EYEPIECE

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Scrutinizing Two of the Universe's Most Extreme Phenomena

Black Holes

By Maya Kushner

If you can't see a black hole, how would you know it's there?

Dr. Alex Filippenko, distinguished professor in the physical sciences at the University of California, Berkeley, attempted to explain how black holes could be identified, using detection techniques, when he spoke at the Northeast Astronomy Forum in Suffern, N. Y., April 16.

Filippenko began by showing a surprising picture...of a black hole! He revealed his picture by simply showing nothing on the slide but blackness, his version of what a black hole would look like if we could see it. His humor illustrated the difficulty astronomers have encountered.

So how does one capture a picture of a black hole if it can't be seen in the dark background of space, and it emits no light since not even light can escape its local gravitational hold?

Scientists once called black holes "gravitationally collapsed objects" and asserted the most massive stars might actually be "dark stars." Using Newton's laws, they correctly estimated the value of the Schwarzschild radius, although it was more accurately arrived at using Einstein's laws, where gravity is a curvature and warping of time and space. Since light has energy but no mass, we can't use Newtonian but rather Einsteinian laws.

Mathematician Karl Schwarzschild in 1916 theorized the gravitational radius. It's the distance from the center of an object so that, if the mass of an object were compressed within that region, the escape speed would equal

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Gamma-ray Bursts

By Alan Rude

Concluding the AAA's 2010-11 AAA lecture series May 6 at the AMNH, NASA's Dr. David Thompson demonstrated how the Fermi Gamma-ray Telescope (Fermi) has allowed astronomers to explore some extreme phenomena of the universe, such as pulsars, blazars and gamma-ray bursts.

Thompson, who's with NASA's Goddard Space Flight Center, is deputy project scientist for the Fermi Project. Fermi was launched in 2008, and in its time aloft has discovered and investigated distant sources of gamma rays, the most powerful form of light. The instrument has greatly added to our knowledge of the cosmos.

In 1963, the Air Force launched the first in a series of satellites, inspired by the just-signed nuclear test-ban treaty with the Soviet Union to monitor atmospheric nuclear tests, which would emit gamma rays from Earth if tests had continued. Observations showed directions of incoming gamma rays ruled out the Sun and Earth as sources. It was concluded some were "of cosmic origin."

Fermi, which orbits at an altitude of 565 km, has two instruments: the Large Area Telescope (LAT) and the Gamma-ray Burst Monitor (GBM). The LAT detects

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Board Approves $10 Dues Increase

Meeting in special session May 11, the AAA board of directors approved an increase in the club's dues, from $25 to $35, effective with the 2012 dues year. The membership must approve the increase. ■

Tony Hoffman Wraps Up What's Up After 18 Years

By Tony Hoffman

Keep Looking Up! After 18 years of writing What's Up, this is my last column. Although I'm grateful that I've been able to keep at it for so long, my life's situation has necessitated I let go of certain commitments. Fortunately, AAA President Richard Rosenberg will continue to provide a preview of the next month's celestial happenings. The seeds of it are doubtless in his excellent This Month's Sky, which has appeared on the club's Web site for several years. I still look forward to writing the occasional column and review for the newspaper.

I started writing What's Up in mid-1993. I'd answered a notice that former editor Jack Dittrick had run in *Eyepiece*, looking for someone to write a column of monthly sky happenings. He agreed to take me on, and I've written the column through one of the most amazing periods of astronomical discovery the world has known.

I thought I'd touch on a few things that have happened in astronomy during my tenure.

In July 1994 the 20-odd fragments of Comet Shoemaker-Levy 9 collided with Jupiter. The next year I met Levy, along with the late comet expert Brian G. Marsden, at a Hayden Planetarium event. Both signed a copy of What's Up I'd brought with me. Along with his signature, Marsden scribbled "Go find a comet!" This was about eight months before the Solar and Heliospheric Observatory (SOHO) launched, and no one had any inkling of the trove of tiny comets I and other amateurs would find in its images, from the comfort of our homes on our computer screens, within a few years. The SOHO comets project is but one of many "citizen science" astronomy projects (which started with SETI@home) that have allowed amateurs as well as the general public to participate in useful scientific research and discovery.

Four exceptional comets have appeared in the past 15 years: Hyakutake in 1996, Hale-Bopp the following year, and McNaught and Holmes in 2007. The first three were called Great Comets, of unusual brilliance and/or tail length. Comet Holmes is a very faint periodic comet that rapidly underwent a millionfold increase in brightness to show as a ghostly, expanding cloud of dust and gas that moved slowly through Perseus. Other spectacular sky events have included the 2001 Leonid meteor storm and the 2004 transit of Venus across the face of the Sun

In 1996, the first exoplanets--planets orbiting another star (in this case, 51 Pegasi)--were discovered. In the 15 years since then, more than 500 exoplanets have been found, with thousands more suspected planets awaiting confirmation. NASA's Kepler mission and similar surveys have proved what we long suspected, that our galaxy is teeming not just with stars but with planets. What we didn't expect is that there would be such an amazing variety of worlds, from "hot Jupiters" closely circling their parent stars, to ones that orbit backwards, to mini solar systems radically different from our own.

Speaking of new worlds, a number of sizable icy bodies have been found at the fringe of the solar system. When a team headed by Mike Brown--the most prolific discoverer of such bodies--found Eris, an object believed larger than Pluto, it set into motion a reassessment of the definition of a planet, which ultimately led to Pluto joining Eris in a new class of objects, dwarf planets. The explanet also became the most prominent example of another newly defined class of objects, the plutoids, dwarf planets that orbit beyond Neptune. The new definitions are controversial and may yet be revisited, particularly in light of the wide range of exoplanets being found.

These are some topics I've written about, in addition to previewing upcoming sky events. I hope I can write more *Eyepiece* articles about topics such as these.

June 1 New Moon at 5:03 p.m.; partial solar eclipse visible from northern Canada, Siberia, Norway, Japan and Greenland.
June 8 First-quarter Moon at 10:11 p.m.
June 10 Moon lies near Saturn.
June 11 Moon at perigee, 228,161 miles away, 9:41 p.m.
June 15 Full Moon at 4:14 p.m.; total lunar eclipse visible from eastern hemisphere.
June 18 Venus lies near Aldebaran.
June 21 Summer Solstice occurs at 1:16 p.m.
June 26 Moon lies near Jupiter.
June 28 Pluto is at opposition near star cluster M25 in Sagittarius; Moon lies near Mars

A Message from AAA President Richard Rosenberg

Hello members:

We're expanding our presence at Pier 1 in Brooklyn, to Thursday nights June through September. The Brooklyn Bridge Park Conservancy supplies the scopes. Come by and learn how to use an 8" scope with a Dobsonian mount.

Also on Pier 1, a special event will take place Friday, June 3. Join amateur astronomers from all over the metropolitan area to hear Timothy Ferris and others, and view the heavens. The event is part of the second World Science Festival, which runs June 1-5 at various locations in the city (http://worldsciencefestival.com/).

Rik Davis has stepped down from the board after long service. He'll continue to chair our solar observing and Carl Schurz observing sessions. I don't know how many people have joined the AAA as a result of Rik showing them the sky and handing out our brochure, which he produces, but we would be a significantly smaller group without him.

Tony Hoffman is also stepping down from his monthly *Eyepiece* column "What's Up?" after 18 years. Tony never failed to let us know, in lively fashion, what celestial events would be happening in the upcoming month. It will be my difficult duty to continue in his footsteps starting next month.

On May 21, I was interviewed on topics in astronomy by George Bodarky of WFUV radio for his Cityscapes program. You can hear the interview at http://wfuv.streamguys.us/archive/11173.asx.

Beginning this month, we'll once again have monthly observing at North-South Lake in the Catskills. Check www.aaa.org for specific dates, which were being finalized at press time.

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

Rosenberg Is Elected to Sixth Term as AAA President

By Dan Harrison

Richard Rosenberg was elected to a sixth term as AAA president by the board of directors, which met May 18 following the club's annual meeting.

Susan Andreoli was named vice president, succeeding Rik Davis, who's leaving the board. Thomas Haeberle was re-elected treasurer, Joe Delfausse financial secretary and Edward J. Fox recording secretary.

The membership endorsed nominating-committee recommendations for the board. Andreoli and Evan Schneider succeed Davis and Gerceida Jones. Continuing on the board, for three-year terms, are former president Michael O'Gara, Haeberle, Bruce Kamiat and Shana Tribiano. This will be Andreoli's second stint on the board. Leo Genn was elected to the remaining two years of the term of Alice Barner, who recently resigned.

Discussing the state of the club, Rosenberg noted that membership has been rising--it hit 400 last month--for a number of reasons: AAA classes; face time in the media, especially *Time Out New York;* the High Line, "which has done a lot to publicize us," and the AMNH, where "some people have been pushing the club." Rosenberg noted the club's new observing locations, including the Brooklyn Heights promenade, which he called exciting. "It's with regret we left Cadman Plaza. It's darker than Brooklyn Heights but the latter has better observing."

Movies with a View will again be Thursdays June-September on the Brooklyn waterfront, and summer upstate observing at North-South Lake will be monthly.

The club is trying to schedule more sessions at the Marine Park Salt Marsh in Brooklyn. It's has finally gotten the telescope working at the Solaria apartment building in Riverdale. "You can see some nice dark sky from

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AMNH Speaker Puts Exoplanets Into Perspective

By Evan Schneider

Five thousand years ago, the Babylonians recorded observations about planets in our solar system. On April 26, Emily Rice, AMNH exoplanets astronomer, presented her perspective on how we see ourselves in the solar system and what methodologies are used to try and identify Earthlike planets in distant galaxies.

Astronomers use data from Earthbound and Earth-orbiting telescopes, and from spacecraft missions, to seek planets traversing paths across faraway suns.

Two detection methods involve the measurement of light and the interaction between a star and its planet(s). By measuring the light of a star on a constant basis, astronomers can detect a wobble as the gravity between the star and an orbiting body interacts. Larger-magnitude wobbles indicate more massive stars. Detecting this wobble, astronomers can infer a planet is nearby.

A second method is to identify a star with a transiting planet. By measuring decrease in light output from a star as a planet moves across it, a small amount of light is blocked, allowing calculation of the planet's size. This is more difficult since the planetary system needs to be aligned with our sight path for measurements to be made. A third method is to block light from a star that obscures an orbiting planet.

These methodologies apply to any star/planet relationship. But to identify and classify exoplanets of greatest interest, astronomers must find planets in a system's habitable zone, the distance from a star where a planet's water can remain liquid on its surface. Planets close to the size of Earth orbiting at this distance are referred to as Goldilocks Planets, for being not too far and not too close to the star, but instead "just right."

Rice pointed up to the dome star field to Gliese 581, a promising example of exoplanet research. This red dwarf, 20.3 light-years from Earth, contains four to six exoplanets, with Gliese 581g in the middle of the system's habitable zone. Keck scientists discovered Gliese 581g utilizing Chile-based HARPS (High Accuracy Radial Velocity Planet Searcher), and HIRES (High Resolution Echelle Spectrometer), the largest and most mechanically complex of Keck's main instruments. Measuring the characteristics of light is key to finding and classifying all exoplanets, Rice observed.

Although the concept of exoplanets isn't new, discovery has just recently occurred; the first were observed just 15 years ago. As with many discoveries, technology needed to catch up with conceptual thinking, and astronomers have counted and classified 546 exoplanets.

Rice pointed to the dome again as it lit up with circles and names of exoplanets observed all around us. Many have been identified by NASA's Kepler Mission (www.kepler.nasa.gov), where 150,000 stars are monitored every six minutes. Initial estimates by Kepler scientists state there may be as many as 50 billion exoplanets in the Milky Way. Kepler's field of view is a region along the Cygnus arm of our galaxy, a small piece of the sky with so many stars. When the dome graphic displayed this field of view, the magnitude of our universe became apparent.

Utilizing the AMNH's planetary dataset, Rice asked to fly us to Jupiter. We stopped to observe it and to acknowledge that size matters in seeking exoplanets. Earth is a relatively small planet. Looking for other Earths our size would be very difficult at great distances. So Jupiter was named the benchmark for sizing up potential exoplanets.

While we search with telescopes, exoplanets may have already heard from us. In the late 1930s, radio-wave transmissions began and have travelled through Earth's ionosphere and outward. AMNH's Earth radiosphere appeared on the dome (http://www.haydenplanetarium.org/universe/duguide/mwt_radio_sphere.php). Overlaying the sphere with known exoplanets, it's clear we've touched many inadvertently through our transmissions.

AAA member Maya Kushner inquired whether there are tests for temperatures on exoplanets. Rice said no. "We can estimate how bright an exoplanet is, and only infer what the temperature may be. The extreme distance of each observation can distort measurement." ■

Webb Seen Needing More Public Support If It's to Fly

By Dan Harrison

Following her April 17 presentation at the Northeast Astronomy Forum in Suffern, N.Y., on the next-generation James Webb Space Telescope (JWST), Dr. Heidi B. Hammel, executive vp of the Association of Universities for Research in Astronomy, and Interdisciplinary Scientist at the JWST, was asked this question:

"Reading between the lines, are you saying that without adequate public support, such as that which led to reversal of plans to kill the Hubble, the JWST may not get off the ground, especially in a climate of tangible budget cutting?

Her answer couldn't have been more concise: "Bingo!"

She summed up the JWST, scheduled to launch in 2015, almost as succinctly: "It's totally awesome but costs a lot."

With the JWST, it's not simply been a question of cost, but cost overruns. The telescope will cost at least $1.5 billion more than the $5 billion NASA estimated just two years ago. Furthermore, much of NASA's funding for astrophysics missions is being gobbled up by the JWST, whose rising cost is putting future missions in jeopardy. The telescope will need infusions of $200 million in each of the next two years if it's to be launched in 2015.

In her presentation, Hammel noted that an independent report, commissioned by Sen. Barbara Mikulski (D-MD) after indications of cost overruns surfaced, said last November that cost growth and schedule delay stemmed from technical, management and budgetary causes. It urged changes that could diminish the risk of future cost increases without compromising the JWST's performance, including integration of management structure and adequate reserves.

Two fundamental mistakes were made when JWST as approved, Hammel said. First, the budget wasn't based

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the speed of light.

Black holes are a possible end state to exploding supernovae, the other being neutron stars. Another indicator is gamma-ray bursts (GRBs). Most observed GRBs are believed to be a narrow beam of intense radiation released during a supernova event, such as when as a rapidly rotating, high-mass star collapses to form a black hole, or in the merger of two neutron stars. We may also look to central regions of galaxies several times the Sun's mass, such as the Sombrero Galaxy.

In lieu of an actual picture of a black hole, one might look to see how neighboring objects behave. For example, stars near a black hole would move faster because of the enormity of mass of a black hole.

Another method is to look for the red/blue shift in absorption lines. In a binary system, using Doppler, we can also evaluate the absorption lines.

Astronomers also use another detection method, looking for stars that emit X-rays. Generally, stars don't give off gigantic amounts of X-rays unless orbiting a neutron star or black hole.

Filippenko has made numerous observations, using radial velocity vs. time measurements in logging the movement of visible stars.

Measurements are also used to find lots of mass in a small amount of volume. For example, in M87 the Virgo Cluster, there seems to be 3 billion-6 billion solar masses within a central light year. In Andromeda, there are 140 million solar masses. The Milky Way has 4 million.

Astronomers may also try to identify the Penrose Process when looking for black holes. Near the black hole, energy can be extracted from a rotating black hole. That's made possible because rotational energy of the black hole isn't inside its event horizon, but outside it in part of the ergosphere, a region in which objects are propelled in concurrence with rotating space-time.

Infrared is another good way to go, using adaptive op-

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Review: A Comprehensive Atlas of Herschel Objects

By Greg Matloff

Let's say you're very fortunate in your choice of observing location and equipment. Unlike most residents of the New York metropolitan area, you're blessed with dark skies and good seeing. And you have an instrument with a computerized star finder to supplement its setting circles. You've also grown a bit blasé about the Moon and naked-eye planets. Andromeda, Orion and the Pleiades are old hat and you're seeking new challenges in the night sky.

You could do a lot worse than work your way through the northern Herschel objects. James Mullaney and Wil Tirion have authored a beautiful guide to these deep-sky objects, "The Cambridge Atlas of Herschel Objects" (Cambridge University Press, $35). The authors are qualified to have produced this elegant, comprehensive atlas. Mullaney is a fellow of the Royal Astronomical Society, with more than 500 articles and seven books to his credit. Tirion is a skilled uranographer who's created star maps for atlases, books and magazines.

As most *Eyepiece* readers are aware, the Herschels (Caroline, Sir John and Sir William) were perhaps the greatest observers of the late 18th and early 19th centuries, and rank among the foremost observers of all time. Using Newtonian reflectors in the 12-48-inch aperture range, they mapped the northern sky from observing sites near London and the southern sky from South Africa. Their discovery of Uranus may have triggered interest in deep-sky objects that might be mistaken by casual observers for undiscovered planets or comets.

Although they were inspired by the earlier Messier tabulation of 110 deep-sky objects, the Herschels composed a much more comprehensive list of about 2,500 objects. These are classified in the book as open clusters, globular clusters, diffuse nebula, supernova remnants, galaxies and objects now considered to be nonexistent. The original Herschel Object classifications as bright nebulae, faint nebulae, very faint nebulae, planetary nebulae, very large nebulae, compressed/rich star clusters, compressed star clusters and coarsely scattered star clusters are listed for comparison. Where appropriate, Messier and New General Catalog designations are given for each Herschel object.

The introductory section concentrates on the history of the Herschel family, including their contributions to music and their principal telescopes, object-selection criteria and observing hints. This is followed by a tabulation arranged by right ascension of the 215 "Herschel Showpieces," those Herschel Objects particularly striking in telescopes with 2-14-inch apertures. Some of these are even visible with good binoculars. As well as coordinates and descriptions of the objects, approximate distances are listed when known.

Following a listing of references are the beautiful star charts. Two index charts of the celestial northern and southern hemispheres are followed by 32 multi-color sector charts. These present the visible magnitudes of major field stars, locations of variable and binary stars, and locations/classification of Herschel Objects.

Maps are printed in red-light friendly colors. This encourages use without affecting night vision.

Appendix A presents constellation abbreviations and relevant map numbers as an observing aid. Appendix B is full tabulation of the 2,500+ Herschel Objects, arranged by right ascension.

The "Cambridge Atlas of Herschel Objects" belongs in the reference collection of any committed deep-sky observer. My only "criticism" is the sheer beauty of the product. Rather than risking damage to my copy while observing, I would photocopy relevant star charts and keep the original work safely in my bookcase! ■

Book for Youngsters

For the special kid(s) in your life, check out "Space Stars and the Beginning of Time: What the Telescope Saw" by Elaine Scott (Houghton Mifflin Harcourt, $17.99). Written for youngsters 8-12, the book begins with historical background on telescopes and moves on to instruments aboard the Hubble, and the hue and cry after Hubble's termination was announced following the 2003 Columbia disaster. Then come chapters on the Big Bang and the early universe, dark forces and black holes, the life cycle of a star and "recipe for a planet." ■

Review: Guide to Seeing Eclipses and Related Phenomena

By Tony Hoffman

Although David H. Levy made his name as a comet discoverer, he's written books on a variety of astronomical subjects, and has even earned a Ph.D. from the Hebrew University of Jerusalem on literature and the night sky. In his "Guide to Eclipses, Transits, and Occultations" (Cambridge University Press, paperback, $25.99), he combines scientific explanations, historical accounts, personal anecdotes and literary references to create a book that should be of interest to anyone from neophytes to veteran eclipse chasers.

The book contains 17 chapters, split between six parts. Part I is called The Magic and History of Eclipses. The first chapter describes a deep partial solar eclipse seen in London in 1605, and a lunar eclipse two weeks later, and talks about how eclipses served as a narrative device in "King Lear," which was showing at the time. "Just as Shakespeare used the eclipses of 1605 to arouse his audience's curiosity, this book aims to use eclipses as a tool to inspire deeper interest in the night sky."

The next chapter describes how Arthur Eddington's measurements of the position of stars close to the Sun in photographs taken during a 1919 eclipse confirmed Albert Einstein's general theory of relativity. The theory proposed that the gravity of a massive object such as a star can bend light, and displacement of stars in the photos exactly as predicted proved the theory in dramatic fashion, to the delight of both men.

Part II, Observing Solar Eclipses, starts out with the most important subject, safety. Even the reduced light of a deep partial eclipse can produce eye damage or even blindness, and the Sun's relative dimness makes it deceptively easy to stare at. Levy stresses that the eclipsed Sun shouldn't be looked at directly until the Diamond Ring effect appears and totality is imminent. He explains what equipment is safe for viewing the Sun (no. 14 welder's goggles, or sheets of aluminized Mylar designed for solar observing), and what's not (smoked glass, medical X-rays and more).

Levy describes what to expect when viewing a partial solar eclipse and an annular eclipse (when the Moon appears smaller than the Sun, which is visible as a blazing ring surrounding the Moon's dark disk). He saves most of his effort for total solar eclipses, and discusses in detail the different stages of totality, drawing on his own experience as well as excerpting historical accounts. He covers not only visual observation, but eclipse photography and videography.

Besides practical advice, Levy keeps returning to the wonder of these events, which leave an indelible impression on those who have seen them and draw people to travel huge distances to stand in the Moon's shadow.

Part III is Observing Lunar Eclipses, in which Levy describes partial, total and penumbral lunar eclipses; how terrestrial volcanism affects eclipse darkness and color, and lunar-eclipse photography. Part IV discusses occultations, when the Moon (or other body) passes in front of a star or planet. Timing occultations--particularly grazing ones, in which a star appears to approach the Moon tangentially and skims across its very edge--can help better determine the profile of the lunar limb. Occultations in which an asteroid passes in front of a star are key to determine the asteroid's orbit and diameter, particularly occultations in which observers spread out are able to measure the time the star is covered by the asteroid.

Part V discusses planetary transits, in which Mercury or Venus crosses the face of the Sun. Transits of Venus usually appear in pairs separated by eight years, with more than 100 years between the pairs. The most recent transit of Venus was in 2004. The next is in 2012.

Part VI describes the 77 eclipses Levy has witnessed, plus several occultations and transits, including transits of several of Jupiter's moons. If the book has a flaw, the extent to which he describes his eclipse experiences at times feels self-indulgent, although often such accounts illustrate points Levy's trying to make or provide a personal connection to readers to inspire them to better appreciate these wonders.

The book includes lists of solar and lunar eclipses between now and 2024, and what parts of the world are favored for viewing them. A table of upcoming transits would have been helpful. ■

Mission Recommendations in an Age of Austerity

By Jason Kendall

The dream of interplanetary spaceflight met fiscal reality March 31 when the AMNH hosted a town-hall meeting about NASA's Decadal Survey of Planetary Sciences. The document is the result of about 200 contributing scientists and determines the future of NASA's planetary exploration.

Hosting the discussion was Denton Ebel, curator in charge of the museum's Department of Earth and Planet Sciences. He introduced Jim Adams, deputy director-planetary science, NASA, and Ralph McNutt Jr., MESSENGER scientist and decadal-committee member.

Adams began with a brief overview of previous planetary-science missions. He discussed such successful unmanned exploratory missions as Mariner 10 to Mercury, Magellan to Venus, and numerous successful Mars missions beginning with Viking and going through the Mars rovers Spirit and Opportunity. Also included were the Galileo probe to Jupiter and the ongoing success of the Cassini mission to Saturn. The current missions of Dawn, New Horizons, Juno, MESSENGER, StarDust NeXT and EPOXI were outlined.

Every mission goes through changes from drawing board to final launch, Adams noted. Voyager missions sent back astonishing discoveries despite being subjected to significant downscaling and change. All planetary missions had to be perfectly timed, but had budget and redesign issues, and had to be supported by the public. Even after huge cuts, the Voyagers completed the astonishing Grand Tour and continue their interstellar mission.

McNutt spoke about budgetary constraints that dictate NASA projects. With the top priority of scientific exploration, NASA is required by law to do a decadal survey. This is presented to Congress to demonstrate the agency has gathered the consensus of the scientific community on how tax dollars should be spent. This budget must, in turn, answer to many masters: current operations, new technologies and leading-edge missions.

McNutt discussed two types of missions that fall under the purview of the survey, and gave an impassioned plea to allocate money for another group of missions. These are small missions, so-called Discovery Class missions, which due to their small size and opportunistic nature aren't part of the survey, but nonetheless are part of the operating budget of the Planetary Sciences Division.

Because of these missions' success and their ability to blaze trails to larger-scale missions, the survey recommends continued funding of these missions with a cost cap of $500 million per mission. Previous Discovery missions include Mars Pathfinder, Stardust, MESSENGER and Kepler.

The survey recommended that two New Frontiers missions be carried out, to be chosen from a Comet Surface Sample Return, a Lunar South Pole-Aitken Basin Sample Return, a Saturn Probe, a Trojan Tour and Rendezvous, a Venus In Situ Explorer, an Io Observer and a Lunar Geophysical Network.

Great Flagship Missions were also discussed. They pose the greatest expense and challenges, but reap the greatest scientific rewards. Only one was recommended, with highest priority given to a Mars Astrobiology Explorer-Cacher to find and return scientifically useful Mars samples. Then came a Jupiter-Europa Orbiter, and in third place a Uranus Orbiter and Probe.

McNutt spoke extensively about the tradeoffs, given numerous funding constraints. He also emphasized the need for domestic plutonium to be developed again. All plutonium currently comes from Russia, and only a few tons of kilograms are left.

Budget battles in Congress and the 30-year steady decline in space funding were discussed. All recommendations have a total cost cap of $20 billion for the next 10 years.

Speakers exhorted attendees to read the survey and support the findings of the scientists who accomplished much with a slowly shrinking budget, and to try to help get that budget raised through citizen support.

The decadal survey is at http://solarsystem.nasa.gov/2013decadal/. ■

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gamma rays individually, using technology similar to that used in terrestrial particle accelerators. Its field of view covers about 20% of the sky at any one time, and it scans continuously, covering the whole sky every three hours. The sky seen from the LAT is far different from the sky seen with our eyes because only the gamma-ray portion of the electromagnetic spectrum is recorded.

The GBM detects sudden flares of gamma-ray bursts to the edge of the universe. Even at such distances, GRBs are detectable since they're the most powerful energy sources ever discovered.

Fermi has made discoveries in these areas, which have greatly expanded our picture of the cosmos:

Gamma-ray Pulsars. These super-dense neutron stars emit beams of radiation which sweep through our line of sight, causing the star to seem to wink on and off. The most notable is the Vela Pulsar, which exhibits the extreme density of an object with a 12-mile diameter (less than the length of Manhattan) having 1.5 solar masses. There may be a whole population of pulsars we can't detect except through their gamma-ray emissions, Thompson suggested.

Unidentified Sources. Nearly 40% of gamma-ray-emitting objects seen by Fermi's LAT remain mysteries. They don't seem to match any known classes of gamma-ray sources. Some of these objects may provide a partial explanation of dark matter, an ongoing Fermi search.

Blazars. These are compact quasars (quasi-stellar objects) associated with supermassive black holes at the centers of active, giant elliptical galaxies. Blazars are among the most energetic phenomena in the universe and have jets we see when they point in the direction of Earth. Through an optical illusion, many of these jets appear to have speeds faster than light.

Gamma-ray bursts are flashes of gamma rays associated with extremely powerful explosions that have been observed in galaxies billions of light-years away. GRBs are the most violent and powerful events in the cosmos. They emit jets which are highly focused and which we can observe when pointed directly at Earth. There is the unlikely possibility that a nearby GRB-- say, 10,000 light-years away--caused one or more of Earth's mass extinctions. However, meteor/asteroid impacts are considered far more likely to have been the cause.

GRBs are of extremely short duration; those lasting more than two seconds are designated "long." Therefore the GBM and LAT have been designed to react to a GRB in microseconds. An important finding is that after traveling billions of light-years, high-energy gamma rays appear to reach Earth less than one second after their lower-energy electromagnetic counterparts coming from the same source. This finding supports Einstein's relativity principles and challenges certain theories of quantum mechanics that predict such very-high-energy radiation may be slowed by the quantum foam of space-time.

Last year, Fermi made an interesting discovery regarding the Milky Way. It revealed there were huge gamma-ray-emitting "bubbles" or "lobes," one above and one below the galactic plane, each 25,000 light-years in diameter. It's thought these might be remnants of activity from the supermassive black hole at the galaxy center.

Thompson said Fermi has far exceeded its original goals in exploring extreme cosmic phenomena. It was designed for at least a five-year life, meaning until 2013. Besides the U.S., five other countries have funded Fermi, Indications are we and they would like to prolong it. ■

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tics to compensate for the image of a selected star field. Scientists can also look at Keplerian orbit. This is a closed ellipse that occurs when an object orbits a point mass, such as a planet orbiting the Sun, or a binary-star system. In general, stars' orbits in a galaxy aren't Keplerian, since they don't orbit around a point mass. With stars around the Milky Way's black hole, however, they orbit around a point mass, so are in Keplerian orbit.

Finally, Filippenko said, look for tidal forces near a supermassive black hole. They're much less than tidal forces near a low-mass black hole.

So black holes are detected by their huge gravitational influence. There are millions of small black holes per galaxy, typically 5-15 solar masses, and one big black hole in most galaxies, 1 million-1 billion solar masses.■

Briefs: Huge Population of Planets Likely Has No Parent

Astronomers have discovered a new class of alien planet: a vast population of Jupiter-mass worlds that float through space without any discernible host star, a new study finds. While some of these exoplanets could potentially be orbiting a star from very far away, the majority most likely have no parent star. These strange worlds aren't statistical anomalies. They likely outnumber "normal" alien planets with obvious parent stars by at least 50%, and are nearly twice as common in our galaxy as main-sequence stars. Astronomers have long predicted the existence of free-flying rogue alien planets, but their huge numbers may surprise many researchers, and force some to rethink how the planets came to be. The find was made using gravitational microlensing, which watches what happens when a massive object passes in front of a star from our perspective. The nearby object bends and magnifies the light from the distant star. A team looked at two years of data from a telescope monitoring 50 million Milky Way stars for microlensing events. It identified 474 such events, including 10 lasting less than two days. The short duration of these 10 events indicated the foreground object in each case was not a star but a planet roughly the mass of Jupiter. Signals from their parent stars were nowhere to be found. Either these 10 planets orbit very far from their host stars, more than 10 times the Earth-Sun distance, or they have no host stars at all. Discovery of 10 short-duration events in two years suggests a huge population of these unbound or distantly orbiting Jupiter-mass exoplanets throughout the galaxy. Since it's probably rare for huge planets to orbit more than 10 Earth-Sun distances, at least 75% of Jupiter-mass planets are likely rogues, floating through space unbound to a star. Rogues may have formed close to a host star, then were ejected from their solar systems by gravitational influence of huge neighbor planet.

An expensive, ambitious astrophysics experiment 17 years in the making was installed May 19 on the International Space Station. The $2 billion Alpha Magnetic Spectrometer (AMS) will hunt for clues about some of the universe's strangest phenomena, from dark matter to antimatter. The instrument was delivered to the orbiting laboratory by space shuttle Endeavour, which launched its final mission May 16. The AMS is the most expensive science experiment ever flown on the station. It's a product of 17 years of work by more than 500 scientists in 16 countries. The giant experiment houses a 3-foot-wide magnet that will bend paths of cosmic ray particles flying through space, sending them into special detectors that will measure their properties. Various cosmic particles that can't come through our atmosphere to Earth will be collected. Scientists hope the particles will include exotic species such as antimatter and even strange matter, which contains rare particles called strange quarks. AMS will also search for signs of the elusive dark matter scientists suspect permeates space, but have yet to detect directly. The experiment almost never flew. After the 2003 space shuttle Columbia accident, the flight slated to launch AMS was cancelled. It took lobbying by scientists, and a bill passed by Congress, to add a space-shuttle mission to launch AMS.

The largest three-dimensional map of the distant universe has been created using the light of the brightest objects. The map provides an unprecedented view of what the universe looked like 11 billion years ago. Normally, researchers make maps of the universe by looking at galaxies. Here they're looking at intergalactic hydrogen gas, which blocks light. Scientists relied on the light of the brightest objects in the cosmos, quasars. To make a 3-D map of the universe, researchers relied on 14,000 quasars. The map reveals a time when the first galaxies started coming together to form large clusters.

A huge ocean may lie beneath Titan's surface, according to Cassini observations. Certain details of Titan's orbit and rotation aren't compatible with a celestial body that's solid all the way through, but they make sense if the moon is assumed to have a subsurface ocean. The new study isn't the first to suggest Titan may have an underground ocean, but it adds new evidence. The moon tilts 0.3 degrees on its axis of rotation. Previous studies concluded Titan's tilt and moment of inertia don't make sense if the moon's completely solid, but the numbers could work if it has an underground ocean. A team found Titan's orbital behavior makes sense if it's assumed to have a solid interior surrounded by a liquid-water ocean, which itself sits beneath an icy shell. The sizes of these layers are tough to pin down, but modeling suggests the shell might be 93-124 miles thick and the ocean 3-264 miles deep, with the solid interior making up the rest. Current thinking about Titan's formation and

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Briefs: Impacts Could Have Created Thick Titan Atmosphere

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evolution suggests the ocean would be primarily water rather than hydrocarbons or something else.

An untold number of cosmic impacts could have created the mysteriously thick atmosphere of Titan, experiments suggest. Titan is the only moon in the solar system with a substantial atmosphere, whose main ingredient is nitrogen. Where it came from has long been debated. It could be primordial or could have originated later. Japanese scientists suggest asteroids and comets slamming into Titan's ammonia ice could have converted it to nitrogen gas several hundred million years after the moon's formation. Some 4 billion years ago, the solar system saw cosmic impacts blast planets and moons. To see if such impacts would deliver enough energy to convert ammonia ice to nitrogen, researchers used laser guns and bullets made of gold, platinum and copper foil. The beams vaporized the back of the bullets, propelling them at high speeds at targets made of ammonia and water ice. Researchers found ammonia is very easily converted to nitrogen molecules by impacts.

A powerful star explosion in deep space has puzzled astronomers. The explosion may be the death cry of a star as it was ripped apart by a black hole. High-energy radiation continues to brighten and fade from the location, 3.8 billion light-years away in Draco. Astronomers have never witnessed an explosion so bright, long lasting and variable. The explosion looks like a gamma-ray burst, but the flaring emissions from these events never last more than a few hours. Scientists know of objects in our galaxy that can produce repeated bursts, but they're thousands to millions of times less powerful than the bursts they're seeing now. The explosion was detected when Swift detected an X-ray eruption, the first in a series of blasts. Hubble pinpointed the blast's source: the center of a small galaxy in Draco. Chandra made a four-hour exposure of the source. The explosion likely arose when a star wandered too close to its galaxy's central black hole. Intense tidal forces probably tore the star apart, and infalling gas continues to stream toward the black hole. Modeling indicates the spinning black hole formed an outflowing jet, blasting X-rays and gamma rays in our direction. Stars have been disrupted by supermassive black holes, but none have shown the X-ray brightness and variability here, with repeated flaring. Scientists think the X-rays may be coming from matter moving near the speed of light in a particle jet that forms as the star's gas falls toward the black hole.

A NASA probe orbiting Earth has confirmed two key predictions of Einstein's general theory of relativity, which describes how gravity causes masses to warp space-time around them. The Gravity Probe B (GP-B) mission has studied two aspects of Einstein's theory about gravity: the geodetic effect, or the warping of space and time around a gravitational body, and frame-dragging, which describes the amount of space and time a spinning objects pulls with it as it rotates. GP-B confirmed two predictions of Einstein's universe, having far-reaching implications across astrophysics. It used four gyroscopes to measure the hypotheses. The probe confirmed both effects by pointing its instruments at a star called IM Pegasi. If gravity didn't affect space and time, GP-B's gyroscopes would always point in the same direction while the probe was in polar orbit around Earth. However, the gyroscopes experienced small changes in direction of their spin while Earth's gravity pulled at them, confirming Einstein's theories. The mission's star tracker and gyroscopes were the most precise ever produced. Additional innovations were applied to NASA's Cosmic Background Explorer mission, which determined the background radiation left over from soon after the Big Bang.

A comet plunged into the Sun last month just as a huge eruption exploded from its surface, but the two events are likely not related. NASA's Solar and Heliospheric Observatory (SOHO) spotted the comet diving toward the Sun May 10 and 11. By coincidence, a massive coronal mass ejection (CME) erupted at about the same time. Scientists have yet to find a physical connection between Sun-grazing comets and CMEs. In fact, the CME erupted before the comet could possibly have had any effect. The comet was first discovered by amateur astronomer Sergey Shurpakov. Astronomers suspect it was part of the Kreutz family of comets. Kreutz comets' orbits approach within a few hundred thousand miles of the Sun. Kreutz comets are thought to be the remains of a giant comet that broke apart several centuries ago.

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Briefs: 2-Asteroid Collision Likely Caused Metamorphosis

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The strange metamorphosis astronomers observed in an asteroid last year was likely caused by a collision with a smaller rock, two new studies report. In December, astronomers noticed asteroid (596) Scheila had brightened unexpectedly. The rock was also sporting new and short-lived dust plumes. Collisions between asteroids create rock fragments, from dust to boulders, that impact planets and their moons. Yet this is the first time scientists have caught one just weeks after the smashup, long before the evidence fades away. Scheila is 70 miles wide and orbits the Sun every five years. On December 11, images revealed Scheila to be twice as bright as expected, and immersed in a faint comet-like glow. Looking through archived images, astronomers determined Scheila's outburst began between November 11 and December 3. A collision with another asteroid wasn't the only possibility. Researchers recently learned some objects categorized as asteroids can be dormant comets that can come back to life in some parts of their orbit and start shedding water vapor. Some researchers initially thought this might be the case with Scheila. But in mid-December, Swift captured multiple images and a spectrum of the asteroid, which showed the fuzz around Scheila was dust and not gas. So Scheila wasn't just going through a comet-like outgassing phase. Hubble data are explained by the impact, at 11,000 mph, of a previously unknown asteroid about 100 feet in diameter. Scheila's dual dust plumes--bright in the north, fainter in the south--were formed when small particles ejected by the crash were pushed away from the asteroid by sunlight. A small asteroid likely smashed into Scheila at an angle of less than 30 degrees, leaving a crater 1,000 feet across. A more direct strike probably wouldn't have produced distinct dust plumes. Scientists estimate the crash ejected more than 660,000 tons of dust. The absence of ice in Schiela's interior demonstrates it's unlike comets.

NASA's Mars Reconnaissance Orbiter has discovered the amount of atmosphere changes dramatically as the tilt of the planet's axis varies. This can affect the stability of liquid water, if it exists, and increase the frequency and severity of dust storms. Researchers identified a large, buried deposit of frozen carbon dioxide (dry ice)at the South Pole. Scientists suspect much of this enters the atmosphere and swells its mass when Mars' tilt increases. The deposit holds up to 80% as much carbon dioxide as the atmosphere. Various clues suggest the deposit is dissipating, adding gas to the atmosphere each year. Mars' atmosphere is 95% carbon dioxide. There's a small perennial cap of carbon-dioxide ice on top of Martian water ice, but the buried deposit has 30 times more dry ice than estimated. A tilted Mars with a thicker carbon-dioxide atmosphere causes a greenhouse effect that tries to warm the surface, while thicker, longer-lived polar ice caps try to cool it. Simulations show polar caps cool more than the greenhouse warms.

The universe's first stars may have been extraordinarily fast spinners, at more than 1 million miles per hour. These "spinstars" formed right after the Big Bang and were likely massive giants, according to a new study. They died young after no more than 30 million years. The nuclear-fusion reactions that drove these stars also provided the universe with its first elements heavier than helium. A 12-billion-year-old globular cluster of stars, NGC 6522, provided the basis for the spinster proposal. NGC 6522, the oldest known globular cluster in our galaxy, probably witnessed the early phases of the seeding of these heavy elements across the cosmos. Scientists calculated the stars would have whirled with a surface speed of 1.1 million mph. By comparison, our Sun spins at 4,400 mph, and massive stars in the Milky Way typically spin at 220,000 mph. Spinstars' high rate of spin would cause overlap between inner and outer gas layers of a star that wouldn't otherwise mix. The resulting nuclear reactions would generate radioactive neon, which in turn would emit neutrons that would collide with iron and other heavy atoms to create strontium and yttrium. After the stars died, these elements made their way into star-forming clouds and eventually into the stars of NGC 6522. Spinstars' fast spinning could have led them to create and disperse heavy elements across the universe much earlier than thought. Their whirling could also have led to a greater-than-expected number of gamma-ray bursts. Spinstars could have lost mass during their evolution via stellar winds, which could help explain why the imprints of very massive stars believed to have existed in the early universe aren't seen.

The most powerful solar flare in nearly five years, in February, was triggered by interactions between sunspots

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on the solar surface that rotate and twist the Sun's magnetic field, a new study shows. The flare was the first of the current solar cycle to receive the most powerful X-Class designation. From five days of observation, scientists found the active flaring region contained five newly emerged sunspots. All rotated between 50 and 130 degrees, some clockwise and others counterclockwise. In addition to the large flare, the same region released more than 40 smaller flares during five days that were studied.

Astronomers have pinned down details of an exotic nearby alien planet that's almost as dense as lead. 55 Cancri e is 60% larger in diameter than Earth but eight times as massive. That makes it the densest solid planet known, twice as dense as Earth. Astronomers previously thought 55 Cancri e took 2.8 days to orbit its star. But a new study reveals it orbits in less than 18 hours. The world is part of a multiplanet solar system 40 light-years from Earth, in Cancer. Parent star 55 Cancri is bright enough to be seen by the unaided eye. Since 1997, astronomers have discovered five planets circling 55 Cancri, including 55 Cancri e in 2004. Starlight is dimmed by only 0.02% during each transit, so the planet's diameter is 13,049 miles, only some 60% larger than Earth. Using this information, researchers were able to calculate 55 Cancri e's density.

Radio waves from the aurorae of planets such as Jupiter and Saturn could be used to detect exoplanets that orbit large distances from their parent star, according to a new study. This is the first study to predict radio emissions by exoplanetary systems such as those found at Jupiter or Saturn. At both planets, aurorae-related radio waves are generated by interactions with ionized gas escaping from the volcanic moons Io and Enceladus. Emissions could be detected from radio aurorae from Jupiter-like systems orbiting at distances as far out as Pluto. In many scenarios, exoplanets orbiting stars that emit bright ultraviolet light would generate enough radio power to be detectable from Earth. For the brightest stars and fastest-moving planets, radio emissions would be detectable from systems up to 150 light-years from Earth.

Poisonous carbon monoxide has been discovered in Pluto's atmosphere after a search lasting nearly two decades. A new study also detected the atmosphere extending much higher than thought. Astronomers found a strong signal of carbon monoxide gas in Pluto's atmosphere. The atmosphere was known to extend more than 60 miles, but new findings raise that to more than 1,860 miles, equivalent to a quarter of the distance to Pluto's largest moon, Charon. The CO is about minus 364 degrees. The signal is more than twice as strong as an upper limit predicted by other researchers. The change in brightness over the last decade is startling. The atmosphere may have grown in size, or the CO abundance may have been boosted. Fluctuations in the atmosphere were seen before, but only in the lower atmosphere, where methane has also been seen to vary. Atmospheric gases are most likely produced by solar heating of ice.

The best places to look for planets that can support life may be white dwarfs, a new study suggests. Our Sun and more than 90% of all stars in our galaxy will end up as white dwarfs, made up of their dim, fading cores. These cooling stars are typically 40%-90% of the Sun's mass, but only the same volume as Earth, and they're as common as Sunlike stars. As cool as white dwarf stars might get, they'd be warm enough to possess habitable zones. Before a star fades to become a white dwarf, it usually bloats to become a red giant, destroying planets as close as Earth. But more distant worlds could survive, and once a red giant sheds its outer layers of gas to leave behind a white dwarf, outer planets could eventually migrate into habitable zones. New worlds could also originate from debris left by the star's transformation. Since white dwarfs are so cool, planets would have to be close to dying stars to be within their habitable zones, perhaps 500,000-2 million miles away, just far enough for the star's gravitational field to not rip these worlds apart. The planets would be tidally locked, meaning the same side would always face the white dwarfs and the opposite side would always be in darkness. The best areas for habitation might be toward the edges of the light zone. Since white dwarfs are tiny, a habitable-zone Earth-sized planet passing in front of a white dwarf would produce a 50% dip in light. If there are Earth-like planets in white dwarfs' habitable zones, they should be easy to detect even from the ground, using scopes as small as 3 feet across. It's been proposed that researchers survey the 20,000 white dwarfs within a distance of 325 light-years from Earth. The nearest white dwarf to us is Sirius B, about 8.5 light-years, which packs about the same mass as the Sun into the same volume on Earth.

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Astronomers have identified what appears to be a cosmic smoking gun for a historic supernova explosion, a find that may help the search for dark energy. Evidence suggests the famed Tycho supernova, about 13,000 light-years from Earth, formed when its parent star stripped too much material from a companion, forcing its thermonuclear detonation. A study of the exploded star's remains also suggests that, in general, stars can survive the intense impact generated when their stellar companions undergo a supernova death. The Tycho supernova remnant, first observed in 1572 by Tycho Brahe, was formed by a Type Ia supernova. Type Ia supernovas have helped gauge the universe's expansion rate, an effect attributed to the prevalence of dark energy. There's been a long-standing question about what causes Type Ia supernovas. While studying the Tycho supernova, researchers found an arc of X-ray emission in the remnant. They suspect it was created by the shock wave generated when a white dwarf exploded (the original Tycho star explosion), and blasted material off the surface of a nearby companion star. Astronomers have different ideas about what triggers Type Ia supernovas. One involves the merger of two small white dwarfs. In this scenario, no companion star or evidence of material blasted off a companion star should exist after the initial explosion. In another competing theory, a white dwarf draws material off a normal, Sun-like companion star until a thermonuclear explosion occurs. While both scenarios could occur, the latest observations imply the latter theory is most likely.

Astronomers have discovered a star that may have been among the second generation of stars to form after the Big Bang. In the dwarf galaxy Sculptor 290,000 light-years away, the star has a similar chemical make-up to the Milky Way's oldest stars. This supports the theory that our galaxy underwent a cannibal phase, reaching its current size by swallowing dwarf galaxies and other building blocks. If dwarf galaxies are the foundation of larger galaxies, older stars should be found in older galaxies, especially those with metal-poor stars. Because they're products of stellar evolution, metals were rare in the early universe, so old stars tend to be metal-poor. Surveys haven't turned up extremely metal-poor stars in dwarf galaxies. The Milky Way seems to have stars much more primitive than any of those found in dwarf galaxies.

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on current, bottoms-up estimates of projected costs, and didn't reflect existing threats against the budget. Second, NASA management didn't fully recognize the budget's inadequacy: Reserves added to the budget were inadequate, and reserves were skewed to the out years so inadequate reserves were provided in the years needed.

In the wake of the report, a number of changes have been implemented. And NASA is conducting a bottoms-up cost estimate, which should be completed by September.

If people believe the JWST is worth it, Hammel said, they must do two things: write to (or visit) their senators and representatives, and write to NASA administrator Charles Bolden.

The JWST, which is making excellent technical progress, "will be the dominant astronomical space facility for the next decade, enabling an astonishing range of investigations by the astronomical community."

The giant infrared JWST will peer back to the early universe. It's being built to probe such phenomena as "first light and reionization, assembly of galaxies, birth of stars and protoplanetary systems, and planetary systems and the origin of life."

The JWST dwarfs other space telescopes at 6.5 meters, vs. 2.4 meters for the Hubble and 0.8 meters for Spitzer, among other data, Hammel observed. It will orbit L2 930,000 miles from Earth. Features include an integrated science instrument module, five-layer sunshield, solar array, primary (elliptical)/secondary (hyperbolic)/tertiary (elliptical) mirrors, multiple spectrometers and near- and mid-infrared imagers. ■

Contacting the AAA

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Events on the Horizon
June 2011

M: members; P: open to the public; T: bring your telescopes, binoculars, etc.;
C: cancelled if cloudy; AMNH: For ticket information, call (212) 769-5200
HQ: at AAA headquarters, Downtown Community Center, 120 Warren St.

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

NOTE: Summer observing begins this month at North-South Lake in the Catskills. At press time, the dates hadn't been finalized. Check www.aaa.org for further information.

Thursdays, June 2, 9, 16, 23, 30, sunset-10 p.m.
Observing at Pier 1 in Brooklyn, P, T, C
Info: http://www.aaa.org/movieswithaview.

Thursday, June 2, 8-9:30 p.m.
World Science Festival panel, Skirball Center, NYU
In "The Dark Side of the Universe" panelists will discuss what dark matter and dark energy are and how we know they're there. "The Mystery of Dark Matter," will be Friday, June 3 from 2 to 3 at NYU's Rosenthal Pavilion. Info: www.worldsciencefestival.com.

Friday, June 3, 8:30-midnight
Star Party at World Science Festival, Brooklyn Bridge Park, Brooklyn, P, T, C

Saturday, June 4, 7:30-11 p. m.
Observing at Great Kills Gateway National Park, Staten Island, P, T, C Next date: July 23.

Monday, June 6, 7:30 p. m.
Hayden Planetarium event, P, AMNH
"Exoplanets and the Search for Life Beyond Earth" with Marc S. Kaufman and Sara Seager. As our knowledge of exoplanets grows, does the likelihood of finding signs of life in the cosmos increase? MIT's Sara Seager, an expert on exoplanets, will discuss this and new discoveries with Marc Kaufman, author of "Exoplanets and the Search for Life Beyond Earth," a new book on astrobiology.

Tuesdays, June 7, 14, 21, 28
Observing on the High Line, Manhattan, P, T, C
Enter at 14th Street. Next dates: Tuesdays in July.

Wednesday, June 8, 8-10 PM
Observing at Brooklyn Heights Promenade, P, T, C
At end of Montague Street. Next date: July 6.

Friday, June 10, 8:30-11 p. m.
Observing at Carl Schurz Park, Manhattan, P, T, C
Next date: July 15.

Fridays June 10 and 24, 8-11 p. m.
Observing at Inwood Hill Park, Manhattan, P, T, C
Next dates: July 8 and 22.

Friday, July 10, 8-10 p. m.
Observing at Floyd Bennett Field, Brooklyn, P, T, C
Next date: September 16.

Wednesday, June 22, dusk-10 p. m.
Observing at Prospect Park, Brooklyn, P, T, C
Next date: July 20.

Saturday, June 25, 10 am.-noon
Solar observing at Central Park, P, T, C
At the Conservatory Water. Next date: July 30.

Jupiter Aligns with Venus

By Joseph A. Fedrick

Jupiter was supposed to have a close conjunction with Mars May 1. However, from my location I couldn't see Jupiter clear obstructions near the horizon until morning twilight and even then it was partially obscured by tree branches. Jupiter displayed a faint pale off-white disk with two faint equatorial cloud belts barely visible at 50x in my 60mm refractor.

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there," Rosenberg observed. Bart Fried, a telescope restorer, would give the club a scope if it can set up an observatory, the president noted. At an earlier board meeting, possible sites were discussed. Rosenberg also said DVDs are available through the AAA website.

Rosenberg said he hopes for two classes this fall. One would be an "Astronomy 101" class and the other would be more advanced. The basic class is already in place, to focus on planets. It will be taught by Dr. Laird Whitehill. Rosenberg praised board member Jason Kendall for the class he recently taught on astrophysics.

Other praise came from O'Gara, who saluted Davis for his many years on the board, and Tribiano, who lauded board member Tony Hoffman, who's giving up the What's Up column in *Eyepiece* this month after 18 years.

Board member Joe Delfausse reported on bylaws changes passed by the board at a special meeting May 11. The board will now fill vacancies rather than the president. References to *Sky & Telescope* and *Astronomy* are eliminated since new subscriptions and renewals are now handled directly by club members instead of through the club. Eliminated from the bylaws are a specific dues amount and the foreign-member classification The corresponding secretary post is being abolished. ■

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I couldn't see Mars. The waning crescent Moon was a thin sliver several degrees above Jupiter. I also couldn't see the earthshine because the twilight had grown so bright.

Several degrees to the right (south) of the Moon was dazzling bright Venus, which displayed a nearly fully illuminated tiny disk at 50x in my refractor.

I watched the angular distance between Jupiter and Venus gradually shrink during several mornings in early May. On May 11, Jupiter and Venus fit into the same field of view in my 60mm refractor at 50x. On all days in the first half of May, I was unable to see Mercury or Mars. Obstructions near my horizon blocked my view of the planets until the twilight had grown so bright that I couldn't locate them. I needed an unobstructed view from a wide-open location as some area in the Catskills, the Palisades or a beach. Some pictures of Jupiter are being shown on the Internet from more southerly locations, such as the Philippines at 10 degrees North, where the ecliptic makes a more steep angle to the horizon, allowing Jupiter to rise earlier in a darker sky.

During the summer, Jupiter will have climbed higher, allowing me to again view this interesting, dynamic planet. ■

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