COMING EVENTS
Public Observing
Prairie Park Nature Center
Sunday, JANUARY 26
8:00 PM

Monthly Meetings
FRIDAY, FEBRUARY 14
7:30 PM
2001 Malott
MAPPING THE STARS
WITH GAIA

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Report from the Officers
The annual end-of-year celebration went off without a hitch. The docu-
mentary film, The City Dark, was very well received and opened a few eyes to
the fundamental issue of what happens if we lose the ability to have an
environment where it actually gets dark each night, above and beyond the obvious
issues for astronomy. Light pollution is an ever-growing problem that is blocking out
(Continued on page 2)

A New Year’s Welcome to new club member
BRIAN YOCAM

The Good News About Winter
By Bill Pellerin, Houston Astronomical Society

The good news about winter is that the skies are dark longer than they are bright (for
those of us north of the equator); the bad news about winter is that it cold, often
frightfully so, at night. More good news: when a cold front blows through, sometimes
accompanied by bad weather, it’s not uncommon to have very clear skies behind the
front. Astronomers say that the ‘transparency’ of the sky is good. What’s often not
good is the steadiness of the air in the atmosphere, which astronomers call the
‘seeing’. Poor seeing makes stars look like blobs and planets look like bigger blobs.

For me, living in the southern United States, the cold is a challenge. I can be driven
inside by the cold temperatures faster than anything. In fact, it doesn’t need to be
that cold to be a problem. Astronomical observing does not require a high level physical
activity. I’m either sitting at a map table (often with a computer-based map) or sitting
at the eyepiece, or transitioning between the two. Much more of the time is sitting
than transitioning.

What are some things you can do to make the cold weather tolerable?

If it’s seriously cold outside, you shouldn’t have the expectation that you’re going to
be able to stay out for all night or even several hours. There are the hearty souls who
can do this, but for most of us observing in very cold weather is an exercise in futility.
The coldest night on which I had scheduled an observing session was in New Mex-
ico, some years ago, over a Thanksgiving weekend. It was 8 degrees F outside. I
don’t remember how many observations I made or what I observed, but I do recall
spending a lot of time in the warming room at the site drinking coffee and trying to
steel myself against the cold so I could go outside again. It didn’t work.

The common advice is to dress in layers, and I suppose that’s good advice. Wear
everything you have because, as they say, it’s the space between the layers that

(Continued on page 2)
the night sky in major cities, obscuring all but the moon and a few bright stars and planets. Bob Parks, executive director of the International Dark Sky Association joins "CBS This Morning: Saturday" to discuss what can be done to combat this growing problem: http://www.cbsnews.com/videos/how-bad-is-light-pollution

Hope everyone had a great time and left with the door prize of their choice. ALCOR Bill Winkler has sent along a recommendation for on-line viewing. NRAO has produced a 24-minute video on the history of the radio observatory entitled “Beyond the Visible”. The film is narrated by Jodie Foster of Contact fame and can be streamed on-line at You-Tube and http://vimeo.com/70554007. If you have a little time, check it out.

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

I have a ski suit that I bought at one of the sporting goods supply stores in January of 2009. The jacket consists of two pieces, an inner jacket and an outer jacket. These can be separated if using the two jackets simultaneously makes you too warm. I also have a pair of ski pants that I can pull on over my blue jeans and keep the lower half of my torso warm. In addition, I have a ‘mad bomber’ hat available from many sources. Just search for ‘mad bomber hat’ on the Internet and you’ll find plenty of them.

Covering the ears is a problem for me because I need glasses to read star charts, but avoid glasses when looking through the telescope. The glasses are more difficult to take off and to put on with ear flaps. By the way, it’s easy to tune-out the focusing problems of my eyes by adjusting the telescope, but if you have astigmatism you’ll need a corrector on your eyepiece to deal with that. TeleVue is the only company that sells these, as far as I know and whether you need one or not depends on the size of the exit cone of your eyepiece. If stars have horizontal lines going through them on one side of focus and vertical lines going through them on the other side of focus, you likely have astigmatism. Check with your eye doctor or read your prescription.

I use mittens that have the tips of the fingers open so I can feel small parts (eyepiece screws, etc.) when I’m outside. The mittens have a fold-over pocket for the exposed fingers when the fine-touch capability isn’t needed. The final piece of clothing I (sometimes) use is called ‘moon boots’ — very warm and furry inside and generally water resistant outside. Not good for doing a lot of walking, however. Some nice wool socks help.

I also use the chemical hand warmers, available from a sporting goods supply store. These are activated by contact with the air and they stay warm for several hours. I put them in the pocket of my jacket and put my hands in those pockets as needed to absorb the warmth. It feels good to wrap my hands around those warmers; they provide a good bit of relief from the cold. There are also chemical warmers for boots, but I haven’t used them.

Walk around. It’s always a good idea to get out of your chair and go for a brisk walk. Doing so will loosen you up and warm you up a bit. Worth the effort. You can take a break as well. At the Texas Star Party there’s a snack booth that serves hot food and drinks all night. This isn’t an endurance contest. Go inside a warm space to thaw out and have a warm beverage.

Another approach — ( imagers only) — once you set up your telescope and camera and autoguider, etc., you can walk away from your setup and connect to your near-telescope computer from another computer (in a warm place). Software that does this is typically called ‘remote control’ software. These warm places could be your travel trailer, your car, your warm-room or even your house if your house and observatory are co-located. Some versions of Windows has the ability to be remote controlled.

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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
Herschel Space Telescope Spies Active Argon in Crab Nebula

Just like a group of people, the periodic table of chemical elements has its share of team players and loners. While some elements tend to react more easily with other species, forming molecules and other compounds, others hardly ever take part in chemical reactions and are mainly found in isolation. 'Inert' elements par excellence are the noble gases: helium, neon, argon, krypton, xenon and radon.

The name of one of them – argon – derives from the Greek word for idle, to emphasize its highly inert nature. But noble gases are not entirely inactive. While at first scientists doubted that chemical compounds could even contain noble gases, several such species are now known and have been extensively studied in the laboratory.

Things are more complex in space. Over the decades, astronomers have detected atoms and ions of noble gases in a variety of cosmic environments, ranging from the Solar System to the atmospheres of stars, from dense nebulae to the diffuse interstellar medium. But the search for noble-gas based compounds had until now proved unsuccessful, suggesting that these almost inert elements might have a hard time reacting with other species in space. A new study, led by Michael Barlow from University College London, UK, and based on data from ESA's Herschel Space Observatory, has found the first evidence of such a compound in space. The results are published in the journal Science. The team of astronomers has detected emission from argon hydride (ArH⁺), a molecular ion containing the noble gas argon, in the Crab Nebula. A wispy and filamentary cloud of gas and dust, the Crab Nebula is the remnant of a supernova explosion that was observed by Chinese astronomers in the year 1054.

(Continued on page 9)
The Big Picture: GOES-R and the Advanced Baseline Imager

By Kieran Mulvaney

The ability to watch the development of storm systems – ideally in real time, or as close as possible – has been an invaluable benefit of the Geostationary Operational Environmental Satellites (GOES) system, now entering its fortieth year in service. But it has sometimes come with a trade-off: when the equipment on the satellite is focused on such storms, it isn’t always able to monitor weather elsewhere.

“Right now, we have this kind of conflict,” explains Tim Schmit of NOAA’s National Environmental Satellite, Data, and Information Service (NESDIS). “Should we look at the broad scale, or look at the storm scale?” That should change with the upcoming launch of the first of the latest generation of GOES satellites, dubbed the GOES-R series, which will carry aloft a piece of equipment called the Advanced Baseline Imager (ABI).

According to Schmit, who has been working on its development since 1999, the ABI will provide images more frequently, at greater resolution and across more spectral bands (16, compared to five on existing GOES satellites). Perhaps most excitingly, it will also allow simultaneous scanning of both the broader view and not one but two concurrent storm systems or other small-scale patterns, such as wildfires, over areas of 1000km x 1000km.

Although the spatial resolution will not be any greater in the smaller areas than in the wider field of view, the significantly greater temporal resolution on the smaller scale (providing one image a minute) will allow meteorologists to see weather events unfold almost as if they were watching a movie.

So, for example, the ABI could be pointed at an area of Oklahoma where conditions seem primed for the formation of tornadoes. “And now you start getting one-minute data, so you can see small-scale clouds form, the convergence and growth,” says Schmit.

In August, Schmit and colleagues enjoyed a brief taste of how that might look when they turned on the GOES-14 satellite, which serves as an orbiting backup for the existing generation of satellites.

“We were allowed to do some experimental imaging with this one-minute imagery,” Schmit explains. “So we were able to simulate the temporal component of what we will get with ABI when it’s launched.”

The result was some imagery of cloud formation that, while not of the same resolution as the upcoming ABI images, unfolded on the same time scale. You can compare the difference between it and the existing GOES-13 imagery here:


Learn more about the GOES-R series of satellites here: http://www.goes-r.gov. Kids should be sure to check out a new online game that’s all about ABI! It’s as exciting as it is educational. Check it out at http://scijinks.gov/abi
Mapping the Stars With GAIA

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

FRIDAY FEB. 14, 2014
7:30 PM
2001 Malott Hall
University of Kansas
Free & Open to the Public
Hubble Space Telescope Sees Evidence of Water Vapor Venting off Jovian Moon

NASA's Hubble Space Telescope has observed water vapor above the frigid south polar region of Jupiter's moon Europa, providing the first strong evidence of water plumes erupting off the moon's surface.

Previous scientific findings from other sources already point to the existence of an ocean located under Europa's icy crust. Researchers are not yet certain whether the detected water vapor is generated by water plumes erupting on the surface, but they are confident this is the most likely explanation.

Should further observations support the finding, it would make Europa the second moon in the solar system known to have water vapor plumes. The findings were published in the Thursday, Dec. 12, online issue of Science Express, and reported at the meeting of the American Geophysical Union in San Francisco.

"By far the simplest explanation for this water vapor is that it erupted from plumes on the surface of Europa," said lead author Lorenz Roth of Southwest Research Institute in San Antonio, Texas. "If those plumes are connected with the subsurface water ocean we are confident exists under Europa's crust, then this means that future investigations can directly investigate the chemical makeup of Europa's potentially habitable environment without drilling through layers of ice. And that is tremendously exciting."

In 2005, NASA's Cassini orbiter detected jets of water vapor and dust spewing off the surface of Saturn's moon Enceladus. Although ice and dust particles subsequently have been found in the Enceladus plumes, only water vapor gases have been measured at Europa so far.

Hubble's spectroscopic observations provided the evidence for Europa plumes in December 2012. Time sampling of auroral emissions measured by Hubble's imaging spectrograph enabled the researchers to distinguish between features created by Jupiter's magnetospheric particles and local enhancements of gas, and to also rule out more exotic explanations such as serendipitously observing a rare meteorite impact. The imaging spectrograph detected faint ultraviolet light from an aurora, powered by Jupiter's intense magnetic field, near the moon's south pole. Atomic oxygen and hydrogen produce a variable auroral glow and leave a telltale sign that they are products of water molecules being broken apart by electrons along magnetic field lines.

"We pushed Hubble to its limits to see this very faint emission. These could be stealth plumes, because they might be tenuous and difficult to observe in the visible light," said Joachim Saur of the University of Cologne in Germany. Saur, who is principal investigator of the Hubble observation campaign, co-wrote the paper with Roth. Roth suggested long cracks on Europa's surface, known as lineae, might be venting water vapor into space. Cassini has seen similar fissures that host Enceladus' jets.

The Hubble team found that the intensity of Europa's plumes, like that of Enceladus's plumes, varies with the moon's orbital position. Active jets have been seen only when Europa is farthest from Jupiter. But the researchers could not detect any sign of venting when Europa is closer to Jupiter.

One explanation for the variability is these lineae experience more stress as gravitational tidal forces push and pull on the moon and open vents at larger distances from Jupiter. The vents are narrowed or closed when the moon is closest to the gas giant planet.

"The apparent plume variability supports a key prediction that Europa should tidally flex by a significant amount if it has a subsurface ocean," said Kurt Retherford, also of Southwest Research Institute.

Europa's and Enceladus' plumes have remarkably similar abundances of water vapor. Because Europa has roughly 12 times more gravitational pull than Enceladus, the vapor, whose temperature is measured at minus 40 degrees Celsius, does not escape into space as it does at Enceladus. Instead, it falls back onto the surface after reaching an altitude of 125 miles, according to the Hubble measurements. This could leave bright surface features near the moon's south polar region, the researchers hypothesize.

"If confirmed, this new observation once again shows..." (Continued on page 8)
The Rise and Fall of Galactic Cities

In the fable of the town and country mice, the country mouse visits his city-dwelling cousin to discover a world of opulence. In the early cosmos, billions of years ago, galaxies resided in the equivalent of urban or country environments. Those that dwelled in crowded areas called clusters also experienced a kind of opulence, with lots of cold gas, or fuel, for making stars.

Today, however, these galactic metropolises are ghost towns, populated by galaxies that can no longer form stars. How did they get this way and when did the fall of galactic cities occur?

A new study from NASA's Spitzer Space Telescope finds evidence that these urban galaxies, or those that grew up in clusters, dramatically ceased their star-making ways about 9 billion years ago (our universe is 13.8 billion years old). These galactic metropolises either consumed or lost their fuel. Galaxies in the countryside, by contrast, are still actively forming stars.

"We know the cluster galaxies we see around us today are basically dead, but how did they get that way?" wondered Mark Brodwin of the University of Missouri-Kansas City, lead author of this paper, published in the Astrophysical Journal. "In this study, we addressed this question by observing the last major growth spurt of galaxy clusters, which happened billions of years ago."

Researchers studying distant galaxies get a peek into the past since the galaxies' light takes time, sometimes billions of years, to reach us. Brodwin and his colleagues used Spitzer to study 16 galaxy clusters that existed between the time our universe was 4.3 and 6 billion years old. Spitzer's infrared vision allows it see the dust warmed by new stars, revealing star-formation rates. NASA's Hubble Space Telescope and the W.M. Keck Observatory were used to measure the galaxies' distances from Earth.

This is one of the most comprehensive looks at distant galaxy clusters yet, revealing new surprises about their environments. Previous observations of relatively nearby clusters suggested that the urban, cluster galaxies produced all their stars early in the history of our universe in one big burst. This theory, called monolithic collapse, predicted that these tight-knit galaxies would have used all their fuel at once in an early, youthful frenzy. But the new study shows this not to be the (Continued on page 10)
This festive NASA Hubble Space Telescope image resembles a holiday wreath made of sparkling lights. The bright southern hemisphere star RS Puppis, at the center of the image, is swaddled in a gossamer cocoon of reflective dust illuminated by the glittering star. The super star is ten times more massive than our Sun and 200 times larger. RS Puppis rhythmically brightens and dims over a six-week cycle. It is one of the most luminous in the class of so-called Cepheid variable stars. Its average intrinsic brightness is 15,000 times greater than our Sun's luminosity.

The nebula flickers in brightness as pulses of light from the Cepheid propagate outwards. Hubble took a series of photos of light flashes rippling across the nebula in a phenomenon known as a "light echo." Even though light travels through space fast enough to span the gap between Earth and the Moon in a little over a second, the nebula is so large that reflected light can actually be photographed traversing the nebula. By observing the fluctuation of light in RS Puppis itself, as well as recording the faint reflections of light pulses moving across the nebula, astronomers are able to measure these light echoes and pin down a very accurate distance. The distance to RS Puppis has been narrowed down to 6,500 light-years (with a margin of error of only one percent). For an exquisite video created with the help of KU alumna Misty Cracraft, go to http://hubblesite.org/newscenter/archive/releases/2013/51/video/b/.

the power of the Hubble Space Telescope to explore and opens a new chapter in our search for potentially habitable environments in our solar system," said John Grunsfeld, an astronaut who participated in Hubble servicing missions and now serves as NASA's associate administrator for science in Washington, D.C. "The effort and risk we took to upgrade and repair the Hubble becomes all the more worthwhile when we learn about exciting discoveries like this one from Europa."
“At first, the discovery seemed bizarre,” comments Barlow. “With hot gas still expanding at high speeds after the explosion, a supernova remnant is a harsh, hostile environment, and one of the places where we least expected to find a noble-gas based molecule,” he adds. Argon hydride is produced when ions of argon (Ar+) react with hydrogen molecules (H₂), but these two species are usually found in different regions of a nebula. While ions form in the most energetic regions, where radiation from a star or stellar remnant ionizes the gas, molecules take shape in the denser, colder pockets of gas that are shielded from this powerful radiation.

“But we soon realised that even in the Crab Nebula, there are places where the conditions are just right for a noble gas to react and combine with other elements. There, in the transition regions between ionised and molecular gas, argon hydride can form and survive,” explains Barlow. This new picture was supported by the comparison of the Herschel data with observations of the Crab Nebula performed at other wavelengths, which revealed that the regions where they had found ArH⁺ also exhibit higher concentrations of both Ar⁺ and H₂. There, argon ions can react with hydrogen molecules forming argon hydride and atomic hydrogen. In the partly ionised gas filling these regions, molecules collide frequently with ions and free electrons. These collisions excite the molecular structure of ArH⁺ making it rotate; in turn, molecular rotations produce the emission features detected in the spectrum of the Crab Nebula by Herschel.

The discovery was truly serendipitous: we were observing the Crab Nebula to study its dust content. But then, on top of the emission from dust, we found two emission lines that had never been seen before,” says co-author Bruce Swinyard, also from University College London. The identification of these lines was a challenging task. To this end, the astronomers exploited two extensive databases of molecular spectra and, after lengthy investigation, they matched the observed features with two characteristic lines emitted by ArH⁺. “And there’s icing on the cake: from a molecule’s emission, we can determine the isotope of the elements that form it – something that we can’t do when we see only ions,” adds Swinyard. The Herschel data indicate that the argon hydride found in the Crab Nebula is made up of the argon isotope ³⁶Ar. This is the first time that astronomers could identify the isotopic nature of an element in a supernova remnant. “Finding that argon in the Crab Nebula consists of ³⁶Ar was not surprising because this is the dominant isotope of argon across the Universe. And it’s also the main argon isotope to be synthesized in the nuclear reactions during supernova explosions, so its detection in the Crab Nebula confirms that this iconic nebula was created by the explosive death of a massive star,” explains Barlow. The astronomers are planning further observations with other facilities to seek new emission lines in the Crab Nebula’s spectrum, possibly from molecules containing different isotopes of argon. The detection of such a molecule would enable them to study the ratio of different isotopes produced by supernovae and to learn more about the nuclear reactions that take place when a massive star dies.

"This is not only the first detection of a noble-gas based molecule in space, but also a new perspective on the Crab Nebula. Herschel has directly measured the argon isotope we expect to be produced via explosive nucleosynthesis in a core-collapse supernova, refining our understanding of the origin of this supernova remnant," concludes Göran Pilbratt, Herschel Project Scientist at ESA.
case: The urban galaxies continued to make stars longer than expected, until suddenly production came to a halt around 9 billion years ago, or about 3 billion years later than previously thought.

A second study using observations from the Herschel Space Observatory, led by Stacey Alberts at the University of Massachusetts-Amherst and published in the Monthly Notices of the Royal Astronomical Society journal, finds a similar transition epoch. Alberts and colleagues observed 300 clusters over a longer period of time, dating back to when the universe was 4 to 10 billion years old. Herschel, which ran out of coolant in April of 2013 as expected, detected longer wavelengths of infrared light than Spitzer, which is still up and running. The two telescopes complement each other, allowing scientists to confirm results and probe different aspects of cosmic conundrums.

"We find that around 9 billion years ago, cluster galaxies were as active as their counterparts outside of clusters; however, their rate of star formation decreases dramatically between then and now, much more quickly than we see in isolated galaxies," said Alberts.

Why do the urban galaxies shut down their star formation sooner and more rapidly than the country bumpkins? Brodwin says this may have to do with galaxy mergers. The more crowded a galactic environment, as is the case in young, growing galaxy clusters, the more often two galaxies will collide and merge. Galaxy mergers induce bursts of fuel-consuming star formation, and also feed growing supermassive black holes, which then blast out radiation that heats up the gas and quickly shuts off the star formation.

"It's as if boom times for galaxies in clusters ended with a sudden widespread collapse," said Peter Eisenhardt of NASA's Jet Propulsion Laboratory, Pasadena, Calif., who led a previous study that identified the distant galaxy cluster sample used by Brodwin and Alberts. "They go from vibrantly forming new stars to the quiescent state they've been in for the last half of the history of the universe, and the switch happens surprisingly fast."