LOCAL PUBLIC OBSERVING
After the City Band Concerts
   South Park  West of Mass St.
    June 9
    June 23
    July 7
    9:30PM

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Report from the Officers: As is often the case, the weather proved unpredictable for our first attempt at summer viewing after the Band concerts. With a 30% chance of thunderstorms and billowing clouds rolling through Lawrence at 6PM, the decision was made to cancel the session for last Wednesday. The rain never came and apparently the skies did clear somewhat by 9:30. So, for those who attended and set up their own scopes, good call. Hopefully we can all be on the same page as the weather for the next scheduled public observing on June 9. As the next date approaches, please contact Rick about helping out, either by setting up a scope or simply helping with crowd control.

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A Hearty Welcome to new AAL Member
Brian Schafer

See Pluto in 2010
By Tony Flanders, Sky and Telescope
Have you ever seen Pluto through a telescope? Do you want to try? All you need is a good 8-inch scope, access to dark skies, lots of persistence, and excellent star charts.

We can’t help you with the telescope, dark-sky site, or necessary character qualities. But this article (pg. 6) contains all the charts you need to find Pluto in May or June 2010. The July issue of Sky & Telescope includes charts for

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Discussions are still under way about the possibility of identifying a dark site for observing by club members, coordinated whenever the mood strikes through the club Facebook page. An initial effort has been made by Bill Wachspress to promote this idea and, for now, he will probably communicate with club members via email and/or Facebook, so check the site periodically for more updates. For those of you interested in attempting some science with your scopes, check out the note below.

A reminder: the Prairie Astronomy Club of Lincoln will be the host for MSRAL 2010 - the annual meeting of the Mid-States Region of the Astronomical League on June 4-5, 2010. For more info, check out http://www.msral2010.info/.

As always, if anyone has any ideas, suggestions, or input on how we can make the club better, please contact Rick (rcjbm@sbcglobal.net). Have a great Memorial Day Weekend.

We would like to invite you to apply for the second Citizen Sky Workshop.

Citizen Sky is a recently formed citizen science project spearheaded by the American Association of Variable Star Observers (AAVSO) and funded by the National Science Foundation. For the next two years the project will focus on the very interesting, very bright eclipsing variable star, epsilon Aurigae. This variable star has an eclipse only every 27.1 years. The eclipse lasts for about 2 years and we happen to be in the middle of one right now! We held our first workshop on epsilon Aurigae and the Citizen Sky project in early August 2009 (just as the eclipse was beginning) at the Adler Planetarium in Chicago. Our second workshop will be held this September at the California Academy of Sciences in San Francisco and will focus on data analysis and scientific paper writing. We will have travel grants available for workshop participants. The application form is now online and the first round of participant selection will take place in mid-June. (Participation in the first workshop is not required.)

For more information on the Citizen Sky Project please visit: www.citizensky.org
Specific information about the workshop including application instructions can be found at: http://www.citizensky.org/content/workshop-schedule-and-info

Feel free to send any questions to: rebecca@aavso.org

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July through October.
This is one of the best years in Pluto's 249-year orbit around the Sun to view the dwarf planet. In May and June, it crosses Messier 24, the Small Sagittarius Star Cloud, one of the pieces of sky most densely packed with stars. A high-power telescopic field of view will include hundreds of stars comparable to Pluto in brightness. Then, in July, Pluto crosses Barnard 92, one of the most prominent of all dark clouds, where typical backyard telescopes show no stars whatsoever.

Whether you call it a planet, a dwarf planet, a minor planet, an asteroid, a comet — or all of the above — Pluto is a special object. It's the most distant chunk of solid material that can be seen through the eyepiece of normal backyard telescopes.

Pluto is almost impossible to see when the Moon is up, so each month there's a two or three-week window of visibility, depending precisely where you live. At mid-northern latitudes, these windows are roughly:
May 6-24 from 2 a.m. to dawn  June 3-22 from midnight to 3 a.m.  July 2-19 from nightfall to 1 a.m.
Aug. 1-15 from nightfall to 11:30 p.m.  Aug. 29 - Sept. 11 from nightfall to 9:30 p.m.  Sept. 27 - Oct. 9 at nightfall

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: our president, Rick Heschmeyer at rcjbm@sbcglobal.net, our webmaster, Gary Webber, at gwebber@ku.edu, or our 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://www.ku.edu/~aal.

Copies of the Celestial Mechanic can also be found on the web at http://www.ku.edu/~aal/celestialmechanic
Out of Whack Planetary System Offers Clues to a Disturbed Past
AAS Press Release

Astronomers are reporting today the discovery of a planetary system way out of tilt, where the orbits of two planets are at a steep angle to each other. This surprising finding will impact theories of how multi-planet systems evolve, and it shows that some violent events can happen to disrupt planets' orbits after a planetary system forms, say researchers.

"The findings mean that future studies of exoplanetary systems will be more complicated. Astronomers can no longer assume all planets orbit their parent star in a single plane," says Barbara McArthur of The University of Texas at Austin's McDonald Observatory. McArthur and her team used data from the Hubble Space Telescope, the giant Hobby-Eberly Telescope, and other ground-based telescopes combined with extensive modeling to unearth a landslide of information about the planetary system surrounding the nearby star Upsilon Andromedae.

McArthur reported these findings in a press conference today at the 216th meeting of the American Astronomical Society in Miami, along with her collaborator Fritz Benedict, also of McDonald Observatory, and team member Rory Barnes of the University of Washington. The work also will be published in the June 1 edition of the Astrophysical Journal. For just over a decade, astronomers have known that three Jupiter-type planets orbit the yellow-white star Upsilon Andromedae. Similar to our Sun in its properties, Upsilon Andromedae lies about 44 light-years away. It's a little younger, more massive, and brighter than the Sun.

Combining fundamentally different, yet complementary, types of data from Hubble and ground-based telescopes, McArthur's team has determined the exact masses of two of the three known planets, Upsilon Andromedae c and d. Much more startling, though, is their finding that not all planets orbit this star in the same plane. The orbits of planets c and d are inclined by 30 degrees with respect to each other. This research marks the first time that the "mutual inclination" of two planets orbiting another star has been measured. And, the team has uncovered hints that a fourth planet, e, orbits the star much farther out.

"Most probably Upsilon Andromedae had the same formation process as our own solar system, although there could have been differences in the late formation that seeded this divergent evolution," McArthur said. "The premise of planetary evolution so far has been that planetary systems form in the disk and remain relatively co-planar, like our own system, but now we have measured a significant angle between these planets that indicates this isn't always the case."

Until now the conventional wisdom has been that a big cloud of gas collapses down to form a star, and planets are a natural byproduct of leftover material that forms a disk. In our solar system, there's a fossil of (Continued on page 8)
Ancient Supernova Riddle, Solved
By Dr. Tony Phillips

Australopithecus squinted at the blue African sky. He had never seen a star in broad daylight before, but he could see one today. Was it dangerous? He stared for a long time, puzzled, but nothing happened, and after a while he strode across the savanna unconcerned.

Millions of years later, we know better.

That star was a supernova, one of many that exploded in our corner of the Milky Way around the Pliocene era of pre-humans. Australopithecus left no records; we know the explosions happened because their debris is still around. The solar system and everything else within about 300 light-years is surrounded by supernova exhaust—a haze of million-degree gas that permeates all of local space. Supernovas are dangerous things, and when one appears in the daytime sky, it is cause for alarm. How did Earth survive? Modern astronomers believe the blasts were too far away (albeit not by much) to zap our planet with lethal amounts of radiation. Also, the Sun’s magnetic field has done a good job holding the hot gas at bay. In other words, we lucked out.

The debris from those old explosions has the compelling power of a train wreck; astronomers have trouble tearing their eyes away. Over the years, they’ve thoroughly surveyed the wreckage and therein found a mystery—clouds of hydrogen and helium apparently too fragile to have survived the blasts. One of them, whimsically called “the Local Fluff,” is on the doorstep of the solar system.

“The observed temperature and density of the Fluff do not provide enough pressure to resist the crushing action of the hot supernova gas around it,” says astronomer Merav Opher of George Mason University. “It makes us wonder, how can such a cloud exist?”

NASA’s Voyager spacecraft may have found the answer. NASA’s two Voyager probes have been racing out of the solar system for more than 30 years. They are now beyond the orbit of Pluto and on the verge of entering interstellar space. “The Voyagers are not actually inside the Local Fluff,” explains Opher. “But they are getting close and can sense what the cloud is like as they approach it.”

And the answer is …

“Magnetism,” says Opher. “Voyager data show that the Fluff is strongly magnetized with a field strength between 4 and 5 microgauss. This magnetic field can provide the pressure required to resist destruction.” If fluffy clouds of hydrogen can survive a supernova blast, maybe it’s not so surprising that we did, too. “Indeed, this is helping us understand how supernovas interact with their environment—and how destructive the blasts actually are,” says Opher.

Maybe Australopithecus was on to something after all.

Opher’s original research describing Voyager’s discovery of the magnetic field in the Local Fluff may be found in Nature, 462, 1036-1038 (24 December 2009). The Space Place has a new Amazing Fact page about the Voyagers’ Golden Records, with sample images and sounds of Earth. Just in case one of the Voyager’s ever meets up with ET, we will want to introduce ourselves. Visit http://spaceplace.nasa.gov/en/kids/voyager.
A team of astronomy researchers at Florida Institute of Technology and Rochester Institute of Technology in the United States and University of Sussex in the United Kingdom, find that the supermassive black hole (SMBH) at the center of the most massive local galaxy (M87) is not where it was expected. Their research, conducted using the Hubble Space Telescope (HST), concludes that the SMBH in M87 is displaced from the galaxy center.

The most likely cause for this SMBH to be off center is a previous merger between two older, less massive, SMBHs. “We also find, however, that the iconic M87 jet may have pushed the SMBH away from the galaxy center,” said Daniel Batcheldor, Florida Tech assistant professor in the Department of Physics and Space Sciences, who led the investigation. The study of M87 is part of a wider HST project directed by Andrew Robinson, professor of physics at RIT. “What may well be the most interesting thing about this work is the possibility that what we found is a signpost of a black hole merger, which is of interest to people looking for gravitational waves and for people modeling these systems as a demonstration that black holes really do merge,” says Robinson. “The theoretical prediction is that when two black holes merge, the newly combined black hole receives a ‘kick’ due to the emission of gravitational waves, which can displace it from the center of the galaxy.”

David Merritt, professor of physics at RIT, adds: “Once kicked, a supermassive black hole can take millions or billions of years to return to rest, especially at the center of a large, diffuse galaxy like M87. So searching for displacements is an effective way to constrain the merger history of galaxies.”

Jets, such as the one in M87, are commonly found in a class of objects called Active Galactic Nuclei. It is commonly believed that supermassive black holes can become active as a result of the merger between two galaxies, the infall of material into the center of the galaxy, and the subsequent merger between their black holes. Therefore, it is very possible that this finding could also be linked to how active galaxies—including quasars, the most luminous objects in the universe—are born and how their jets are formed.

This research will be presented at the American Astronomical Society (AAS) Conference on May 25 in Miami, Fla. It will also be published in The Astrophysical Journal Letters peer-reviewed scientific journal. Because many galaxies have similar properties to M87, it is likely that SMBHs are commonly offset from their host galaxy centers. The potential offsets, however, would be very subtle and researchers would rely on the Hubble Space Telescope to detect them.

“Unfortunately, the highest spatial resolution camera onboard HST could not be revived during the recent servicing mission. This means we have to rely on the huge archive of HST data to find more of these vagrant SMBHs, as we did for M87,” added Batcheldor.

Regardless of the displacement mechanism, the implication of this result is a necessary shift in the classic SMBH paradigm; no longer can it be assumed that all SMBHs reside at the centers of their host gal-

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Path of Pluto 2010

May 2010

June 2010

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A surprising discovery that hydrogen gas clouds found in abundance in and above our Milky Way Galaxy have preferred locations has given astronomers a key clue about the origin of such clouds, which play an important part in galaxy evolution.

"We've concluded that these clouds are gas that has been blown away from the Galaxy's plane by supernova explosions and the fierce winds from young stars in areas of intense star formation," said H. Alyson Ford of the University of Michigan, whose Ph.D thesis research from Swinburne University formed the basis for this result. The team, consisting of Ford and collaborators Felix J. Lockman, of the National Radio Astronomy Observatory (NRAO), and Naomi Mclure-Griffiths of CSIRO Astronomy and Space Science, presented their findings to the American Astronomical Society's meeting in Miami, Florida.

The astronomers studied gas clouds in two distinct regions of the Galaxy. The clouds they studied are between 400 and 15,000 light-years outside the disk-like plane of the Galaxy. The disk contains most of the Galaxy's stars and gas, and is surrounded by a "halo" of gas more distant than the clouds the astronomers studied.

"These clouds were first detected with the National Science Foundation's Robert C. Byrd Green Bank Telescope, and are quite puzzling. They are in a transitional area between the disk and the halo, and their origin has been uncertain," Lockman explained. The research team used data from the Galactic All-Sky Survey, made with CSIRO's Parkes radio telescope in Australia.

When the astronomers compared the observations of the two regions, they saw that one region contained three times as many hydrogen clouds as the other. In addition, that region's clouds are, on average, twice as far above the Galaxy's plane.

The dramatic difference, they believe, is because the region with more clouds lies near the tip of the Galaxy's central "bar," where the bar merges with a major spiral arm. This is an area of intense star formation, containing many young stars whose strong winds can propel gas away from the region. The most massive stars also will explode as supernovae, blasting material outward. In the other region they studied, star formation activity is more sparse.

"The properties of these clouds show clearly that they originated as part of the Milky Way's disk, and are a major component of our Galaxy. Understanding these clouds is important in understanding how material moves between the Galaxy's disk and its halo, a critical process in the evolution of galaxies," Lockman said.

The clouds consist of neutral hydrogen gas, with an average mass equal to that of about 700 Suns. Their sizes vary greatly, but most are about 200 light-years across. The astronomers studied about 650 such clouds in the two widely-separated regions of the Galaxy.
axies. This may result in some interesting impacts on a number of fundamental astronomical areas, and some interesting questions.

For example, how would an accreting (growing by the gravitational attraction of matter) or quiescent SMBH interact with the surrounding nuclear environment as it moves through the bulge? What are the effects on the standard orientation-based unified model of active galactic nuclei and how have dynamical models of the SMBH mass been centered if the SMBH is quiescent? Especially thought-provoking, added Eric Perlman, associate professor of physics and space sciences at Florida Tech, is that our own galaxy is expected to merge with the Andromeda galaxy in about three billion years. "The result of that merger will likely be an active elliptical galaxy, similar to M87. Both our galaxy and Andromeda have SMBHs in their centers, so our result suggests that after the merger, the SMBH may wander in the galaxy's nucleus for billions of years."

David Axon, Dean of Mathematical and Physical Sciences at Sussex, concludes by saying that "In current galaxy formation scenarios galaxies are thought to be assembled by a process of merging. We should therefore expect that binary black holes and post coalescence recoiling black holes, like that in M87, are very common in the cosmos."

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that creation event because all of the eight major planets orbit in nearly the same plane. The outermost dwarf planets like Pluto are in inclined orbits, but these have been modified by Neptune's gravity and are not embedded deep inside the Sun's gravitational field. Several different gravitational scenarios could be responsible for the surprisingly inclined orbits in Upsilon Andromedae. "Possibilities include interactions occurring from the inward migration of planets, the ejection of other planets from the system through planet-planet scattering, or disruption from the parent star's binary companion star, Upsilon Andromedae B," McArthur said.

Barnes, an expert in the dynamics of extrasolar planetary systems, added, "Our dynamical analysis shows that the inclined orbits probably resulted from the ejection of an original member of the planetary system. However, we don't know if the distant stellar companion forced that ejection, or if the planetary system itself formed in such a way that some original planets were ejected. Furthermore, we find that the revised configuration still lies right on the precipice of instability: The planets pull on each other so strongly that they are almost able to throw each other out of the system."

The two different types of data combined in this research were astrometry from the Hubble Space Telescope and radial velocity from ground-based telescopes. Astrometry is the measurement of the positions and motions of celestial bodies. McArthur's group used one of the Fine Guidance Sensors (FGSs) on the Hubble telescope for the task. The FGSs are so precise that they can measure the width of a quarter in Denver from the vantage point of Miami. It was this precision that was used to trace the star's motion on the sky caused by its surrounding — and unseen — planets.

Radial velocity makes measurements of the star's motion on the sky toward and away from Earth. These measurements were made over a period of 14 years using ground-based telescopes, including two at McDonald Observatory and others at Lick, Haute-Provence, and Whipple Observatories. The radial velocity provides a long baseline of foundation observations, which enabled the shorter duration, but more precise and complete, Hubble observations to better define the orbital motions. The fact that the team determined the orbital inclinations of planets c and d allowed them to calculate the exact masses of the two planets. The new information told us that our view as to which planet is heavier has to be changed. Previous minimum masses for the planets given by radial velocity studies put the minimum mass for planet c at 2 Jupiters and for planet d at 4 Jupiters. The new, exact masses, found by astrometry are 14 Jupiters for planet c and 10 Jupiters for planet d.

"The Hubble data show that radial velocity isn't the whole story," Benedict said. "The fact that the planets actually flipped in mass was really cute."

The 14 years of radial velocity information compiled by the team uncovered hints that a fourth, long-period planet may orbit beyond the three now known. There are only hints about that planet because it's so far out that the signal it creates does not yet reveal the curvature of an orbit. Another missing piece of the puzzle is the inclination of the innermost planet, b, which would require precision astrometry 1,000 times greater than Hubble's, a goal attainable by a space mission optimized for interferometry.

The team's Hubble data also confirmed Upsilon Andromedae's status as a binary star. The companion star is a red dwarf less massive and much dimmer than the Sun.

"We don't have any idea what its orbit is," Benedict said. "It could be very eccentric. Maybe it comes in very close every once in a while. It may take 10,000 years." Such a close pass by the secondary star could gravitationally perturb the orbits of the planets.
WISE Telescope Has Heart and Soul

NASA's Wide-field Infrared Survey Explorer, or WISE, has captured a huge mosaic of two bubbling clouds in space, known as the Heart and Soul nebulae. The space telescope, which has completed about three-fourths of its infrared survey of the entire sky, has already captured nearly one million frames like the ones making up this newly released mosaic.

"This new image demonstrates the power of WISE to capture vast regions," said Ned Wright, the mission's principal investigator at UCLA, who presented the new picture at the American Astronomical Society meeting in Miami. "We're looking north, south, east and west to map the whole sky."

The Heart nebula is named after its resemblance to a human heart; the nearby Soul nebula happens to resemble a heart too, but only the symbolic kind with two lobes. The nebulae, which lie about 6,000 light-years away in the constellation Cassiopeia, are both massive star-making factories, marked by giant bubbles blown into surrounding dust by radiation and winds from the stars. The infrared vision of WISE allows it to see into the cooler and dustier crevices of clouds like these, where gas and dust are just beginning to collect into new stars.

The new image was captured as WISE circled over Earth's poles, scanning strips of the sky. It is stitched together from 1,147 frames, taken with a total exposure time of three-and-a-half hours. The mission will complete its first map of the sky in July 2010. It will then spend the next three months surveying much of the sky a second time, before the solid-hydrogen coolant needed to chill its infrared detectors runs dry. The first installment of the public WISE catalog will be released in summer 2011.

About 960,000 WISE images have been beamed down from space to date. Some show ethereal star-forming clouds, while others reveal the ancient light of very remote, powerful galaxies. And many are speckled with little dots that are asteroids in our solar system. So far, the mission has observed more than 60,000 asteroids, most of which lie in the main belt, orbiting between Mars and Jupiter. About 11,000 of these objects are newly discovered, and about 50 of them belong
to a class of near-Earth objects, which have paths that take them within about 48 million kilometers (30 million miles) of Earth's orbit.

One goal of the WISE mission is to study asteroids throughout our solar system and to find out more about how they vary in size and composition. Infrared helps with this task because it can get better size measurements of the space rocks than visible light.

"Infrared will help us understand more about the sizes, properties and origins of asteroids near and far," said Amy Mainzer, the principal investigator of NEOWISE, a program to study and catalog asteroids seen by WISE (the acronym comes from combining near-Earth object, or NEO, with WISE).

WISE will also study the Trojans, asteroids that run along with Jupiter in its orbit around the sun in two packs -- one in front of and one behind the gas giant. It has seen more than 800 of these objects, and by the end of the mission, should have observed about half of all 4,500 known Trojans. The results will address dueling theories about how the outer planets evolved.

"WISE is the first survey capable of observing the two clouds in a uniform way, and this will provide valuable insight into the early solar system," said astronomer Tommy Grav of Johns Hopkins University, Baltimore, Md., who presented the information at the astronomy meeting.

Comets have also made their way into WISE images, with more than 72 observed so far, about a dozen of them new. WISE is taking a census of the types of orbits comets ride in. The data will help explain what kicks comets out of their original, more distant orbits and in toward the sun.