COMING EVENTS

Public Observing
Sunday January 29
Prairie Park Nature Center
8:00 PM

Sunday February 26
Prairie Park Nature Center
8:00 PM

Saturday February 11
USD497 Science Fair Expo
South Middle School
Fair Open House/EXPO
2:00 - 4:30 p.m.

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Report from the Officers:
The image at right was taken by a staff member at CTIO in Chile on the morning of Dec. 22 and was seen naked-eye by Dr. Anthony-Twarog of KU, who happened to be on the mountain observing during Comet Lovejoy’s passage near the Sun. Not a bad way to end the year!

Another change in the administration of the AAL for the com-
(Continued on page 2)

A New Year’s Welcome to new club member
Rod Duke

Grote Reber - Radio Astronomer
By Bill Pellerin, Houston Astronomical Society, GuideStar Editor

When you think about the pioneers in astronomy, the name Grote Reber does not generally come to mind. Yet, it is Grote Reber who was one of the early observers of the sky at radio frequencies.

When we observe the sky in visual light, we are taking advantage of the fact that our eyes see a small part of the electromagnetic spectrum; we call this part of the spectrum visual light. The electromagnetic spectrum includes radiation at many other wavelengths, though, and observing the sky at these other wavelengths can tell us things about the sky that we can’t learn from what we observe at visual wavelengths.

Radio astronomer Grote Reber was born in 1911 and died in 2002, just two days shy of his 91st birthday. He was an electrical engineering graduate of what is now known as the Illinois Institute of Technology and an amateur radio operator with the call sign W9GFZ. That amateur radio call sign is now owned by the National Radio Astronomy Observatory Amateur Radio Club in Socorro, NM. A personal note – on August 28, 2000 I made contact with W9GFZ via ham radio on the event of the dedication of the Green Bank (WV) radio telescope and I have a confirming postcard from that day as a souvenir.

Mr. Reber’s work in radio astronomy is only preceded by Karl Jansky’s work. Jansky was working for Bell Telephone Labs on a project to determine sources of interference in transcontinental cable systems. In completing this work, Jansky discovered a radio signal that was associated with the Milky Way, and was, as might be expected, strongest in the Sagittarius constellation – the center of the Milky Way galaxy. Jansky was not authorized by his employer to continue the investigation of the radio signals from space so his work on the subject was completed once radio sources that would interfere with cable communications were identified. The radio signals from space
(Continued on page 2)
The club is open to all people interested in sharing their love for astronomy. Monthly meetings are typically on the second Friday of each month and often feature guest speakers, presentations by club members, and a chance to exchange amateur astronomy tips. Approximately the last Sunday of each month we have an open house at the Prairie Park Nature Center. Periodic star parties are scheduled as well. For more information, please contact the club officers: president, Rick Heschmeyer at rcjbm@sbcglobal.net, webmaster, Howard Edin, at howard@howardedin.com, AlCor William Winkler, at billwink10@yahoo.com, or faculty advisor, Prof. Bruce Twarog at btwarog@ku.edu. Because of the flexibility of the schedule due to holidays and alternate events, it is always best to check the Web site for the exact Fridays and Sundays when events are scheduled. The information about AAL can be found at http://groups.ku.edu/~astronomy
Copies of the Celestial Mechanic can also be found on the web at http://groups.ku.edu/~astronomy/celestialmechanic

(Continued from page 1)

were too weak to affect cable communications.

Grote Reber, hearing of Jansky's work, applied to work at Bell Labs in 1933, but this was during the depression and no job was available. Undaunted, Mr. Reber personally funded and built his own radio telescope, a 31 foot dish, at his home in Wheaton, Illinois. He had contacted a construction company about building the dish for him, but the cost would have been $7000. This was in 1936; adjusted for inflation the cost would have been over $110,000 today. This was out of the question, so he built the antenna himself, at his own expense, in four months. He spent $1300 (over $23,000 today) of his own money on the project. The finished antenna was considered to be the first radio telescope – designed and built to examine radio signals from space.

With the electronics built and the observing program designed, and after a couple of false starts (he initially chose the wrong frequencies to monitor), Grote Reber began his observing program in 1939. Every evening, after work, he would monitor the output of the system and record the results on paper charts. He produced a map of the sky showing the parts of the sky that were 'bright' at radio frequencies and confirmed Jansky's results. These results were ultimately published as radio ‘brightness’ contour diagrams in the Astrophysical...
Quadrantids Meteor Shower Will Create Brief, Beautiful Show On Jan. 4

The 2012 Quadrantids, a little-known meteor shower named after an extinct constellation, will present an excellent chance for hardy souls to start the year off with some late-night meteor watching.

Peaking in the wee morning hours of Jan. 4, the Quadrantids have a maximum rate of about 100 per hour, varying between 60-200. The waxing gibbous moon will set around 3 a.m. local time, leaving about two hours of excellent meteor observing before dawn. It’s a good thing, too, because unlike the more famous Perseid and Geminid meteor showers, the Quadrantids only last a few hours -- it's the morning of Jan. 4, or nothing.

Like the Geminids, the Quadrantids originate from an asteroid, called 2003 EH1. Dynamical studies suggest that this body could very well be a piece of a comet which broke apart several centuries ago, and that the meteors you will see before dawn on Jan. 4 are the small debris from this fragmentation. After hundreds of years orbiting the sun, they will enter our atmosphere at 90,000 mph, burning up 50 miles above Earth's surface -- a fiery end to a long journey!

The Quadrantids derive their name from the constellation of Quadrans Muralis (mural quadrant), which was created by the French astronomer Jerome Lalande in 1795. Located between the constellations of Bootes and Draco, Quadrans represents an early astronomical instrument used to observe and plot stars. Even though the constellation is no longer recognized by astronomers, it was around long enough to give the meteor shower -- first seen in 1825 -- its name.

Given the location of the radiant -- northern tip of Bootes the Herdsman -- only northern hemisphere observers will be able to see Quadrantids.

Reber determined that the radio signals were stronger at lower frequencies (longer wavelengths). This finding ruled out thermal radiation (radiation that occurs due to the motion of charged particles) as the source of the radio signals; thermal radiation would be stronger at higher frequencies. Only a few years later, the source of the radio signals was found to be what is called synchrotron radiation. This radiation occurs when electrons, moving near the speed of light, undergo a change in velocity as the result of a magnetic field.

The interesting thing is that for 10 years, Reber was the only one looking at the sky at radio wavelengths. Following the publication of his results, he began to get noticed, and was hired at the University of Virginia. His telescope was moved to Green Bank, WV in the 1960’s and it is there today.

Reber then went to Hawaii to continue his work in a less noisy radio environment. From there, for the last 50 years of his life, he lived in Tasmania (off the southeast coast of Australia). Tasmania provided a even quieter radio environment, especially on long winter nights.

He never accepted the idea of an expanding universe and the concept of the Big Bang and published a paper about the ‘Stable Universe’.

If you find yourself in Cambridge, Tasmania, drop by the Grote Reber Museum.
Dawn Takes a Closer Look
By Dr. Marc Rayman

Dawn is the first space mission with an itinerary that includes orbiting two separate solar system destinations. It is also the only spacecraft ever to orbit an object in the main asteroid belt between Mars and Jupiter. The spacecraft accomplishes this feat using ion propulsion, a technology first proven in space on the highly successful Deep Space 1 mission, part of NASA’s New Millennium program.

Launched in September 2007, Dawn arrived at protoplanet Vesta in July 2011. It will orbit and study Vesta until July 2012, when it will leave orbit for dwarf planet Ceres, also in the asteroid belt.

Dawn can maneuver to the orbit best suited for conducting each of its scientific observations. After months mapping this alien world from higher altitudes, Dawn spiraled closer to Vesta to attain a low altitude orbit, the better to study Vesta’s composition and map its complicated gravity field.

Changing and refining Dawn’s orbit of this massive, irregular, heterogeneous body is one of the most complicated parts of the mission. In addition, to meet all the scientific objectives, the orientation of this orbit needs to change.

These differing orientations are a crucial element of the strategy for gathering the most scientifically valuable data on Vesta. It generally requires a great deal of maneuvering to change the plane of a spacecraft’s orbit. The ion propulsion system allows the probe to fly from one orbit to another without the penalty of carrying a massive supply of propellant. Indeed, one of the reasons that traveling from Earth to Vesta (and later Ceres) requires ion propulsion is the challenge of tilting the orbit around the sun.

Although the ion propulsion system accomplishes the majority of the orbit change, Dawn’s navigators are enlistling Vesta itself. Some of the ion thrusting was designed in part to put the spacecraft in certain locations from which Vesta would twist its orbit toward the target angle for the low-altitude orbit. As Dawn rotates and the world underneath it revolves, the spacecraft feels a changing pull. There is always a tug downward, but because of Vesta’s heterogeneous interior structure, sometimes there is also a slight force to one side or another. With their knowledge of the gravity field, the mission team plotted a course that took advantage of these variations to get a free ride.

The flight plan is a complex affair of carefully timed thrusting and coasting. Very far from home, the spacecraft is making excellent progress in its expedition at a fascinating world that, until a few months ago, had never seen a probe from Earth.

Keep up with Dawn’s progress by following the Chief Engineer’s (yours truly’s) journal at http://dawn.jpl.nasa.gov/mission/journal.asp. And check out the illustrated story in verse of “Professor Starr’s Dream Trip: Or, how a little technology goes a long way,” at http://spaceplace.nasa.gov/story-prof-starr.

This article was provided courtesy of the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.
Hubble Serves Up a Holiday Snow Angel

The bipolar star-forming region, called Sharpless 2-106, or S106 for short, looks like a soaring, celestial snow angel. The outstretched “wings” of the nebula record the contrasting imprint of heat and motion against the backdrop of a colder medium. Twin lobes of super-hot gas, glowing blue in this image, stretch outward from the central star. This hot gas creates the “wings” of our angel. A ring of dust and gas orbiting the star acts like a belt, cinching the expanding nebula into an “hourglass” shape.

Hubble Racks Up 10,000 Science Papers

NASA’s Hubble Space Telescope has passed another milestone in its 21 years of exploration: the 10,000th refereed science paper has been published. This makes Hubble one of the most prolific astronomical endeavors in history.

For the past 21 years thousands of astronomers around the world in over 35 countries have been engaged in Hubble research. Outside of the United States, the top five nations publishing the most Hubble findings are the United Kingdom, Germany, Italy, France, and Spain.

The papers are based on Hubble observations that cover nearly every frontier in astronomy. The five top referenced science papers are, in order: the search for distant supernovae used to characterize dark energy; the precise measurement of the universe’s rate of expansion; the apparent link between galaxy mass and central black hole mass; early galaxy formation in the Hubble Deep Field; and the evolutionary models for low-mass stars and brown dwarfs.

The 10,000th paper’s lead author is Zach Cano of the Astrophysics Research Institute, Liverpool John Moores University, Liverpool, United Kingdom. He reports on the identification of the faintest supernova ever associated with a long-duration gamma-ray burst — an intense gusher of high-energy radiation following the death of a star.

As typical of many Hubble programs, this involved collaborative observations with other observatories. The gamma-
ray burst was first detected on March 16, 2010, by NASA’s Swift high-energy space telescope. The Faulkes Telescope South and the Gemini Telescope South joined Hubble in making parallel observations of the gamma-ray burst’s location in visible and infrared light.

The number of science papers written based on Hubble archival data has increased to the point where it has eclipsed the number of papers resulting from new observations. Hubble’s archive contains data from over 1 million exposures. This astronomical treasure trove will serve as a key “data mine” serving generations of astronomers for decades to come, long after Hubble has stopped operations.

The first science paper from a Hubble observation was submitted on October 1, 1990, by Tod Lauer of the National Optical Astronomy Observatory in Tucson, Ariz. This paper reported observations of the environment around a suspected black hole in the core of galaxy NGC 7457.

Data from Hubble’s longest operating camera, the Wide Field Planetary Camera 2 (which was active from 1994 to 2009), was used for nearly half of the papers. The next most highly ranking instrument is the Advanced Camera for Surveys, which was installed in 2002 and is still operating. This is followed by three other top-ranking instruments: the Space Telescope Imaging Spectrograph, the Near Infrared and Multi-Object Spectrograph, and the Faint Object Spectrograph.

Unlike other space astrophysics programs, five space shuttle servicing missions to Hubble from 1993 to 2009 repaired various components of the telescope and upgraded it with ever more powerful instruments. This ensured an ongoing program of cutting-edge science spanning over two decades. With a suite of state-of-the-art science instruments, Hubble is presently at its apex of scientific capability.
Astronomers using NASA's Spitzer and Hubble space telescopes have discovered that one of the most distant galaxies known is churning out stars at a shockingly high rate. The blob-shaped galaxy, called GN-108036, is the brightest galaxy found to date at such great distances.

The galaxy, which was discovered and confirmed using ground-based telescopes, is 12.9 billion light-years away. Data from Spitzer and Hubble were used to measure the galaxy's high star production rate, equivalent to about 100 suns per year. For reference, our Milky Way galaxy is about five times larger and 100 times more massive than GN-108036, but makes roughly 30 times fewer stars per year.

"The discovery is surprising because previous surveys had not found galaxies this bright so early in the history of the universe," said Mark Dickinson of the National Optical Astronomy Observatory in Tucson, Ariz. "Perhaps those surveys were just too small to find galaxies like GN-108036. It may be a special, rare object that we just happened to catch during an extreme burst of star formation."

The international team of astronomers, led by Masami Ouchi of the University of Tokyo, Japan, first identified the remote galaxy after scanning a large patch of sky with the Subaru Telescope atop Mauna Kea in Hawaii. Its great distance was then carefully confirmed with the W.M. Keck Observatory, also on Mauna Kea.

"We checked our results on three different occasions over two years, and each time confirmed the previous measurement," said Yoshiaki Ono of the University of Tokyo, lead author of a new paper reporting the findings in the Astrophysical Journal.

GN-108036 lies near the very beginning of time itself, a mere 750 million years after our universe was created 13.7 billion years ago in an explosive "Big Bang." Its light has taken 12.9 billion years to reach us, so we are seeing it as it existed in the very distant past.

Astronomers refer to the object's distance by a number called its "redshift," which relates to how much its light has stretched to longer, redder wavelengths due to the expansion of the universe. Objects with larger redshifts are farther away and are
With the holiday season in full swing, a new image from an assembly of telescopes has revealed an unusual cosmic ornament. Data from NASA’s Chandra X-ray Observatory and ESA’s XMM-Newton have been combined to discover a young pulsar in the remains of a supernova located in the Small Magellanic Cloud, or SMC. This would be the first definite time a pulsar, a spinning, ultra-dense star, has been found in a supernova remnant in the SMC, a small satellite galaxy to the Milky Way. In this composite image, X-rays from Chandra and XMM-Newton have been colored blue and optical data from the Cerro Tololo Inter-American Observatory in Chile are colored red and green. The pulsar, known as SXP 1062, is the bright white source located on the right-hand side of the image in the middle of the diffuse blue emission inside a red shell. The diffuse X-rays and optical shell are both evidence for a supernova remnant surrounding the pulsar. The optical data also displays spectacular formations of gas and dust in a star-forming region on the left side of the image. A comparison of the Chandra image with optical images shows that the pulsar has a hot, massive companion.

Astronomers are interested in SXP 1062 because the Chandra and XMM-Newton data show that it is rotating unusually slowly - about once every 18 minutes. (In contrast, some pulsars are found to revolve multiple times per second, including most newly born pulsars.) This relatively leisurely pace of SXP 1062 makes it one of the slowest rotating X-ray pulsars in the SMC. Two different teams of scientists have estimated that the supernova remnant around SXP 1062 is between 10,000 and 40,000 years old, as it appears in the image. This means that the pulsar is very young, from an astronomical perspective, since it was presumably formed in the same explosion that produced the supernova remnant. Therefore, assuming that it was born with rapid spin, it is a mystery why SXP 1062 has been able to slow down by so much, so quickly. Work has already begun on theoretical models to understand
New Evidence for Complex Molecules On Pluto's Surface

The new and highly sensitive Cosmic Origins Spectrograph aboard the Hubble Space Telescope has discovered a strong ultraviolet-wavelength absorber on Pluto's surface, providing new evidence that points to the possibility of complex hydrocarbon and/or nitrile molecules lying on the surface, according to a paper recently published in the Astronomical Journal by researchers from Southwest Research Institute and Nebraska Wesleyan University. Such chemical species can be produced by the interaction of sunlight or cosmic rays with Pluto's known surface ices, including methane, carbon monoxide and nitrogen. The project, led by SwRI's Dr. Alan Stern, also included SwRI researchers Dr. John Spencer and Adam Shinn, and Nebraska Wesleyan University researchers Dr. Nathaniel Cunningham and student Mitch Hain.

"This is an exciting finding because complex Plutonian hydrocarbons and other molecules that could be responsible for the ultraviolet spectral features we found with Hubble may, among other things, be responsible for giving Pluto its ruddy color," said Stern. The team also discovered evidence of changes in Pluto's ultraviolet spectrum compared to Hubble measurements from the 1990s. The changes may be related to differing terrains seen now versus in the 1990s, or to other effects, such as changes in the surface related to a steep increase in the pressure of Pluto's atmosphere during that same time span.

"The discovery we made with Hubble reminds us that even more exciting discoveries about Pluto's composition and surface evolution are likely to be in store when NASA's New Horizons spacecraft arrives at Pluto in 2015," Stern added.

Meteorite Shockwaves Trigger Dust Avalanches On Mars

Dust avalanches around impact craters on Mars appear to be the result of the shock wave preceding the actual impact, according to a study led by an undergraduate student at the University of Arizona. When a meteorite careens toward the dusty surface of the Red Planet, it kicks up dust and can cause avalanching even before the rock from outer space hits the ground, a research team led by an undergraduate student at the University of Arizona has discovered.

"We expected that some of the streaks of dust that we see on slopes are caused by seismic shaking during impact," said Kaylan Burleigh, who led the research project. "We were surprised to find that it rather looks like shockwaves in the air trigger the avalanches even before the impact."

Because of Mars' thin atmosphere, which is 100 times less dense than Earth's, even small rocks that would burn up or break up before they could hit the ground here on Earth crash into the Martian surface relatively unimpeded. Each year, about 20 fresh craters between 1 and 50 meters (3 to 165 feet) show up in images taken by the HiRISE camera on board NASA's Mars Reconnaissance Orbiter. The High Resolution Imaging Science Experiment, or HiRISE, is operated by the UA's Lunar and Planetary Laboratory and has been photographing the Martian surface since 2006, revealing features down to less than 1 meter in size.

For this study, the team zoomed in on a cluster of five large craters, which all formed in one impact event close to Mars' equator, about 825 kilometers (512 miles) south of the boundary scarp of Olympus Mons, the tallest mountain in the solar system. Previous observations by the Mars Global Surveyor orbiter, which imaged Mars for nine years until 2006, showed that this cluster was blasted into the dusty surface between May 2004 and February 2006. The results of the research, which Burleigh first took on as a freshman under former UA Regents Professor H. Jay Melosh, are published in the planetary science journal *Icarus*. Previous studies had looked at dark or light streaks on the Martian landscape interpreted as landslides, but none had tied such a large number of them to impacts.

The authors interpret the thousands of downhill-trending dark streaks on the flanks of ridges covering the area as dust avalanches caused by the impact. The largest crater in the cluster measures 22 meters, or 72 feet across and occupies roughly the area of a basketball court. Most likely, the cluster of craters formed as the meteorite broke up in the atmosphere, and the fragments hit the ground like a shotgun blast. Narrow, relatively dark streaks varying from a few meters to about 50 meters in length scour the slopes around the impact site.

"The dark streaks represent the material exposed by the avalanches, as induced by the airblast from the impact," Burleigh said. "I counted more than 100,000 avalanches and, after repeated counts and deleting duplicates, arrived at 64,948."When Burleigh looked at the distribution of avalanches around the impact site, he realized their number decreased with distance in every direction, consistent with the idea that they were related to the impact event. But it wasn't until he noticed a pair of peculiar surface features resembling a curved dagger, described as scimitars, extending from the central impact crater, that the way in which the impact caused the avalanches became evident.

"Those scimitars tipped us off that something other than seismic shaking must be causing the dust avalanches," Burleigh said. As a meteor screams through the atmosphere at several times the speed of sound, it creates shockwaves in the air.
seen further back in time. GN-108036 has a redshift of 7.2. Only a handful of galaxies have confirmed redshifts greater than 7, and only two of these have been reported to be more distant than GN-108036. Infrared observations from Spitzer and Hubble were crucial for measuring the galaxy's star-formation activity. Astronomers were surprised to see such a large burst of star formation because the galaxy is so small and from such an early cosmic era. Back when galaxies were first forming, in the first few hundreds of millions of years after the Big Bang, they were much smaller than they are today, having yet to bulk up in mass.

During this epoch, as the universe expanded and cooled after its explosive start, hydrogen atoms permeating the cosmos formed a thick fog that was opaque to ultraviolet light. This period, before the first stars and galaxies had formed and illuminated the universe, is referred to as the "dark ages." The era came to an end when light from the earliest galaxies burned through, or "ionized," the opaque gas, causing it to become transparent. Galaxies similar to GN-108036 may have played an important role in this event.

"The high rate of star formation found for GN-108036 implies that it was rapidly building up its mass some 750 million years after the Big Bang, when the universe was only about five percent of its present age," said Bahram Mobasher, a team member from the University of California, Riverside. "This was therefore a likely ancestor of massive and evolved galaxies seen today."

Simulating the shockwaves generated by impacts on Martian soil with computer models, the team observed the exact pattern of scimitars they saw on their impact site.

"We think the interference among different pressure waves lifts up the dust and sets avalanches in motion. These interference regions, and the avalanches, occur in a reproducible pattern," Burleigh said. "We checked other impact sites and realized that when we see avalanches, we usually see two scimitars, not just one, and they both tend to be at a certain angle to each other. This pattern would be difficult to explain by seismic shaking." In the absence of plate tectonic processes and water-caused erosion, the authors conclude that small impacts might be more important in shaping the Martian surface than previously thought.