transfer when the transferred skill is of the same level. Vertical transfer is when a lower-level skill is needed to solve a higher-level problem (e.g., using galaxy redshifts to build a Hubble diagram to find the age of the universe). Low-road transfer is an automatic application of skill or knowledge (as in the relationship between the Earth-Sun distance and Earth’s temperature, applied to find the temperature of Mars). High-road transfer requires deliberate attention to seemingly disparate characteristics of two problems in order to develop a solution.

As educators, we seek especially to improve the far-, vertical-, and high-road-transfer abilities of students. Some authors claim that this is a bold but unachievable quest, because knowledge is highly contextualized. As D.K. Detterman says, there is little research evidence for meaningful transfer — if you want a student to learn a particular skill, teach it to them.

John Sweller, Richard Clark, and Paul Kirschner, exploring the skills of chess masters, find that their problem-solving skills are only average in other contexts. In fact, the masters do poorly when random game configurations are presented to them. Masters apparently only excel in long-term memory of specific information, which speaks poorly about development of general problem-solving skills. D.N. Perkins and Gavriel Salomon claim that transfer is rare, because most of the knowledge that students acquire is “inert” — they do not know how to apply knowledge to new situations even when the transfer distance is small.

But other experts dispute that transfer cannot be taught. Perkins and Salomon agree that part of the issue is that students were not taught for transfer in the first place. Instruction needs to decontextualize knowledge and skills. If we wish students to be able to apply the problem solving used in finding stellar distances, then we need to abstract the ideas of problem solving in our Astro 101 courses to other situations such as economics, political science, or philosophy. While one can argue that these disciplines are outside the purview of Astro 101, building cognitive bridges is our mandate if students are to succeed.

Teaching for transfer should emphasize mindful interactions with learning. To prevent students from merely memorizing information and retrieving it on cue, we should introduce “hugging” — if we want students to know how to find the distances of galaxies using their magnitudes, then we need to introduce and practice this idea when stellar magnitudes and distances are introduced. High-road transfer will not occur if these low-road transfers are not developed first.

High-road transfer requires “bridging,” or the explicit introduction of patterns, analogies, and other learning tools. A. Marini and R. Genereux (The Challenge of Teaching for Transfer, 1995) suggest that we need to teach students to distinguish between content and conceptual knowledge, and procedural and strategic knowledge, in order for them to be able to apply their learning in new situations. Bridging exercises may be as simple as asking students during class to provide examples of similar conceptual structures from past course sections, or engaging them in finding useful analogies.

Tackling bridging and far transfer may seem like a task that we neither have the time nor, perhaps, the skills to engage. But I suggest that we embrace hugging explicitly in the classroom so students succeed with low-road transfer. And we, at least, discuss the ideas of high-road transfer with them, so we expose them to the greater possibilities of learning. Who knows, perhaps if they learn to take the low road, they will aim for the high road once they know it exists.

DAVID BRUNING teaches astronomy at a Midwestern state university. He believes in teaching students explicitly about cognition and how learning works.
**Turnover**

*The end of term, and the departure of my current class, is always a little sad.*

Every December brings the bittersweet end to yet another Fall term. By this time each semester, I'm usually ready to collapse. Homework assignments, which I've been procrastinating grading, have matured into intimidating stalagmites on my kitchen table. Papers and projects crowd out the other e-mails in my inbox. Every one of the tasks I was “totally going to get done this semester” seems to laugh at me from neglected to-do lists. So even with final exams still to be written, the last day of class always brings a great sense of relief — the piles (at least until new ones begin in January) won’t grow any bigger!

While I’m celebrating the possibility of momentarily being caught up with work, however, the reality that another class has come to an end is also a little sad. Students in my Honors classes are required to take one Honors science course in the Fall and another in the Spring, so I will commonly have some students take a second semester with me. But because I primarily teach introductory level classes (mostly for students who are not majoring in science), I will never again see in the classroom most of the students I have come to know during the semester.

This means I have very little time to influence how these students think and feel about science. I believe I’ve done my job correctly if students walk away from my courses having been challenged, but also having had a positive experience with science. I hope they’ve learned some factual content, stretched their creative capacity, gained an understanding of the process of modern science, and had some fun with science.

I reflect on these goals at the end of every semester — have I succeeded at any of them? In some semesters, it’s easy to read the room — the students are vocal and expressive and let you know in many ways what has gone right and wrong. Other semesters, the students...
are like a tough nut — hard to crack and revealing few of their thoughts. In fact, each class develops its own personality, which is always more than just a sum of individual student personalities. Students react, interact, and feed off one another to transform each class into its own living entity. For this reason, two sections taught in the same semester, with the exact same content, can be completely different from each other. Alas, success in one section does not guarantee success in the other.

With reflection, on both goals and class personalities, come the thoughts of how to teach the course again in a later semester. This is always the moment I realize that the end-of-semester feeling of collapse is both inevitable and my own fault. No matter how many times I’ve taught the same class, I am never satisfied that everything went perfectly. I’m sure most of our lives would be easier if we could live with “good enough” — but I know I’m not the only one who constantly tweaks and changes course. There is no doubt that the end of each semester would be a lot calmer without this constant addition, subtraction, and changing of material.

Modern science changes quickly, particularly in astronomy and physics. With non-science majors, part of improving their science literacy is to hook them with the most relevant material — particularly whatever they are encountering in the media. The constant need to keep the material interesting and up-to-date is definitely a challenge. Thus every semester ends in the same frantic way. The payoff, hopefully, is that my students have learned — and will retain — an appreciation for science. So, don’t mind me. I’ll just be a crumpled heap over there in the corner for a little while, but I will be ready, in a few weeks, to start the cycle all over again.

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Celebrating the ASP’s Past Quarter Century

Some personal reflections on the ASP’s recent history.

By Andrew Fraknoi

n 1989, the Astronomical Society of the Pacific (ASP) celebrated its 100th year of service to astronomy, education, and the public. Now, remarkably, another 25 years have passed, and the ASP commemorates its 125th anniversary on February 7, 2014. As the Executive Director of the Society from 1978 to 1992, and then as Senior Educator, I was deeply involved in the ASP’s past quarter century. Obviously it’s not possible to do justice, in this short article, to the full range of the Society’s activities during the past 25 years. So my aim is to highlight the ones that I have some personal knowledge of and that may be of interest to our readers. In the extended version of this article on the ASP’s website, I have included a series of charts, boxes, illustrated tables, and more images to give you a better flavor of all that happened from 1989 to 2013.

An Amazing Quarter Century
To mark the occasion of the ASP’s 100th anniversary, we commissioned Katherine Bracher, an astronomer and historian, to write a centennial history of the Society, which you can find on the History of the ASP webpage. That history ended with the ASP buying an office building in San Francisco as its permanent home and holding a large, centennial-celebration meeting at the University of California, Berkeley. (The late Carl Sagan of Cornell University was the public keynote speaker, and quickly sold out the largest hall on campus.) Certificates and letters of congratulations were received from the President of the United States, the Governor of California, and many other political and scientific leaders. Also, the International Astronomical Union named Asteroid 2848 Asteroid ASP, in honor of the Society’s work in education and public outreach.

During this period, the Society elected its first president who was a professional science-museum educator (Dennis Schatz). The ASP’s educational programs expanded to include many new audiences such as park rangers, pre-school children, educators in nature and environmental centers, and a host of people (from around the world) who use the materials the ASP makes available free via the Web.

Awards for Education
Ever since Catherine Wolfe Bruce endowed the ASP’s first and still most prestigious prize (the Bruce Gold Medal) in 1898, the Society has viewed recognizing achievement in astronomy as a key part of its work. What we were missing at the time of the ASP’s centennial...
were specific awards for work in astronomy education. The Society did have a long-standing award for astronomy popularization (the Klumpke-Roberts Award), but it often went to scientists whose remarkable contributions were in public outreach and not in formal education. Yet much of the important work of capturing new enthusiasts for astronomy went on quietly, behind-the-scenes, in our nation's classrooms. Surely, the ASP was the right organization to recognize this work, if we could find donors to endow new awards in the area of education.

In the early 1990s, ASP supporters Cindy and Terry Brennan, who had fond memories of a high-school teacher transmitting a love of astronomy, agreed to fund a new award for a lifetime of contributions to teaching high school astronomy. The Society presented the first Brennan Award in 1993, and this award has honored either a high school astronomy teacher, or someone who trains high school astronomy teachers, ever since.

Another opportunity came some years later. I was at a wonderful party for ASP meeting attendees at the home of Board member (and renowned comet discoverer) David Levy in Tucson in 2005. There I fell into a discussion with veteran planetarium educator (and long-time friend of the ASP) Jeanne Bishop, whose father, Richard Emmons, had recently passed away. Emmons was a polymath who had been an engineer, a college teacher, a sky observer, planetarium designer, and astronomy enthusiast — and someone his community members called “Mr. Astronomy.” Jeanne was eager to honor him with some sort of lasting memorial through the ASP, but wasn’t sure what parts of his work the Society should recognize.

Given her father’s passion for college teaching, and the lack of any prize in the US for college teaching of astronomy, she was happy when I suggested that we set up an ASP Emmons Award to recognize those who devote their lives to teaching introductory astronomy for non-science majors. The award has been part of the ASP repertoire ever since.

In the meantime, in 2000, a generous ASP Board member very kindly set up the ASP Las Cumbres Award for significant educational and outreach work by an amateur astronomer. The ASP had no trouble finding amateur astronomers who spent a considerable part of their time helping others appreciate the wonders of the universe. (Indeed, as you will see later, the Society was so inspired by the work of amateurs in outreach that a national program, called the Night Sky Network, was initiated to nurture it.)

Thus, a suite of educational recognitions was now all-inclusive. The ASP, whose mission had increasingly focused on the vital work of astronomy education, now boasted awards that recognized work in all the main arenas where scientists, educators, and enthusiasts shared their passion for the heavens with others.

**ASP Meetings**

Since 1989, the Annual Meetings and Conferences of the ASP have changed quite dramatically. Back in the 1980s these meetings, always in a university setting, provided a smorgasbord of programs — something for each segment of the Society’s membership. Back then, universities welcomed scientific societies and allowed them to use the facilities at a very reasonable rate or even free.
Those days are long gone, and after the 1990s a variety of meeting formats were tried to help keep expenses down and bring in more revenue. Meetings were shortened, simplified, and placed in accessible hotels. Meeting topics became more focused, and new audiences were found for them. Although many of the gatherings during the last 25 years were successful as experiences for the participants, meeting finances remained unpredictable.

During the past seven years, the meetings have focused on astronomy education and public outreach (EPO), bringing together the cadre of educators and astronomers for whom this was their major professional concern. Thanks to increased funding of education from both the National Science Foundation (NSF) and NASA, there was significant growth in this part of the astronomy community during the 1990s and 2000s. The ASP was happy to provide a “watering hole” meeting where EPO practitioners could share their projects and experiences.

**Cosmos in the Classroom**

There is one addition to ASP meetings that I am particularly proud of. One of the most important interfaces between the astronomical community and the public is the world of “Astronomy 101” — the introductory astronomy course taught at colleges and universities around the US and taken by an estimated 250,000 students each year. Many of these courses are taught at smaller colleges, often at institutions that do not have an active research program in astronomy. In many colleges, such as the one where I teach, the astronomy “department” consists of one full-time faculty member and perhaps one or two evening part-timers. In the past, such instructors have often felt isolated from the mainstream of the astronomy world and have had few opportunities for getting to know each other and compare notes.

So in 1996 I started organizing ASP symposia, for instructors of introductory astronomy for non-science majors, that we called **Cosmos in the Classroom**. There was a very positive response to these meetings (with about 200 instructors coming to some of them), and they have been held every three years or so on a pleasant college campus, where participants could take the time to get to know each other. By raising funds for this worthwhile cause from a number of government programs and private companies, we were able to offer scholarships in the form of travel money for instructors from small colleges where no travel budgets existed. Many grateful participants from such institutions told us that this was the first astronomy meeting they had ever been able to attend in their faculty careers.
However, there were many Astro 101 instructors around the country who could not afford to come. Soon we hit on the idea of publishing all the papers and handouts from each Cosmos symposium as an inexpensive loose-leaf notebook that could be of immediate use to anyone who teaches introductory astronomy. The last of these notebooks was published as a CD-ROM, but the idea remains the same.

The ASP Takes a New Path
After we celebrated the Society’s 100th anniversary in 1989, the Board, staff, and I began looking at the long-term funding of Society activities. Even with the wider range of income sources that we had managed to find in the 1980s, our hopes for tackling the growing scientific illiteracy in this country (and elsewhere) were far greater than our resources. Savvy ASP Presidents such as Frank Drake and Julie Lutz (and many Board members) urged us to take a look at federal grants as an additional way to support our educational work. Agencies such as the NSF and NASA were taking a deeper interest in education, and they might welcome a proposal for an innovative project using the ASP’s existing educational expertise and national scope.

Remarkably, up to this point (more than 100 years into our history), the ASP had never won, or even requested, a federal grant, but we geared up to do so. Our first proposal went to the Informal Science Education branch of the National Science Foundation, and, to our great delight, our suggestion for a new kind of astronomy education project was accepted and fully funded. It would be the first of several successful proposals to NSF and NASA for programs and projects. Indeed, such grants became a significant source of funding for the Society in the following decade.

Project ASTRO
The first NSF-grant idea we came up with was, in many ways, an amalgam of all the approaches and constituencies we had been experimenting with in the 1980s. The seed came from the responses we had to our summer meeting workshops on astronomy for teachers in grades 3–12. Time and again, teachers who had taken the workshop would approach us and say something like, “Gee, that was fun and I’m excited about including more astronomy in my classes next year. But it’s still a little scary for me, since I never really took astronomy in college. It would be so great to have one of you [workshop presenters] come into my classroom and help me out!”

While the few of us who taught these workshops would hardly have the time to go into classrooms around the country, these requests provided an inspiration. Could we train a cadre of astronomers (both professional and amateur) who could partner with a local school teacher and “adopt” a class for a year? And could we develop a notebook of activities and resources that would allow us to transfer what we had found effective in our summer workshops to these volunteer astronomers? We asked the NSF if we could start an experiment in California to see if this might allow us to expand our outreach to schools.

We called the program Project ASTRO and, with Dennis Schatz’ help, began offering workshops for astronomers and their teacher partners in San Francisco and Los Angeles in 1994.

Michael Bennett, Andrew Fraknoi, and Jessica Richter, key early ASP staff members of Project ASTRO, celebrate the news that the Society received a grant to expand the program nationwide in the late 1990s. (ASP)
The collaborations were so successful that we were able to get NSF funding to expand our staff and start a national network of Project ASTRO sites, many of which continue to this day. Thousands of partners have now been trained to do hands-on, inquiry-based activities in grades 4–9, and more than 300,000 students have had “their own astronomer” visit their classroom as a result.

As part of this project, we began to collect the best astronomy activities and teaching resources from projects and programs around the country. We published them in a giant notebook called *The Universe at Your Fingertips*. This became the best-selling product the ASP ever produced, with tens of thousands of copies finding homes in colleges, schools, amateur clubs, planetaria, and museums throughout the world. Today, the notebook is published as a DVD-ROM (so it can include images and videos), but the spirit of encouraging a hands-on approach to the pleasures of exploring astronomy for young people remains the same.

**Family ASTRO**

At many Project ASTRO schools, teachers got the whole family involved by having observing or discussion projects that the students took home. Others sponsored back-to-school nights where the local amateur astronomy club members set up their telescopes. The promise of telescopes sometimes brought out parents who never came to school activities, and the teachers were delighted. This led us to propose (and the NSF to fund) a new branch of the program, called **Family ASTRO**, where we trained our volunteer astronomers to offer weekend or evening sessions specifically devoted to family astronomy projects and games. The idea was to get families away from watching the stars on television and help them to know the real stars in the sky instead.

One of the advisors for this project was the head of a professional game company, and when we showed him the ideas we had for family astronomy games, he chuckled gently — the way parents do when young children show them an especially clumsy drawing or poem. Taking pity on us, he offered us some volunteers from his company staff and helped us design and produce games we would never have developed on our own. These educational games, such as *The Universe at Your Fingertips*, the collection of activities and resource materials for Project ASTRO, comes as a DVD-ROM and includes images, videos, and plenty of background information to help astronomers and teachers form effective partnerships. (ASP)
as *Moon Mission* and *Cosmic Decoders*, were quite a hit with both trainers and families, and they are still available through the ASP’s *AstroShop*.

**A Continuation: Astronomy Ambassadors**

We were again delighted when the National Academy of Sciences ultimately selected Project ASTRO as one of the best science education programs using scientists in the US. During the intervening years, it has generated ideas for many other programs at the Society, including some dedicated to improving outreach through amateur clubs, and one that helps small museums and nature centers do more hands-on astronomy activities. More recently, staff has been transferring some of the training methods used for Project ASTRO to the new *Astronomy Ambassadors* program the ASP is undertaking with the American Astronomical Society (AAS). When she was President of the AAS, Debra Elmegreen of Vassar College wanted to see young astronomers at the university level receive training to be more effective when it came to education and outreach. Her idea was to help graduate students, post-docs, and newly minted faculty feel comfortable in classroom and public situations (something graduate school doesn’t always prepare you for.)

Some of the same techniques that made Project ASTRO volunteers comfortable visiting a sixth-grade classroom also work well for astronomers explaining their work at a city festival or fair, or giving a talk at the local science museum. The inaugural joint ASP/AAS workshop was held in January 2013, and others followed.

**The Night Sky Network**

One of the most interesting findings from the evaluators’ analysis of the initial growth phases of Project ASTRO was that dedicated amateur astronomers performed every bit as well as professionals as “visiting astronomer” partners in the schools. When it comes to explaining the phases of the Moon or the scale of the solar system to sixth graders, knowing the detailed physics of black-hole accretion disks doesn’t give you much of an advantage. In fact, well-prepared amateurs, using the ASP’s hands-on activities, were very effective in helping teachers bring age-appropriate astronomy to their classrooms. Similarly, in Family ASTRO, some of the dedicated amateur partners were the most successful leaders of family activity groups in the whole program.

This led the Society to think seriously about the amazing potential, for education and public outreach, available in the hundreds of amateur astronomy clubs and thousands of amateur astronomers in the US. Starting with a planning grant from the NSF, the ASP conducted a survey of amateur astronomers explaining their work at a city festival or fair, or giving a talk at the local science museum. The inaugural joint ASP/AAS workshop was held in January 2013, and others followed.
astronomers in 2002 to learn more about the kinds of outreach they were doing, and what needs and challenges they identified to doing more and better outreach. The results indicated that while clubs did engage in considerable community outreach, they were frustrated because there weren’t many existing materials designed to be used at club observing sessions or community outreach events. Another thing they wished for was opportunities to exchange ideas with amateurs in other cities who were also conducting outreach.

Intrigued by these results, the leaders of the Navigator Program at the Jet Propulsion Lab provided funding to establish an online community, with the Society taking the lead to create The Night Sky Network. The ASP recruited more than 100 astronomy clubs from across the country to launch the network in 2004 and provided them with an outreach toolkit called “PlanetQuest.” It contained easy, hands-on demonstrations that they could do in multiple settings, including the low-light venues of their observing events (“star parties”). For easy training, a DVD demonstrating the activities was included.

As word of the Network spread, there were soon several hundred clubs involved — a real coalition of amateur astronomers from across the country actively engaging their communities in showing and explaining the skies (and basic ideas in astronomy) via outreach events. The ASP, under contract to NASA, developed 11 outreach toolkits on a variety of popular astronomy topics, created more training DVDs on how best to use the outreach materials, and provided ongoing support and recognition through monthly newsletters, awards, telecons, and webcasts with NASA scientists.

As of 2013 there were 425 clubs involved, and they have logged more than 25,000 outreach events — from school enrichment programs to urban and county fairs. To date, these events have touched the lives of some 2.7 million people. Whenever there is an eclipse, a good meteor shower, a planet transit, or other sky event, the Night Sky Network clubs are setting up telescopes, volunteering their time in formal and informal educational settings, and talking to local reporters — acting as trained ambassadors of the astronomical community.

**Celebrating Galileo**

In 2009, the International Astronomical Union sponsored a worldwide celebration of the 400th anniversary of Galileo turning the telescope to the heavens. Each country was encouraged to organize events and ongoing educational programs for this International Year of Astronomy. The ASP was active in both the international and the US organizing committees — I had the pleasure of serving as the Executive Secretary for the US Program Committee. Many cities and regions around the country offered lectures, star parties, booths at community fairs, open houses, teacher workshops, and other programs during the course of the year.
The ASP helped teachers and other educators to do hands-on astronomy through its **Galileo Teacher Training Program** (GTTP). Some of the workshop agenda was based on the activities and materials the Society had developed for its annual “Universe in the Classroom” weekend workshops between 1980 and 2002. But others were developed specifically for the new project and involved Galileo’s iconic observations of the moons of Jupiter and the phases of Venus.

With more than 30 years of teacher workshops under its belt, the Society has now trained more than 5,000 teachers in the US and Canada on how to do astronomy units and projects in their grade 3–12 classes. Many of those teachers have gone on to train their own colleagues and give talks at conferences for teachers on the techniques they learned from the ASP.

**Other Programs**

There are a number of other excellent education and public outreach programs offered by the ASP during the past quarter century, and I want to mention them briefly:

**Sharing the Universe** was an NSF-funded study of amateur astronomy clubs to discover what sorts of structures and activities encourage more involvement in education, and to develop additional support mechanisms that will help establish a culture of outreach within a club.

**Astronomy from the Ground Up** is creating a growing community of 1,000 informal educators (and counting) in small science and nature centers who are bringing more astronomy to their audiences (often in institutions where no one had offered astronomy programs before). This community of educators is actively supported by materials and training developed by the ASP and others, and by ongoing communication and online learning through a Web portal.

**Sky Rangers** is a project to extend the training and materials from **Astronomy from the Ground Up** to the dedicated rangers who work with the public in national and state parks. Through this innovative program, they receive tools to help their many thousands of visitors enjoy the night sky and the ideas and discoveries of astronomy.

**My Sky Tonight** is an NSF-supported program, working with children’s museums and science museums, which offers informal astronomy learning opportunities for young children. It’s designed to help them develop identities as “kids who like science” in a culture where there is pressure not to be proud of an interest in science.

The **Galileo Educator Network** has been formed to help teacher educators and teacher professional development providers engage and educate teachers of astronomy and to promote the effective use of NASA-developed and NASA-supported resources.

Together with the SETI Institute, the ASP offers **SOFIA Education and Outreach**, which provides educational and public outreach...
programs for NASA’s Stratospheric Observatory for Infrared Astronomy (SOFIA) project. Selected teachers get to fly in SOFIA’s 747 airplane, which carries a 2.5-meter (100-inch) telescope, and be part of a research project.

The ASP cosponsors a local public lecture series — the Silicone Valley Astronomy Lectures — that explains new astronomical developments in everyday language and brings astronomers to audiences of up to 950 people. Thanks to a generous donor, the series is recorded in both audio and video format. The ASP hosts the site for the audio podcasts, while the videos can be found on the SVAstronomyLectures YouTube page.

The ASP as a Publisher
The ASP first became a publisher in 1918, when written transcripts of its Adolfo Stahl public lectures were issued as a souvenir book. (That print volume is now quite a collector’s item.) The ASP also published various soft-cover books and booklets during the 1980s, when the Society’s catalog of educational materials became a million-dollar-plus enterprise.

But in 1988, just as we were going into our centennial celebrations, the ASP began publishing a new series of hardcover books encompassing the proceedings of technical conferences on a wide range of astronomical topics. Astronomers had been complaining for years that commercial publishers were raising prices on such conference volumes, confident that university libraries would buy them no matter what the price. The ASP thought that there would be room in the marketplace for books priced so individual scientists (and not just libraries) could afford them — and it turned out there was. And thus the ASP’s Conference Series was born.

Since then, the ASP has published nearly 500 volumes for scientists, graduate students, and libraries, and has become the largest publisher of conference proceedings in the field of astronomy and astrophysics. These days, many people obtain the books (or specific papers) electronically, and in 2013 the ASP Conference Series website had more than 100,000 visitors from more than 150 different countries.

Our Other Publications
These days, the word “publication” no longer means a printed book or magazine. The world is going digital, and the ASP is no exception.

In May 1925, the ASP published the first of what turned out to be more than 46 years of ASP Leaflets, a series of small pamphlets that explained astronomical topics in a non-technical manner. In 1972 they were replaced by Mercury Magazine, which covers astronomy, astronomy education, the history of science, and Society news, also at a non-technical level. In 2008, Mercury moved from a print to an electronic (PDF) format.

Also in PDF format is Astronomy Beat, a monthly column in which astronomers and astronomy educators take readers “behind the scenes” and describe how new projects and discoveries really happen. It began in mid-2008 and has now published more than one hundred issues.

The Universe in the Classroom, the ASP’s newsletter on teaching astronomy in grades 3–12, started in the winter of 1984-85 and is now hosted on our website. Each issue features astronomy articles, classroom-ready activities, and resources.

The Society’s website has become a much-recommended place where educators can find hands-on activities, articles of particular interest, astronomy updates, and resource guides. Some of the more popular resource guides on the Educational Resources webpage include “Debunking Pseudoscience,” “Women in Astronomy,” “The Moon,” “Exoplanets,” and “Science Fiction with Good Astronomy.”

Finally, while not a publication as such, the AstroShop is the
Society's Web-based catalog of educational materials and features activity guides and kits, family games, books, DVDs, observing aids, and much more. Its contents are designed to help K–12 teachers (and astronomers who work with them), college educators, families, and amateur astronomers who do outreach.

Onward to the Next Quarter Century

As I mentioned at the outset, this is not an exhaustive or balanced history of the Society’s last 25 years. It’s merely a stroll down memory lane by a former ASP staff member who was fortunate to participate in so much of it. There were many other ways in which the years brought change — for example, much of our work and communication went from printed materials, mailed via the good old post office, to online information accessed any time from any computer, tablet, or smartphone.

During this time, our non-profit Society also tried a number of different ways to increase the donations received from individuals and companies who support our goals and our educational endeavors. In this regard, I’d like to acknowledge the late Michael Gibbs. As the Society’s Director of Advancement between 2005 and 2008, his efforts were instrumental in reviving and advancing the ASP’s Fund Development effort, giving renewed vigor to both our meetings and our educational programs.

There are so many other good stories about the last quarter century at the ASP. There was the time I was watching my favorite television show, “The West Wing,” and suddenly Project ASTRO was mentioned in connection with the debate the characters were having about whether an egg could be stood on its end only during the Spring Equinox. I almost fell off my chair! (If you want to see it, the episode was during Season 4 and is entitled “Evidence of Things Not Seen.”) Or the Google Hangout NASA organized to calm fears about the end of the world on the Winter Solstice of 2012, with former ASP President David Morrison and I joining other skeptical scientists around the country.

In early 2014 the Society named Linda Shore as its new Executive Director, whose pleasure and responsibility it will be to build on the last 25 years (and the full 125-year history) of the organization. With a country and a world mired in too much apathy and ignorance about science, and with the denial of so many facts about our planet and our universe in the media and among some political leaders — yet with a guarantee of remarkable discoveries about the cosmos flowing from new instruments and new ideas in our field — Linda will have a tremendous opportunity to guide the ASP to an even greater role in science, education, and outreach. Here’s to many more decades of the ASP being a force to be reckoned with, in both the astronomical community and the public understanding of science.

ANDREW FRAKNOI was the Executive Director of the ASP from 1978 to 1992. The year 2013 marked his 40th year of involvement with the Society, starting as a volunteer and now as an educational consultant. Currently he is Chair of the Astronomy Department at Foothill College and served as the founding co-editor of Astronomy Education Review. His hobby is making bibliographies (hey, it’s no worse than golf or knitting), and the ASP has indulged him by featuring his resource guides on its website.
Discovering the Universe at Astronomy Camp

Research and fun go hand-in-hand during the University of Arizona's summer Astronomy Camp.

By Elena Saavedra Buckley

The silhouette of Kitt Peak National Observatory is prominent in this double-exposure of sunset during the transit of Venus on June 5, 2012. Astronomy Campers used four of the telescopes shown here. Copyright David A. Harvey Photography; used with permission.
There’s a saying I’ve heard in multiple forms, but the basic premise is this. No matter where you are, you can look up at the Moon and know that someone, somewhere else in the world, is looking up at the same one.

If you happened to gaze at the Moon in late June during the past few years, chances are a group of teenagers was looking at it too. These teens, though, were probably looking at it a bit differently — with giant telescopes on a high peak in Arizona.

They were attending Astronomy Camp, a nine-day summer program held at Kitt Peak National Observatory near Tucson, Arizona. I had the privilege of being one of those teenagers this past year at the Advanced Teen camp, and I know I’ll never look at the Moon, or the rest of the sky, in the same way.

Astronomy Camp sounds fairly straightforward, and it is. It’s a summer haven for kids interested in studying the cosmos. One might think, though, that the camp is for those who grew up around telescopes and whose first word was “Andromeda.” This presumption, which I previously shared, is fortunately wrong.

My Path to Astronomy
My interest in astronomy began only a year before I traveled to Kitt Peak. I have always been interested in science, but it was rarely serious compared to my dreams of being a concert pianist or prize-winning poet. In 2012, though, I attended a creative writing camp in rural Ohio, and I couldn’t stop crafting pieces about the motion of the Sun and fictional gas giants.

That August, the Curiosity Rover landed on Mars, and I stayed up with the scientists at the Jet Propulsion Laboratory — thanks to live-streaming video. I knew I wanted to study space the minute the rover’s tires touched the red dirt. Just by spending time thinking about the stars and our place among them, I felt as if I was decoding my brain, understanding how it was meant to work.

The same year, I bought a six-inch reflecting telescope, subscribed to Astronomy magazine, and Googled “astronomy camp.” Applying to the Kitt Peak camp was next. I descended the stairs of the University of New Mexico’s science library a few times after school and wrote my application essay through the eyes of a fictional assistant to astronomer Fritz Zwicky. But even though I had leather-bound records of Zwicky’s supernova data on my desk, there was still a level of connectivity with astronomy I hadn’t reached. Many levels, in fact.

Those levels weren’t far away, though, and they grew closer as I wrapped up school after receiving my acceptance e-mail. The thought of going to a science camp mildly terrified me at first — the only summer programs I was familiar with were woodsy music camps and poetry workshops held on college campuses. An atmosphere like Kitt Peak was foreign. I knew, though, that even if my fellow campers could identify every visible star or build a telescope from found materials, we would connect somehow. After all, we all saw the same Moon each night.

I packed a down jacket and pants (against my summer tendencies), and threw my headlamp in my suitcase, new batteries included.

Welcome to Kitt Peak
At the airport, a battered, coffee-stained “Astronomy Camp” sign greeted me. Two blonde, bubbly counselors named Shae and Chrystin immediately handed me a nametag emblazoned with the Eagle Nebula. The first people I met were from Virginia, Washington, Ohio, and Texas, and they were playing a viciously competitive game of cards. On the highway to the observatory, I spent time talking with one camper about the French horn. Making friends wasn’t hard, especially when the majority of attendees had read Brian Greene’s The Elegant Universe and could sing most of The Phantom of the Opera.
My mild concerns dissolved by the time the road began winding between granite boulders, climbing its way up the mountain.

Kitt Peak sprawls over a ridge in the Quinlan Mountains southwest of Tucson. Bright white among the fuzzy, deep green of the trees, the buildings look like chess pieces scattered along the curved asphalt. During my time on the mountain, it seemed like a telescope was built each day — I saw a new dome around every building, and it was incredible to think that each could angle towards the sky, make observations, and help astronomers understand the cosmos that surrounds our planet.

The two instruments that anchor the observatory are the Mayall 4-meter reflector, housed in a stoic, monstrous dome (and the setting of a Kitt Peak-themed murder mystery written by Katie, a fellow camper), and the McMath-Pierce solar telescope, a long pillar angled into the ground that looks like it could grow legs and crawl down the face of the mountain.

After settling into our dormitories and acquainting ourselves with Kitt Peak’s layout, we gathered at the Bok 90-inch telescope, one of the instruments we frequented during our nine-day stay. The building that houses the 90-inch reminded me of what a secret library should look like, albeit lacking shelves of books. They were replaced by the 90-inch itself, a powerful instrument with a towering frame that swung around the sky with a deep, smooth rumble. My friend Shayna described the feeling of standing next to the telescope well. “It’s like seeing a dinosaur skeleton at a museum. You’re never quite ready for it, and it’s a bit beyond comprehension.”

That first night we viewed Arcturus, the Snowball Nebula, and Saturn through the 90-inch’s occasionally used eyepiece (instead of spectrometers or CCDs operated from the control room, instruments we would become familiar with during the camp). The view of Saturn, unlike my six-inch scope’s blurry, rice-grain-sized image of the planet, was clearer than my imagination. The shadow of the rings, pronounced sharply against the gas giant’s sphere, kept my eye glued to the eyepiece.
Off To Work We Go

Astronomy Camp, while broad and varied, focuses on research projects the campers lead and carry out. When it came time to choose ours from a long list of desirable choices, my friends and I stuck together and chose to study exoplanet transits and the typing of Kepler stars. Once our names were assigned to specific astronomical happenings, we suddenly felt like real astronomers. Together, we used the 90-inch telescope and the WIYN 0.9-meter, and for nine days we secretly became the kings and queens of stars and orbiting bodies outside our solar system.

Our research began at 12:30 am on a Wednesday morning. After spending time memorizing summer constellations and eating bagels, we made our way to the 90-inch, blindly finding our way along the winding asphalt road, Tucson twinkling softly to the east. I constantly used my headlamp’s red light when navigating our way from the dorms to the 90-inch. My nighttime identity slowly became superhero-like, as though Kitt Peak in crimson was the result of a bite from a radioactive space bug.

With six in our star-typing project, the control room of the 90-inch was always filled with chairs, notebooks, and people, one of whom was probably asleep at any given moment. Despite our sometimes unbearable tiredness, being in that dimly lit, wood-paneled room felt important, as if we were at the source of never-ending information. With the guidance of Kate Brutlag Follette and Patrick Sheehan, graduate students at the University of Arizona and top-notch control-room companions, we learned to take biases, flats, and darks, find our target stars with online databases, position the telescope just right, and modify the spectra we collected with black body light curves.

Even for tasks as ultimately simple as typing stars, it felt like massive amounts of work had to be put in, and we had Patrick reduce data on the carpeted floor as we collected more. The control room’s instruments — the double-monitor computers, the fuzzy television showing the 90-inch’s field of view, the old-school buttons and switches used to slew the telescope — began to feel like extensions of our arms after just hours of work. Although what we knew was dwarfed by what we had to learn, we made instant connections with the stars above our heads. As we analyzed our data and compared the spectra to those of known stars, the Kepler objects we studied seemed closer, as if they sat right outside the atmosphere. Our data collection ended as the Sun rose, and we watched it from the McMath-Pierce, our star a fluorescent pink as it crept past the horizon.
We worked on our exoplanet project, with help from counselors Vanessa Bailey, Kate, Patrick, and others, using two telescopes: the WIYN 0.9 meter telescope, just a short drive from the 90-inch (a drive that sometimes included Rice Crispy Treats and hot chocolate), and the Roll-Off-Roof observatory, a 16-inch instrument located on a rooftop deck that resembles an empty hot tub. While the mirrors of the WIYN and the Roll-Off-Roof are smaller in diameter than other instruments on the mountain, the data we collected was no less astonishing.

Unlike taking single exposures of stars to type them based on their spectra, mapping the light curves of stars with transiting exoplanets requires continuous observing and data collecting as the planet passes by its host star. The very real time constraints of astronomy arose when we scrambled to locate a star before its planet began to transit, a process that involved ten people pointing to various places in the telescope’s field of view and the finder chart. (“That has to be it.” “No, look at that speck of fuzz, I swear that’s this galaxy over here.”) We eventually mapped the stellar light curves for two stars with planets (TrES-3b and Qatar-1b), calculated their radii, and learned about their suns. It took most of the camp to complete our projects.

**Visiting the Large Binocular Telescope**

In addition to our research, Astronomy Camp gave us insight into the lives of astronomers via visits to the University of Arizona’s Mirror Lab and the Large Binocular Telescope (LBT) on Mount Graham, one of the largest optical telescopes in the world. While leaving our projects stagnant for one night pained us, the LBT visit did not disappoint. It did the opposite.

A long drive up the mountain led us to the LBT, a colossal building surrounded by forest. The scientists of the LBT and the other two telescopes on the peak — the Submillimeter Telescope (SMT) and the Vatican Advanced Technology Telescope, also known as the “pope scope” — waved as our white vans rolled up the dirt roads.

We slept in the lobby of the LBT that night, sleeping bags lined up tightly against the walls, but not before a tour of the facility. Just as the name suggests, the LBT is composed of two mirrors, both 8.4 meters across, that work together to gather immense amounts of light. Standing on the rotating building’s floor, the telescope towered above us — it filled the space to its edges, and the red metal of the frame dominated our vision. Many telescopes I’ve seen, if placed...
next to the LBT for comparison, would likely be mistaken for screws. On our tour, the building started to gradually spin. The dome opened slowly, letting a dim light sneak through the widening gap, while the LBT moved its huge body like a sentient being. A fire had burned many of Mt. Graham’s highest trees, leaving them black and scrawny, and the air was grey with ash and wispy clouds. It looked dystopian, and we were in the only oasis.

That night we ate spaghetti prepared by our surrogate parents (Ann and Wyatt Schlingman, amateur astronomers and two of our counselors), worked on projects, took power naps, and toured the LBT and SMT control rooms, looking at both the instruments themselves and the data being collected. The astronomers in the SMT — Yancy Shirley, a University faculty member, Brian Svoboda, a graduate student, and telescope operator Bob Moulton — quickly converted me to a radio astronomy fan with their intricate mapping of regions of cosmic gas. Those at the LBT, all sitting behind monitors, seemed to control the world around them.

I unfortunately went to sleep too early, before my friends Jordan and Justin made a second, exciting trip into the LBT control room late at night. There, the astronomers attempted to observe Neptune. This task is difficult for any telescope no matter the size, and it was likely painstaking to create a decipherable image of the gas giant with the abundance of ash and clouds in the air. Somehow, though, the LBT succeeded, capturing Neptune through multiple filters. The feat was remarkable and resulted in three dreamy images of the planet. The fact that the LBT was able to see distinct clouds in Neptune’s atmosphere, despite those on Earth, emphasized the telescope’s awesome abilities.

**Combining Research and Fun**
The drive back to Kitt Peak signaled the latter half of the camp and the approaching day of departure. We continued with our projects, collecting data on a total of six stars and two transiting exoplanets with the help of some amazing counselors. In addition to our research, we split up into different groups to work on two camp-wide projects: designing a hypothetical space station and preparing for debates against other teams on real, important, space-themed topics — the future of NASA.
manned missions and the search for intelligent extraterrestrial beings. I still think about my group’s space station, a torus orbiting the asteroid Ceres, and daydream about living on it.

While Astronomy Camp was filled with research and welcome work, some of the most valuable memories I made were with my friends. It can be hard to find people to talk with about quasars, SpaceX, or telescopes, but it can be even harder to find people with whom you still get along after projects, late nights, and problem solving.

During those nine days, we sang. We talked about astronomy and everything besides astronomy, and we stayed up way too late. We made liquid nitrogen Dippin’ Dots, and we took a barrage of selfies during sunsets. Most often, we’d lie on our backs staring up at the darkest skies we knew, helping each other learn the constellations. But sometimes we were just silent, trying to feel the movement of the giant rock we call our home planet underneath us.

Astronomy Camp let me solidify my love for the sky, but it also demystified my concept of the study of it. Being an astronomer is hard, complex work, but it is a crucially important field — one we young people, interested in space, can have an impact on. As long as we’re under the same Moon, we can study it and what’s beyond and always feel connected by looking outward.

ELENA SAAVEDRA BUCKLEY is a senior at Sandia Preparatory School in Albuquerque, New Mexico. She attended the University of Arizona’s Astronomy Camp in June of 2013, where she solidified the love of the cosmos she hopes to continue at college next year. She does a fair amount of things on Earth, too, such as edit for the national literary magazine Polyphony H.S., play piano, and perform mock trials.
NASA Curiosity: First Mars Age Measurement

NASA / Jet Propulsion Laboratory

NASA’s Curiosity rover is providing vital insight about Mars’ past and current environments that will aid plans for future robotic and human missions. In a little more than a year on the Red Planet, the mobile Mars Science Laboratory has determined the age of a Martian rock, found evidence the planet could have sustained microbial life, taken the first readings of radiation on the surface, and shown how natural erosion could reveal the building blocks of life.

The second rock Curiosity drilled for a sample on Mars, which scientists nicknamed “Cumberland,” is the first ever to be dated from an analysis of its mineral ingredients while it sits on another planet. A report by Kenneth Farley of the California Institute of Technology in Pasadena, and co-authors, estimates the age of Cumberland at 3.86 billion to 4.56 billion years old. This is in the range of earlier estimates for rocks in Gale Crater, where Curiosity is working.

“The age is not surprising, but what is surprising is that this method worked using measurements performed on Mars,” said Farley. “When you’re confirming a new methodology, you don’t want the first result to be something unexpected. Our understanding of the antiquity of the Martian surface seems to be right.”

The analysis of Cumberland from a sample drilled by Curiosity was a fundamental and unprecedented measurement considered unlikely when the rover landed in 2012. Farley and his co-authors adapted a 60-year-old radiometric method for dating Earth rocks that measures the decay of an isotope of potassium as it slowly changes into argon, an inert gas.

MORE INFORMATION

This mosaic of images from the Mast Camera instrument on NASA’s Curiosity Mars rover shows a series of sedimentary deposits in the Glenelg area of Gale Crater, from a perspective in Yellowknife Bay looking toward west-northwest. Curiosity’s science team has estimated that the “Cumberland” rock that the rover drilled for a sample of the Sheepbed mudstone deposit (at lower left in this scene) has been exposed at the surface for only about 80 million years. [NASA/JPL-Caltech/MSSS]
Dawn Mission Provides Reality Check for HST and Earth-Based Studies of Vesta

*Planetary Science Institute*

Up-close observations of the giant asteroid Vesta by NASA’s Dawn spacecraft have confirmed and provided new insights into more than 200 years of Earth-based observations, according to research led by Planetary Science Institute Research Scientist Vishnu Reddy. “Since the vast majority of asteroids can only be studied remotely by ground-based and space-based facilities, confirming the accuracy of such observations is important to our exploration of the broader solar system,” Reddy said.

Vesta is the second most massive asteroid in the main asteroid belt and has a crust, mantle and core like our Earth. It has been studied intensely by Earth and space based telescopes since its discovery in 1807.

Early ground-based observations showed that Vesta’s color and surface composition changed as it rotated around its axis. Observations made by astronomers using the NASA Infrared Telescope Facility showed distinct compositional units. Dawn’s observations have confirmed these rotational color variations and the presence of compositional units.

“A generation of scientific questions based on lower resolution data have been resolved by visiting Vesta,” the Dawn mission’s principal investigator Christopher Russell said.

Using the Hubble Space Telescope, astronomers not only saw the giant impact basin in the southern hemisphere of Vesta for the first time, but also identified numerous bright and dark features on Vesta that correspond to different compositional units. Maps created using high-resolution images from Dawn’s framing camera confirmed the presence of these features.

“It is an amazing feeling to realize how accurately and how much detail Hubble tells us about Vesta when Dawn got there,” said PSI Research Scientist Jian-Yang Li, Dawn Participating Scientist who mapped the surface of Vesta using Hubble data.

MORE INFORMATION

These two images compare topographic maps of the giant asteroid Vesta as discerned by NASA’s Hubble Space Telescope (top) and as seen by NASA’s Dawn spacecraft (bottom). Although the absolute scale ranges are slightly different in Dawn data, Vesta’s relative topography is remarkably consistent between the two data sets. [NASA/ESA/Cornell and NASA/JPL-Caltech/UCLA/MPS/DLR/IDA]
Clay-Like Minerals Found on Icy Crust of Europa

Jet Propulsion Laboratory

A new analysis of data from NASA’s Galileo mission has revealed clay-type minerals at the surface of Jupiter’s icy moon Europa that appear to have been delivered by a spectacular collision with an asteroid or comet. This is the first time such minerals have been detected on Europa’s surface. The types of space rocks that deliver such minerals typically also often carry organic materials.

“Organic materials, which are important building blocks for life, are often found in comets and primitive asteroids,” said Jim Shirley, a research scientist at NASA’s Jet Propulsion Laboratory, Pasadena, Calif. “Finding the rocky residues of this comet crash on Europa’s surface may open up a new chapter in the story of the search for life on Europa,” he said.

Shirley and colleagues, funded by a NASA Outer Planets Research grant, were able to see the clay-type minerals called phyllosilicates in near-infrared images from Galileo taken in 1998. Those images are low resolution by today’s standards, and Shirley's group is applying a new technique for pulling a stronger signal for these materials out of the noisy picture. The phyllosilicates appear in a broken ring about 25 miles (40 kilometers) wide, which is about 75 miles (120 kilometers) away from the center of a 20-mile-diameter (30 kilometer) central crater site.

The leading explanation for this pattern is the splash back of material ejected when a comet or asteroid hits the surface at an angle of 45 degrees or more from the vertical direction. A shallow angle would allow some of the space rock’s original material to fall back to the surface. A more head-on collision would likely have vaporized it or driven that space rock’s materials below the surface.

It is hard to see how phyllosilicates from Europa’s interior could make it to the surface, due to Europa’s icy crust, which scientists think may be up to 60 miles (100 kilometers) thick in some areas. Therefore, the best explanation is that the materials came from an asteroid or comet.

This artist’s concept shows a possible explosion resulting from a high-speed collision between a space rock and Jupiter’s moon Europa. Clay-type minerals have been found on Europa’s surface. The pattern of these minerals suggests an asteroid about 3,600 feet (1,100 meters) across or a comet about 5,600 feet (1,700 meters) across could have hit at a shallow angle. [NASA/JPL-Caltech]
Hubble Discovers Water Vapor Venting From Jupiter’s Moon Europa

*Hubble European Space Agency*

The NASA/ESA Hubble Space Telescope has discovered water vapor erupting from the frigid surface of Jupiter’s moon Europa, in one or more localized plumes near its south pole.

Europa is already thought to harbor a liquid ocean beneath its icy crust, making the moon one of the main targets in the search for habitable worlds away from Earth. This new finding is the first observational evidence of water vapor being ejected off the moon’s surface.

“The discovery that water vapor is ejected near the south pole strengthens Europa’s position as the top candidate for potential habitability,” said lead author Lorenz Roth of the Southwest Research Institute in San Antonio, Texas. “However, we do not know yet if these plumes are connected to subsurface liquid water or not.”

The Hubble discovery makes Europa only the second moon in the solar system known to have water vapor plumes. In 2005, NASA’s Cassini orbiter detected plumes of water vapor and dust spewing off the surface of the Saturnian moon Enceladus.

So far, only water vapor has been detected — unlike the plumes on Enceladus, which also contain ice and dust particles. Roth suggests long cracks on Europa’s surface, known as linea, might be venting water vapor into space. Similar fissures have been photographed near Enceladus’s south pole by the Cassini spacecraft. It is unknown how deep inside Europa’s crust the source of the water may be.

Roth asks, “Do the vents extend down to a subsurface ocean or are the ejecta simply from warmed ice caused by friction stresses near the surface?”

MORE INFORMATION

This artist’s impression shows Jupiter and its moon Europa, using actual Jupiter and Europa images in visible light. The Hubble ultraviolet images showing the faint emission from the water vapor plumes have been superimposed, respecting the size but not the brightness of the plumes. [NASA/ESA/M. Kornmesser]
World’s Most Powerful Exoplanet Camera Turns its Eye to the Sky

Gemini Observatory

After nearly a decade of development, construction, and testing, the world’s most advanced instrument for directly imaging and analyzing planets around other stars is pointing skyward and collecting light from distant worlds.

The instrument, called the Gemini Planet Imager (GPI), was designed, built, and optimized for imaging faint planets next to bright stars and probing their atmospheres. It will also be a powerful tool for studying dusty, planet-forming disks around young stars. It is the most advanced such instrument to be deployed on one of the world’s biggest telescopes: the 8-meter Gemini South telescope in Chile.

“Even these early first-light images are almost a factor of 10 better than the previous generation of instruments. In one minute, we are seeing planets that used to take us an hour to detect,” says Bruce Macintosh of the Lawrence Livermore National Laboratory who led the team that built the instrument.

GPI detects infrared (heat) radiation from young Jupiter-like planets in wide orbits around other stars, those equivalent to the giant planets in our own solar system not long after their formation. Every planet GPI sees can be studied in detail.

“Most planets that we know about to date are only known because of indirect methods that tell us a planet is there, a bit about its orbit and mass, but not much else,” says Macintosh. “With GPI we directly image planets around stars — it’s a bit like being able to dissect the system and really dive into the planet’s atmospheric makeup and characteristics.”

For GPI’s first observations, the team targeted previously known planetary systems, including the well-known Beta Pictoris system; in it GPI obtained the first-ever spectrum of the very young planet Beta Pictoris b. The first-light team also used the instrument’s polarization mode to study a faint ring of dust orbiting the very young star HR4796A. With previous instruments, only the edges of this dust ring could be seen, but with GPI astronomers can follow the entire circumference of the ring.

MORE INFORMATION

Gemini Planet Imager’s first light image of Beta Pictoris b, a planet orbiting the star Beta Pictoris. The star, Beta Pictoris, is blocked in this image by a mask so its light doesn’t interfere with the light of the planet. In addition to the image, GPI obtains a spectrum from every pixel element in the field of view to allow scientists to study the planet in great detail. [Processing by Christian Marois, NRC Canada.]
Hubble Sees Cloudy Super-Worlds with Chance for More Clouds

*NASA / Space Telescope Science Institute*

Scientists using NASA’s Hubble Space Telescope have characterized the atmospheres of two of the most common type of planets in the Milky Way galaxy and found both may be blanketed with clouds. The planets are GJ 436b, located 36 light-years from Earth in the constellation Leo, and GJ 1214b, 40 light-years away in the constellation Ophiuchus. Despite numerous efforts, the nature of the atmospheres surrounding these planets had eluded definitive characterization until now. The researchers described their work as an important milestone on the road to characterizing potentially habitable, Earth-like worlds beyond the solar system.

The two planets fall in the middle range in mass, between smaller, rockier planets such as Earth and larger gas giants such as Jupiter. GJ 436b is categorized as a “warm Neptune” because it is much closer to its star than frigid Neptune is to the sun. GJ 1214b is known as a “super-Earth” because of its size. Both GJ 436b and GJ 1214b can be observed transiting, or passing in front of, their parent stars. This provides an opportunity to study these planets in more detail as starlight filters through their atmospheres.

Using Hubble, astronomers led by Laura Kreidberg and Jacob Bean of the University of Chicago took a closer look at GJ 1214b. They found what they consider definitive evidence of high clouds blanketing the planet and hiding information about the composition and behavior of the lower atmosphere and surface. The new Hubble spectra also revealed no chemical fingerprints in GJ 1214b’s atmosphere, but the data were so precise they could rule out cloud-free compositions of water vapor, methane, nitrogen, carbon monoxide, or carbon dioxide for the first time.

“Both planets are telling us something about the diversity of planet types that occur outside of our own solar system; in this case we are discovering we may not know them as well as we thought,” said Heather Knutson [Caltech, Pasadena, California].

This illustration compares the sizes of exoplanets GJ 436b and GJ 1214b with Earth and Neptune. These so-called super-Earths have masses between gas giants, like Neptune, and smaller, rocky planets, like Earth. No such type of planet exists in our solar system. [NASA/ESA/A. Feild and G. Bacon (STScI)]

More Information
First Planet Found Around Solar Twin in Star Cluster

European Southern Observatory

Astronomers have used ESO’s HARPS planet hunter in Chile, along with other telescopes around the world, to discover three planets orbiting stars in the cluster Messier 67. Although more than one thousand planets outside the solar system are now confirmed, only a handful have been found in star clusters. Remarkably one of these new exoplanets is orbiting a star that is a rare solar twin — a star that is almost identical to the Sun in all respects.

Anna Brucalassi (Max Planck Institute for Extraterrestrial Physics, Garching, Germany), lead author of the new study, and her team wanted to find out more. “In the Messier 67 star cluster, the stars are all about the same age and composition as the Sun. This makes it a perfect laboratory to study how many planets form in such a crowded environment, and whether they form mostly around more massive or less massive stars.”

The team carefully monitored 88 selected stars in Messier 67 during a period of six years to look for the tiny telltale motions of the stars towards and away from Earth that reveal the presence of orbiting planets.

Three planets were discovered, two orbiting stars similar to the Sun and one orbiting a more massive and evolved red giant star. The first two planets both have about one-third the mass of Jupiter and orbit their host stars in seven and five days respectively. The third planet takes 122 days to orbit its host and is more massive than Jupiter.

The first of these planets proved to be orbiting a remarkable star — it is one of the most similar solar twins identified so far and is almost identical to the Sun. It is the first solar twin in a cluster that has been found to have a planet. Two of the three planets are “hot Jupiters” — planets comparable to Jupiter in size, but much closer to their parent stars and hence much hotter.
Stormy Stars? NASA’s Spitzer Probes Weather on Brown Dwarfs

Jet Propulsion Laboratory

Swirling, stormy clouds may be ever-present on cool celestial orbs called brown dwarfs. New observations from NASA’s Spitzer Space Telescope suggest that most brown dwarfs are roiling with one or more planet-size storms akin to Jupiter’s “Great Red Spot.”

“As the brown dwarfs spin on their axis, the alternation of what we think are cloud-free and cloudy regions produces a periodic brightness variation that we can observe,” said Stanimir Metchev of the University of Western Ontario, Canada. “These are signs of patchiness in the cloud cover.” Metchev is principal investigator of the brown dwarf research.

Brown dwarfs form as stars do, but lack the mass to fuse atoms continually and blossom into full-fledged stars. They are, in some ways, the massive kin to Jupiter.

Scientists think that the cloudy regions on brown dwarfs take the form of torrential storms, accompanied by winds and, possibly, lightning more violent than that at Jupiter or any other planet in our solar system. However, the brown dwarfs studied so far are too hot for water rain; instead, astronomers believe the rain in these storms, like the clouds themselves, is made of hot sand, molten iron or salts.

In a Spitzer program named “Weather on Other Worlds,” astronomers used the infrared space telescope to watch 44 brown dwarfs as they rotated on their axis for up to 20 hours. Previous results had suggested that some brown dwarfs have turbulent weather, so the scientists had expected to see a small fraction vary in brightness over time. However, to their surprise, half of the brown dwarfs showed the variations.
AAS Meeting Highlights New Hubble Science Finds

NASA

NASA’s Hubble Space Telescope is providing a new perspective on the remote universe. Scientists described the findings in a news conference during January’s American Astronomical Society (AAS) meetings. Highlighted in the briefing were three discoveries: four unusually bright galaxies as they appeared 13 billion years ago, the deepest image ever obtained of a galaxy cluster, and a sampling of galaxies thought to be responsible for most of the stars we see today.

The ultra-bright, young galaxies, discovered using data from NASA’s Hubble and Spitzer space telescopes, are bursting with star formation activity, which accounts for their brilliance. These fledgling galaxies are only one-twentieth the size of the Milky Way, but they probably contain about one billion stars crammed together.

An unprecedented long distance view of the universe comes from an ambitious collaborative project with Hubble called The Frontier Fields. It is the longest and deepest exposure obtained to date of a cluster of galaxies, and shows some of the faintest and youngest galaxies ever detected.

Hubble also uncovered a substantial population of 58 young, diminutive galaxies that scientists long suspected were responsible for producing a majority of stars now present in the cosmos during the universe’s early years. Deep exposures in ultraviolet light, made with Hubble’s Wide Field Camera 3, revealed a sampling of galaxies that existed more than 10 billion years ago, when the universe was roughly 3.4 billion years old.

MORE INFORMATION

Astronomers used the sharp eye of the HST and the magnification power of the giant cluster of galaxies Abell 1689 to find 58 remote galaxies (circled). [NASA/ESA/B. Siana and A. Alavi (University of California, Riverside)]
Linda Shore Named Executive Director of the ASP
The ASP is pleased to announce the appointment of Linda Shore to the position of Executive Director. Most recently, Shore served as Director of the Teacher Institute at San Francisco’s renowned science museum, the Exploratorium. While there she led a staff of scientists and educators, and created nationally recognized teaching programs. “I am deeply honored and excited to assume the role of Executive Director for the ASP, an organization whose mission so strongly resonates with my personal passion for increasing science literacy through the study of astronomy,” said Shore.

In Memoriam: Michael G. Gibbs
It is with profound sadness that the Astronomical Society of the Pacific reports the sudden death of its Board member and secretary, Michael G. Gibbs, on December 10, 2013. He was 41 years old. Michael has served as an ASP Board member since 2008, and as the Board secretary since 2010. Prior to that, from 2005 to 2008, Michael was the Society’s Director of Advancement and was instrumental in reviving and advancing the ASP’s Fund Development effort.

Michael earned his bachelors, masters, and doctorate in education at DePaul University, and began his career as an Assistant Vice President at DePaul. After leaving the ASP, Michael continued his passion for education as the Vice President of Advancement at Capitol College in Laurel, MD. While at Capitol he was the director of its Space Science Education and Public Outreach program and an Associate Professor. Michael furthered his career at the Planetary Science Institute in Tucson, AZ as the Deputy Director and Chief Advancement Officer. He had just recently taken on the role of Vice President for Development and Education at the National Tiger Sanctuary in Springfield, MO.

In addition to serving on the Board of the ASP, Michael served on the boards of numerous non-profit organizations across the United States and was highly recognized by many civic organizations for his services to the communities in which he lived and worked. The Society has lost a true friend, and we will miss his intelligence, his guidance, and his quick wit.

In Memoriam: Halton C. Arp
Halton C. Arp, an American astronomer and former ASP Board President (1981–83), passed away on December 28, 2013. He was 86. A staff astronomer for 29 years at Hale Observatories, he catalogued many beautiful examples of interacting and merging galaxies in his *Atlas of Peculiar Galaxies* (1996), which started as an attempt to
better understand spiral galaxies. Throughout his career he was a critic of the Big Bang theory and advocated a rival, non-standard cosmology (the Steady State theory). Halton argued his side of the redshift story in his 1989 book, *Quasars, Redshifts and Controversies.* A lengthy obituary appeared in the *New York Times.*

**In Memoriam: Harold McNamara**

The ASP sadly reports that Harold McNamara, astronomer at Brigham Young University and former editor of the ASP’s *Publications of the ASP* and the ASP Conference Series, passed away on January 9, 2014 at the age of 90.

Harold completed his bachelor’s and doctorate degrees and a post-doctorate research fellowship at the University of California at Berkeley. He began his career at Brigham Young University in 1955, retiring as a professor of astrophysics more than 50 years later at age 83 — even as he continued to publish.

In 1968, he became editor of the refereed journal *Publications of the ASP (PASP)*. Under his aegis during the next 20 years, the *PASP* grew by a factor of more than three, providing an outlet for astronomical results of a scientific nature and serving to keep readers in touch with current astronomical research. He was also a member of the ASP’s Board of Directors (1968-69).

In 1988, Harold shepherded a new ASP enterprise to its first product: a volume of the proceedings of a scientific conference titled “Progress and Opportunities in Southern Hemisphere Optical Astronomy: The CTIO 25th Anniversary Symposium.” This was the birth of the ASP Conference Series (ASPCS), which provides a low-cost and expeditiously published avenue for documenting and distributing the proceedings of scientific and related conferences, symposia, colloquia, and meetings. He served as editor of the ASPCS for 16 years, and was succeeded by fellow BYU astronomer J. Ward Moody in 2004.

Harold edited more than 200 volumes for the ASP and contributed more than 100 scientific journal articles on his own research. In 2000 he was awarded the AAS’s George Van Biesbroeck Prize, which recognizes “long-term extraordinary or unselfish service to astronomy.” Harold provided extraordinary service to the ASP during the years, and we will miss him.

**Save the Date: August 2–6, 2014**

In our 125th anniversary year, the ASP is excited to host our marquee conference for education and public outreach professionals under the banner of “Celebrating Science: Putting Education Best Practices to Work.” The event will take place at the Hyatt Regency in Burlingame, CA, conveniently located near the San Francisco International Airport. You can sign up for further information and updates as they become available, on our [annual meeting webpage](https://www.asp.org/meetings/125th).
THE ASTRONOMICAL SOCIETY OF THE PACIFIC WISHES TO THANK the following organizations and individuals for their generous philanthropic support. This list reflects gifts and grants received between March 1 and September 30, 2013, of $100 or more. Funds raised support the ASP’s mission to foster scientific curiosity, advance science literacy, and share the joy of exploration and discovery — to encourage tomorrow’s science, technology, and academic leaders. Although each star shines alone, they add up to a glittering night sky. Likewise, each donation adds to the next to make a great impact. Thank you for believing in the ASP!

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James E. Hesser
Lynne A. Hillenbrand
Beth Hufnagel in memory of Appollonia Koglin
Nick Itsines
Joseph B. Jensen**
Clyde R. Jolie-Ashe in memory of Steven M. Ashe
Richard R. Joyce
Alan S. Kane
Isaac M. Kikawada
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David C. Koo
Louis W. Kunz
Shawn A. Laatsch+
Cliff Lai
Robert L. Layman
Jeffrey E. Lockwood in honor of Andrew Fraknoi
Loris Magnani
John C. Mather
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Liam McDaid
Nancy D. Morrison
Terry D. Oswalt
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Shirlee D. Perkins
Laura M. Petiolas in honor of Karen Meyer
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Frederick J. Raab
Martin Ratcliffe in memory of Matt Rempe
John W. Reed in memory of Drs. Eli & Nola A. Haynes, and Dr. Frank N. Edmunds, Jr. and Mr. Russell C. Maag
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Seth Shostak
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Donn R. Starkey
Jeff L. Stoner
Paula Szkody
John D. Trasco
Robert G. Tull
Constance E. Walker+
William J. Welch
Anne G. Young

Family Membership
Lars & Mary Anderson
Marni & Richard Berendsen
Stephen & Mary Helen Burroughs
Alice G. Enevoldsen
NEW MEMBERS — The ASP welcomes new members who joined between October 1 and December 31, 2013.

Individual
Bruce Abels, West Chicago, IL
James J. Brokaw, Indianapolis, IN
Liza K. Coe, Los Altos, CA
Allison M. Dibley, Concord, CA
Thomas R. English, Archdale, NC
John G. Erickson, Richmond, CA
Debra A. Fischer, New Haven, CT
Alberto Galindo, San Jose, CA
Richard Greenwald, Huntington Beach, CA
Gary J. Hitz, Cottage Grove, MN
David E. Ishmael, Lake Oswego, OR
Emily Joseph, Tucson, AZ
Harish G. Khandrika, La Jolla, CA
David M. Meyer, Evanston, IL
Phillip Molnar, Brunswick, OH
Marla H. Moore, Silver Spring, MD
Paul Morgan, Roseburg, OR
Neal S. Robinson, Bountiful, UT
Rene A. Walterbos, Las Cruces, NM
Neil M. Wheeler, Santa Rosa, CA
Gur Windmiller, La Mesa, CA

Family
Gerald Frost Family, Malibu, CA

Student
Kevin Huber, Bern, Switzerland
Alan Lefor Utsunomiya, Japan

Supporter’s Circle
Adolf N. Witt, Maumee, OH
Larry T. Woods, Walnut Creek, CA

Technical
Julia Victoria V. Augustine, Greensburg, PA
Mark E. Biglieri, San Rafael, CA
Kenneth C. Chambers, Honolulu, HI
Dennis W. Dawson, New Britain, CT
James N. Head, Walnut Creek, CA
Steven Hoell, Tucson, AZ
Robert A. Knop, Squamish, BC, Canada
Donald H. Martins, Anchorage, AK
John T. McGraw, Placitas, NM
Silvia Torres-Perimbert, Mexico City, Mexico
J. Allyn Smith, Clarksville, TN
Paul F. Sydney, Makawao, HI

Institution
Tohoku University, Sendai, Miyagi, Japan

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Mercury Contributors
Jennifer Birriel
Katherine Bracher
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Stephen Case
Bethany E. Cobb
Clifford J. Cunningham
Paul Deans
Daniel D. Durda
Jonathan P. Gardner
Heidi B. Hammel
Emily Joseph
Shawn Laatsch
Emily Lakdawalla
James Lochner
Jeff Mangum
James G. Manning**
Christopher Wanjek

Supporter’s Circle Membership
Ismar Cintora
Edward K. Conklin
Andrea K. Dobson
Marc A. Gineris
Douglas T. Hanks
William R. Hearst, III
Lynne A. Hillenbrand
Steve B. Howell
Francine Jackson
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John W. Reed
Dennis L. Schatz
W. Thomas Stalker, III
Larry T. Woods

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We apologize in advance for any errors or omissions. If you have a correction, please contact Kathryn Harper in the Development Department at 415-715-1406 or by e-mail (kharper@astrosociety.org) so that we may correct our records.
The Skies of February
If you’re reading this on or before January 31st, head outside about 45 minutes after sunset that evening and look low in the west-southwest. There you may spot a very thin crescent Moon (a mere 31 hours old) to the lower right of a modestly bright star that is actually the planet Mercury. An older crescent Moon hovers above Mercury the next evening. This elusive little planet hangs around for only another week before diving into the solar glare.

Jupiter is high in the east at sunset and is extremely high in the south later in the evening. This makes it a fine target for telescopic observations, so take advantage of its high elevation during the evening hours. The waxing gibbous Moon is below Jupiter on the 10th.

Mars rises in the east around midnight. The Moon visits the vicinity of the red planet on the 18th, when the two of them plus the white star Spica make a pretty triangle. Saturn rises after midnight and is high in the south before dawn breaks. On the 21st and 22nd, the Moon is to Saturn’s upper right and lower left respectively.

Venus rises about two hours before the Sun and is a brilliant beacon in the southeast as dawn breaks. (In fact, it’s at its brightest on the 11th.) On the 26th, look for a thin crescent Moon to the lower left of Venus. The next morning, can you spot the even-thinner crescent Moon closer to the horizon? If you see it, cast your gaze to the lower left of the Moon in search of dim Mercury. Yes, it’s barely visible again this month, but now in the east-southeast at dawn.

The Skies of March
Although there are no planets low in the west at dusk, Jupiter blazes high in the south and sets well after midnight. The Moon is positioned below this giant world on the evenings of the 9th and 10th. Mars rises in the early evening, followed by Saturn two hours later. The waning gibbous Moon hangs below Mars on the 18th (with the white star Spica nearby) and sits a mere 2° below Saturn on the 20th.

Brilliant Venus continues to rise out of the east-southeast some two hours before the Sun. On the 27th, Venus and the crescent Moon make a lovely pair in the dawn sky. If you have a very clear and flat east-southeast horizon, you may spot dim Mercury rising about an hour before the Sun at the start of the month. But it never climbs very high above the horizon and begins to retreat toward the Sun by the 10th.

The equinox falls on the 20th at 12:57 pm EDT (9:57 PDT), and spring officially begins in the Northern Hemisphere.

On March 20th an unusual event takes place, but you can see it only if you observe from a narrow, 40-mile-wide path extending through eastern Ontario (Canada), upstate New York, New York city, and western Connecticut. It’s an occultation of Regulus (the brightest star in Leo, the Lion) by the small asteroid 163 Erigone. Just after 2:00 am Eastern Time, Regulus will vanish for up to 12 seconds as seen by observers along the path. Look for more information about
The total lunar eclipse this April may look much like the one on February 20, 2008, when the Moon also passed through the southern half of Earth’s shadow. [Richard Tresch Fienberg]

A total eclipse of the Moon is this month’s celestial highlight — but only if you live in North or South America, Hawaii, New Zealand, or all but the very western edge of Australia. Mid-eclipse occurs on April 15 at 07:45:40 Universal Time, which translates into local times of 03:45 am Eastern, 00:45 Pacific, or 21:44 on the evening of the 14th in Hawaii. But be aware that the easily visible portion of the eclipse starts two hours prior, which means those observing in the Mountain Time zone or farther west need to be skywatching during the evening of the 14th.

A total lunar eclipse begins with the delicate penumbral shading on the eastern edge of the Moon as it slides into Earth’s outer shadow. The dimming is impossible to see at first but may be more noticeable about 30 minutes after it begins. However, there is no mistaking the beginning of the partial eclipse, as an ever-growing bite of darkness eats away at the eastern lunar limb.

Totality begins as the last sliver of sunlight slips off the Moon’s rim. Depending on the brightness of the Earth’s shadow, it may be difficult to observe exactly when this happens. But there’s certainly no doubt when the bright full Moon is replaced by a dull copper/orange/red Moon — and totality begins.

During totality, the northern limb of the Moon is deep in the Earth’s shadow, while the southern limb is closer to the edge of the umbra. As a result, the northern limb will likely appear darker than the southern lunar limb.
After nearly 80 minutes of totality, a brightening on the Moon’s southeastern edge signals the beginning of the second partial phase. About an hour later, the remaining darkness of the Earth’s umbral shadow slips off the lunar surface.

Here is a link to a NASA PDF that provides a few more details, including a map showing where the eclipse can be seen. By the way, the April lunar eclipse is the first of four consecutive total lunar eclipses — a series known as a tetrad.

Meanwhile…after sunset on the 3rd, look for the 4-day-old crescent Moon resting in the Hyades open star cluster in Taurus, the Bull. Jupiter appears high in the southwest at sunset and is nicely placed for viewing during the rest of the evening. On the 6th the Moon appears to the giant planet’s lower left.

Mars is at opposition on the 8th, which means it rises as the Sun sets and is visible all night. Although it’s at its brightest, its appearance in a telescope remains small (because it’s a mere 15 arcseconds in diameter). Mars shines near Spica, and the red/white color contrast makes for an interesting sight. Before midnight on the 13th, the full Moon appears to the right of Mars and on the 14th, to the red planet’s lower left. Two nights later, the Moon sits a mere 1° to the right of Saturn. The ringed planet rises after darkness falls and is high in the south during the early morning hours.

Venus glows as the “Morning Star” low in the east-southeast, rising some two hours before the Sun. At dawn on the 25th, look for the crescent Moon more than 5° to the planet’s upper right. Mercury is lost in the solar glare.

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**Star Charts**

If you’d like a star chart to help you explore the naked-eye night sky, you have several options: purchase a star wheel (planisphere) or planetarium software, download a PDF showing the sky this month, find an online star chart, or locate an app for your tablet or smart phone.

**PDF Star Charts.** Skymaps produces a well-done chart that goes beyond a mere monthly star chart. It includes a list of monthly highlights and observable celestial objects. The downside: each month is available only at the very end of the previous month. Another nice star chart is available from Orion Telescopes and Binoculars; you can download it one month in advance. If you’d like simple star charts that don’t show the planets, a set of 12 is available from the Canada Science and Technology Museum.

**Online Star Charts.** Sky View Café gives you control over the chart’s date, time, and location, plus a few other options. But the chart names only a few bright stars, doesn’t identify the constellations, and the printout of the resulting chart is poor. The star chart created on the Tau Astronomy Club website offers fewer options but a better printout. But it lists no star names and the stars are color coded based on their spectral type.

**Apps For Tablets and Smart Phones.** SkySafari 4 ($2.99 for the basic version; available for iPhone, iPad, and iPod touch; now available for Android) is a very well done star chart app and is the one I use consistently. The Sky HD by Software Bisque is one of the most popular planetarium programs out there, and is now available for the iPad. If ASP stargazers have a favorite night sky app, regardless of the device, I’d like to hear about it.

— P.D.
A Different Look at Saturn

On July 19, 2013, in an event celebrated the world over, NASA’s Cassini spacecraft slipped into Saturn’s shadow and turned to image the planet, seven of its moons, its inner rings — and, in the background, our home planet, Earth. With the Sun’s powerful and potentially damaging rays eclipsed by Saturn itself, Cassini’s onboard cameras took advantage of this unique viewing geometry. They acquired a panoramic mosaic of the Saturn system that allows scientists to see details in the rings, and throughout the system, as they are backlit by the Sun.

With both Cassini’s wide-angle and narrow-angle cameras aimed at Saturn, Cassini captured 323 images in slightly more than four hours. This final mosaic uses 141 of those wide-angle images. Images taken using the red, green, and blue spectral filters of the wide-angle camera were combined to create this natural-color view. This image spans about 404,880 miles (651,591 kilometers) and looks toward the unlit side of the rings from about 17° below the ring plane. Image scale on Saturn is about 45 miles (72 kilometers) per pixel.

Very high-resolution digital versions of this image are available, including a brightened version with contrast and color enhanced, a version with just the planets annotated, and a completely annotated version. Image courtesy NASA/JPL-Caltech/SSI.