**COMING EVENTS**

**Public Observing**  
**Sunday September 30**  
Prairie Park Nature Center  
9:00 PM

**Monthly Meeting**  
**Friday Sept. 14**  
7:30 PM, 2001 Malott

Twinkle, Twinkle Little Star  
The End of the Age of Wondering

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**Report from the Officers:** Kudos to Bill Winkler for taking on a little public education by setting up a solar observing station on the first day of the Fall semester at one of the local elementary schools. As seen at left, the overcast skies did clear by the end of the afternoon and the kids had a great time with a direct view and with the sunspotter.

The major local event of last month was the launch of the RBSP satellite. The details of the mission are given in the article below and an example of one of the ways that the sun may have an impact on the Earth is given on pg. 3. KU Professor Emeritus Tom Armstrong, with a distinguished career in Space Physics, is running the Science Operations Center for RBSPICE, one of the four key instruments on the satellite, from Lawrence through his tech company, Fundamental

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**Of Local Interest - NASA Launches Radiation Belt Storm Probes**

NASA’s Radiation Belt Storm Probes (RBSP), the first twin-spacecraft mission designed to explore our planet’s radiation belts, launched into the predawn skies at 4:05 a.m. Aug. 30 from Cape Canaveral Air Force Station, Fla. "Scientists will learn in unprecedented detail how the radiation belts are populated with charged particles, what causes them to change and how these processes affect the upper reaches of the atmosphere around Earth,” said John Grunsfeld, associate administrator for NASA’s Science Mission Directorate at Headquarters in Washington. “The information collected from these probes will benefit the public by allowing us to better protect our satellites and understand how space weather affects communications and technology on Earth.”

The two satellites, each weighing just less than 1,500 pounds, comprise the first dual-spacecraft mission specifically created to investigate the hazardous regions of near-Earth space, known as the radiation belts. These two belts, named for their discoverer, James Van Allen, encircle the planet and are filled with highly charged particles. The belts are affected by solar storms and coronal mass ejections and sometimes swell dramatically. When this occurs, they can pose dangers to communications, GPS satellites and human spaceflight.

“We have never before sent such comprehensive and high-quality instruments to study high radiation regions of space,” said Barry Mauk, RBSP project scientist at the Johns Hopkins University’s Applied Physics Laboratory (APL) in Laurel, Md. “RBSP was crafted to help us learn more about, and ultimately predict, the response of the radiation belts to solar inputs.”

The hardy RBSP satellites will spend the next 2 years looping through every part of both Van Allen belts. By having two spacecraft in different regions of the belts

(Continued on page 2)
Technologies. Dr. Mona Kessel, a KU grad and former student of Tom’s, is NASA Mission Scientist for the project. (We are hoping to arrange a presentation by Tom for either the Nov. or Dec. AAL meeting.) Tom arranged a televised view of the launch through Hobbs in downtown Lawrence. A hearty band of locals showed up for donuts and camaraderie, only to be foiled by technical issues and, eventually, by the weather (not here but in Florida) as Hurricane Isaac ensured that any delay would be extended for at least a week. The launch finally did go off on the 30th, but we have plenty of promotional items available for attendees at the first meeting this month. Speaking of the first meeting, it is now scheduled for Friday, Sept. 14 in our usual location, 2001 Malott at 7:30 PM. Our speaker will be Prof. Twarog of KU, regaling us with a talk presented at the Mid-States Regional Convention in Kansas City in June, as well as updating the latest info from the Kepler satellite. This month we also return to our Sunday public observing sessions in at Prairie Park Nature Center. The first session will begin at 9PM, Sunday, Sept. 30.

An astronomical event of note this month is the Autumnal Equinox. As he has done for decades, Prof. Ted Johnson will conduct his Autumnal Equinox Starlight Walking Tour of Mount Oread between 5 a.m. and shortly after 7 a.m. on Friday, September 21, 2012. If you have an interest in joining the tour, more details can be found at the AAL website under Events.

Any suggestions for improving the club or the newsletter are always welcome. Stay Cool!

(Continued from page 1)

at the same time, scientists finally will be able to gather data that describe the belts’ changes over space and time. Designers fortified RBSP with special protective plating and rugged electronics to operate and survive within this punishing region of space that other spacecraft avoid. In addition, a space weather broadcast will transmit selected data from those instruments around the clock, giving researchers a check on current conditions near Earth.

"The excitement of seeing the spacecraft in orbit and beginning to perform science measurements is like no other thrill," said Richard Fitzgerald, RBSP project manager at APL. "The entire RBSP team, from across every organization, worked together to produce an amazing pair of spacecraft." RBSP was lifted into orbit aboard an Atlas V 401 rocket from Launch Complex 41, as the rocket’s plume lit the dark skies over the Florida coast. The first RBSP spacecraft separated from the Atlas rocket’s Centaur booster 1 hour, 18 minutes, 52 seconds after launch. The second RBSP spacecraft separated 12 minutes, 14 seconds later.

Mission controllers using APL’s 60-foot satellite dish established radio contact with each probe immediately. During the next 60 days, operators will power up all flight systems and science instruments and deploy long antenna booms, two of which are more than 54 yards long. Data about the particles that swirl through the belts, and the fields and waves that transport them, will be gathered by five instrument suites designed and operated by teams at the New Jersey Institute of Technology in Newark; University of Iowa in Iowa City; University of Minnesota in Minneapolis; the University of New Hampshire in Durham; and the National Reconnaissance Office in Chantilly, Va. The data will be analyzed by scientists across the nation almost immediately.

The two satellites of RBSP mark the 65th and 66th spacecraft built and launched by APL since 1961. APL has a long and storied history of space exploration and innovation, including the development of the first satellite-based navigation system in 1960 and the building and management of current NASA missions including MESSENGER, the first spacecraft to orbit Mercury, and New Horizons, the first spacecraft to explore Pluto and the Kuiper Belt region.

“We are proud to have designed, tested and delivered to NASA a pair of remarkable spacecraft,” said John Sommerer, head of APL’s Space Department. “They have been well-equipped to undertake a challenging research mission within the harshest near-Earth space environment. The data collected by RBSP will inform scientifically profound and socially beneficial study for years to come.

“RBSP is the second mission in NASA’s Living With a Star (LWS) program to explore aspects of the connected sun-Earth system that directly affect life and society. LWS is managed by the agency’s Goddard Space Flight Center in Greenbelt, Md. APL built the RBSP spacecraft and will manage the mission for NASA.

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 rcjm@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

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Scientists have long suspected that the Sun's 11-year cycle influences climate of certain regions on Earth. Yet records of average, seasonal temperatures do not date back far enough to confirm any patterns. Now, armed with a unique proxy, an international team of researchers show that unusually cold winters in Central Europe are related to low solar activity -- when sunspot numbers are minimal. The freezing of Germany's largest river, the Rhine, is the key. Although Earth’s surface overall continues to warm, the new analysis has revealed a correlation between periods of low activity of the Sun and of some cooling -- on a limited, regional scale in Central Europe, along the Rhine.

"The advantage with studying the Rhine is because it's a very simple measurement," said Frank Sirocko lead author of a paper on the study and professor of Sedimentology and Paleoclimatology at the Institute of Geosciences of Johannes Gutenberg University in Mainz, Germany. "Freezing is special in that it's like an on-off mode. Either there is ice or there is no ice."

From the early 19th through mid-20th centuries, riverboat men used the Rhine for cargo transport. And so docks along the river have annual records of when ice clogged the waterway and stymied shipping. The scientists used these easily-accessible documents, as well as other additional historical accounts, to determine the number of freezing episodes since 1780. Sirocko and his colleagues found that between 1780 and 1963, the Rhine froze in multiple places fourteen different times. The sheer size of the river means it takes extremely cold temperatures to freeze over making freezing episodes a good proxy for very cold winters in the region, Sirocko said.

Mapping the freezing episodes against the solar activity's 11-year cycle -- a cycle of the Sun's varying magnetic strength and thus total radiation output -- Sirocko and his colleagues determined that ten of the fourteen freezes occurred during years when the Sun had minimal sunspots. Using statistical methods, the scientists calculated that there is a 99 percent chance that extremely cold Central European winters and low solar activity are inherently linked. "We provide, for the first time, statistically robust evidence that the succession of cold winters during the last 230 years in Central Europe has a common cause," Sirocko said.

With the new paper, Sirocko and his colleagues have added to the research linking solar variability with climate, said Thomas Crowley, Director of the Scottish Alliance for Geoscience, Environment, and Society, who was not involved with the study. "There is some suspension of belief in this link," Crowley said, "and this study tilts the argument more towards thinking there really is something to this link. If you have more statistical evidence to support this explanation, one is more likely to say it's true."

The study, conducted by researchers at Johannes Gutenberg and the Institute for Atmospheric and Climate Science in Zurich, Switzerland, is set to be published August 25 in Geophysical Research Letters, a journal of the American Geophysical Union.

When sunspot numbers are down, the Sun emits less ultraviolet radiation. Less radiation means less heating of Earth’s atmosphere, which sparks a change in the circulation patterns of the two lowest atmospheric levels, the troposphere and stratosphere. Such changes lead to climatic phenomena such as the North Atlantic Oscillation, a pattern of atmospheric pressure variations that influences wind patterns in the North Atlantic and weather behavior in regions in and around Europe.

"Due to this indirect effect, the solar cycle does not impact hemispherically averaged temperatures, but only leads to regional temperature anomalies," said Stephan Pfahl, a co-author of the study who is now at the Institute for Atmospheric and Climate Science in Zurich.

The authors show that this change in atmospheric circulation leads to cooling in parts of Central Europe but warming in other European countries, such as Iceland. So, sunspots don't necessarily cool the entire globe -- their cooling effect is more localized, Sirocko said. In fact, studies have suggested that the extremely cold European winters of 2010 and 2011 were the result of the North Atlantic Oscillation, which Sirocko and his team now link to the low solar activity during that time.

The 2010 and 2011 European winters were so cold that they resulted in record lows for the month of November in certain countries. Some who dispute the occurrence of anthropogenic climate change argue that this two-year period shows that Earth's climate is not getting any warmer. But climate is a complex system, Sirocko said. And a short-term, localized dip in temperatures only temporarily masks the effects of a warming world.

(Continued on page 8)
First a caravan of white observatory cars arrives, winding up the narrow road to the 2600-m- (~8500-foot-) high summit. Then the shutters around the domes open, and rays from the setting sun alight on colossal mirrors and metal struts. It’s the beginning of another busy night at Mt. Paranal, Chile, where I am learning about new, more efficient ways of managing a modern observatory.

I stepped into the observatory’s control room to soak up some of the new, unfamiliar culture. Here, under florescent lights and drop ceilings are banks of computer screens, one bank to control each of the four big telescopes on the mountaintop and a few others too. At each bank sits two people, a telescope operator and an astronomer.

The layout of this workspace was not unfamiliar to me. But the way these Mt. Paranal astronomers work certainly was. When I was cutting my teeth at Mt. Palomar observatory in California, I would only go to the telescope to take my own data. In stark contrast, everyone observing at Mt Paranal tonight is taking data for someone else.

The Mt. Paranal astronomers each spend 105 nights a year here on the mountain performing various duties, including taking data for other astronomers. The latter, they call “executing the queue.” Headquarters in Germany decides what parts of the sky will have priority on any given night (the queue). Then the Mt. Paranal astronomers march up the mountain and carry out this program, choosing calibrators, filling the log books, and adapting to changing conditions. They send the data back to headquarters, and from there it makes its way out to the wider astronomical community for study.

This new way of working allows the Mt. Paranal astronomers to specialize in just one or two telescope instruments each. Surely this plan is more efficient than the old-fashioned way, where each of us had to learn every instrument we used from scratch—sifting through manuals at 3:00 AM when the filter wheel got stuck or the cryogen ran out, watching precious observing time tick away. Here at Mt. Paranal, much of the work is done in a big room full of people, not off by yourself, reducing some dangers of the process. Also, queue observing cuts down on plane travel, an important step for cutting carbon emissions.

It’s a brand new age, I thought as I watched the giant domes spin in the silent, cold Chilean night. And maybe with queue observing, some of the romance is gone. Still, my colleagues and I couldn’t help saying as we stared out across the moonlit mountains: I can’t believe how lucky we are to be here.

Dr. Marc J. Kuchner is an astrophysicist at the Exoplanets and Stellar Astrophysics Laboratory at NASA’s Goddard Space Flight Center. NASA’s Astrophysics Division works on big questions about the origin and evolution of the universe, galaxies, and planetary systems. Explore more at http://www.science.nasa.gov/astrophysics/. Kids can explore these topics at http://spaceplace.nasa.gov/space.
TWINKLE, TWINKLE LITTLE STAR
The End of Wondering in the Age of ASTEROSEISMOLOGY

Dr. Bruce Twarog
Dept. of Physics and Astronomy, KU

FRIDAY SEPT. 14, 2012
7:30 PM
2001 Malott Hall
University of Kansas
FREE AND OPEN TO THE PUBLIC
Two independent papers have been submitted confirming 41 new transiting planets in 20 multiple planet systems in the Kepler field of view. The diagram shows the newly submitted transiting planets in green along with the unconfirmed planet candidates in the same system in violet. Systems are ordered horizontally by increasing Kepler number and KOI designation and vertically by orbital period. Jason Steffen, Fermilab Center for Particle Astrophysics.

Two newly submitted studies verify 41 new transiting planets in 20 star systems. These results may increase the
 Last year, astronomers discovered a quiescent black hole in a distant galaxy that erupted after shredding and consuming a passing star. Now researchers have identified a distinctive X-ray signal observed in the days following the outburst that comes from matter on the verge of falling into the black hole.

This tell-tale signal, called a quasi-periodic oscillation or QPO, is a characteristic feature of the accretion disks that often surround the most compact objects in the universe -- white dwarf stars, neutron stars and black holes. QPOs have been seen in many stellar-mass black holes, and there is tantalizing evidence for them in a few black holes that may have middleweight masses between 100 and 100,000 times the sun’s.

Until the new finding, QPOs had been detected around only one supermassive black hole -- the type containing millions of solar masses and located at the centers of galaxies. That object is the Seyfert-type galaxy REJ 1034+396, which at a distance of 576 million light-years lies relatively nearby.

"This discovery extends our reach to the innermost edge of a black hole located billions of light-years away, which is really amazing. This gives us an opportunity to explore the nature of black holes and test Einstein’s relativity at a time when the universe was very different than it is today," said Rubens Reis, an Einstein Postdoctoral Fellow at the University of Michigan in Ann Arbor. Reis led the team that uncovered the QPO signal using data from the orbiting Suzaku and XMM-Newton X-ray telescopes, a finding described in a paper published today in Science Express.

The X-ray source known as Swift J1644+57 -- after its astronomical coordinates in the constellation Draco -- was discovered on March 28, 2011, by NASA’s Swift satellite. It was originally assumed to be a more common type of outburst called a gamma-ray burst, but its gradual fade-out matched nothing that had been seen before. Astronomers soon converged on the idea that what they were seeing was the aftermath of a truly extraordinary event -- the awakening of a distant galaxy’s dormant black hole as it shredded and gobbled up a passing star. The galaxy is so far away that light from the event had to travel 3.9 billion years before reaching Earth.

The star experienced intense tides as it reached its closest point to the black hole and was quickly torn apart. Some of its gas fell toward the black hole and formed a disk around it. The innermost part of this disk was rapidly heated to temperatures of millions of degrees, hot enough to emit X-rays. At the same time, through processes still not fully understood, oppositely directed jets perpendicular to the disk formed near the black hole. These jets blasted matter outward at veloci-

(Continued on page 8)
"Climate is not ruled by one variable," said Sirocko. "In fact, it has [at least] five or six variables. Carbon dioxide is certainly one, but solar activity is also one."

Moreover, the researchers also point out that, despite Central Europe's prospect to suffer colder winters every 11 years or so, the average temperature of those winters is increasing and has been for the past three decades. As one piece of evidence of that warming, the Rhine River has not frozen over since 1963. Sirocko said such warming results, in part, from climate change. To establish a more complete record of past temperature dips, the researchers are looking to other proxies, such as the spread of disease and migratory habits.

"Disease can be transported by insects and rats, but during a strong freezing year that is not likely," said Sirocko. "Also, Romans used the Rhine to defend against the Germanics, but as soon as the river froze people could move across it. The freezing of the Rhine is very important on historical timescales."

It wasn't, however, the Rhine that first got Sirocko to thinking about the connection between freezing rivers and sunspot activity. In fact, it was a 125-mile ice-skating race he attended over 20 years ago in the Netherlands that sparked the scientist's idea.

The two research teams used data from NASA's Kepler space telescope, which measures dips in the brightness of more than 150,000 stars, to search for transiting planets. "The sheer volume of planet candidates being identified by Kepler is inexorable," said lead researcher Jason Steffen, the Brinson postdoctoral fellow at Fermilab Center for Particle Astrophysics in Batavia, Ill. "This information helps us understand how our own solar system fits into the population of all planetary systems."

Nineteen of the newly validated planetary systems have two closely spaced transiting planets and one system has three. Five of the systems are common to both of these independent studies. The planets range from Earth-size to more than seven times the radius of Earth, but generally orbit so close to their parent stars that they are hot, inhospitable worlds. The planets were confirmed by analyzing Transit Timing Variations (TTVs). In closely packed systems, the gravitational pull of the planets causes the acceleration or deceleration of a planet along its orbit. These "tugs" cause the orbital period of each planet to change from one orbit to the next. TTV demonstrates that two transiting planet candidates are in the same system and that their masses are planetary in nature.

"These systems, with their large gravitational interactions, give us important clues about how planetary systems form and evolve," said lead researcher Jason Steffen, the Brinson postdoctoral fellow at Fermilab Center for Particle Astrophysics in Batavia, Ill. "This information helps us understand how our own solar system fits into the population of all planetary systems."

The two research teams used data from NASA's Kepler space telescope, which measures dips in the brightness of more than 150,000 stars, to search for transiting planets. "The sheer volume of planet candidates being identified by Kepler is inspiring teams to look at the planet confirmation and characterization process differently. This TTV confirmation technique can be applied to large numbers of systems relatively quickly and with little or no follow-up observations from the ground," said Natalie Batalha, Kepler mission scientist at NASA's Ames Research Center, Moffett Field, Calif. "Perhaps the bottleneck between identifying planet candidates and confirming them just got a little wider."

"QPOs send us information from the very brim of the black hole, which is where the effects of relativity become most extreme," Reis said. "The ability to gain insight into these processes over such a vast distance is a truly beautiful result and holds great promise."

As hot gas in the innermost disk spirals toward a black hole, it reaches a point astronomers refer to as the innermost stable circular orbit (ISCO). Any closer to the black hole and gas rapidly plunges into the event horizon, the point of no return. The inward spiraling gas tends to pile up around the ISCO, where it becomes tremendously heated and radiates a flood of X-rays. The brightness of these X-rays varies in a pattern that repeats at a nearly regular interval, creating the QPO signal. The data show that Swift J1644+57's QPO cycled every 3.5 minutes, which places its source region between 2.2 and 5.8 million miles (4 to 9.3 million km) from the center of the black hole, the exact distance depending on how fast the black hole is rotating. To put this in perspective, the maximum distance is only about 6 times the diameter of our sun. The distance from the QPO region to the event horizon also depends on rotation speed, but for a black hole spinning at the maximum rate theory allows, the horizon is just inside the ISCO.

"QPOs send us information from the very brim of the black hole, which is where the effects of relativity become most extreme," Reis said. "The ability to gain insight into these processes over such a vast distance is a truly beautiful result and holds great promise."
Hubble Watches Star Clusters on a Collision Course
HST Press Release

Astronomers using data from NASA’s Hubble Space Telescope have caught two clusters full of massive stars that may be in the early stages of merging. The clusters are 170,000 light-years away in the Large Magellanic Cloud, a small satellite galaxy to our Milky Way.

What at first was thought to be only one cluster in the core of the massive star-forming region 30 Doradus (also known as the Tarantula Nebula) has been found to be a composite of two clusters that differ in age by about one million years.

The entire 30 Doradus complex has been an active star-forming region for 25 million years, and it is currently unknown how much longer this region can continue creating new stars. Smaller systems that merge into larger ones could help to explain the origin of some of the largest known star clusters.

Lead scientist Elena Sabbi of the Space Telescope Science Institute in Baltimore, Md., and her team began looking at the area while searching for runaway stars, fast-moving stars that have been kicked out of their stellar nurseries where they first formed.

"Stars are supposed to form in clusters, but there are many young stars outside 30 Doradus that could not have formed where they are; they may have been ejected at very high velocity from 30 Doradus itself," Sabbi said.

She then noticed something unusual about the cluster when looking at the distribution of the low-mass stars detected by Hubble. It is not spherical, as was expected, but has features somewhat similar to the shape of two merging galaxies where their shapes are elongated by the tidal pull of gravity. Hubble’s circumstantial evidence for the impending merger comes from seeing an elongated structure in one
of the clusters, and from measuring a different age between the two clusters.

According to some models, the giant gas clouds out of which star clusters form may fragment into smaller pieces. Once these small pieces precipitate stars, they might then interact and merge to become a bigger system. This interaction is what Sabbi and her team think they are observing in 30 Doradus.

Also, there is an unusually large number of high-velocity stars around 30 Doradus. Astronomers believe that these stars, often called "runaway stars" were expelled from the core of 30 Doradus as the result of dynamical interactions. These interactions are very common during a process called core collapse, in which more-massive stars sink to the center of a cluster by dynamical interactions with lower-mass stars. When many massive stars have reached the core, the core becomes unstable and these massive stars start ejecting each other from the cluster.

The big cluster R136 in the center of the 30 Doradus region is too young to have already experienced a core collapse. However, since in smaller systems the core collapse is much faster, the large number of runaway stars that has been found in the 30 Doradus region can be better explained if a small cluster has merged into R136.

Follow-up studies will look at the area in more detail and on a larger scale to see if any more clusters might be interacting with the ones observed. In particular the infrared sensitivity of NASA's planned James Webb Space Telescope (JWST) will allow astronomers to look deep into the regions of the Tarantula Nebula that are obscured in visible-light photographs. In these areas cooler and dimmer stars are hidden from view inside cocoons of dust. Webb will better reveal the underlying population of stars in the nebula.

The 30 Doradus Nebula is particularly interesting to astronomers because it is a good example of how star-forming regions in the young universe may have looked. This discovery could help scientists understand the details of cluster formation and how stars formed in the early universe.