

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Calendar of Events

PUBLIC OBSERVING
Prairie Park Nature Center
 SUNDAY—September 28
 8:30 - 10:00 PM

SUNDAY—October 26
 SUNDAY— December 7
 8:00 - 9:30 PM

MONTHLY MEETINGS
2001 Malott, 7:30 PM
 FRIDAY—October 10
 A RECIPE for GALAXY
 CLUSTERS
 Dr. Greg Rudnick

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Report from the Officers:



Hello everyone. As some of you will note, we are, for the first time, sending out the newsletter in PDF format via email. This saves time, paper, and mailing costs. If you are receiving the paper version, it probably means that we don't have an email address for you. If you would like to get the email version—the images are a lot more attractive in color—please send your email address to Bruce (btwarog@ku.edu). Our first Public Observing Session of the fall was held on August, 31 at Prairie Park Nature Center. In spite of a small glitch with the timer for the parking lot lights, all in all it was a very good start to our fall observing schedule. Several club members brought

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Of Local Interest—Hubble Repair Mission Set for Oct. 14

Hubble precisely measured the age of the universe. It found evidence of dark energy. It brought you images of distant galaxies in the young universe. And now, with the state-of-the-art instruments delivered by Servicing Mission 4 (SM4), the Hubble Space Telescope will look onto the universe with new eyes, surpassing even its previous vision.

Hubble was designed to be repaired and upgraded by astronauts, and these servicing missions have occurred several times since Hubble's launch in 1990. NASA has selected a crew for the upcoming servicing, and the astronauts are currently training. The mission is scheduled for October 14, 2008.

Veteran astronaut Scott D. Altman will command the final space shuttle mission to Hubble. Navy Reserve Capt. Gregory C. Johnson will serve as pilot. Mission specialists include veteran spacewalkers John M. Grunsfeld and Michael J. Massimino, and first-time space fliers Andrew J. Feustel, Michael T. Good and K. Megan McArthur. Grunsfeld, Massimino and Altman have visited Hubble on previous servicing missions.

SM4 has an ambitious program of activities and three main objectives.

The first objective is to extend Hubble's operational life by at least five years. Over a series of five spacewalks, astronauts will replace all six gyroscopes, install new batteries, and exchange a degraded Fine Guidance Sensor with a new one. They will also install replacement thermal insulation on critical component bays of the telescope, and attach a mechanism that will aid in Hubble's final de-orbiting.

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their telescopes. Karen Camarda (see photo on pg. 1) brought her 8-inch Orion Dobsonian, as did William Winkler with his 6-inch. David Kolb brought his vintage 8-inch Criterion SCT and Rex Powell his 13-inch Coulter dobsonian (below). Michael and Rick Heschmeyer brought their 5 and 8 inch Celestron SCTs as well. The weather was beautiful and we had about 40 people show up to look through the scopes. Jupiter and a number of Messier objects were observed including M32 and 33, M57 and M13. One of KU's new astronomy professors, Dr. Greg Rudnick, will our featured guest at the October club meeting, scheduled for FRIDAY, OCTOBER 10. His presentation is entitled "**Recipe for a Galaxy Cluster: A Lot of Dark Matter, A Bunch of Hot Gas, and a Sprinkling of Galaxies**". Before coming to KU, Dr. Rudnick worked for the National Optical Astronomy Observatories studying the evolution of galaxies and galaxy clusters, so I am sure that his presentation will be informative and entertaining. Our next *Public Observing Session* is scheduled (sans parking lot lights) for Sunday, September 28 from 8:30 to 10 pm at Prairie Park Nature Center. Once again we will need club members to bring their telescopes. Please contact Rick Heschmeyer if you are planning on attending, with or without scope. While not on the website yet, mark your calendars for **Friday, November 21 at 7 pm**. That is the date for our annual Cub Scout Astronomy program. Last year we had 275 attendees, so we'll need as much help as we can get for this event.



If anyone has any ideas, suggestions, or input on how we can make the club better, please contact Rick. Look forward to seeing everyone at the September Open House and/or the October meeting.

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The second objective is to enhance Hubble's scientific power. Astronauts will install two new instruments, the Wide Field Camera 3 (WFC3) and the Cosmic Origins Spectrograph (COS). WFC3, which sees in visible, infrared and ultraviolet light, will improve Hubble's sensitivity 10-30 times because of improvements in technology and design that have occurred since the last instruments were installed. COS, Hubble's new spectrograph, will improve Hubble's sensitivity at least 10 times. Spectrographs are instruments that break light into its component colors, revealing information about the object emitting the light. COS sees ultraviolet light, which is particularly important because most of the ultraviolet light from space is absorbed by the Earth's atmosphere, making ground-based telescope observations impossible.

The third objective is to repair Hubble's out-of-commission instruments, the Space Telescope Imaging Spectrograph (STIS) and the Advanced Camera for Surveys (ACS). STIS stopped working in 2004 and ACS failed in 2007. ACS is Hubble's most prominent camera. Its wide field of view and ability to see in wavelengths from ultraviolet to visible light allows it to conduct broad surveys of the universe, study the nature and distribution of galaxies, and examine some of the universe's earliest activity. ACS was responsible for the Hubble Ultra Deep Field Image, NASA's deepest view of the cosmos. STIS is a spectrograph. It separates light into its component colors, allowing scientists to examine the object's temperature, chemical composition, density and motion. STIS can see in ultraviolet, visible and near-infrared and has been used to examine black holes, quasars and planets. If these objectives can be successfully carried out during the servicing mission, then Hubble will be at the apex of its scientific capability, with six working, complementary science instruments. These upgrades will keep Hubble functioning at the pinnacle of astronomy well into the next decade.

FOR A RELATED ARTICLE, SEE PG. 8.

About the Astronomy Associates of Lawrence

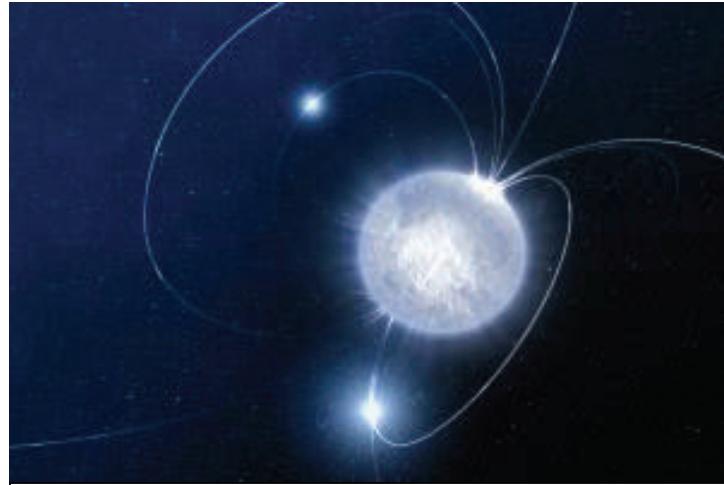
The club is open to all people interested in sharing their love for astronomy. Monthly meetings are typically on the second Friday of each month and often feature guest speakers, presentations by club members, and a chance to exchange amateur astronomy tips. Approximately the last Sunday of each month we have an open house on Memorial Stadium. Periodic star parties are scheduled as well. For more information, please contact the club officers: Luis Vargas at lvargas@ku.edu, Gary Webber at gwebber@ku.edu, our faculty advisor, Prof. Bruce Twarog at btwarog@ku.edu, 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>

Missing Link Of Neutron Stars? Bizarre Hibernating Stellar Magnet Discovered

ESO Press Release

Astronomers have discovered a most bizarre celestial object that emitted 40 visible-light flashes before disappearing again. It is most likely to be a missing link in the family of neutron stars, the first case of an object with an amazingly powerful magnetic field that showed some brief, strong visible-light activity.



Astronomers have discovered a possible magnetar that emitted 40 visible-light flashes before disappearing again. Magnetars are young neutron stars with an ultra-strong magnetic field a billion billion times stronger than that of the Earth. The twisting of magnetic field lines in magnetars give rise to 'starquakes', which will eventually lead to an intense soft gamma-ray burst. In the case of the SWIFT source, the optical flares that reached the Earth were probably due to ions ripped out from the surface of the magnetar and gyrating around the field lines. (Credit: ESO/L. Calçada)

This weird object initially misled its discoverers as it showed up as a gamma-ray burst, suggesting the death of a star in the distant Universe. But soon afterwards, it exhibited some unique behaviour that indicates its origin is much closer to us. After the initial gamma-ray pulse, there was a three-day period of activity during which 40 visible-light flares were observed, followed by a brief near-infrared flaring episode 11 days later, which was recorded by ESO's Very Large Telescope. Then the source became dormant again.

"We are dealing with an object that has been hibernating for decades before entering a brief period of activity", explains Alberto J. Castro-Tirado, lead author of a new paper in the journal Nature. The most likely candidate for this mystery object is a 'magnetar' located in our own Milky Way galaxy, about 15 000 light-years away towards the constellation of Vulpecula, the Fox. Magnetars are young

neutron stars with an ultra-strong magnetic field a billion billion times stronger than that of the Earth. "A magnetar would wipe the information from all credit cards on Earth from a distance halfway to the Moon," says co-author Antonio de Ugarte Postigo. "Magnetars remain quiescent for decades. It is likely that there is a considerable population in the Milky Way, although only about a dozen have been identified."

Some scientists have noted that magnetars should be evolving towards a pleasant retirement as their magnetic fields decay, but no suitable source had been identified up to now as evidence for this evolutionary scheme. The newly discovered object, known as SWIFT J195509+261406 and showing up initially as a gamma-ray burst (GRB 070610), is the first candidate. The magnetar hypothesis for this object is reinforced by another analysis, based on another set of data, appearing in the same issue of Nature.

Forty-two scientists used data taken by eight telescopes worldwide, including the BOOTES-2 robotic telescope at EELM-CSIC, the WATCHER telescope at Boyden Observatory (South Africa), the 0.8-m IAC80 at Teide Observatory (Spain), the Flemish 1.2-m Mercator telescope at Observatorio del Roque de los Muchachos (Spain), the Tautenburg 1.34-m telescope (Germany), the 1.5-m at Observatorio de Sierra Nevada (IAA-CSIC), the 6.0-m BTA in Russia, the 8.2-m VLT at ESO in Chile and the IRAM 30-m Pico Veleta y Plateau de Bure telescopes, together with the SWIFT (NASA) and XMM-Newton (ESA) satellites.

About Neutron stars

Neutron stars is the bare, condensed remain of a massive star with between eight and fifteen times the mass of the Sun, which has expelled its outer layers following a supernova explosion. Such stars are only around 20 kilometres in diameter, yet are more massive than the Sun. Magnetars are neutron stars with magnetic fields hundreds of times more intense than the average neutron star fields. The energy release during one flare in the course of a period of activity can amount to the energy released by the Sun in 10 000 years.



Extreme Starburst

by Dr. Tony Phillips

A star is born. A star is born. A star is born.

Repeat that phrase 4000 times and you start to get an idea what life is like in distant galaxy J100054+023436. Astronomers using NASA's Spitzer Space Telescope and ground-based observatories have found that the galaxy gives birth to as many as 4000 stars a year. For comparison, in the same period of time the Milky Way produces only about 10. This makes J100054+023436 an extreme starburst galaxy.

"We call it the 'Baby Boom galaxy,'" says Peter Capak of NASA's Spitzer Science Center at the California Institute of Technology in Pasadena, CA. "It is undergoing a major baby boom, producing most of its stars all at once. If our human population was produced in a similar boom, then almost all people alive today would be the same age."

Capak is lead author of a paper entitled "Spectroscopic Confirmation of an Extreme Starburst at Redshift 4.547" detailing the discovery in the July 10th issue of *Astrophysical Journal Letters*. The galaxy appears to be a merger, a "train wreck" of two or more galaxies crashing together. The crash is what produces the baby boom. Clouds of interstellar gas within the two galaxies press against one another and collapse to form stars, dozens to hundreds at a time.

This isn't the first time astronomers have witnessed a galaxy producing so many stars. "There are some other extreme starburst galaxies in the local universe," says Capak. But the Baby Boom galaxy is special because it is not local. It lies about 12.3 billion light years from Earth, which means we are seeing it as it was 12.3 billion years ago. The universe itself is no older than 14 billion years, so this galaxy is just a youngster (Capak likens it to a 6-year-old human) previously thought to be incapable of such rapid-fire star production.



The "Baby Boom" galaxy loosely resembles the galaxy shown here, called Zw II 96, in this Hubble Space Telescope image. This galaxy is only 500 million light-years away, while the Baby Boom galaxy is 12.3 billion light-years away.

The Baby Boom galaxy poses a challenge to the Hierarchical Model of galaxy evolution favored by many astronomers. According to the Hierarchical Model, galaxies grow by merging; Add two small galaxies together, and you get a bigger galaxy. In the early years of the universe, all galaxies were small, and they produced correspondingly small bursts of star formation when they merged. "Yet in J100054+023436, we see an extreme starburst. The merging galaxies must be pretty large."

Capak and colleagues are busy looking for more Baby Boomers "to see if this is a one-off case or a common occurrence." The theory of evolution of galaxies hangs in the balance.

Meanwhile... A star is born. A star is born. A star is born.

See more breathtaking Spitzer images at www.spitzer.caltech.edu/Media/mediaimages. Kids can play the new Spitzer "Sign Here!" game at spaceplace.nasa.gov/en/kids/spitzer/signs. This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and

Theory Of Sun's Role In Formation Of Solar System Questioned

Press Release: UC– San Diego

A strange mix of oxygen found in a stony meteorite that exploded over Pueblito de Allende, Mexico nearly 40 years ago has puzzled scientists ever since. Small flecks of minerals lodged in the stone and thought to date from the beginning of the solar system have a pattern of oxygen types, or isotopes, that differs from those found in all known planetary rocks, including those from Earth, its Moon and meteorites from Mars.

Now scientists from UC San Diego and Lawrence Berkeley National Laboratory have eliminated one model proposed to explain the anomaly: the idea that light from the early Sun could have shifted the balance of oxygen isotopes in molecules that formed after it turned on. When they beamed light through carbon monoxide gas to form carbon dioxide, the balance of oxygen isotopes in the new molecules failed to shift in ways predicted by the model they report in the September 5 issue of Science.

"It's solar system forensics. We're understanding a little about how it got made," said Mark Thiemens, Dean of the Division of Physical Sciences and a professor of chemistry and biochemistry at UC San Diego, who directed the project. The results pare down the potential explanations for how gas and dust coalesced to form the planets and will help this team and others interpret samples of the solar wind returned by NASA's Genesis spacecraft.

Scientists think the early Sun emitted intense far-ultraviolet light. Light energy at these very short wavelengths will dislodge oxygen atoms from molecules, freeing them to hook up with others in new combinations. In the process, the oxygen atoms absorb some of the energy. This is how gases became dust and then larger minerals that collided and continued to build to form the planets. Oxygen, the most abundant element in the solar system, is a player in almost all of these reactions.

Each oxygen isotope responds to a unique set of light wavelengths. An abundance of a particular oxygen isotope within in a cloud of gas molecules will quench the light at its preferred wavelengths, shielding gas molecules farther along the light's path. Other wavelengths, including those that dislodge different oxygen isotopes, will continue unimpeded, favoring the inclusion of these rarer isotopes in new molecules.

The balance of oxygen isotopes found in the Allende meteorite is tipped toward the most abundant one, ^{16}O . Planetary rocks have relatively more rarer heavier oxygen isotopes, as though rare isotopes were preferred as the planets formed.

"We decided to directly test this idea that photoshielding could change the isotope ratios," said Subrata Chakraborty, a postdoctoral fellow at UC San Diego and first author of the paper. The team focused an intense beam of far-ultraviolet light generated by the Lawrence Berkeley National Laboratory's Advanced Light Source into a tube filled with carbon monoxide gas. The light knocked some of the oxygen atoms free, allowing them to recombine with other carbon monoxide molecules to form carbon dioxide. Chakraborty then collected and analyzed the carbon dioxide to determine the balance of oxygen isotopes in the new molecules.

By precisely controlling the wavelength of the light, the scientists were able to set up conditions that should have resulted in oxygen isotope mixes that matched either those found on Earth or in the Allende meteorite. Wavelengths known to be absorbed by ^{16}O should result in carbon dioxide molecules enriched with the heavier forms of oxygen. They tested two of these wavelengths: one enriched the mix; the other did not.

Wavelengths not absorbed by ^{16}O should result in a mix that matched that found in the Allende meteorite. Again,

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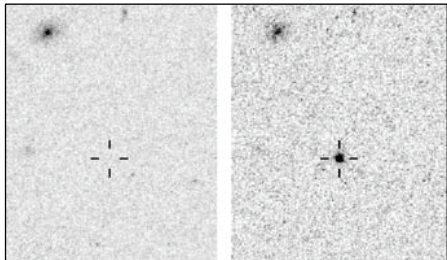


Pale specks on the surface of this meteorite are among the oldest minerals in the solar system. An odd mix of oxygen atoms within these minerals has puzzled scientists for decades. (Credit: Susan Brown)

Hubble Finds a Mystery Object—skypub.com

Don't get the idea that we've found every kind of astronomical object there is in the universe. In a paper to appear in the *Astrophysical Journal*, astronomers working on the Supernova Cosmology Project report finding a new kind of *something* that they cannot make any sense of.

The project used the Hubble Space Telescope to monitor very distant galaxy clusters for supernovae. On February 21, 2006, in the direction of a far-away cluster in Bootes named CL 1432.5+3332.8 (redshift 1.112, light travel time 8.2 billion years), Hubble began seeing something brighten. It continued brightening for about 100 days and peaked at 21st magnitude in two near-infrared colors. It then faded away over a similar timescale, until nothing was left in view down to 26th magnitude. The object brightened and faded by a factor of at least 120, maybe more. The mystery object did not behave like any known kind of supernova. It is not even in any detectable galaxy. "The shape of the light curve is inconsistent with microlensing," say the researchers. They recorded three spectra of it — and its spectrum, they write, "in addition to being inconsistent with all known supernova types, is not matched to any spectrum in the Sloan Digital Sky Survey database" of vast numbers of objects. "We suggest that the transient may be one of a new class." What's its distance? That would certainly be a first step to figuring it out, but only the broadest constraints can be put on its distance. Its lack of parallax motion means that it can't be closer than about 130 light-years, and a lack of cosmic hydrogen absorption in its spectrum means that it can't be farther than 11 billion light-years (when "distance" is defined by light travel time). That leaves a lot of leeway.



Now you don't see it, now you do. Something in Bootes truly in the middle of nowhere — apparently not even in a galaxy — brightened by at least 120 times during more than three months and then faded away. Its spectrum was like nothing ever seen, write the discoverers, with "five broad absorption bands between 4100 and 6500 Angstroms and a mostly featureless continuum longward of 6500 Angstroms." Even the cause of the spectral features is unknown.

MOST DARK-MATTER DOMINATED GALAXY FOUND— (Yale University press release) A team led by a Yale University astronomer has discovered the least luminous, most dark matter-filled galaxy known to exist. The galaxy, called Segue 1, is one of about two dozen small satellite galaxies orbiting our own Milky Way galaxy. The ultra-faint galaxy is a billion times less bright than the Milky Way, according to the team's results, to be published in an upcoming issue of *The Astrophysical Journal* (ApJ). But despite its small number of visible stars, Segue 1 is nearly a thousand times more massive than it appears, meaning most of its mass must come from dark matter.

"I'm excited about this object," said Marla Geha, an assistant professor of astronomy at Yale and the paper's lead author. "Segue 1 is the most extreme example of a galaxy that contains only a few hundred stars, yet has a relatively large mass." Geha, along with her colleague Josh Simon at the California Institute of Technology, has observed about half of the dwarf satellite galaxies that orbit the Milky Way. These objects are so faint and contain so few stars that at first they were thought to be globular clusters — tightly bound star clusters that also orbit our host galaxy. But by analyzing the light coming from the objects using the Keck telescope in Hawaii, Geha and Simon showed that these objects are actually galaxies themselves, albeit very dim ones.

Looking only at the light emitted by these ultra-faint galaxies, Geha and her colleagues expected them to have correspondingly low masses. Instead, they discovered that they are between 100 and 1000 times more massive than they appear. Invisible dark matter, she said, must account for the difference. Although dark matter doesn't emit or absorb light, scientists can measure its gravitational effect on ordinary matter and believe it makes up about 85 percent of the total mass in the universe. Finding ultra-faint galaxies like Segue 1, which is so rife with dark matter, provides clues as to how galaxies form and evolve, especially at the smallest scales.

"These dwarf galaxies tell us a great deal about galaxy formation," Geha said. "For example, different theories about how galaxies form predict different numbers of dwarf galaxies versus large galaxies. So just comparing numbers is significant."

It's only recently that astronomers have discovered just how prevalent these dwarf satellite galaxies are, thanks to projects like the Sloan Digital Sky Survey, which imaged large areas of the nighttime sky in greater detail than ever before. In the past two years alone, the number of known dwarf galaxies orbiting the Milky Way has doubled from the dozen or so brightest that were discovered during the first half of the twentieth century. Geha predicts astronomers will find even more as they continue to sift through new data. "The galaxies I now consider bright used to be the least luminous ones we knew about," she said. "It's a totally new regime. This is a story that's just unfolding."

Frustrated NASA Chief Vents in Internal E-Mail Over Fate of Agency

The Orlando Sentinel

In congressional testimony and speeches across the country, NASA Administrator Mike Griffin has presented the Bush administration's space policy as under pressure but on track to returning humans to the moon by 2020. His public face has been steadfast. But privately, the agency chief is far less certain.

In a remarkably candid internal e-mail to top advisers obtained by the Orlando Sentinel, Griffin lashed out last month at the White House for what he called a "jihad" to shut down the space shuttle, expressed frustration at the lack of funding for a new moon rocket -- and despaired about the future of America's human-spaceflight program. The tone of the note depicts a man watching as his finely crafted plans for a revitalized space-faring NASA appear to be melting before his eyes.

"My own view is about as pessimistic as it is possible to be," Griffin wrote Aug. 18. NASA on Friday confirmed the authenticity of the e-mail, which offers a rare insight into Griffin's views as the agency faces its greatest challenge since the end of the Apollo era and perhaps in its 50-year history. Griffin wrote his e-mail in response to messages from advisers encouraging him to call off the retirement of the shuttle.

In the e-mail, Griffin says he fully expects the next president to order NASA to continue flying the shuttle, even though he considers the aging orbiter unsafe and consuming money needed to design and build his Ares moon rocket and Orion crew capsule. He acknowledges that the shuttle will remain -- for the foreseeable future -- the only means to transport U.S. astronauts to the international space station.

What about shuttle?

Griffin last week acknowledged in an interview with the Sentinel that he recently ordered his agency to look into the possibility of more shuttle flights after the orbiter's planned retirement in 2010, but his e-mail makes clear he did so grudgingly. "They will tell us to extend shuttle," he says of a new administration. "There is no other politically tenable course. It will appear irrational -- heck, it will be irrational -- to say we've built a Space Station we cannot use, that we're throwing away a \$100 billion investment, when the cost of saving it is merely to continue flying Shuttle."

And the long-term cost of such a move, he writes, will likely matter little to America's next political leadership.

"Extending the shuttle creates no damage that they will care about other than to delay the lunar program. They will not count that as a cost," he writes. "They will not see what that does for U.S. leadership in space in the long term. And even if they do, they have a problem in the short term that must be solved."

Griffin's harshest words were reserved for his bosses in the White House: the Office of Management and Budget, which sets spending goals, and the Office of Science and Technology Policy, which advises the president. "In a rational world, we would have been allowed to pick a shuttle retirement date to be consistent with Ares/Orion availability, we would have been asked to deploy Ares/Orion as early as possible (rather than 'not later than 2014') and we would have been provided the necessary budget to make it so," he wrote. "The rational approach didn't happen, primarily because for OSTP and OMB, retiring the shuttle is a jihad rather than an engineering and program management decision."

The White House would not comment when asked about the e-mail. But a few hours later, Griffin penned a retraction. "The leaked internal e-mail fails to provide the contextual framework for my remarks, and my support for the administration's policies," he said in a statement to the Sentinel. A no-nonsense and supremely self-confident engineer with a pilot's license and seven degrees -- including a Ph.D. in aerospace engineering -- Griffin, 58, was brought into NASA in April 2005 to turn President Bush's vision of sending astronauts to the moon and Mars into reality.

Restoring the glamour

His aim was to restore the glamour that has been fading since the agency's moon days. He was no fan of the shuttle or the space station, saying they kept Americans circling Earth rather than exploring the stars. Key to his plan was retiring the shuttle in 2010 and distancing the agency from the space station. It called for a three-year gap between the shuttle's retirement and advent of the Ares rocket. The money freed up from the shuttle program was to give Ares its final financial push to the launchpad.

But the moon initiative put severe pressure on NASA's budget, forcing Griffin into a difficult balancing act: trying to create a next-generation spaceship without crippling other programs, ranging from Earth-observation satellites to Mars robots.

Still, Griffin continued to support the administration's plan, with no public complaint.

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Bean-counter battle

Over time, the White House failed to back NASA's budget requests, holding it at about \$17 billion, and Congress rebuffed bids to increase it by \$1 billion or more. Meanwhile, technical issues slowed development of the Ares rocket. The gap grew to five years, amid grumbling by Congress and dissident scientists and engineers inside NASA. "When Mike began the job, he and his team were counting down the months, knowing that they had limited time to accomplish what they wanted," said a friend of Griffin's who asked not to be identified. "They were ramming plans through the agency to make them unstoppable.

"But now it's falling apart."

Space historian Howard McCurdy of American University said Griffin's tensions with the White House are not without precedent: Even in the days of Apollo, NASA bosses battled administration bean counters. "What you are looking at is the fog of public policymaking," McCurdy said. "If you looked down from a distance, [Apollo] was this beautiful straight line to the moon. But if you got up close, it was the fog of war with fights over money and strategy. It's the same now."

Griffin's top aides have urged him to extend the shuttle program because Russia's invasion of Georgia looks likely to cut off NASA's access to Russian Soyuz spaceships.

Dependence on Russia

If the shuttle is retired, NASA needs Soyuz to take astronauts to the space station for at least five years, until the Ares rocket is ready in 2015. But NASA's contract to buy Soyuz runs out in 2011. To buy more, Congress must waive a ban on high-tech purchases from Russia because of Moscow's nuclear dealings with Iran.

That waiver is looking extremely unlikely. The Georgia incursion has chilled U.S.-Russia relations, and Congress is in no mood to channel dollars to Moscow's aerospace industry even if it means grounding U.S. astronauts.

Griffin has termed U.S. dependence on the Russians "unseemly" but said the Soyuz was a crucial part of a transition from the shuttle era.

But in his e-mail, Griffin says his White House bosses were uninterested in the space station and didn't care one way or another about relying on the Russians.

"They were always 'okay' with buying Soyuz . . . and even if it didn't happen, well, that was okay too," he wrote.

"Mike's e-mail approaches Shakespearean tragedy: capturing a brilliant man's painful recognition that there is no easy way out of this box that NASA is in," said James Muncy, a space-policy consultant who worked in Congress and the Reagan administration.

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of the two the team tested, one did and one did not. "Some process is altering the mix, but it can't be photoshielding," Chakraborty said.

Samples returned by the GENESIS spacecraft will have to be interpreted in light of these results, Thiemens said. By analyzing samples of the Sun's outer atmosphere captured from the solar wind, the mission aims to determine the original composition of the solar nebula, the swirl of dust and gas that formed the solar system. Measurements by Thiemen's research group and others will help to resolve the chemical mismatch between the meteorite inclusions and planetary rocks.

Several other models have been proposed to explain the anomaly—including the idea that an exploding star could have blasted in an extra dose of ^{16}O —only to have been discarded when experimental evidence showed them to be unlikely. The only one left standing, according to Thiemens, is an idea called molecular symmetry that says an atom flanked by two oxygen isotopes is more likely to become a stable molecule if the two isotopes are mismatched. This quieter process would also favor the formation of molecules that included rarer oxygen isotopes.

"There's no violence," Thiemens said. "It doesn't require a star blowing up or turning on to cast a nebula-wide shadow. It's symmetry." Musahid Ahmed of Lawrence Berkeley National Laboratory and Teresa Jackson of UC San Diego are co-authors of the paper. NASA and the Department of Energy funded the project.

Celestial Mechanics October 2008



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