**COMING EVENTS**

**Special Presentation**
**Sept. 04, 2014, 7:30 PM**
Dr. Paul Sorenson
Eldridge Extended
*From the Smallest to the Biggest*

**Club Meeting**
**Sept. 12, 2014, 7:30 PM**
2001 Malott
Dr. Ed Wiley
*Six days at Kitt Peak, A Pro-Am Adventure*

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**Volume 40 Number 09 SEPTEMBER 2014**

**Report from the Officers**

Hope everyone is finding the end of summer to be the transition to new and exciting Fall, whether you are still in school at any level or simply heading back to work after a great vacation. The Fall semester is opening with an active calendar of events for both the club and Physics and Astronomy at KU. First, note the event scheduled for this week on Thursday at the Eldridge Extended meeting hall (201 W. Eighth St.) downtown. The full poster for *From the Smallest to the Biggest: How Our Inward Search Sheds Light on the Earliest Moments of the Universe* can be found on pg. 5.

The first meeting of the AAL is now scheduled for **FRIDAY SEPTEMBER 12** (not 19), in 2001 Malott. Our guest speaker is Prof. Emeritus Ed Wiley, a dedicated and talented amateur astronomer who will regale us with his adventures as a telescope user at the national observatory at Kitt Peak outside Tucson. The poster for his talk is found on pg. 6.

On **Sunday, Sept. 28**, we will have our first public observing session at *Prairie Park Nature Center* south of Lawrence, starting at 9PM, weather permitting. Those interested in either setting up a scope or learning to use one should coordinate with Rick Heschmeyer, either by email or at the first meeting on Sept. 12.

Our annual **Cub Scout evening** is tentatively scheduled for **Friday, Oct. 17**. As usual, this will take place in Wescoe Hall and requires a significant degree of help in supplying observing stations for the 200 or so scouts and parents who normally attend. Please place this on your calendar and be prepared to respond when the call is made. (Continued on page 2)

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**Of Local Interest**

In addition to providing an informative talk at the first monthly meeting in September, Dr. Ed Wiley also has an offer to those of you who still make use of magazines in an ancient format called paper. Dr. Wiley is staging a move from Lawrence and has almost 8 years worth of both *Sky and Telescope* magazine and *Astronomy* magazine. Rather than throwing them out, Ed is making them available first to anyone who is interested in contacting him and coming by to pick them up. If you have an interest, Dr. Wiley can be reached at edwiley@sunflower.com.
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 rcbm@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/ . We will let you know if this changes in the future. 

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

Anna Loves Science

“Everyone Loves Science,” encourages community members to have fun with science and not be intimidated by it. The event is designed for attendees to ask questions and participate. Physics professor Mats Selen will lead hands-on, educational physics activities designed to engage attendees and improve learning. Selen and his colleagues at the University of Illinois developed these programs as part of student outreach efforts, showcasing the fun of science through a Physics Van.

As noted last month, if you attempted to access the club web site recently, you may have come to a dead end. The KU Club and Organizations administration last month dropped all club web sites from their server. Our temporary home for now is http://www.physics.ku.edu/aal/. We will let you know if this changes in the future.

About the Astronomy Associates of Lawrence

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Copies of the Celestial Mechanic can also be found on the web at http://www.physics.ku.edu/aal/celestialmechanic
NASA's Hubble Finds Supernova Star System Linked to Potential 'Zombie Star'

Astronomers using NASA's Hubble Space Telescope for the first time have spotted a star system that later produced an unusual supernova explosion of a white dwarf, the stripped-down core of an ordinary star at the end of its life.

Examining archived Hubble images taken before the supernova, astronomers say they have detected the blue companion star of the white dwarf. The white dwarf slowly siphoned fuel from its companion, eventually igniting a runaway nuclear reaction in the dead star, and producing a weak supernova blast.

This particular supernova is classified as a Type Iax, a recently identified class of stellar explosion. These exploding stars are less energetic and fainter than Type Ia supernovae, which also originate from exploding white dwarfs in binary systems. Astronomers originally thought these weaker stellar blasts were unique Type Ia supernovae. So far, they have identified more than 30 of these mini-explosions, which occur at one-fifth the rate of Type Ia supernovae.

"Astronomers have been searching for decades for the progenitors of Type Ia's," said Saurabh Jha of Rutgers University in Piscataway, New Jersey. "Type Ia's are important because they're used to measure vast cosmic distances and the expansion of the universe. But we have very few constraints on how any white dwarf explodes. The similarities between Type Iax's and normal Type Ia's make understanding Type Iax progenitors important, especially because no Type Ia progenitor has been conclusively identified. This discovery shows us one way that you can get a white dwarf explosion."

The inset panel is a pair of Hubble Space Telescope images of the spiral galaxy NGC 1309 that were taken before and after the appearance of Supernova 2012Z, in the outskirts of the galaxy. The white X-shaped feature at the top of the image of the galaxy marks the location of the supernova. The stellar blast is a member of a unique class of supernova called Type Iax. These supernovae are less energetic, and hence fainter, on average, than their well-known cousins, Type Ia supernovae, which also originate from exploding white dwarfs in binary systems.

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When you think about gravitation here on Earth, you very likely think about how constant it is, at 9.8 m/s² (32 ft/s²). Only, that's not quite right. Depending on how thick the Earth's crust is, whether you’re slightly closer to or farther from the Earth's center, or what the density of the material beneath you is, you'll experience slight variations in Earth's gravity as large as 0.2%, something you'd need to account for if you were a pendulum-clock-maker.

But surprisingly, the amount of water content stored on land in the Earth actually changes the gravity field of where you are by a significant, measurable amount. Over land, water is stored in lakes, rivers, aquifers, soil moisture, snow and glaciers. Even a change of just a few centimeters in the water table of an area can be clearly discerned by our best space-borne mission: NASA's twin Gravity Recovery and Climate Experiment (GRACE) satellites.

Since its 2002 launch, GRACE has seen the water-table-equivalent of the United States (and the rest of the world) change significantly over that time. Groundwater supplies are vital for agriculture and provide half of the world's drinking water. Yet GRACE has seen California's central valley and the southern high plains rapidly deplete their groundwater reserves, endangering a significant portion of the nation's food supply. Meanwhile, the upper Missouri River Basin—recently home to severe flooding—continues to see its water table rise.

NASA's GRACE satellites are the only pieces of equipment currently capable of making these global, precision measurements, providing our best knowledge for mitigating these terrestrial changes. Thanks to GRACE, we've been able to quantify the water loss of the Colorado River Basin (65 cubic kilometers), add months to the lead-time water managers have for flood prediction, and better predict the impacts of droughts worldwide. As NASA scientist Matthew Rodell says, "[W]ithout GRACE we would have no routine, global measurements of changes in groundwater availability. Other satellites can't do it, and ground-based monitoring is inadequate." Even though the GRACE satellites are nearing the end of their lives, the GRACE Follow-On satellites will be launched in 2017, providing us with this valuable data far into the future. Although the climate is surely changing, it's water availability, not sea level rise, that's the largest near-term danger, and the most important aspect we can work to understand!

Learn more about NASA's GRACE mission here: http://www.nasa.gov/mission_pages/Grace/

Kids can learn all about launching objects into Earth's orbit by shooting a (digital) cannonball on NASA's Space Place website. Check it out at: http://spaceplace.nasa.gov/how-orbits-work/
From the Smallest to the Biggest: How Our Inward Search Sheds Light on the Earliest Moments of the Universe

Dr. Paul Sorensen
Brookhaven National Laboratory
Upton, New York

Thursday, September 4, 2014
7:30 p.m.
Eldridge Extended Bliss Room
201 W. 8th Street
Lawrence, KS

Presentation Abstract:
One hundred years ago, we discovered that almost all our mass is contained inside tiny, extremely dense, nuclei at the center of the atoms from which we are made. Twenty years later, we discovered that the universe is expanding and distant galaxies are flying away from us through vast swathes of nearly empty space. Over the last 80 years, scientists have gazed out the furthest reaches of the cosmos and probed deeply into the smallest building blocks of matter. Find out how these two directions converge in the huge particle colliders where nuclei are smashed into each other to recreate tiny droplets of matter that only existed in the very earliest moments of the expansion of the universe.

About Dr. Paul Sorensen:
Dr. Paul Sorensen has made important contributions studying nuclear collisions and the phases of the Quark Gluon Plasma, as part of the STAR Collaboration. The nuclear collisions are generated by physicists as they attempt to recreate the matter that existed in the universe one millionth of a second after the Big Bang. They do so by smashing together beams of heavy ions moving at nearly the speed of light in Brookhaven’s world-class accelerator, the Relativistic Heavy Ion Collider (RHIC). The matter that they create behaves like a “perfect” liquid — having almost no viscosity or frictional resistance to flow. After earning a B.S. in physics from the University of Nebraska – Lincoln, in 1996, Dr. Sorensen went on to earn an M.S. and a Ph.D. in physics, both from the University of California, Los Angeles, in 1999 and 2003, respectively. He was a postdoctoral researcher at the Lawrence Berkeley National Laboratory for two years before joining Brookhaven Lab in 2005 as a Goldhaber Distinguished Fellow. In 2008, he became an associate physicist at Brookhaven. He received the 2009 George E. Valley Jr. Prize from the American Physical Society (APS). Dr. Sorensen is committed to Education and Outreach activities. In 2011, he became a member of the Steering Committee for the Alan Alda Center for Communicating Science. Since 2012, Dr. Sorensen has served as the Chair of the RHIC Users Executive Committee.

Department of Physics and Astronomy Public Lecture
For more information: http://physics.ku.edu  785-864-4626  physics@ku.edu
ASTRONOMY ASSOCIATES of LAWRENCE

Dr. Edward O. Wiley

Prof. Emeritus, EEB, University of Kansas

Friday, Sept. 12, 2014
7:30 PM, 2001 Malott

SIX DAYS at KITT PEAK:
A PRO-AM ADVENTURE

Free and Open to the Public
The weak supernova, dubbed SN 2012Z, was found in the Lick Observatory Supernova Search in January 2012. Fortuitously, Hubble’s Advanced Camera for Surveys also observed the supernova’s host galaxy, NGC 1309, in 2005, 2006, and 2010, before the supernova outburst. NGC 1309 resides 110 million light-years away. Curtis McCully, a graduate student at Rutgers and lead author of the team’s paper, reprocessed the pre-explosion images to make them sharper and noticed an object at the supernova’s position. “I was very surprised to see anything at the supernova’s location. We expected that the progenitor system would be too faint to see, like in previous searches for normal Type Ia supernova progenitors. It is exciting when nature surprises us,” McCully said.

The likelihood that the object detected was just a chance alignment unrelated to the supernova is less than one percent. After studying the object’s colors and computer simulations showing possible Type Iax progenitor systems, the team concluded that what they were seeing was most likely the light of a star that had lost its outer hydrogen envelope, revealing its helium core.

“Back in 2009, when we were just starting to understand this class, we predicted that these supernovae were produced by a white dwarf and helium star binary system,” said team member Ryan Foley of the University of Illinois at Urbana-Champaign, who helped identify Type Iax supernovae as a new class. “There’s still a little uncertainty with this Hubble study, but it is essentially validation of our claim.”

According to the team, one possible scenario for the oddball star system predicts that a seesaw game ensues between the stars, with each star donating mass to the other. The stars originally weighed about seven and four times that of our Sun, respectively. The more massive seven-solar-mass star evolves quickly, dumping its hydrogen and helium onto its smaller companion. Now slimmed down to just one solar mass, the once-more massive star is left with a carbon and oxygen core, becoming a white dwarf. The companion star, which began with just four solar masses, is now bulked up and begins to evolve quickly, growing larger and engulfing the white dwarf. The outer layers of this “combined” star are ejected, leaving behind the white dwarf and the two-solar-mass helium core of the companion star. The white dwarf is still siphoning matter from its partner until it becomes unstable and explodes as a mini-supernova, ejecting about half a solar mass of material.

Unlike a normal Type Ia supernova, which destroys its white dwarf, the explosion of a Type Iax is thought to leave behind a battered and bruised white dwarf. Since this dead star comes back to life as it explodes, astronomers have nicknamed it a “zombie star.” The team acknowledges that they can’t totally rule out other possibilities for the object’s identity, including the possibility that it was simply a single, massive star that exploded as a supernova. To settle those uncertainties and confirm their hypothesis, the team plans to use Hubble again in 2015 to observe the area when the supernova’s light has dimmed enough to show any possible zombie star and helium companion.

The astronomers already have seen the aftermath of one Type Iax supernova blast. Hubble images taken of supernova 2008ha in January 2013, more than four years after it exploded, show an object at the supernova’s location. The supernova resides in the galaxy UGC 12682, located 69 million light-years away. The object could be either the zombie remnant star or the companion. Based on the object’s colors, the team suggests in a separate paper that the star is the companion, weighing more than three solar masses. It is significantly less luminous and redder than the SN 2012Z progenitor system. The findings will be published in the Aug. 11 issue of The Astrophysical Journal.

“SN 2012Z is one of the more powerful Type Iax supernovae and SN 2008ha is one of the weakest of the class, showing that Type Iax systems are very diverse,” explained Foley, the SN 2008ha paper’s lead author. “And perhaps that diversity is related to how each of these stars explodes. Because these supernovae don’t destroy the white dwarf completely, we surmise that some of these explosions eject a little bit and some eject a whole lot.”

The astronomers hope their new findings will spur the development of improved models for these white dwarf explosions and a more complete understanding of the relationship between Type Iax and normal Type Ia supernovae and their progenitors.

We not only witnessed what appears to be the wreckage of a huge smashup, but have been able to track how it is changing -- the signal is fading as the cloud destroys itself by grinding its grains down so they escape from the star,” said Kate Su of the University of Arizona and co-author on the study. “Spitzer is the best telescope for monitoring stars regularly and precisely for small changes in infrared light over months and even years.”

A very thick cloud of dusty debris now orbits the star in the zone where rocky planets form. As the scientists observe the star system, the infrared signal from this cloud varies based on what is visible from Earth. For example, when the elongated cloud is facing us, more of its surface area is exposed and the signal is greater. When the head or the tail of the cloud is in view, less infrared light is observed. By studying the infrared oscillations, the team is gathering first-of-its-kind data on the detailed process and outcome of collisions that create rocky planets like Earth.
NASA's WISE Findings Poke Hole in Black Hole 'Doughnut' Theory

A survey of more than 170,000 supermassive black holes, using NASA's Wide-field Infrared Survey Explorer (WISE), has astronomers reexamining a decades-old theory about the varying appearances of these interstellar objects.

The unified theory of active, supermassive black holes, first developed in the late 1970s, was created to explain why black holes, though similar in nature, can look completely different. Some appear to be shrouded in dust, while others are exposed and easy to see.

The unified model answers this question by proposing that every black hole is surrounded by a dusty, doughnut-shaped structure called a torus. Depending on how these "doughnuts" are oriented in space, the black holes will take on various appearances. For example, if the doughnut is positioned so that we see it edge-on, the black hole is hidden from view. If the doughnut is observed from above or below, face-on, the black hole is clearly visible.

However, the new WISE results do not corroborate this theory. The researchers found evidence that something other than a doughnut structure may, in some circumstances, determine whether a black hole is visible or hidden. The team has not yet determined what this may be, but the results suggest the unified, or doughnut, model does not have all the answers.

"Our finding revealed a new feature about active black holes we never knew before, yet the details remain a mystery," said Lin Yan of NASA's Infrared Processing and Analysis Center (IPAC), based at the California Institute of Technology in Pasadena. "We hope our work will inspire future studies to better understand these fascinating objects."

Yan is the second author of the research accepted for publication in the Astrophysical Journal. The lead author is post-doctoral researcher, Emilio Donoso, who worked with Yan at IPAC and has since moved to the Instituto de Ciencias Astronómicas, de la Tierra y del Espacio in Argentina. The research also was co-authored by Daniel Stern

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THE MOST PRECISE MEASUREMENT YET OF THE DISTANCE TO THE PLEIADES STAR CLUSTER IS REVIVING A DISPUTE THAT HAS SPLIT THE ASTRONOMY COMMUNITY LARGELY DOWN A TRANS-ATLANTIC DIVIDE FOR THE PAST 17 YEARS.

The latest result, from a US team using a worldwide network of radio telescopes, is in good agreement with more than a dozen previous measurements to the Pleiades, made using multiple techniques. But it stands in sharp contrast to a figure from the Hipparcos satellite of the European Space Agency (ESA). The authors of the latest study, published today in Science, say they believe that the Hipparcos measurement is an error, and worry that the same problem could affect its successor mission, ESA’s Gaia space telescope, which began taking data last month. The alternative is even less appealing: if Hipparcos is right, then accepted theories of the physics of stars could require some mending.

Using radio telescopes including the Very Long Baseline Array, the US team exploited the physics of electromagnetic waves to operate the instruments as one giant, precise, Earth-sized telescope. They calculated the distance to the Pleiades cluster by watching five of its stars (two of them forming a binary system) over a period of 18 months. They calculated the cluster’s distance by watching four of its stars appear to shift ever-so-slightly in the sky as the Earth orbited the Sun, in a modern twist to the centuries-old parallax method. The less those stars shifted relative to the background — defined by a galaxy so distant it doesn’t appear to move at all — the farther away they were.

The team got a result of 136.2 parsecs (444.2 light years), concurring with nearly all previous estimates. But the Hipparcos result puts the cluster 16 parsecs closer to Earth. The uncertainties of both measurements are less than two parsecs.

Much rides on the debate. The Pleiades cluster is made of young stars, only 100 million years old, and visible to the naked eye in the Taurus constellation. Many of the consensus measurements were made using the apparent brightness of the stars, and compared that with their intrinsic brightness based on models of their stellar burning processes. This means that if the Hipparcos distance is correct, it challenges scientists’ understanding of young stars — and everything that happens to them afterwards, including the fate of their planetary systems, says Carl Melis, an astronomer at the University of California in San Diego and the study’s first author. “If we don’t understand young stars, we’re kind of hosed.”

That could very well be the case, says astronomer Floor van Leeuwen at the University of Cambridge, UK, who was a member of the Hipparcos science team and stands firmly behind its results. Hipparcos surveyed almost 120,000 stars two decades ago to generate a three-dimensional map of the skies. Published in 1997, that map is still the most complete stellar survey of its kind.

Van Leeuwen singles out the physics of convection in the stars’ outer layers as an area of uncertainty that could have thrown off previous results.

David Soderblom, an astronomer at the Space Telescope Science Institute in Baltimore, Maryland, commends the Hipparcos efforts but questions its results, given the countervailing consensus. “They have done, by any measure, the best job humanly possible on their data,” says Soderblom, who obtained one of the previous Pleiades distances using the

(Continued on page 10)
at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, and Roberto Assef of Universidad Diego Portales in Chile and formerly of JPL.

Every galaxy has a massive black hole at its heart. The new study focuses on the "feeding" ones, called active, supermassive black holes, or active galactic nuclei. These black holes gorge on surrounding gas material that fuels their growth. With the aid of computers, scientists were able to pick out more than 170,000 active supermassive black holes from the WISE data. They then measured the clustering of the galaxies containing both hidden and exposed black holes -- the degree to which the objects clump together across the sky.

If the unified model was true, and the hidden black holes are simply blocked from view by doughnuts in the edge-on configuration, then researchers would expect them to cluster in the same way as the exposed ones. According to theory, since the doughnut structures would take on random orientations, the black holes should also be distributed randomly. It is like tossing a bunch of glazed doughnuts in the air -- roughly the same percentage of doughnuts always will be positioned in the edge-on and face-on positions, regardless of whether they are tightly clumped or spread far apart.

But WISE found something totally unexpected. The results showed the galaxies with hidden black holes are more clumped together than those of the exposed black holes. If these findings are confirmed, scientists will have to adjust the unified model and come up with new ways to explain why some black holes appear hidden.

"The main purpose of unification was to put a zoo of different kinds of active nuclei into a single umbrella," said Donoso. Now, that has become increasingly complex to do as we dig deeper into the WISE data."

Another way to understand the WISE results involves dark matter. Dark matter is an invisible substance that dominates matter in the universe, outweighing the regular matter that makes up people, planets and stars. Every galaxy sits in the center of a dark matter halo. Bigger halos have more gravity and, therefore, pull other galaxies toward them.

Because WISE found that the obscured black holes are more clustered than the others, the researchers know those hidden black holes reside in galaxies with larger dark matter halos. Though the halos themselves would not be responsible for hiding the black holes, they could be a clue about what is occurring.

"The unified theory was proposed to explain the complexity of what astronomers were seeing," said Stern. "It seems that simple model may have been too simple. As Einstein said, models should be made 'as simple as possible, but not simpler.'"

Scientists still are actively combing public data from WISE, put into hibernation in 2011 after scanning Earth's entire sky twice. WISE was reactivated in 2013, renamed NEOWISE, and given a new mission to identify potentially hazardous near-Earth objects.

Hubble Space Telescope. "But I'm pretty confident they're wrong."

Melis and Soderblom say that if a systematic error skewed the Hipparcos measurements, a similar gremlin could also bedevil ESA's Gaia space telescope, which was due to begin taking data last month. It will use similar techniques to map the distances to roughly a billion stars in our Galaxy over the next five years.

Hipparcos used the same parallax method, but its cameras, built using 1970s technology, could not detect background galaxies for reference. Instead, it checked all of its surveyed stars against every other star in its 118,000-strong catalogue, a monumental task that required two independent teams to verify each other's work.

Gaia, however, is sensitive enough to use distant galaxies as reference points. "Whether that's going to save them from whatever caused the Pleiades error, I'm not really sure," says Melis.

Soderblom proposes that the Hipparcos data may have been thrown off by bright stars that overwhelmed the detector — an idea that van Leeuwen rejects because of Hipparcos' internal consistency.

Both sides acknowledge that the divide tends to fall between the US and European communities. "Ultimately, the controversy would evaporate immediately if members of the European community, especially Hipparcos team members, were willing to admit that their distance wasn't right," Melis says.

Van Leeuwen says, "Everyone relies on [Hipparcos], everyone trusts it — except for the people who are looking at the Pleiades in the States." He stresses that it is a scientific debate, but says he feels that some astronomers are not listening. "If you don't produce that kind of answer, you're persona non grata."