COMING EVENTS

Band Concert
Public Observing

Downtown Lawrence
South Park west of Mass St.

July 16
9:00 PM

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Report from the Officers

With the skies clearing for the July 4 holiday, it finally became clear enough for some
downtown observing on Wed., our first successful evening this summer, though the
low temperatures provided an unusually crisp edge to the late night observing. As
part of our calm summer schedule, we have one more shot at public observing on
July 16, same time and same location.

Please note the newsletter posting of a telescope for sale on pg. 7. While hardly a
low-end item, the scope has been used by our colleagues in Topeka and should be in
excellent condition. If you are interested in stepping up to a new level of observing
and have the resources, this should be a good buy.

One of the reasons for obtaining first-rate equipment is the ability to do quality ob-
serving, particularly imaging, with digital cameras. Time magazine asked the Astro-

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Of Local Interest

NASA’s Hubble to Begin Search Beyond Pluto for a
New Horizons Mission Target

After careful consideration and anal-
ysis, the Hubble Space Telescope
Time Allocation Committee has rec-
ommended using Hubble to search
for an object the Pluto-bound NASA
New Horizons mission could visit
after its flyby of Pluto in July 2015.

The planned search will involve tar-
geting a small area of sky in search
of a Kuiper Belt object (KBO) for the
outbound spacecraft to visit. The
Kuiper Belt is a vast debris field of
icy bodies left over from the solar
system’s formation 4.6 billion years
ago. A KBO has never been seen up

This is an artist’s rendering of the New Horizons spacecraft encountering a Kuiper
Belt object — a city-sized icy relic left over from the birth of our solar system. The
Sun, more than 4.1 billion miles (6.7 billion kilometers) away, shines as a bright star
embedded in the glow of the zodiacal dust cloud. Jupiter and Neptune are visible as
orange and blue “stars” to the right of the Sun.

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About the Astronomy Associates of Lawrence

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)

The full execution of the KBO search is contingent upon the results from a pilot observation using Hubble observations provided by Mountain's director's discretionary time.

The space telescope will scan an area of sky in the direction of the constellation Sagittarius to try and identify any objects orbiting within the Kuiper Belt. To discriminate between a foreground KBO and the clutter of background stars in Sagittarius, the telescope will turn at the predicted rate that KBOs are moving against the background stars. In the resulting images, the stars will be streaked, but any KBOs should appear as pinpoint objects.

If the test observation identifies at least two KBOs of a specified brightness, it will demonstrate statistically that Hubble has a chance of finding an appropriate KBO for New Horizons to visit. At that point, an additional allotment of observing time will continue the search across a field of view roughly the angular size of the full Moon.

Astronomers around the world apply for observing time on the Hubble Space Telescope. Competition for time on the telescope is extremely intense and the requested observing time significantly exceeds the observing time available in a given year. Proposals must address significant astronomical questions that can only be addressed with Hubble's unique capabilities and are beyond the capabilities of ground-based telescopes. The proposals are peer reviewed annually by an expert committee, which looks for the best possible science that can be conducted by Hubble and recommends to the STScI director a balanced program of small, medium, and large investigations.

Though Hubble is powerful enough to see galaxies near the horizon of the universe, finding a KBO is a challenging needle-in-haystack search. A typical KBO along the New Horizons' trajectory may be no larger than Manhattan Island and as black as charcoal.

Even before the launch of New Horizons in 2006, Hubble has provided consistent support for this edge-of-the-solar system mis-

(Continued on page 10)
Spitzer Spies an Odd, Tiny Asteroid

Astronomers using NASA's Spitzer Space Telescope have measured the size of an asteroid candidate for NASA's Asteroid Redirect Mission (ARM), a proposed spacecraft concept to capture either a small asteroid, or a boulder from an asteroid. The near-Earth asteroid, called 2011 MD, was found to be roughly 20 feet (6 meters) in size, and its structure appears to contain a lot of empty space, perhaps resembling a pile of rubble. Spitzer's infrared vision was key to sizing up the asteroid.

"From its perch up in space, Spitzer can use its heat-sensitive infrared vision to spy asteroids and get better estimates of their sizes," said Michael Mommert of Northern Arizona University, Flagstaff, lead author of a new study appearing today, June 19, in the Astrophysical Journal Letters. David Trilling, also of Northern Arizona University, leads the team of astronomers.

The Spitzer results confirm that asteroid 2011 MD has characteristics suitable for the ARM proposal, elevating it to the "valid candidate" level. Valid candidates are those asteroids with the right size, mass and rotation rate to be feasibly captured by the robotic spacecraft. Two other valid candidates have been identified so far. (The proposal to capture a boulder from an asteroid involves a different set of criteria.) NASA continues to search for and find new potential candidates using its ground-based asteroid survey programs.

Prior to the Spitzer study, the size of 2011 MD was only very roughly known. It had been observed in visible light, but an asteroid's size cannot be determined solely from visible-light measurements. In visible light alone, for example, a white snowball in space could look just as bright as a dark mountain of cosmic rock. The objects may differ in size but reflect the same amount of sunlight, appearing equally bright.

Infrared light, on the other hand, is a better indicator of an object's true size. This is because an object's infrared glow depends largely on its temperature, not its reflectivity.

From the new Spitzer data, the team was able to measure the size of asteroid 2011 MD. When the infrared and visible-light observations were combined, the asteroid's density and mass could also be measured. The density of 2011 MD is remarkably low -- about the same as water, which agrees with a separate analysis of observations taken in 2011. Since rock is about three times more dense than water, this implies that about two-thirds of the asteroid must be empty space.

What does an asteroid with that much empty space look like? The team doesn't know, but proposes two possible solutions: it might be a collection of loosely bound rocks, like a fleet of flying boulders, or a solid rock with surrounding fine debris.

A similar "rubble-pile" type of composition was also found for asteroid 2009 BD, another valid candidate for ARM. Trilling and colleagues used Spitzer to help pin down the size of that asteroid to roughly 10 to 13 feet (3 or 4 meters).

In both studies, Spitzer stared at

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This image of asteroid 2011 MD was taken by NASA's Spitzer Space Telescope in Feb. 2014, over a period of 20 hours. The long observation, taken in infrared light, was needed to pick up the faint signature of the small asteroid (center of frame). The Spitzer observations helped narrow down the size of the space rock to roughly 20 feet (6 meters), making it one of a few candidates for NASA's proposed Asteroid Redirect Mission for which sizes are approximately known. This image was taken by Spitzer's Infrared Array Camera at a wavelength of 4.5 microns.
As we look at the universe on larger and larger scales, from stars to galaxies to groups to the largest galaxy clusters, we become able to perceive objects that are significantly farther away. But as we consider these larger classes of objects, they don't merely emit increased amounts of light, but they also contain increased amounts of mass. Under the best of circumstances, these gravitational clumps can open up a window to the distant universe well beyond what any astronomer could hope to see otherwise.

The oldest style of telescope is the refractor, where light from an arbitrarily distant source is passed through a converging lens. The incoming light rays—initially spread over a large area—are brought together at a point on the opposite side of the lens, with light rays from significantly closer sources bent in characteristic ways as well. While the universe doesn't consist of large optical lenses, mass itself is capable of bending light in accord with Einstein's theory of General Relativity, and acts as a gravitational lens!

The first prediction that real-life galaxy clusters would behave as such lenses came from Fritz Zwicky in 1937. These foreground masses would lead to multiple images and distorted arcs of the same lensed background object, all of which would be magnified as well. It wasn't until 1979, however, that this process was confirmed with the observation of the Twin Quasar: QSO 0957+561. Gravitational lensing requires a serendipitous alignment of a massive foreground galaxy cluster with a background galaxy (or cluster) in the right location to be seen by an observer at our location, but the universe is kind enough to provide us with many such examples of this good fortune, including one accessible to astrophotographers with 11” scopes and larger: Abell 2218.

Located in the Constellation of Draco at position (J2000): R.A. 16h 35m 54s, Dec. +66° 13' 00" (about 2° North of the star 18 Draconis), Abell 2218 is an extremely massive cluster of about 10,000 galaxies located 2 billion light years away, but it's also located quite close to the zenith for northern hemisphere observers, making it a great target for deep-sky astrophotography. Multiple images and sweeping arcs abound between magnitudes 17 and 20, and include galaxies at a variety of redshifts ranging from z=0.7 all the way up to z=2.5, with farther ones at even fainter magnitudes unveiled by Hubble. For those looking for an astronomical challenge this summer, take a shot at Abell 2218, a cluster responsible for perhaps the most glorious gravitational lens visible from Earth!

Learn about current efforts to study gravitational lensing using NASA facilities: http://www.nasa.gov/press/2014/january/nasas-fermi-makes-first-gamma-ray-study-of-a-gravitational-lens/

Kids can learn about gravity at NASA's Space Place: http://spaceplace.nasa.gov/what-is-gravity/
Swiftly Moving Gas Streamer Eclipses Supermassive Black Hole

An international team of astronomers using data from several NASA and European Space Agency (ESA) space observatories has discovered unexpected behavior from the supermassive black hole at the heart of the galaxy NGC 5548. Their findings may provide new insights into the interactions of supermassive black holes and their host galaxies.

Researchers detected a clumpy gas stream flowing rapidly outward from a supermassive black hole, blocking 90 percent of its emitted X-rays. This deep look into a black hole's environment yields clues to the behavior of black holes embedded in the center of active galaxies.

"There are other galaxies that show gas streams near a black hole, but they haven't changed their position as dramatically," said Gerard Kriss of the Space Telescope Science Institute (STScI) in Baltimore, Maryland. "This is the first time we've seen a stream like this move into the line of sight. We just happened to get lucky."

According to Kriss, the streamer is long-lived, and just recently started crossing Hubble's line of sight. In galaxies such as NGC 5548, streamers at an inclination this high above the accretion disk are rare. This overhead view of the black hole and its environment provides a new perspective in the structures of outflowing material associated with active black holes.

The discovery was made during an intensive observing campaign with NASA's Hubble Space Telescope, Swift spacecraft, Nuclear Spectroscopic Telescope Array (NuSTAR), and Chandra X-ray Observatory, and ESA's X-ray Multi-Mirror Mission (XMM-Newton) and Integral gamma-ray observatory. The international team, led by scientist Jelle Kaastra of the SRON Netherlands Institute for Space Research, conducted the most extensive monitoring campaign ever of an active galaxy in 2013 and 2014. This is the first direct evidence of a long-predicted shielding process that is needed to accelerate powerful gas streams, or winds, to high speeds. These winds only occur if their starting point is shielded from X-rays. The winds may be so strong that they can blow off gas that otherwise would have fallen onto the black hole. Black hole winds can therefore regulate both the growth of the black hole and its galaxy.

The newly discovered gas stream in the Type 1 Seyfert galaxy NGC 5548 — one of the best-studied sources of this type over the past half-century — provides this protection. It appears the shielding has been going on for at least three years. Immediately after Hubble observed NGC 5548 on June 22, 2013, the team discovered unexpected features in the data.

"There were dramatic changes since the last observation with Hubble in 2011. I saw signatures of much colder gas than were present before, indicating that the wind had cooled down due to a strong decrease of ionizing X-ray radiation from the nucleus," Kriss said.

After combining and analyzing data from the six observatories, the team was able to put the pieces of the puzzle together. Supermassive black holes in the nuclei of active galaxies, such as NGC 5548, expel large amounts of...
NGC 4258 (M106): Galactic Pyrotechnics On Display

A galaxy about 23 million light years away is the site of impressive, ongoing, fireworks. Rather than paper, powder, and fire, this galactic light show involves a giant black hole, shock waves, and vast reservoirs of gas.

This galactic fireworks display is taking place in NGC 4258 (also known as M106), a spiral galaxy like the Milky Way. This galaxy is famous, however, for something that our Galaxy doesn't have - two extra spiral arms that glow in X-ray, optical, and radio light. These features, or anomalous arms, are not aligned with the plane of the galaxy, but instead intersect with it.

The anomalous arms are seen in this new composite image of NGC 4258, where X-rays from NASA’s Chandra X-ray Observatory are blue, radio data from the NSF’s Karl Jansky Very Large Array are purple, optical data from NASA’s Hubble Space Telescope are yellow and blue, and infrared data from NASA’s Spitzer Space Telescope are red.

A new study of these anomalous arms made with Spitzer shows that shock waves, similar to sonic booms from supersonic planes, are heating large amounts of gas - equivalent to about 10 million Suns. What is generating these shock waves? Radio data shows that the supermassive black hole at the center of NGC 4258 is producing powerful jets of high-energy particles. Researchers think that these jets strike the disk of the galaxy and generate shock waves. These shock waves, in turn, heat some of the gas - composed mainly of hydrogen molecules - to thousands of degrees. As shown in our additional, composite image, part of the evidence for this heating process comes from the similarity in location between the hydrogen and X-ray emission, both thought to be caused by shocks, and the radio jets.

The Chandra X-ray image reveals huge bubbles of hot gas above and below the plane of the galaxy. These bubbles indicate that much of the gas that was originally in the disk of the galaxy has been heated to millions of degrees and ejected into the outer regions by the jets from the black hole.

The ejection of gas from the disk by the jets has important implications for the fate of this galaxy. Researchers estimate that all of the remaining gas will be ejected within the next 300 million years - very soon on cosmic time scales - unless it is somehow replenished. Because most of the gas in the disk has already been ejected, less gas is available for new stars to form. Indeed, the researchers used Spitzer data to estimate that stars are forming in the central regions of NGC 4258,
at a rate which is about ten times less than in the Milky Way Galaxy.

The European Space Agency's Herschel Space Observatory was used to confirm the estimate from Spitzer data of the low star formation rate in the central regions of NGC 4258. Herschel was also used to make an independent estimate of how much gas remains in the center of the galaxy. After allowing for the large boost in infrared emission caused by the shocks, the researchers found that the gas mass is ten times smaller than had been previously estimated. Because NGC 4258 is relatively close to Earth, astronomers can study how this black hole is affecting its galaxy in great detail. The supermassive black hole at the center of NGC 4258 is about ten times larger than the one in the Milky Way, and is also consuming material at a faster rate, potentially increasing its impact on the evolution of its host galaxy.

These results were published in the June 20th, 2014 issue of The Astrophysical Journal Letters and are available online. The authors are Patrick Ogle, Lauranne Lanz and Philip Appleton from the California Institute of Technology in Pasadena, CA.

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FOR SALE: NGT 18" - upgraded SiTech 'goto' slewing

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owned by the Northeast Kansas Amateur Astronomer's League (NEKAAL)

contact: Gary Hug
garyhug@ksmail.net
785-220-1933
New Suspect Identified in Supernova Explosion

Supernovas are often thought of as the tremendous explosions that mark the ends of massive stars’ lives. While this is true, not all supernovas occur in this fashion. A common supernova class, called Type Ia, involves the detonation of white dwarfs — small, dense stars that are already dead.

New results from NASA’s Spitzer Space Telescope have revealed a rare example of Type Ia explosion, in which a dead star “fed” off an aging star like a cosmic zombie, triggering a blast. The results help researchers piece together how these powerful and diverse events occur.

“It’s kind of like being a detective,” said Brian Williams of NASA’s Goddard Space Flight Center in Greenbelt, Maryland, lead author of a study submitted to the Astrophysical Journal. “We look for clues in the remains to try to figure out what happened, even though we weren’t there to see it.”

Supernovas are essential factories in the cosmos, churning out heavy metals, including the iron contained in our blood. Type Ia supernovas tend to blow up in consistent ways, and thus have been used for decades to help scientists study the size and expansion of our universe. Researchers say that these events occur when white dwarfs -- the burnt-out corpses of stars like our sun -- explode.

Evidence has been mounting over the past 10 years that the explosions are triggered when two orbit-

This infrared image from NASA’s Spitzer Space Telescope shows a close-up of N103B -- all that remains from a supernova that exploded a millennium ago in the Large Magellanic Cloud, a satellite galaxy of the Milky Way 160,000 light years away.

Spitzer’s instruments pick up infrared light emitted by dust in both the remnant and the surrounding interstellar medium. The infrared light has been translated to colors we see in this image, allowing astronomers to dissect the scene. In this image, dust associated with the remnant appears red, while dust in the ambient background of the galaxy appears yellow and green. Stars in the field appear blue.

By studying the infrared light emitted from this supernova remnant, astronomers have determined that the density of the gas surrounding the supernova is much higher than is typical for a Type Ia supernova, which are those that occur when dead stars called white dwarfs explode. Astronomers believe that this dense material was expelled prior to the supernova explosion, possibly by a companion to the white dwarf -- an aging star that shed the material.

Most Type Ia supernovas do not show evidence for this process occurring, making N103B an example of a rare subclass of Type Ia explosions. In fact, only one other remnant of a Type Ia explosion shows evidence for this: the remnant of Kepler’s supernova in our own galaxy, the remains of the explosion of a star witnessed on Earth in 1604 A.D.

The red data shows infrared light with wavelengths of 16 and 24 microns, while shorter-wavelength infrared light of 3.6, 4.5, and 8 microns is shown as blue, cyan and green, respectively.

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New molecules around old stars

When low- to middleweight stars like our Sun approach the end of their lives, they eventually become dense, white dwarf stars. In doing so, they cast off their outer layers of dust and gas into space, creating a kaleidoscope of intricate patterns known as planetary nebulas. These actually have nothing to do with planets, but were named in the late 18th century by astronomer William Herschel, because they appeared as fuzzy circular objects through his telescope, somewhat like the planets in our Solar System.

Over two centuries later, planetary nebulae studied with William Herschel's namesake, the Herschel space observatory, have yielded a surprising discovery. Like the dramatic supernova explosions of weightier stars, the death cries of the stars responsible for planetary nebulas also enrich the local interstellar environment with elements from which the next generations of stars are born.

While supernovas are capable of forging the heaviest elements, planetary nebulae contain a large proportion of the lighter 'elements of life' such as carbon, nitrogen, and oxygen, made by nuclear fusion in the parent star. A star like the Sun steadily burns hydrogen in its core for billions of years. But once the fuel begins to run out, the central star swells into a red giant, becoming unstable and shedding its outer layers to form a planetary nebula. The remaining core of the star eventually becomes a hot white dwarf pouring out ultraviolet radiation into its surroundings.

This intense radiation may destroy molecules that had previously been ejected by the star and that are bound up in the clumps or rings of material seen in the periphery of planetary nebulas. The harsh radiation was also assumed to restrict the formation of new molecules in those regions. But in two separate studies using Herschel astronomers have discovered that a molecule vital to the formation of water seems to rather like this harsh environment, and perhaps even depends upon it to form. The molecule, known as OH⁺, is a positively charged combination of single oxygen and hydrogen atoms.

In one study, led by Dr Isabel Aleman of the University of Leiden, the Netherlands, 11 planetary nebulae were analysed and the molecule was found in just three.

"We think that a critical clue is in the presence of the dense clumps of gas and dust, which are illuminated by UV and X-ray radiation emitted by the hot central star," says Dr Aleman.

"This high-energy radiation interacts with the clumps to trigger chemical reactions that leads to the formation of the molecules."

Meanwhile, another study, led by Dr Mireya Etxaluze of the Instituto de Ciencia de los Materiales de Madrid, Spain, focused on the Helix Nebula, one of the nearest planetary nebulae to our Solar System, at a distance of 700 light years. The central star is about half the mass of our Sun, but has a far higher temperature of about 120,000°C. The expelled shells of the star, which in optical images appear reminiscent of a human eye, are known to contain a rich variety of molecules. Herschel mapped the presence of the crucial molecule across the Helix Nebula, and found it to be most abundant in locations where carbon monoxide molecules, previously ejected by the star, are most likely to be destroyed by the strong UV radiation. Once oxygen atoms have been liberated from the carbon monoxide, they are available to make the oxygen–hydrogen molecules, further bolstering the hypothesis that the UV radiation may be promoting their creation. The two studies are the first to identify in planetary nebulae this critical molecule needed for the formation of water, although it remains to be seen if the conditions would actually permit the formation of water.

"The proximity of the Helix Nebula means we have a natural laboratory on our cosmic doorstep to study in more detail the chemistry of these objects and their role in recycling molecules through the interstellar medium," says Dr Etxaluze.

"Herschel has traced water across the Universe, from star-forming clouds to the asteroid belt in our own Solar System," says Göran Pilbratt, ESA's Herschel project scientist.

"Now we have even found that stars like our Sun could contribute to the formation of water in the Universe, even as they are in their death throes."
matter through powerful winds of ionized gas. For instance, the persistent wind of NGC 5548 reaches velocities exceeding 621 miles (approximately 1,000 kilometers) per second. But now a new wind has arisen, much stronger and faster than the persistent wind.

"The new wind reaches speeds of up to 3,107 miles (5,000 kilometers) per second but is much closer to the nucleus than the persistent wind," Kaastra said. "The new gas outflow blocks 90 percent of the low-energy X-rays that come from very close to the black hole, and it obscures up to a third of the region that emits the ultraviolet radiation at a few light-days' distance from the black hole."

Hubble was used to discover four small moons orbiting Pluto and its binary companion object Charon, providing new targets to enhance the mission's scientific return. And Hubble has provided the most sensitive search yet for potentially hazardous dust rings around Pluto. Hubble also has made a detailed map of the dwarf planet's surface, which astronomers are using to plan New Horizons' close-up reconnaissance photos.

In addition to Pluto exploration, recent Hubble solar system observations have discovered a new satellite around Neptune, probed the magnetospheres of the gas-giant planets, found circumstantial evidence for oceans on Europa, and uncovered several bizarre cases of asteroids disintegrating before our eyes. Hubble has supported numerous NASA Mars missions by monitoring the Red Planet's seasonal atmospheric changes. Hubble has made complementary observations in support of the Dawn asteroid mission, and comet flybys. Nearly 20 years ago, in July 1994, Hubble documented the never-before-seen string of comet collisions with Jupiter that resulted from the tidal breakup of comet Shoemaker-Levy 9.

"The planned search for a suitable target for New Horizons further demonstrates how Hubble is effectively being used to support humankind's initial reconnaissance of the solar system," said Mountain. "Likewise, it is also a preview of how the powerful capabilities of the upcoming James Webb Space Telescope will further bolster planetary science. We are excited by the potential of both observatories for ongoing solar system exploration and discovery."

The team says the small asteroids probably formed as a result of collisions between larger asteroids, but they do not understand how their unusual structures could have come about. They plan to use Spitzer in the future to study more of the tiny asteroids, both as possible targets for asteroid space missions, and for a better understanding of the many asteroid denizens making up our solar system.

How to Measure the Size of an Asteroid

Observations of infrared light coming from asteroids provide a better estimate of their true sizes than visible-light measurements. This diagram illustrates why. At left, are three asteroids with different sizes and compositions. Even though they are different, they can appear to the same to a visible-light telescope because they reflect the same amount of sunlight. It's impossible to know their sizes.

For example, the small, white asteroid has a more reflective surface so it can appear to have the same brightness as a larger, dark asteroid. The same is true of a shiny penny and larger piece of dull copper -- they could, in some circumstances, reflect the same amount of total light. The right side of the illustration shows what happens in the infrared. When an asteroid is hit with sunlight, it radiates some of that back as infrared light. The amount of infrared light that comes off an asteroid thus depends on the size of its exposed surface area. When infrared and visible-light observations are combined, the reflectivity of a surface, or its albedo, can also be determined.