Calendar of Events

September Meeting:
Friday, Sept. 16
1001 Malott, 7:30 PM
Wading in the Tidal Streams of the Milky Way
Bruce Twarog, KU
PUBLIC OBSERVING
Sunday Sept. 25
8:30PM, Memorial Stadium
October Event
Special Lecture:
Mon. Oct 24, 7:30 PM
Alderson Auditorium
Dr. Jim Kasting, Penn State
Early Earth: Climate & Life

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From the Officers
Report From the Officers on the August Meeting:

This should be easy because we had no official meeting in August; instead people were encouraged to attend the national ALCON Convention in Kansas City. Despite the rains that sometimes amounted to torrential downpours, the ALCON meeting was very impressive. There was a wide array of speakers from all over the country, as well as a long list of commercial vendors hawking their wares to enthusiastic amateurs. Amateur astronomy can be an extremely expensive hobby if one takes advantage of all the technology available for even modest size telescopes. Speakers included Mike Bakich, a nationally-known planetarium director who is also an associate editor for Astronomy magazine, Wayne (Mr. Galaxy) Johnson, amateur Chair of the Western Region Astronomical League, Lou Mayo, a planetary scientist working at NASA Goddard, and Mike Bennett, Executive Director of the Astronomical Society of the Pacific, among others. Topics ranged from the Death of Amateur Astronomy to the Cassini Space Probe to the Importance of Public Outreach. Outdoor events, heavily affected by the weather, included a Star-B-que and tour of the Powell Observatory in Louisburg, KS owned by the Astronomical Society of Kansas City.

Speaking of observing, the schedule of dates is now set for the Fall semester of public observing at Memorial Stadium. As happens far too often in Kansas, our first attempt on Sunday August 28 was rained out, but we will try again in Sept. on Sunday the 25th. If you have an interest in some stellar viewing or just want to help out, feel free to come by. If the latter is the case, as always, contact Bruce Twarog at btwarog@ku.edu so we know who will be available to help. The schedule for the rest of the year is on the AAL website and includes Sunday, Oct. 30 and Sunday Dec. 04, 2005. The date in December is designed to avoid the Thanksgiving holiday that conflicts with the last Sunday in Nov. Mark your calendars.

(Continued on page 2)
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 on Memorial Stadium. Periodic star parties are scheduled as well. For more information, please contact the club officers: Hannah Swift at hswift@ku.edu, Gary Webber at gwebber@ku.edu, our faculty advisor, Prof. Bruce Twarog at btwarog@ku.edu, or our events coordinator, Rick Heschmeyer at rcjbm@sbcglobal.net. Because of the flexibility of the schedule due to holidays and alternate events, it is always best to check the Web site for the exact Fridays and Sundays when events are scheduled. The information about AAL can be found at http://www.ku.edu/~aal.

Copies of the Celestial Mechanic can also be found on the web at http://www.ku.edu/~aal/celestialmechanic.
Scientists have shown Earth's core spins faster than its surface, proving a long-suspected notion that our planet's interior rotates more like a fluid than a solid. The speed-up, somewhere between 0.3º and 0.5º per year, is small but real.

Xiaodong Song, a geology professor at the University of Illinois, Urbana-Champaign, and Paul Richards of Columbia University's Lamont-Doherty Earth Observatory presented the first evidence for Earth's fluid-like, or differential, rotation in 1996. But some seismologists, suspecting limitations in the data created the appearance of motion, weren't convinced.

The new study by Song, Richards, and colleagues, published today in the journal Science, ends this debate. "Extraordinary claims require extraordinary proof," says Song. "We believe we have that proof."

Earth's iron core consists of two layers: a solid inner core about 1,500 miles (2,400 kilometers) across and a fluid outer core about 4,350 miles (7,000 km) wide.

The team compared seismic waves from historical earthquakes that traversed Earth's fluid and solid cores over the last 35 years. The researchers examined 17 sets of similar seismic waves — called waveform doublets — from earthquakes occurring in the South Sandwich Islands region off the coast of South America.

The doublets, which were recorded at 58 seismic stations in and near Alaska, allowed the scientists to detect time delays experienced by the waves as they passed through Earth. These delays provide compelling evidence for differential rotation of the solid inner core.

"The similar seismic waves that passed through the inner core show systematic changes in travel times and wave shapes when the two events of the doublet are separated in time by several years," Song explains. "The only plausible explanation is a motion of the inner core."

The most likely explanation for why the inner core rotates at a different speed, Song says, is electromagnetic coupling.

The inner core plays an important role in driving the dynamo that generates Earth's magnetic field. "The magnetic field generated in the outer core diffuses into the inner core, where it generates an electric current," he explains.

The team suggests some sort of electromagnetic twist created by the geodynamo forces the inner core to spin relative to Earth's mantle and crust. "The interaction of that electric current with the magnetic field causes the inner core to spin, like the armature in an electric motor," Song says.

The fluid outer core creates little frictional drag, insulating the solid inner core from the motion of Earth's mantle.

"Differential rotation is a fundamental dynamic process that goes to the heart of the origin of our planet and how it has evolved," Song says. "There is still much to learn about the inner Earth."
Starbirth Reconsidered
By Ker Than, space.com

The most massive stars in our galaxy formed in a process much like that which created our Sun, and not by cannibalizing young, small stars as previously thought, according to a new study.

The stars in question are giants among giants, massive stars that weigh as much as 100 small stars like the Sun, but because they are so rare and evolve so quickly, scientists were unsure how they achieved their colossal girths.

One popular theory was that they swallowed small immature stars called protostars in crowded stellar nurseries, but astronomers recently caught a massive star in the act of being born. Observations suggest it is developing through gravitational collapse, the same gradual process that built the Sun.

Using a radio telescope called the Submillimeter Array (SMA) in Hawaii, astronomers detected a gaseous disk surrounding the massive protostar HW2, located 2,000 light years away in the Cepheus constellation.

The disk contains 1 to 8 times as much gas as the Sun and extends outward for more than 30 billion miles, eight times the distance to Pluto. Earth and the other planets in our solar system are believed to have formed from such a disk 4.5 billion years ago.

Astronomers also detected jets of bipolar gas spewing out from both ends of the HW2's circumstellar disk, a phenomenon previously observed only in the formation of low-mass stars like the Sun.

"Merging low-mass protostars wouldn't form a circumstellar disk and a bipolar jet," said Salvador Curiel, an astronomer at the National Autonomous University of Mexico (UNAM) and an author of the study.

If the cannibalizing theory of massive star formation were true, the spewing gas jets and the circumstellar disk would be destroyed as additional stars were swallowed, Curiel said.

John Dobson turns 90
The AAVSO Discussion list appears a bit quiet, so may I mention this past weekend (Aug 27) was Mr. Dobson's 90th birthday? While not an active variable star observer, I think most would agree he has probably done more for popular astronomy in general than anyone. I wonder how many amateurs and professionals got their start in some way due to Mr. Dobson's influence? The AANC hosted a major birthday party at the Randall Museum in San Francisco. Some highlights: SF Mayor Gavin Newsom proclaimed Aug 27 "John Dobson Day". "Valley of the Dobs" featured some of the SF Sidewalk astronomer's original scopes (which were laughed out of RTMC at their debut, but now have taken over amateur astronomy!) Showing of the first full-length documentary film about Dobson "A Sidewalk Astronomer", followed by a lively question and answer session with Mr. Dobson fielding questions from the audience, ranging from intelligent life in the Universe to refuting the Big Bang and String theory! I have placed some photos from the event here - http://pg.photos.yahoo.com/ph/mlinnolt/album?dir=f0ce&src=ph&tok=phHRkiDBR8N9v9X1. I hope we can look forward to his 100th celebration! Mike Linnolt
The Astronomy Associates of Lawrence present

WADING in the TIDAL STREAMS of the MILKY WAY

Dr. Bruce Twarog
KU, Physics & Astronomy

FRIDAY, SEPTEMBER 16, 2005
7:30 PM, 1001 Malott Hall
University of Kansas
FREE & OPEN TO THE PUBLIC
The Celestial Mechanic

Seeing the Milky Way Take Shape
By Lisa R. Johnston, Skypub.com

When astronomers try to determine the shape of our galaxy, they don't see a giant spiral disk elegantly wrapping its arms around a central glowing bulge — they just see lots of stars in all directions. Given our less-than-advantageous location within the galactic disk, the only way to derive the galaxy's shape is to reconstruct the Milky Way from the inside out. Astronomers have previously noted that the mass of stars near the galactic center appear fatter on the northernmost side. Observations have since concluded that our galaxy has a central bar. Following a recent examination of our galaxy's interior, it seems that the Milky Way's backbone is longer than we thought.

Paying close attention to how certain types of stars are grouped together, a team lead by Robert Benjamin (University of Wisconsin-Whitewater) reviewed the Spitzer Space Telescope's infrared star catalog, the Galactic Legacy Mid-Plane Survey Extraordinaire (GLIMPSE). Designed to study the interior configuration of our home galaxy, GLIMPSE lists nearly 30 million stars in the galactic plane. "What we noticed is one half of the galactic center [contains] 25 percent more stars then the other half," says Ed Churchwell (University of Wisconsin-Madison), coauthor of the team's upcoming paper in Astrophysical Journal Letters.

Spitzer's infrared camera sorted out the older red carbon stars (M giants and late K stars) that shine brightly in the infrared starlight from the opaque glow of countless stars near the galaxy's core. "Once you know what kind of stars populate the bar," says Churchwell, "the shape just jumps out at you."

By knowing the shape and orientation of the long stellar bar jutting through the Milky Way's center and by using other barred-spiral galaxies as examples, scientists can create an artistic rendering of what our galaxy should look like. "Barred spirals look as if their arms originate from the tip of the bar — this should be the case for the Milky Way," says Churchwell, who helped Spitzer Science Center illustrator Robert Hurt draft the pictorial view of our galaxy shown above. The new results imply that the bar is a thin strip of stars spanning roughly 29,000 light-years in length and oriented 45° to the line that connects the Sun and the galactic center (about 28,000 light-years away). The bar is more than one-fourth the diameter of the galactic disk, which is approximately 100,000 light years across. Astronomers previously believed the bar was only about 15,000 light-years long.

"The bar appears a little longer than we thought and this is pretty important for star formation," says Churchwell. The longer bar may help explain how material is transported into the galactic center, where it can induce star formation. This idea could solve a problem in galactic dynamics: how do clusters of massive stars form in the chaotic central bulge — an unlikely place for a fairly new population of stars. "There are strong tidal forces at work in the galactic center," says Churchwell. "How did this material get in there, and how did it condense into stars?" The stability of a narrow bar as a long-term feature of the galaxy will help astronomers understand the dynamics that allow for this to happen.
Elusive Planet Reshapes a Ring Around Neighboring Star
HST Press Release

NASA Hubble Space Telescope’s most detailed visible-light image ever taken of a narrow, dusty ring around the nearby star Fomalhaut (HD 216956), offers the strongest evidence yet that an unruly and unseen planet may be gravitationally tugging on the ring.

Hubble unequivocally shows that the center of the ring is a whopping 1.4 billion miles (15 astronomical units) away from the star. This is a distance equal to nearly halfway across our solar system. The most plausible explanation, astronomers said, is that an unseen planet moving in an elliptical orbit is reshaping the ring with its gravitational pull. The geometrically striking ring, tilted obliquely toward Earth, would not have such a great offset if it were simply being influenced by Fomalhaut’s gravity alone.

An offset of the ring center from the star has been inferred from previous and longer wavelength observations using submillimeter telescopes on Mauna Kea, Hawaii, the Spitzer Space Telescope, Caltech’s Submillimeter Observatory and applying theoretical modeling and physical assumptions. Now Hubble’s sharp images directly reveal the ring’s offset from Fomalhaut. These new observations provide strong evidence that at least one unseen planetary mass object is orbiting the star. Hubble would have detected an object larger than a planet, such as a brown dwarf. “Our new Hubble images confirm those earlier hypotheses that proposed a planet was perturbing the ring,” said Paul Kalas of the University of California at Berkeley. The ring is similar to our solar system’s Kuiper Belt, a vast reservoir of icy material left over from the formation of our solar system planets.

The observations offer insights into our solar system’s formative years, when the planets played a game of demolition derby with the debris left over from the formation of our planets, gravitationally scattering many objects across space. Some icy material may have collided with the inner solar system planets, irrigating them with water formed in the colder outer solar system. Other debris may have traveled outward, forming the Kuiper Belt and the Oort Cloud, a spherical cloud of material surrounding the solar system.

Only Hubble has the exquisite optical resolution to resolve that the ring’s inner edge is sharper than its outer edge, a telltale sign that an object is gravitationally sweeping out material like a plow clearing away snow. Another classic signature of a planet’s influence is the ring’s relatively narrow width, about 2.3 billion miles (25 astronomical units). Without an object to gravitationally keep the ring material intact, astronomers said, the particles would spread out much wider.

“What we see in this ring is similar to what is seen in the Cassini spacecraft images of Saturn’s narrow rings. In those images, Saturn’s moons are ‘shepherding’ the ring material and keeping the ring from spreading out,” Kalas said.

The suspected planet may be orbiting far away from Fomalhaut, inside the dust ring’s inner

(Continued on pg. 8)
edge, between 4.7 billion and 6.5 billion miles (50 to 70 astronomical units) from the star. The ring is
12 billion miles (133 astronomical units) from Fomalhaut, which is much farther away than our outer-
most planet Pluto is from the Sun. These Hubble observations do not detect the putative planet di-
rectly, so the astronomers cannot measure its mass. They will, instead, conduct computer simulations
of the ring's dynamics to estimate the planet's mass.

Kalas and collaborators James R. Graham of the University of California at Berkeley and Mark
Clampin of the NASA Goddard Space Flight Center in Greenbelt, Md., will publish their findings in the

Fomalhaut, a 200-million-year-old star, is a mere infant compared to our own 4.5-billion-year-old Sun.
It resides 25 light-years away from the Sun. Located in the constellation Piscis Austrinus (the Southern
Fish), the Fomalhaut ring is ten times as old as debris disks seen previously around the stars AU Mi-
croscopii and Beta Pictoris, where planets may still be forming. If our solar system is any example,
planets should have formed around Fomalhaut within tens of millions of years after the birth of the star.
The Hubble images also provide a glimpse of the outer planetary region surrounding a star other than
our Sun. Many of the more than 100 planets detected beyond our solar system are orbiting close to
their stars. Most of the current planet-detecting techniques favor finding planets that are close to their
stars.

"The size of Fomalhaut's dust ring suggests that not all planetary systems form and evolve in the same
way — planetary architectures can be quite different from star to star," Kalas explained. "While Fom-
alhaut's ring is analogous to the Kuiper Belt, its diameter is four times greater than that of the Kuiper
Belt."

The astronomers used the Advanced Camera for Surveys' (ACS) coronagraph aboard Hubble to block
out the light from the bright star so they could see details in the faint ring.

"The ACS's coronagraph offers high contrast, allowing us to see the ring's structure against the ex-
tremely bright glare from Fomalhaut," Clampin said. "This observation is currently impossible to do at
visible wavelengths without the Hubble Space Telescope. The fact that we were able to detect it with
Hubble was unexpected, but impressive."

Kalas and his collaborators used Hubble over a five-month period in 2004 — May 17, Aug. 2, and Oct.
27 — to map the ring's structure. One side of the ring has yet to be imaged because it extended be-
yond the ACS camera's field of view. The astronomers will use Hubble again this summer to map the
entire ring. They expect that the additional Hubble data will reveal whether or not the ring has any
gaps, which could have been carved out by the gravitational influence of an unseen body. The longer,
deeper exposures also may show whether the ring has an even wider diameter than currently seen. In
addition, the astronomers will measure the ring's colors to determine its physical properties, including
its composition.

Previous thermal emission maps of Fomalhaut showed that one side of the ring is warmer than the
other side, implying that the ring is off center by about half the distance measured by Hubble. This dif-
ference might be explained by the fact that Hubble's ACS images of the ring's structure are 100 times
sharper than the longer wavelength observations, and hence, yield a much more accurate result. Or
the discrepancy might imply that the ring's size looks different at other wavelengths.

Fomalhaut's dust ring was discovered in 1983 in observations made by NASA's Infrared Astronomical
Satellite (IRAS). The system is a compelling target for future telescopes such as the James Webb
Space Telescope and the Terrestrial Planet Finder, Kalas said.
Picture this: Eighty-eight million miles from Earth, a robot spacecraft plunges into a billowing cloud almost as wide as the planet Jupiter. It looks around. Somewhere in there, among jets of gas and dust, is an icy nugget invisible to telescopes on Earth—a 23,000 mph moving target. The ship glides deeper into the cloud and jettisons its cargo, the “impactor.” Bulls-eye! A blinding flash, a perfect strike.

As incredible as it sounds, this really happened on the 4th of July, 2005. Gliding through the vast atmosphere of Comet Tempel 1, NASA’s Deep Impact spacecraft pinpointed the comet’s 3x7-mile wide nucleus and hit it with an 820-lb copper impactor. The resulting explosion gave scientists their first look beneath the crust of a comet.

That’s navigation.
Credit the JPL navigation team. By sending commands from Earth, they guided Deep Impact within sight of the comet’s core. But even greater precision would be needed to strike the comet’s spinning, oddly-shaped nucleus. On July 3rd, a day before the strike, Deep Impact released the impactor. No dumb hunk of metal, the impactor was a spaceship in its own right, with its own camera, thrusters and computer brain. Most important of all, it had “AutoNav.”

AutoNav, short for Autonomous Navigation, is a computer program full of artificial intelligence. It uses a camera to see and thrusters to steer—no humans required. Keeping its “eye” on the target, AutoNav guided the impactor directly into the nucleus. The system was developed and tested on another “Deep” spacecraft: Deep Space 1, which flew to asteroid Braille in 1999 and Comet Borrelly in 2001. The mission of Deep Space 1 was to try out a dozen new technologies, among them an ion propulsion drive, advanced solar panels and AutoNav. AutoNav worked so well it was eventually installed on Deep Impact.

“Without AutoNav, the impactor would have completely missed the nucleus,” says JPL’s Ed Riedel, who led the development of AutoNav on Deep Space 1 and helped colleague Dan Kubitschek implement it on Deep Impact. En route to the nucleus, AutoNav “executed three maneuvers to keep the impactor on course: 90, 35, and 12.5 minutes before impact,” says Riedel. The nearest human navigators were 14 light-minutes away (round trip) on Earth, too far and too slow to make those critical last-minute changes. Having proved itself with comets, AutoNav is ready for new challenges: moons, planets, asteroids … wherever NASA needs an improbable bulls-eye.

Dr. Marc Rayman, project manager for Deep Space 1, describes the validation performance of AutoNav in his mission log at http://nmp.nasa.gov/ds1/arch/mrlog13.html (also check mrlog24.html and the two following). Also, for junior astronomers, the Deep Impact mission is described at http://spaceplace.nasa.gov/en/kids/deepimpact/deepimpact.shtml This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.