COMING EVENTS
PUBLIC OBSERVING

BAND CONCERT SCHEDULE
WEDNESDAY 9:00 PM

June 15
June 29
July 13

President
Rick Heschmeyer
rcjbm@sbcglobal.net

ALCOR
William Winkler
billwink10@yahoo.com

University Advisor
Dr. Bruce Twarog
btwarog@ku.edu

INSIDE THIS ISSUE
Officer's Report (continued) 2
Young Star—Giant Planet? 3
NASA SPACE PLACE 4
Young Galaxies—Giant BH? 5
Tycho’s SN Expansion 6
Mars Portrait 7
Tycho SN (continued) 7
Green Bank StarQuest XIII 8
ALCON 2016 9
Gamma Rays from Arp 220 10
Young Star (continued) 10
Rotating Comets 11
Young Galaxies continued) 11

Report from the Officers
This hasn’t been a great few weeks for observing. First the skies were cloudy for the Mercury transit, cancelling a rather significant public viewing event coordinated with the Lawrence Public Library. Then, after multiple attempts to initiate observing at the Baker Wetlands Science Center, it looks like the third time was the charm. The first post Band Concert Observing Session was then cancelled due to clouds after presenting the tantalizing possibility of being clear for most of the day. Fortunately, we’ve also had a moderately lovely first weekend in June, permitting some observing before the cloudy skies and thunderstorm possibilities return on Monday.

Returning to the first clear observing at Baker, it looks like the event was a hit. A number of photos from the site are included. From Bill Winkler, club ALCOR,

“The public observing went very well. The screen on the 14” showed Jupiter and its red spot, Saturn, and Mars clearly. Dave Kolb (pictured above) had M13 and M66 and M65 on the screen of his 8-inch, and there were several other telescopes. No wind! Heavy dewing later. Roger Boyd and also Bill Wachspress dropped by after Buskering.”
The experience was positive enough that an impromptu session was coordinated yesterday evening (June 4) for ideal observing at new moon. The call went out via email but future unscheduled sessions are more likely to be organized via Facebook. So, if you find the impromptu sessions appealing, periodically take a peek at the AAL Facebook page and see what might be happening soon.

From Bill Winkler again, “A fair sized group and smaller telescopes were there. A number of KU graduate students from several fields, too. The scope was used in direct eyepiece mode, not camera to screen. This meant careful climbing into the clamshell in near darkness via two ladders. All viewing was Mars, Jupiter, and Saturn. Rex Powell had his large reflector and

Bill Wachsypress showed the apodizing disk for placing over his objective opening that he is working on. It is said to increase planetary contrast.”

Having the telescope view projected onto a screen seems the ideal way of using the 14-inch (pictured above), since it avoids the need to step into the clamshell dome. The next scheduled observing event is the post-Band Concert Observing session scheduled for downtown on June 15. Assuming we get lucky and the weather cooperates, feel free to join the group in South Park west of Mass. St. after 9 PM. Due to the late time for twilight to finish, no additional sessions are scheduled at the Baker Wetlands for the summer, but we will keep you informed if that changes.

Also, note the invites to two national/regional meetings posted in the newsletter. Any suggestions for improving the club or the newsletter are always welcome.

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 rcfjbm@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://www.physics.ku.edu/AAL/

Copies of the Celestial Mechanic can also be found on the web at http://www.physics.ku.edu/AAL/newsletter
Astronomers find giant planet around very young star

“For decades, conventional wisdom held that large Jupiter-mass planets take a minimum of 10 million years to form,” said Christopher Johns-Krull, the lead author of a new study about the planet, CI Tau b. “That's been called into question over the past decade, and many new ideas have been offered, but the bottom line is that we need to identify a number of newly formed planets around young stars if we hope to fully understand planet formation.”

CI Tau b is at least eight times larger than Jupiter and orbits a 2 million-year-old star about 450 light years from Earth in the constellation Taurus. Johns-Krull and a dozen co-authors from Rice, Lowell Observatory, the University of Texas at Austin, NASA and Northern Arizona University made the peer-reviewed study available online this week.

Earth and the sun are more than 4 billion years old, and while the 3,300-plus catalog of exoplanets includes some older and some younger than Earth, the obstacles to finding planets around newly formed stars are varied and daunting, Johns-Krull said. There are relatively few candidate stars that are young enough, bright enough to view in sufficient detail with existing telescopes and still retain circumstellar disks of gas and dust from which planets form. Stars so young also are often active, with visual outbursts and dimmings, strong magnetic fields and enormous starspots that can make it appear that planets exist where they do not.

CI Tau b orbits the star CI Tau once every nine days. The planet was found with the radial velocity method, a planet-hunting technique that relies upon slight variations in the velocity of a star to determine the gravitational pull exerted by nearby planets that are too faint to observe directly with a telescope. The discovery resulted from a survey begun in 2004 of 140 candidate stars in the star-forming region Taurus-Auriga.

“This result is unique because it demonstrates that a giant planet can form so rapidly that the remnant gas and dust from which the young star formed, surrounding the system in a Frisbee-like disk, is still present,” said Lisa Prato of Lowell Observatory, co-leader of the young planet survey and a co-author on the paper. “Giant planet formation in the inner part of this disk, where CI Tau b is located, will have a profound impact on the region where smaller terrestrial planets are also potentially forming.” Additional team members were Patrick Hartigan, Naved Mahmud, Wei Chen, Wilson Cauley and Joshua Jones, all of Rice; Christopher Crockett and Brian Skiff of Lowell Observatory; Daniel Jaffe, Jacob McLane and Gregory Mace of the University of Texas at Austin; and Charles Beichman of NASA's Jet Propulsion Laboratory. Cauley is currently a postdoctoral researcher at Wesleyan University, and Crockett now writes for Science News.

The team observed CI Tau dozens of times from the University of Texas at Austin's McDonald Observatory near Fort Davis, Texas; the Lowell Observatory in Flagstaff, Ariz.; the NASA Infrared Telescope Facility and the Keck II telescopes on Mauna Kea, Hawaii; and the Kitt Peak National Observatory's 2.1- and 4-meter telescopes in southern Arizona.

(Continued on page 10)
NOAA’s Joint Polar Satellite System (JPSS) to revolutionize Earth-watching

By Ethan Siegel

If you want to collect data with a variety of instruments over an entire planet as quickly as possible, there are two trade-offs you have to consider: how far away you are from the world in question, and what orientation and direction you choose to orbit it. For a single satellite, the best of all worlds comes from a low-Earth polar orbit, which does all of the following:

- orbits the Earth very quickly: once every 101 minutes,
- is close enough at 824 km high to take incredibly high-resolution imagery,
- has five separate instruments each probing various weather and climate phenomena,
- and is capable of obtaining full-planet coverage every 12 hours.

The type of data this new satellite – the Joint Polar Satellite System-1 (JPSS-1) -- will take will be essential to extreme weather prediction and in early warning systems, which could have severely mitigated the impact of natural disasters like Hurricane Katrina. Each of the five instruments on board are fundamentally different and complementary to one another. They are:

1. The Cross-track Infrared Sounder (CrIS), which will measure the 3D structure of the atmosphere, water vapor and temperature in over 1,000 infrared spectral channels. This instrument is vital for weather forecasting up to seven days in advance of major weather events.

2. The Advanced Technology Microwave Sounder (ATMS), which assists CrIS by adding 22 microwave channels to improve temperature and moisture readings down to 1 Kelvin accuracy for tropospheric layers.

3. The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument, which takes visible and infrared pictures at a resolution of just 400 meters (1312 feet), enables us to track not just weather patterns but fires, sea temperatures, nighttime light pollution as well as ocean-color observations.

4. The Ozone Mapping and Profiler Suite (OMPS), which measures how the ozone concentration varies with altitude and in time over every location on Earth's surface. This instrument is a vital tool for understanding how effectively ultraviolet light penetrates the atmosphere.

5. Finally, the Clouds and the Earth's Radiant System (CERES) will help understand the effect of clouds on Earth's energy balance, presently one of the largest sources of uncertainty in climate modeling.

The JPSS-1 satellite is a sophisticated weather monitoring tool, and paves the way for its’ sister satellites JPSS-2, 3 and 4. It promises to not only provide early and detailed warnings for disasters like hurricanes, volcanoes and storms, but for longer-term effects like droughts and climate changes. Emergency responders, airline pilots, cargo ships, farmers and coastal residents all rely on NOAA and the National Weather Service for informative short-and-long-term data. The JPSS constellation of satellites will extend and enhance our monitoring capabilities far into the future.
NASA Telescopes Find Clues for How Giant Black Holes Formed So Quickly

Using data from NASA’s Great Observatories, astronomers have found the best evidence yet for cosmic seeds in the early universe that should grow into supermassive black holes.

Researchers combined data from NASA’s Chandra X-ray Observatory, Hubble Space Telescope, and Spitzer Space Telescope to identify these possible black hole seeds. “Our discovery, if confirmed, explains how these monster black holes were born,” said Fabio Pacucci of Scuola Normale Superiore (SNS) in Pisa, Italy, who led the study. “We found evidence that supermassive black hole seeds can form directly from the collapse of a giant gas cloud, skipping any intermediate steps.”

Scientists believe a supermassive black hole lies in the center of nearly all large galaxies, including our own Milky Way. They have found that some of these supermassive black holes, which contain millions or even billions of times the mass of the sun, formed less than a billion years after the start of the universe in the Big Bang.

One theory suggests black hole seeds were built up by pulling in gas from their surroundings and by mergers of smaller black holes, a process that should take much longer than found for these quickly forming black holes.

These new findings suggest instead that some of the first black holes formed directly when a cloud of gas collapsed, bypassing any other intermediate phases, such as the formation and subsequent destruction of a massive star.

“There is a lot of controversy over which path these black holes take,” said co-author Andrea Ferrara, also of SNS. “Our work suggests we are narrowing in on an answer, where the black holes start big and grow at the normal rate, rather than starting small and growing at a very fast rate.”

The researchers used computer models of black hole seeds combined with a new method to select candidates for these objects from long-exposure images from Chandra, Hubble, and the Spitzer Space Telescope (not shown in this graphic). By analyzing the combined light from the three telescopes, the team was able to search through thousands of objects to look for any that had properties that matched those predicted by their models.

Two candidates emerged that had the expected red color, seen by Hubble and Spitzer, as well as the X-ray profile predicted from Chandra. These objects were found in the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey and the Great Observatories Origins Deep Survey-South surveys. The next steps will involve getting more data on these two intriguing objects as well as extending the analysis to other surveys to look for more direct-collapse black hole candidates.
When the star that created this supernova remnant exploded in 1572, it was so bright that it was visible during the day. And though he wasn't the first or only person to observe this stellar spectacle, the Danish astronomer Tycho Brahe wrote a book about his extensive observations of the event, gaining the honor of it being named after him.

In modern times, astronomers have observed the debris field from this explosion - what is now known as Tycho's supernova remnant - using data from NASA's Chandra X-ray Observatory, the NSF's Karl G. Jansky Very Large Array (VLA) and many other telescopes. Today, they know that the Tycho remnant was created by the explosion of a white dwarf star, making it part of the so-called Type Ia class of supernovas used to track the expansion of the Universe.

Since much of the material being flung out from the shattered star has been heated by shock waves - similar to sonic booms from supersonic planes - passing through it, the remnant glows strongly in X-ray light. Astronomers have now used Chandra observations from 2000 through 2015 to create the longest movie of the Tycho remnant's X-ray evolution over time, using five different images. This shows the expansion from the explosion is still continuing about 450 years later, as seen from Earth's vantage point roughly 10,000 light years away. By combining the X-ray data with some 30 years of observations in radio waves with the VLA, astronomers have also produced a movie, using three different images. Astronomers have used these X-ray and radio data to learn new things about this supernova and its remnant.

The researchers measured the speed of the blast wave at many different locations around the remnant. The large size of the remnant enables this motion to be measured with relatively high precision. Although the remnant is approximately circular, there are clear differences in the speed of the blast wave in different regions. The speed in the right and lower right directions is about twice as large as that in the left and the upper left directions. This difference was also seen in earlier observations. This range in speed of the blast wave's outward motion is caused by differences in the density of gas surrounding the supernova remnant. This causes an offset in position of the explosion site from the geometric center, determined by locating the center of the circular remnant. The astronomers found that the size of the offset is about 10% of the remnant's current radius, towards the upper left of the geometric center. The team also found that the maximum speed of the blast wave is about 12 million miles per hour. This means that the remnant has expanded by about 100 billion miles during the time
**Hubble Takes Mars Portrait Near Close Approach**

On May 12, 2016, astronomers using NASA's Hubble Space Telescope captured this striking image of Mars, when the planet was 50 million miles from Earth. The photo reveals details as small as 20 miles to 30 miles across. This observation was made just a few days before Mars opposition on May 22, when the sun and Mars will be on exact opposite sides of Earth. Mars also will be 47.4 million miles from Earth. On May 30, Mars will be the closest it has been to Earth in 11 years, at a distance of 46.8 million miles. Mars is especially photogenic during opposition because it can be seen fully illuminated by the sun as viewed from Earth.

---

Chandra has observed it. Offsets such as this between the explosion center and the geometric center could exist in other supernova remnants. Understanding the location of the explosion center for Type Ia supernovas is important because it narrows the search region for a surviving companion star. Any surviving companion star would help identify the trigger mechanism for the supernova, showing that the white dwarf pulled material from the companion star until it reached a critical mass and exploded. The lack of a companion star would favor the other main trigger mechanism, where two white dwarfs merge causing the critical mass to be exceeded, leaving no star behind. The significant offset from the center of the explosion to the remnant's geometric center is a relatively recent phenomenon. For the first few hundred years of the remnant, the explosion's shock was so powerful that the density of gas it was running into did not affect its motion. The density discrepancy from the left side to the right has increased as the shock moved outwards, causing the offset in position between the explosion center and the geometric center to grow with time. So, if future X-ray astronomers, say 1,000 years from now, do the same observation, they should find a much larger offset.

(Continued from page 6)
GREEN BANK STAR QUEST XIII

JULY 6, 7, 8, 9 2016 The Dream Continues

Register now to be a part of Star Quest Family!

The Largest Optical & Radio Star Party in the Nation.
Join us for four days of unprecedented educational activities & lectures.
A true learning experience!

This is what Star Quest 13 has to offer!

Saturday July 9th Star Quest 2016 Keynote Speaker will feature
Dr. Seth Shostak
Senior Astronomer and Director of the Center for SETI research.
Dr. Shostak has appeared on many educational television programs,
and has served as Chair of the International Academy of Astronautics.
Star Quest will offer many other notable evening speakers, and daily
presenters in Astronomy.

Visit our web site for details: www.greenbankstarquest.org

• Meet NRAO Radio Astronomers
  • Optical & Radio Astronomy Presentations
  • Learn about Project BREAKTHROUGH Listen

4-day registration is $100 per participant, includes campsites, showers, and access to all events.
Children under 18 admitted free as long as they are accompanied by a registered adult.

• Free shower accommodations available
• Bunk house available for rent
• Dark West Virginia skies in the radio-quiet zone
• Great Vendors, Gift Shop
• Large Raffle on Saturday evening

• Learn to operate a 40ft radio telescope
• Great field observations, campsite included
• High-Tech tours of Green Bank NRAO
• Daily meal plans available for sale
• Nearby West Virginia tourist attractions

For other registration options and details visit our web site www.greenbankstarquest.org
Green Bank Star Quest, PO BOX 1852, CLARKSBURG, WV 26302-1852
For questions only: (304) 600-2855

All events are held indoors.

Sponsored by: Central Appalachian Astronomy Club, National Radio Astronomy Observatory and Kanawha Valley Astronomical Society
August 10 through August 13 features the Astronomical League's national convention coming to the NRECA Center in Arlington, VA. Hotel accommodations are available at the beautiful Westin Arlington Gateway (703-717-6200) and at the nearby equally attractive Hilton Arlington on the Metro Line (703-528-6000). Be sure to ask for the special ALCon rate.

This event is hosted by the Northern Virginia Astronomy Club (NOVAC) and your Astronomical League. The Association of Lunar and Planetary Observers will participate by holding its annual meeting at the event.

Why attend ALCon?

You will rub shoulders with, among others, research astronomers, authors, university professors, and amateurs from across the country, as well as officers of the Astronomical League and partnering organizations. You will listen to and speak with people well versed in imaging, outreach, equipment, club improvement, youth in astronomy, the art of observing, and the science of astronomy.

🌟 Special Tours!
Smithsonian Meteorite Collection
National Air & Space Museum
Steven F. Udvar-Hazy Center
NASA's Goddard Space Flight Center
US Naval Observatory

🌟 Nearly twenty engaging speakers share their experiences and knowledge. Topics include among others: Outreach opportunities, Meteor observing, Observing Venus, New Horizons mission to Pluto, 2017 Total solar eclipse, Spaceflight, The Aristarchos Experiment, Variable star research, Solar astronomy, Gravitational wave astronomy, Youth in Astronomy – and more!

🌟 Thursday night’s Star-BQ held at nearby Barcroft Park features live music by The Awesome Exaggerations!

🌟 Saturday night features the popular gala Awards Banquet with Keynote speaker NASA Administrator Major General Charles Bolden. Discover the future of space exploration from the leader of NASA!

Hope to see you at ALCon 2016!

John Jardine Goss
Astronomical League President

ALCon2016.astroleague.org
Astrophysicists detect most luminous diffuse gamma-ray emission from Arp 220

A University of Oklahoma team has detected for the first time the most luminous gamma-ray emission from a galaxy—the merging galaxy Arp 220 is the nearest ultraluminous infrared galaxy to Earth, and it reveals the hidden extreme energetic processes in galaxies. The first gamma-ray detection of an ultraluminous infrared galaxy occurs when the most energetic cosmic rays collide with the interstellar medium causing these galaxies to glow -- expanding observations of these galaxies to the highest energy ranges. Luminous infrared galaxies and ultraluminous infrared galaxies -- many of them the product of mergers between galaxies -- are the most luminous of all galaxies.

Xinyu Dai, professor in the Homer L. Dodge Department of Physics and Astronomy, OU College of Arts and Sciences, with team members Rhiannon Griffin, OU graduate assistant, and Todd Thompson, professor in the Department of Astronomy and Center for Cosmology and Astro-Particle Physics, Ohio State University, made the discovery after collecting data using the National Aeronautics and Space Administration's Fermi Gamma-Ray Space Telescope. "These galaxies are different because of their immense star formation and extra dust that scatters the light and makes them luminous in the infrared," said Griffin.

"With this detection, we are expanding the range of energies used to study these galaxies. We are very excited about this discovery," said Dai. "The gamma-ray light unveils the population of extreme energetic particles in galaxies, and this discovery shows that the cosmic ray content is proportional to the luminosity of galaxies, even for the most luminous one." Griffin and Dai developed the data collection methodology used to detect the gamma-ray emission from Arp 220. The massive amounts of star formation found in luminous infrared galaxies and ultraluminous infrared galaxies mean lots of massive stars go supernovae—the last stage of a massive star's life marked by one final huge explosion. The explosion accelerates numerous particles to relativistic speeds. These particles become cosmic rays that interact, resulting in particles and light, including gamma-ray emissions. Since cosmic rays are difficult to measure, gamma-rays reveal a hidden energy component in galaxies.

Arp 220 is situated some 250 million light years away, and its center contains over 200 huge star clusters. The most massive of these clusters contains enough material to equal about 10 million suns -- twice as massive as any comparable star cluster in the Milky Way. The gamma-ray emission is expected to trace two compact disks in the nucleus of Arp 200, which contains almost all star-formation activities in this galaxy.

(Continued from page 3)

Initial optical radial velocity data from McDonald Observatory confirmed that a planet might be present, and the team added photometry measurements from Lowell and five years of infrared observations from Hawaii, Kitt Peak and McDonald to rule out the possibility that the optical signal resulted from starspots or another masking phenomenon Johns-Krull said the team has examined about half of the young stars in the Taurus-Auriga survey sample, and the data from several of these suggest that more planets may be found.

"Ours isn't the only group looking for planets around young stars, and my hope is that astronomers can find enough of them to shed light on some of the nagging questions about planet formation," Johns-Krull said. "For instance, the 'brown dwarf desert,' an unexplained paucity of objects that are larger than giant planets but smaller than stars. If close investigation of young stars reveals more brown dwarfs in short-period orbits than elsewhere, that could confirm the theory that they tend to merge with their central stars within a few million years of forming."
For thousands of years, humans have recorded sightings of mysterious comets sweeping across the nighttime skies. These celestial wanderers, "snowballs" of dust and ice, are swift-moving visitors from the cold depths of space. Some of them periodically visit the inner solar system during their journeys around the sun.

Astronomers using NASA's Hubble Space Telescope captured images of Comet 252P/LINEAR just after it swept by Earth on March 21. The visit was one of the closest encounters between a comet and our planet. The comet traveled within 3.3 million miles of Earth, or about 14 times the distance between our planet and the moon. The images reveal a narrow, well-defined jet of dust ejected by the comet's icy, fragile nucleus. The jet also appears to change direction in the images, which is evidence that the comet's nucleus is spinning. The spinning nucleus makes the jet appear to rotate like the water jet from a rotating lawn sprinkler. These observations also represent the closest celestial object Hubble has observed, other than the moon. The comet will return to the inner solar system again in 2021.

The images reveal a narrow, well-defined jet of dust ejected by the comet's icy, fragile nucleus. The nucleus is too small for Hubble to resolve. Astronomers estimate that it is less than one mile across. A comet produces jets of material as it travels close to the sun in its orbit. Sunlight warms ices in a comet's nucleus, resulting in large amounts of dust and gas being ejected, sometimes in the form of jets. The jet in the Hubble images is illuminated by sunlight. The jet also appears to change direction in the images, which is evidence that the comet's nucleus is spinning. The spinning nucleus makes the jet appear to rotate like the water jet from a rotating lawn sprinkler. These observations underscore the dynamics and volatility of a comet's fragile nucleus. Comet 252P/LINEAR is traveling away from Earth and the sun; its orbit will bring it back to the inner solar system in 2021, but not anywhere close to Earth. These visible-light images were taken with Hubble's Wide Field Camera 3.

As scientists, we cannot say at this point that our model is 'the one'," said Pacucci. "What we really believe is that our model is able to reproduce the observations without requiring unreasonable assumptions."