EYEPIECE

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‘How I Killed Pluto—and Why It Had It Coming’

By Evan Schneider

Most of us have never heard of Charlie Kowal. However, most of us have heard of the Palomar Observatory. This astronomer and this facility came together in the 1970s to search for Planet X, a hypothetical planet beyond Pluto that was supposedly exerting gravitational influence on the outer planets. Kowal failed, but his years of diligently photographing objects in what was one day to be called the Kuiper Belt created a unique opportunity.

Mike Brown, professor of planetary astronomy at CalTech, addressed a packed house at the Hayden Planetarium January 10 and shared Kowal’s personal road to success.

Fifty years ago, astronomers building the 200-inch Hale Telescope realized they needed a map of the sky to determine where to point their new scope. This idea gave birth to the Schmidt 48-inch telescope used to create the Palomar Observatory Sky Survey. This same scope would fall to Kowal in the 1970s and to Brown 30 years later, in 2001.

In a lecture that had the same title as his new book, “How I Killed Pluto--and Why It Had It Coming” (Spiegel & Grau, $25), Brown told the story of his life while folding in technical challenges and processes that drove his passion for planet hunting.

In 1977, when Brown was a young CalTech assistant professor, his study of Jupiter turned to new discoveries in the Kuiper Belt. He booked time at Palomar and started on his path. Living in a world of digital imaging, he discovered the best way to inspect large portions of the Kuiper Belt was to utilize the 48-inch Schmidt telescope at Palomar to photograph large sections of the sky onto 14-inch-square glass plates, the way Kowal had searched earlier. Covering an equivalent amount of sky with a digital camera would require a 500-megapixel unit, which didn’t exist. Scopes outfitted with digital cameras had better clarity and reached farther out, but they covered narrow fields of view.

So Brown took three pictures of the sky on three successive nights and compared them--again, Kowal’s methodology. Stars remained in position, but planets or bodies in motion appeared in three different places on the plates. The farther the distance traveled across the plates, the closer the object. He needed to cover a large portion of the sky. This process would take three years to complete.

But this was only the beginning. There were thousands of objects of various sizes and luminosity. Brown spent a year writing a computer program to compare the plate images and then refined the process until he located objects that he could point a large scope with a digital camera at to observe the characteristics. This yielded several potential “planet killers,” but reflective surfaces made the icy bodies appear larger than calculations and observations proved.

On January 5, 2005, Brown revealed to close associates that he’d found an object larger than Pluto. Instead of it meaning a new planet, its physical characteristics and orbit had greater meaning: Pluto would no longer be considered a planet. The body had a frozen methane surface, a traditional elliptical orbit around the Sun with a non-ecliptic tilt and orbited from 38-97 AU.

Brown lit the dome with examples of images moving

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Winter Solstice Lunar Eclipse

By Joseph A. Fedrick

The night of December 20-21 was partially clouded with a thin layer of high ice clouds that around 10 caused a dim halo of light to surround the Moon. By 1:30, the dark inner penumbra formed a bite-like mark near the Moon's edge. I couldn't time actual contact of the full umbral shadow on the Moon. The dark inner umbra simply graded into the umbra and blended with it.

The beginning of totality, at 2:41 a. m., revealed that the outer edge of the umbral shadow was tinted slightly blue, while the rest to the umbra was a dull copper red-brown. I could barely see the lunar Maria and couldn't distinguish any craters with my 10x 50 binoculars during the eclipse. The February 2008 eclipse was brighter and I could see several craters in the bright orange umbra then. Perhaps volcanic activity of the past several months contributed to the darker umbral shadow this year.

Jupiter had set behind houses to my west by the time the eclipse began and Saturn was clouded out on its rising in the east. But the Moon itself was visible in at least partially clear skies until just before 4 a. m., when clouds began to move in and I stopped observing the eclipse.

However, I observed Jupiter on other days in late December and noticed that even with my 60mm scope at 100x, I could see the southern portion of Jupiter's South Equatorial Belt was darker and was blended in the southern temperate belts, a pattern I hadn't seen. A so-called South Equatorial Belt revival was underway at last.

A new white spot has been seen on Saturn since mid-December. It spread out in whitish storms in the North Temperate Region. I noticed a slight brightening of this region the morning of January 5, but the brightest areas of these storms probably faced away from my view.

In the opening weeks of January, I continued to observe the morning skies. Mercury was undergoing an unfavorable morning elongation and was near the horizon, so I didn't see at all during the month. Venus continued to pull away from us. Using my 60mm refractor at 50x and 100x, I watched its brilliant dazzling disk as it became smaller while its phase passed dichotomy (half lit). Even as Saturn appeared higher in the sky each dawn, Jupiter began to appear lower at dusk. The southern half of its South Equatorial Belt darkened while the northern half remained nearly invisible. I thought Jupiter might set into the evening twilight in February and March, only to re-emerge in May with a completely revived South Equatorial Belt. ■

What's Up

By Tony Hoffman

The Sky for February 2011

February's Constellations. Winter's most brilliant stars are at their best in the early evening. Orion lies on the meridian to the south, with Auriga overhead, and Taurus between them. Sirius blazes in the southeast to Orion's lower left. Gemini stands high in the east, with Procyon in Canis Minor beneath it.

Well to the left of Sirius is the red giant Alphard, the brightest star in Hydra. The bowl of the Big Dipper swings up out of the northeast, while Leo rises almost due east. Jupiter, shining at magnitude –2.1, lies near the Circlet of Pisces. The Great Square of Pegasus sinks westward, trailed by Andromeda. Perseus swings to the northwest, with Cassiopeia to its lower right.

Saturn, in Virgo, rises before midnight early in the month, and by 9 p.m. in late February. Saturn shines a bit brighter than Spica, which lies to its lower left. Saturn's rings will be open nearly 10 degrees to our line of sight.

Venus rules the predawn sky, at magnitude -4.2. Rising more than two hours before the Sun, Venus lies near the center of our galaxy, and passes near some of the bright star clusters and nebulae that lie in that direction.

February 1 Moon lies near Mercury.
February 2 New Moon at 9:31 p.m.
February 4 Mars is in conjunction with the Sun.
February 7 Moon lies near Jupiter.
February 11 First-quarter Moon at 2:18 a.m.
February 18 Full Moon at 3:36 a.m.
February 19 Moon is at perigee, 222,604 miles from Earth, 2:24 a.m.
February 21 Moon lies near Saturn.
February 24 Last-quarter Moon at 6:26 p.m.

A Message from AAA President Richard Rosenberg

Hello members:

We'd like to encourage members to take an active role in developing new programs and managing existing ones. Many members have skills that would be tremendously useful to the AAA. The skills we are looking for include:

— Familiarity with a video camera to take images of the sky, and project them onto a screen. This would allow several people to simultaneously look at an image.

— Bringing astronomy to the schools. We need a liaison to the Board of Education and contacts in schools.

— Someone with fundraising and grant-proposal experience.

— Someone with legal expertise.

— Knowledge of hotels.com or similar websites to save money booking speakers for our lectures.

— Bart Fried, restorer of telescopes, has offered an 8-inch refractor if we can provide an observatory, possibly in Floyd Bennett Field. He's offered to help bring this about and will be at the Feb. 16 board meeting at headquarters.

This list isn't complete. You're welcome to add to it. Even better, think of volunteering yourself.

Another opportunity to volunteer is to join the board. If you are interested, the nominating committee which selects the candidates for the board will be appointed at the board meeting. Come to the board meeting if you can, or contact me.

On another subject, I'd like to compliment board member Jason Kendall for the excellent job he did putting together the current AAA class, "Astrophysics for Amateurs," which started January 25 and runs through March 1.

Rich Rosenberg, president@aaa.org, (718) 522-5014

AAA Lecture February 4: 'Illuminating Dark Matter'

Neal Weiner, associate professor in the Center for Cosmology and Particle Physics (CCPP) in the physics department of NYU, will address the AAA on Friday, February 4 on "Illuminating Dark Matter." The free public lecture beings at 6:15 p. m. in the Kaufmann Theater of the AMNH.

The CCPP is a group of faculty, students and research scientists working on fundamental questions at the intersection of particle physics, astrophysics and cosmology.

Weiner's abstract of the lecture is as follows: "One of the central discoveries of modern cosmology is that the universe is dominated by something other than us. More specifically, that the matter that makes up everything we know (protons, neutrons, electrons) is just a tiny fraction of the mass of the universe. The remainder is dark matter and dark energy. While we know it's there, we're ignorant as to what it is. Some experiments have attempted to find it, by looking for rare processes deep underground, or at cosmic rays in space, but rather than clarifying the situation, the results have been increasingly confusing. I will describe our current attempts to understand the dark universe, both theoretically and experimentally, and what we might find out in the coming years."

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Best-Astronomy-Pictures Talk Focuses on Amateurs' Images

By Anne Kiefer

Before Robert Nemiroff**,** physics professor at Michigan Technological University, co-creator of the popular Astronomy Picture of the Day (APOD) website, gave his AAA lecture January 7 at the AMNH on the best astronomy images of 2010, he gave a brief overview of the best astronomy images of all time. These iconic images, known even to those with no particular interest in astronomy, illustrate how influential a great astronomy image can be. Humanity has an inherent interest in space and especially in space travel. The Moon is a manifest destiny of humanity, Nemiroff explained.

Nemiroff opened the "Best Astronomy Images of All Time" list with the image of Earthrise from the Apollo 8 mission in 1968. He also included the image of Neil Armstrong on the Moon. Other images were an image of the Sun captured by the SOHO satellite, an image of Saturn's rings by Cassini and the famed photo of the Eagle Nebula taken by the Hubble.

One image Nemiroff placed in the best-of-all-time category was the Andromeda Galaxy taken by an amateur. He explained that as telescopes and such programs as Adobe Photoshop became relatively cheap and accessible to a broad range of consumers, amateur photography has exploded, and has had an important effect on the field.

Nemiroff's list of the best images of 2010 was very diverse, and included images with unique compositions, such as an image of the lunar eclipse of December 2010 with the Temple of Poseidon in Greece in the foreground. Also on the list was the International Space Station at the moment it passed in front of the Sun. Another photo was a rare example of an image of a person making it onto APOD. It was a photo of an astronaut on the ISS gazing out the window, looking at Earth.

Nemiroff featured the work of amateurs a number of times. Amateurs tend to produce more wide-angle shots, with a focus on the aesthetics of the image, as opposed to simply focusing on scientific importance.

That idea speaks to APOD's original goals. The website was created in 1995 to provide accessible and accurate information about astronomical images. Nemiroff and his co-founder, NASA's Jerry Bonnell, noticed that many astronomy images were circulating on the Internet with incorrect information, if there was any information at all. They decided to create APOD to promote scientific understanding of astronomy images that fascinated so many people.

"The pictures are the hook," Nemiroff explained. The beautiful image is what draws people in, encouraging them to read the brief explanation on the site, and then click to related links to further their understanding of the astronomical phenomena.

But Nemiroff and Bonnell sometimes choose images that aren't particularly scientifically important, but simply very beautiful. This is where the work of amateurs plays an important role. Scientists often look to take images for the sole purpose of furthering scientific understanding. Amateurs, on the other hand, are often more focused on the aesthetics of the image. Their wide-angle shots are very beautiful, and work well on the site.

Amateur photography isn't all about pretty pictures, though. The different approach amateurs use to take images of the sky has often opened up new questions for scientists.

Occasionally, APOD even runs images of Earth; it's a planet, too, Nemiroff observed. One instance stands out. In April 2010, APOD ran an image of the eruption of Eyjafjallajökull, the Icelandic volcano that covered much of Western Europe in a blanket of ash, interrupting air travel for days. This image is especially notable for the bolts of volcanic lightning, an unexplained phenomenon that's the subject of much research.

APOD images often highlight elements of astronomy scientists don't totally understand. Nemiroff said that's what makes astronomy so exciting.

Nemiroff's presentation included images from a variety of non-amateur sources. There were many images from Hubble, as well as images from the Mars rovers and Cassini. Amateurs were from all over the world. ■

Impressions of the Lunar Eclipse by 3 AAA Members

By Jason Kendall

While on a weeklong, Christmastime cruise in the Caribbean with my wife and parents, I had the wonderful opportunity to see the December 21 total lunar eclipse. I worked with the cruise staff to publicize the event. The captain made mention of it in his noon address over the loudspeakers, and the cruise director talked about it after the big show in the main theater.

That night, I organized a short discussion in the ship's library at 11:30. I discussed the history of eclipses, and the methods by which the ancient Greek astronomer Eratosthenes determined the diameter of the Earth to within 15%.

Unfortunately, when we went up to the 11th deck to get outside, the ship's external lights had to be lit, so the deck was quite bright. And worse, we had passed under a cloudbank, and the Moon was only just peeking out at odd moments. But that wasn't daunting to the bunch down in the hot tubs. They were partying it up, hooting about the eclipse from their steamy vantage point.

Then we noticed it: the big hole in the clouds to the south, right in the ship's path. The clouds were fascinatingly low and thick, only about 1,000-2,000 feet up, with nothing beyond. The winds picked up, and about 70 people came from below to look at the eclipse. With all the people up there, the suspense was building, and people were getting excited. The sneaky Moon was toying with the clouds, and it was now a race to see whether we would see the first contact.

Suddenly, we sailed into incredibly clear skies. The Moon emerged from its clumpy veil just after first umbral contact. Fifth-magnitude stars started coming into view as the Moon dimmed slowly with the encroaching eclipse. With this, the crowd chatted and clapped. A number of kids were on deck, away from their parents, and they cornered me with a lot of questions. One boy in particular was very interested; I hope he stays interested.

When totality occurred, the stars leapt out. The Moon had a gorgeous faint red glow to it. A distinct gradient across the Moon showed the depth of the umbra to the south side of the Moon. The color was not a fire-engine red, but rather a deep red, almost rust-colored. It seemed to be an L2 on the Danjon scale during the entire eclipse. The slowly changing ship's direction, combined with the near zenithal location, made judging its position from a prone position a bit difficult.

Stars simply exploded during the eclipse, with magnitude-5 stars easily visible, even under the ship's deck lights. Simply covering them with your hand was enough to make the night sky truly dark. The Hyades were easily visible, as was the fuzziness of the Orion Nebula. M35 was clearly visible as a little swarm right next to the Moon. Numerous doubles were visible, and the band of the Milky Way was the only thing lost by the ship's lights, as it was at the zenith.

Of the 70 or so people on the top deck, most stayed only until full eclipse occurred. The dramatic waxing umbral eclipse produced a loud cheer as the last penumbral brightness winked out, exposing the full eclipse. It was striking to see the sky visibly darken during this event. The high-school kids who met each other onboard were under-dressed for the unexpectedly cool night. My wife bundled herself up in a Russian mink hat, and my mother was wrapped completely from head to toe. My father and I braved the 50-degree evening with light jackets.

Most startling of all was a young Bolivian girl, not even out of high school, who talked about what she was learning in class. She spoke perfect English, and asked me to continually pronounce the names of various constellations and stars, because her teachers hadn't given her the English pronunciations. Then she casually mentioned that in her 10th grade science class, they learned about the HR Diagram. I would love to meet her teacher, who clearly inspired her to learn.

Near the end of totality, we were down to fewer than 10 people on the topmost deck, lying on lounge chairs in silent vigil. We basked in the nighttime glory quietly unfolding above us. As the ship approached Cozumel, Mexico, and we could see its lights in the distance, and

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even though dawn was two hours away, the first rays of the Sun seemed to burst as the Moon began its trek into the penumbra.

The end of totality was brighter than I'd expected, and heralded the end of the evening. There were only four of us on the upper deck by that time, my parents having long since trundled off to bed, coddled to sleep with the wondrous sights and the slow rolling of the vessel. I took my wife's hand and we descended to our stateroom, leaving the end of the eclipse to finish its work.

By George Hripcsak

The December 21 total lunar eclipse was incredible fun. The Columbia University astronomy department and the AAA sponsored an eclipse star party on the steps of Columbia's Low Library.

I arrived around 2 a. m. with a pair of 10x70 binoculars on a tripod and a 10-inch Newtonian. The eclipse was beautiful, with orange-red in the shadow long before totality, and an impressive orange-red once totality began. Some haze and thin clouds in mid-totality cleared before it ended. Nearby stars framed the eclipse nicely.

The highlight of the event, though, was the 250 students who watched the eclipse at its peak. They looked through several telescopes set up for viewing, watched totality approach and asked great questions. The start of totality led to a cheer. One commented, just before totality, that it looked like Mars with its orange-red body and a polar cap made of the last vestiges of sunlight.

The students loved the view through the binoculars. The two-eyed view and the field of view optimized the color and set it in the few background stars.

There was also a full-exit pupil, meaning that light coming out of binocular eyepieces fills the pupils of your eyes, implying you're receiving maximum light and are most likely to see vivid color. Telescopes are used at higher powers, which reduces the exit pupil, lowers the light and makes things look grayer.

There were ample squeals and check-it-outs. The best quote came from a young woman from abroad. On seeing the binoculars, she said, "Let's look at the baby," referring to the binoculars' small size compared to the telescopes.

By Evan Schneider

This is a story about curiosity, about fascination, about dedication. It all took place on a frozen evening, December 20, when a total lunar eclipse occurred at the time of the winter solstice.

The AMNH arranged for its winter-solstice star party. While 200 museum members attended a lunar-eclipse presentation, an intrepid group of AAA members gathered on the terrace, telescopes and binoculars in hand, to set up for 200 pairs of eyes waiting to view the night sky. The event was too early for eclipse viewing, but Jupiter and its four most prominent moons were out and our Moon was in full splendor, so bright that my scope needed a filter to see surface details.

We adjusted our scopes, sipped hot chocolate and waited to show the attendees why we're AAA observers. They came in droves, lined up to see and marveled at what was in the sky. Some looked at Jupiter and the Moon for the first time. Others told stories of observing in New Jersey and under a dark sky in Arizona.

But all this was but a preamble to what would happen at 2:41 a. m. Many planned to stay up for the event. No one was alive for the last winter-solstice total lunar eclipse in 1638. The next one is in 2094. So this night was important for onlookers and astronomers alike.

Several AAA members continued their evening at the Columbia campus, observing from the plaza, but I went to bed. At 2:15 a. m., I awoke, realizing that the eclipse was almost here. I raced to my 24th floor window and looked westward. Hanging ghostly in the sky was the Moon, copper-red and almost completely in shadow. The constellation Orion was bright, twinkling to the south. All was quiet.

I stood in awe, feeling like a part of something magical and spiritual. In the distance, onlookers cheered as the Moon reached total eclipse. I stood transfixed at the window and wondered how many others like me were having the same experience that we will remember for many years. ■

Tyson Advocates Deflection to Avoid an Asteroid Disaster

By Dan Harrison

Although the odds of an asteroid hit in April 2036 are very remote—several in a million—it would be foolish for the global scientific community not to investigate deflection technology, says Dr. Neil deGrasse Tyson.

The Hayden director, speaking in September at the AMNH's SciCafe series, noted that asteroid Apophis will make a close (18,000-mile) appearance in 2029, with no chance of hitting Earth. But if it threads a narrow so-called gravitational keyhole--unlikely but possible--it will hit us seven years later.

"We know how to blow things up, but are less sure where the pieces go," Tyson said, discussing the 900-foot-diameter asteroid. That's why he advocates deflection to make certain Apophis avoids the keyhole. To guarantee this, it would need just a 300-mile nudge, but "if we don't mobilize in time," a 4,000-mile deflection would be required, half Earth's diameter.

"I want to know that we have the power to deflect asteroids so we don't suffer the same fate as our reptilian ancestors 65 million years ago, who didn't have engineers among them," Tyson told an audience so large the event had to be moved from its original venue. "I don't want others to say we were smart enough to have a space program but too dumb to put it into effect and save ourselves from our own extinction."

Tyson called for adequate math, engineering and scientific skills to avoid an asteroid hit--and more. "There aren't enough engineers, and too many investment bankers and lawyers," he said. "With an asteroid coming, people will say to run and to stockpile food. I want people who will ask how we deflect this. I want people to view this as a problem to be solved, not as a disaster to run away from."

Agreeing with a questioner who noted we know more about deep space than the deep sea, Tyson said her statement about solving problems on Earth misses some context. He noted global climate change wasn't understood until the effects of the dinosaur wipeout led to climate models. "The planet-wide greenhouse effect came from studying Venus, with a temperature of 900 degrees.

"No science can claim an understanding of its subject if it's only looking at one thing. Sometimes you have to look up, at multiple phenomena. To only spend money here is suicide."

Tyson noted that NASA gets only half a penny of the tax dollar. "So how much is the universe worth to you?"

He also contended that science could be crippled by undue religious influence. He said that 1,000 years ago, the Middle East was the center of scientific progress because it was open to all lines of thought. It then slid backwards due to an influential religious figure who said math was the work of the devil. "The fact that scientifically diluted Texas textbooks are overtaking mainstream science worries me greatly," Tyson said. "America could fade into insignificance due to attacks on learning."

Asked when we will see interplanetary travel, Tyson called Mars "the only sensible planet we can visit." NASA's plans for a heavy-lift vehicle to go beyond Earth orbit will perhaps materialize by mid-century. "But if the mission isn't clearly defined, it may never happen. You can't rally just around a simple quest to explore."

Tyson observed that parts of the universe have been blocked from our view "because we live in a pancake. Our galaxy is like the pancake and we are like the blueberry because we're wider. If you want to see the rest of the universe, you have to look above and below the pancake. Otherwise, the pancake is in the way. So all the data we have on the universe comes from looking above and below our flattened galaxy.

"Eighty percent of the universe has been observed. There's no reason to believe that the rest, which is blocked by dense clouds of dust and gas, is fundamentally different from what we've seen."

Tyson also delved into what he called one of the great mysteries of the early universe: the creation of asymmetry between matter and antimatter. "One out of 100 million particle-antiparticle pairs was just a particle of matter. This was obviously rare, but accounted for all the matter we know and see and love in the universe." ■

Review: How Did the First Stars and Galaxies Form?

By Edward J. Fox

In his own words, Abraham (Avi) Loeb equates the research described in his book, "How Did the First Stars and Galaxies Form?" (Princeton University Press, $24.95, paper), to researching missing pictures in a family photo album. Pictures of children are frequently taken when they're newly born. Much later, many pictures are taken when the children are older.

Loeb says he's trying to fill in that time between: the early childhood years of the universe. Loeb, professor of astronomy and director of the Institute for Theory and Computation at Harvard University, is investigating the time between the cosmic microwave background (CMB) and our present knowledge of the universe. "In principle, we can image the Universe only as long as it was transparent…" after the CMB.

Loeb starts with the very early history of the universe and doesn't shy away from using many formulae and graphs in describing the process. His work is aimed at a serious student of cosmology, but he writes so a person who isn't proficient with the formulae can still understand what he's trying to convey.

The theories that Loeb and his colleagues have developed form much of the framework for research into the formation of the earliest stars and galaxies. He delves into gravitational growth of perturbations in the expanding universe. "The early epoch of inflation is important not just for producing the global properties of the Universe, but also in generating the homogeneities that seeded the formation of galaxies within it."

Without dark matter, we wouldn't have come into existence, Loeb asserts. This is because ordinary matter, which is coupled to the CMB radiation that filled the universe early on, had a tendency to smooth out. Dark matter is responsible for maintaining the small seed perturbations that led to formation of stars and galaxies.

Loeb believes there are two directions for researchers in cosmology. "One considers the global properties of the Universe and the physical principles that govern it." He believes that as more data come in, knowledge of the initial conditions and the underlying cosmological parameters get refined with greater precision.

The other branch focuses on the formation of observable objects from the original gases, including stars and black holes in galaxies. In this case, as more data come in, the models become more complex, demonstrating that prior analyses were oversimplified.

Loeb believes the first group may come to a point where there's no longer any point in further refining the models, thus ending its work. In the case of the second group, he believes they run the risk of spending their careers on a problem that may never get resolved.

You can hear first hand from Loeb in a nine-minute video he posted on YouTube: . http://www.youtube.com/watch?v=jNB8KuVM6KcIn it, he states, "The universe is the biggest environment surrounding us. And we had better get an informed view of it. ■

AAA Class Sells Out

AAA board member Jason Kendall's class in astrophysics, which started in late January and runs through early March, quickly sold out. The AAA is tentatively planning another course, on an undetermined subject, in the spring.

Kendall's members-only class covers the basics of astrophysics. Sessions are built around a textbook, and are supplemented by Web-based material. The class covers the nature of stars: how they're classified, their power sources, their births, their lives and their deaths.

The class is also covering nucleosynthesis in the Sun, and how it will change as it becomes a red giant. It's learning about degenerate matter in discussing white dwarfs and neutron stars. Other subjects include relativity, black holes, and the tenuous interstellar medium and how stars form from it and change it.

The class text is "Astrophysics is Easy!: An Introduction for the Amateur Astronomer" by Mike Inglis. ■

Highlights from Annual AAS Meeting in Seattle

Scientists have released the largest digital color image of the sky. Sloan Digital Sky Survey-III (SDSS-III) researchers assembled the picture over the last decade from millions of 2.8-megapixel images, creating a color image of more than 1 trillion pixels. SDSS observations previously discovered nearly 500 million astronomical objects. The latest, most precise positions, colors and shapes for these objects were also released. Over the last decade, SDSS scanned one-third of the sky. The enormous new image is forming the basis for new surveys of the universe. These rely on spectra, which can be used to find properties, such as temperature and chemical composition, of stars and galaxies, and how far away they are. Astronomers use SDSS instruments to measure distances to more than 1 million galaxies. The process provides a three-dimensional map of the galaxies' distribution in space. In 2014, the largest 3-D map of galaxies will be produced. The goal is to measure how dark energy has changed over the universe's recent history. SDSS-III has also been studying properties and motions of hundreds of thousands of stars in outer parts of the Milky Way. In conjunction with the huge image of the sky, astronomers are releasing the largest-ever map of the outer galaxy. They've found many streams of stars that belonged to galaxies torn apart by the Milky Way. SDSS-III will undertake other surveys of our galaxy. One will measure spectra for some 8,500 nearby stars, looking for wobbles caused by Jupiter-like planets. The other survey will use an infrared spectrograph for the first systematic study of stars throughout the Milky Way, even stars on the far side of the galaxy.

The Kepler observatory has discovered the smallest planet ever seen beyond our solar system, a rocky world just 1.4 times larger than Earth. Kepler-10b is the first rocky alien planet to be confirmed by Kepler using data collected between May 2009 and early January 2010. But while Kepler-10b is a rocky world, it's not in the habitable zone, a region in a planetary system where liquid water can potentially exist on the surface. Kepler-10b is the first rocky planet outside our solar system. It orbits every 0.84 days. An estimated 8 billion years old, it's some 560 light-years away. Mass is 4.6 times Earth's and surface gravity is thought more than twice Earth's.

Kepler has also stumbled upon triplet stars circling a massive star. The stars orbit each other. It's the first system of its kind that eclipses all three members. The discovery could help scientists understand what makes little stars tick, as two of the triplets are small by stellar standards, with about 0.2% the mass of the Sun. Most stars this small are too dim to be seen from Earth unless they're nearby, but triple star systems aren't a rarity.

Powerful thunderstorms on Earth can fling beams of antimatter into space. Scientists picked up on the never-before-seen phenomenon by peering at thunderstorms with the Fermi Gamma-ray Space Telescope. Antimatter particles were likely created by a terrestrial gamma-ray flash, a burst of gamma rays inside thunderstorms and associated with lightning. These signals are the first evidence thunderstorms make antimatter particle beams. Earth is likely not the only planet that boasts antimatter-generating storms. There's reason to think the processes are on other planets, such as Jupiter and Saturn. But storms there generally occur deeper in their atmospheres, so antimatter beams may be unable to escape into space.

A Jupiter-like alien planet that feeds momentum to its host star may help astronomers understand how a class of solar systems forms and evolves. As it orbits, the planet appears to transfer orbital momentum that speeds the star's rotation. The planet orbits a dwarf K type star in Vulpecula about 63 light-years away. The planet orbits in just 2.2 days. The star's mass and diameter are about 80% the mass and diameter of our Sun. The star, invigorated by its hot Jupiter planet, appears to have been spun up to a rotation speed twice as fast as our Sun. The star also gains angular momentum from magnetic and tidal interactions with the planet. But as the star's spin speeds up, the planet loses orbital angular energy and slows. Loss of momentum in the past may explain why it--and similar planetary systems—orbits so close to its star. While the planet is spiraling toward the star, and is most likely doomed, interacting magnetic fields of star and planet could create a tidal-magnetically locked orbit that might allow the planet to survive. The most likely scenario, however, is that the planet will draw closer to the star, leading to erosion of its atmosphere by the star's intense radiation and strong winds. The planet will ultimately be ripped apart by the star's gravity if it survives the star's radiation and winds. ■

Briefs: Voyager 1 Reaches Key Point at Solar System's Edge

The 33-year odyssey of NASA's Voyager 1 spacecraft has reached a point at the edge of our solar system where there's no outward motion of solar wind. Now hurtling toward interstellar space some 10.8 billion miles from the Sun, Voyager has crossed into an area where the velocity of the hot ionized gas, or plasma, emanating from the Sun has slowed to zero. Scientists suspect the solar wind has been turned sideways by pressure from the interstellar wind in the region between stars. The event is a major milestone in Voyager's passage through the heliosheath, the turbulent outer shell of the Sun's sphere of influence, and the spacecraft's upcoming departure from our solar system. Voyager 1 crossed the termination shock in December 2004 into the heliosheath. Velocity of the solar wind has steadily slowed at about 45,000 mph each year since August 2007, when the solar wind was speeding outward at about 130,000 mph. The outward speed has remained at zero since June. Researchers estimate Voyager will reach interstellar space in about four years.

One of the solar system's great mysteries, the origin of Saturn's rings, may be a case of cosmic murder. The victim: an unnamed moon of Saturn that disappeared 4.5 billion years ago. The suspect: a disk of hydrogen gas that surrounded Saturn when its dozens of moons were forming, but has now fled the scene. The cause of death: a forced plunge into Saturn. The rings are the only evidence left. As the doomed moon made its death spiral, Saturn robbed its outer layer of ice, which then formed rings, according to a new theory. A computer model indicates Saturn stripped ice from a huge moon while it was far enough from the planet that the ice would be trapped in a ring. The original rings were 10-100 times larger than now, but over time ice in the outer rings has coalesced into some of Saturn's tiny inner moons. So what began as moons became rings and then new moons. This helps explain Tethys, an inner moon that didn't quite fit other moon-formation theories. The theory explains heavy ice components of rings better than other possibilities.

Gigantic collisions on Earth, the Moon and Mars 4.5 billion years ago injected precious elements such as gold and platinum into the developing worlds, a new study suggests. In the last days of planet formation, a body as big as Pluto likely slammed into Earth after a Mars-size object hit the planet. Mars and the Moon absorbed smaller but still devastating blows. These crashes may have knocked Earth off its axis by 10 degrees. But they also delivered the elements into the bodies' upper reaches, and possibly brought huge amounts of water to the Moon. Gold, platinum and other elements have a strong affinity for iron. So they should have followed iron down into the cores of Earth, the Moon and Mars as the bodies were forming, leaving a near void in their mantles and crusts. To account for present abundances of gold, platinum certain other elements, researchers said, the impacts would need to deliver about 0.5% of Earth's mass to our mantle, 10 times less mass than that to Mars and about 1,200 times less to our Moon. Using models, the team determined that this could happen if the impactors were dominated by a small number of huge space rocks.

A massive ridge nearly encircling Saturn's moon Iapetus is likely the remains of a mini-moon destroyed by Iapetus' gravity long ago, a new study suggests. This sub-moon probably formed after a giant object smashed into Iapetus and the blasted-off pieces coalesced. Over time--anywhere between 100,000 and 1 billion years, depending on how close the sub-moon initially was to Iapetus--the ring slammed into the moon along its equator, forming a ridge more than twice as tall as Mount Everest. Iapetus' ridge is 62 miles wide and 12 miles high in places. It tracks the moon's equator and covers nearly 75% of Iapetus' surface.

A second look at a group of massive young galaxies 11 billion light-years away has revealed them in the throes of a celestial baby boom, birthing stars at an astonishing scale and rate. The new glimpse, showing the early universe 3 billion years after the Big Bang, may change how scientists think about star formation. Herschel Space Observatory data revealed the new population of galaxies to be hotter than expected, due to stars forming much more rapidly than previously believed. Previous observations had revealed the young galaxies, but their light in the visible spectrum was very faint, obscured by clouds of gas and dust within which new stars were being born. Herschel focused on 70 galaxies in Ursa Major. Data reveal star-formation rates far higher

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Briefs: Huge Asteroid Might be a Dormant Comet

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than seen in the present universe, and indicate the young galaxies possess large reservoirs of gas that will power star formation for hundreds of millions of years. With the discovery, astronomers have provided a much more accurate census of some of the universe's most extreme galaxies at the peak of their activity.

A huge asteroid discovered more than 100 years ago might actually be a dormant comet that's just now coming back to life. The object's about 70 miles wide and has a faint, wispy tail. The object would be only the sixth known comet to reside in the main asteroid belt. On the night of December 11, an astronomer was searching for potentially hazardous asteroids when he came across an object with a bright core and a faint tail. The object orbits slightly out of the ecliptic plane in which most planets and asteroids travel. Previous studies of its color suggested it's composed of primitive carbonaceous material left over from the formation of the solar system and might be an extinct or dormant comet.

With spring on Mars in full swing, NASA is taking advantage of the season's ever-longer periods of daylight to try to reawaken its stuck rover, Spirit, after months of silence. The rover has been dormant since March 22, but mission controllers hope it survived the harsh winter and will wake up. The amount of solar energy available for Spirit is increasing every day. NASA had anticipated Spirit would enter a hibernation-like low-power mode during Mars' long winter.

A patch of land near the huge Martian volcano Olympus Mons may bear evidence of recent plate tectonic activity, new research suggests. The many ridges and scarps on the rumpled apron of land north and west of Olympus Mons are likely signs of tectonic thrusting. This activity could be very recent, within the last 250,000 years or so. If the study's conclusions are confirmed, they would overturn conventional wisdom, which says plate-tectonic forces are unlikely to have played a major role in shaping the surface of Mars, particularly in the recent past. If this is true, Mars would be a better candidate for extraterrestrial life than scientists have thought. Plate tectonics could help replenish nutrients needed to foster life, bringing carbon and other substances from the interior to the surface. Some of the photos depict deflected, meandering drainage features, which provide further evidence of plate tectonics. One scientist thinks Martian plates were moving and grinding perhaps within the last 250,000 years, and even may be at it today. Other researchers have pointed out Mars has several long, relatively straight chains of volcanoes. These features could be explained by plate tectonics. Another piece of evidence is Mars' Valles Marineris, the biggest known canyon complex in the solar system. A few years ago, NASA's Mars Global Surveyor detected striped patterns of magnetic fields on the surface. One possible explanation is ancient tectonic activity.

Red dwarfs might be far more common than thought, enough to triple the number of known stars and possibly boost the number of planets that could harbor life. Astronomers previously couldn't detect them in galaxies other than the Milky Way and close neighbors. They've now detected the faint signature of red dwarfs in eight massive elliptical galaxies 50 million-300 million light-years away. The largest are thought to hold more than 1 trillion stars, vs. 400 billion in the Milky Way. Red dwarfs could make up at least 80% of stars and at least 60% of stars' mass. Galaxies might contain less dark matter than thought. Instead, red dwarfs could contribute more mass than thought.

The first analysis of the atmosphere of an alien planet classified as a "super-Earth" revealed a world likely covered with water vapor or a thick haze. A super-Earth is larger than Earth but smaller than gas giants. The planet's radius is 2.5 times Earth's and its mass is 6.5 times. The water vapor or haze of clouds likely blocks chemicals underneath. Although the prospect of water vapor may sound promising, the planet isn't a candidate for hosting life because it's probably way too warm for liquid water in large quantities.

A nearby small galaxy forming stars at a huge rate seems to have an enormous black hole in its center. This is surprising, because dwarf galaxies usually don't host supermassive black holes. This galaxy could help solve a conundrum: Which comes first, the black hole or the galaxy? The new discovery, of a black hole containing the

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Briefs: Astronomers See Most Distant Galaxy Cluster Ever

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mass of more than 1 million suns inside Henize 2-10, hints at an answer. Henize 2-10 lacks a bulge--a dense collection of stars at the center of most spiral galaxies. Usually, the mass of a galaxy's bulge correlates with the mass of its central black hole. Some researchers thought a galaxy had to have a bulge before a black hole could form. But this galaxy suggests the black hole comes first, because Henize 2-10 is a very low-mass dwarf galaxy without a detectable bulge, yet it already has a supermassive black hole.

Astronomers have glimpsed a "protocluster" of galaxies as they appeared only 1 billion years after the Big Bang, making it the most distant galaxy cluster seen. But finding and studying the birthplace of these regions is difficult. Early protoclusters are rare, and challenging to locate. To detect them, astronomers searched for brighter, easier-to-find objects such as quasars, starbursts, and massive galaxies. They searched in the same area of the sky studied by the Cosmic Evolution Survey (COSMOS). Within the field, they found a galaxy called AzTEC-3 that was rapidly forming stars. Around this system astronomers found 11 times more galaxies than one would expect in a random area of the sky. The dense galactic population indicated the presence of a protocluster. More than 40 million light-years across, the protocluster lies nearly 13 billion light-years away.

Moon water most likely came from comets that pelted the surface, a new study suggests. This water, samples of which were found in lunar-rock samples collected during Apollo missions, is different from water on Earth. Instead, it has the same properties as three comets. If comets delivered most water to the Moon, Earth also received a large cometary input to its oceans. Researchers found the geochemical signals of water in lunar minerals had a ratio of deuterium and hydrogen compounds unique from those in water typically found on Earth. In rock samples studied, scientists discovered that the chemical properties of lunar water were similar to those in comets Hyakutake, Hale-Bopp and Halley.

A dwarf galaxy that's too dim to see but is suspected to orbit the Milky Way may soon be revealed using a new mathematical technique that analyzes the ripples of gas in spiral galaxies. The mass of Galaxy X is predicted at one-hundredth the Milky Way's. The galaxy sits across the Milky Way somewhere in Norma or Circinus, just west of the galactic center in Sagittarius when viewed from Earth. Galaxy X or a satellite galaxy one-thousandth the mass of the Milky Way would still exert a large enough gravitational effect to cause ripples in the Milky Way's disk. Some calculate the galaxy is in a parabolic orbit around the Milky Way, about 300,000 light-years from the galactic center. The galactic radius is about 50,000 light-years. Many large galaxies are thought to have satellite galaxies too dim to see. The Milky Way is surrounded by about 80 known or suspected dwarf galaxies. However, some may just be passing through. Theoretical models of rotating spiral galaxies predict there should be many more satellite galaxies, perhaps thousands, with small ones most prevalent. Dwarf galaxies, however, are faint, and some may be primarily invisible dark matter. A "dark" dwarf galaxy is said to sit on the opposite side of the Milky Way from Earth, and has been unseen because it's obscured by gas and dust in the galaxy's disk.

A NASA spacecraft is providing great looks at parts of the Sun's atmosphere that had evaded detailed study. The Sun's corona is hotter than the surface, but the much brighter solar disk swamps its tenuous light. Historically, researchers have studied the corona during eclipses, when the Moon blocks out the disk and reveals the corona, or by using a coronagraph, which blocks out the Sun's disk. However, eclipses are relatively rare and don't last long, and coronagraphs occlude the inner parts of the corona. NASA's Solar Dynamics Observatory is helping scientists overcome these problems, yielding unprecedented views of the innermost corona 24/7. The instrument that makes this possible is the Atmospheric Imaging Assembly. AIA's images highlight the ever-changing connections between gas captured by the Sun's magnetic field and gas escaping into space. The Sun's magnetic field molds and shapes the corona. Hot solar plasma streams outward in vast loops larger than Earth, then plunges back onto the surface. A computer program has been developed for processing AIA images above the Sun's edge. These processed images imitate the blocking out of the Sun that occurs during a total solar eclipse, revealing the nature of the inner corona. ■

Events on the Horizon
February 2011

M: members; P: open to the public; T: bring your telescopes, binoculars, etc.;
C: cancelled if cloudy;
HQ: at AAA headquarters, Downtown Community Center, 120 Warren St.

For directions to AAA observing events, check the club's website, www.aaa.org.

Friday, February 4, 6:15 p. m.
AAA lecture, P, FREE
Neal Weiner, associate professor in the Center for Cosmology and Particle Physics at NYU, will speak on "Illuminating Dark Matter." The free public lecture is at 6:15 p. m. at the Kaufmann Theater of the AMNH.

Monday, February 7, 7:30 p. m.
Hayden Planetarium lecture, P, AMNH
"The Hidden Reality: Parallel Universes and the Deep Laws of the Cosmos" with Brian Greene.
In recent years, a growing body of work has been converging around a proposal that our universe is only one of many. Theoretical physicist and Columbia University professor Brian Greene will discuss a number of different models of parallel universes. His latest book has the same title as the lecture.

Thursday, February 10, 6:30-8:30 p. m.,
726Broadway, sixth floor conference room
Recent Advances in Astronomy Seminar, M
The seminar now incorporates the Observers' Group. Next date: March 3.

Wednesday, February 16, 7 p. m.
Quarterly AAA board meeting, M, HQ
All club members are invited to attend.

Thursday, February 24, 6 p. m.
Observing, Prospect Park, M
The Prospect Park Alliance will have an event thanking their members at the Picnic House in the Long Meadow. They would like AAA members with telescopes or binoculars to show off the sky.

Saturday, February 26, 10 a. m.-noon
Solar Observing at Central Park, P, T, C
At the Conservatory Water. Next date: March 26.

Lecture continued from page 3

Weiner has broad interests in particle physics and cosmology. His focus is on physics beyond the standard model. In this broad field, his work has included studies of extra dimensional theories (large, small, warped and flat), supersymmetry, grand unification, flavor, neutrino mass, dark matter, inflation and dark energy, as well as relationships between the different subjects.

Weiner was a post doc at the University of Washington prior to joining the CCPP in 2004. He is a graduate of Carleton College and received his Ph.D. in physics at UC Berkeley. He is currently on sabbatical leave at the Institute for Advanced Study in Princeton, N. J.

Other upcoming AAA lectures are: **March 4,** Andrea Dupree, Harvard-Smithsonian Center for Astrophysics, "Searching for Extrasolar Planets with Kepler." **April 1,** Greg Matloff, New York City College of Technology, "Regreening the Earth Using Space Resources." **May 6,** David J. Thompson, NASA, "Exploring the Extreme Universe with the Fermi Gamma-ray Space Telescope."

Dupree's talk will be the club's annual John Marshall Memorial Lecture, which honors a past president and executive director of the AAA who was instrumental in its growth. Marshall died in 1997. ■

If you haven't renewed your membership, next month will be your last issue of *Eyepiece*!

Pluto continued from page 1

across the sky as photographed by the 48-inch Schmidt telescope. It was easy to see the logic of the process. The metamorphosis of that process was fascinating. By chance, Brown had called upon old technology to identify his objects and then blended in new technology to confirm his findings. Fate and timing also played to his favor.

Before confirming his discovery, Brown needed time on the Hubble. Scheduling requires a lengthy proposal and approval process. Not wanting to be scooped by another astronomer, he contacted an associate at Hubble and got time on the telescope. This was the final piece of documentation that was required to complete his analysis.

The evening turned lighter as Brown described the process for naming bodies discovered by the astronomical community. Some of his earlier discoveries were given pet names like Santa, Easter Bunny and Xena. Xena, his Pluto-killing discovery, ultimately became Eris, the largest dwarf planet known in the Kuiper Belt. Before formal submission, it's the astronomer's choice what to call his object. Once released, the International Astronomical Union takes control, not only to classify the body as a planet, dwarf planet, etc., but to determine the correct descriptive name to assign to the discovery.

(For more basic naming information, visit http://en.wikipedia.org/wiki/Astronomical_naming_conventions to read about how this is structured.)

Tyson brought a young girl to the center of the dome with a tee shirt saying, "I (heart image) Pluto." He introduced Kenneth Chang, the *New York Times* reporter who was in contact with Brown at the point of discovery and who's responsible for the article blaming Tyson for demoting Pluto.

Tyson showed the lead story for the next day's *New York Times* science section. The headline read: "The War of the Worlds, Round 2." Eris' size is being challenged, and newer models may prove it smaller than Pluto. ■

Contacting the AAA

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