The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Volume 33 Number 08 **August 2007**

Calendar of Events

FALL PUBLIC OBSERVING SCHEDULE

Weather Permitting
Memorial Stadium

Sunday, August 26
9:00-10:30 PM
Sunday, Sept. 30
8:30-10:00 PM
Sunday, Oct. 28
8:00-9:30 PM
Sunday, Dec. 02
8:00-9:30 PM

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Report from the Officers on COMING EVENTS:

With the rapid transition from summer to school sessions approaching, we are beginning to plan meetings and events for the coming semester. Hopefully as the skies get darker earlier, the weather will also improve. So, with the usual optimism inherent in any astronomical observer in Kansas, the dates for public observing at Memorial Stadium have been set and are posted in the Events Calendar on the left. They are the last Sunday of the month, with the exception of November to avoid the Thanksgiving Break.

(Continued on page 2)

Of Local Interest

Take interplanetary walk and see the city's sights

By Kevin Collison, The Kansas City Star

Kansas City is going out of this world for its next attraction — a walking tour offering a permanent scale model of the solar system reaching from the downtown loop to Union Station.

The exhibit, called Voyage, promises to shrink interplanetary space to the point where one foot equals 2 million miles. Pedestrians can try the light-year shuffle; stroll by the TWA Moonliner and Pluto; encounter a new dwarf planet called Eris, and finish their one-mile odyssey en route to the stars with the Voyager spacecraft. The $327,000 project is being funded by the Ewing Marion Kauffman Foundation and is based on a similar display on the National Mall in Washington, D.C. It is expected to open early next year.

Backers believe the route, which runs along Baltimore Avenue through the Crossroads Arts District to Union Station, will create a fun, walkable connection between downtown districts and at the same time educate people, particularly schoolkids, about the vastness of space. “What’s really exciting is that it puts the size of the planets and the sun on a scale that you can’t do in a museum,” said Jeff Goldstein of the National Center for Earth and Space Science Education.

“The sun is the size of a large grapefruit. The home of the human race is the size of the head of a pin, and the orbit of the moon fits into a child’s hand. That’s how far we’ve been when it comes to space travel.” The idea of a 10 billion-to-one scale model of the solar system was hatched by a University of Colorado astrophysicist and brought to the Smithsonian Institution in 1991. It took 10 years of bureaucratic wrangling before the exhibit opened.

The Washington display (www.voyagesolarsystem.org) is about six football fields long. Each celestial object is marked by an 8 ½ -foot stanchion that includes a scale model where the planets and their larger moons are etched

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From the Officers, continued

(Continued from page 1)

So, please make a note of the dates and, if you have the time and desire, plan on joining us either as an observer or a participant running a telescope.

While on the topic of events, the monthly meeting schedule will return in September. The current schedule of dates for the meetings is Friday, Sept. 14, Friday, Oct. 19, Friday, Nov. 16, and Friday, Dec. 07. The evening of Nov. 16 has been set aside for the annual Cub Scout Astronomy night, and the three KU astronomers are planning on cycling through the other three evenings.

From an astronomical standpoint, keep an eye out for the Perseids this month. The legendary Perseid meteor shower will peak between Aug. 10 and 13. It's expected to display the greatest number of meteors Sunday morning (August 12), late Sunday night and Monday morning (August 13) before dawn. But you'll see some Perseids Saturday (August 11) before dawn, too. The moon is new on Sunday, or between the Earth and sun. This new moon will leave the night sky dark all weekend for the Perseid meteors. These meteors are named for the constellation Perseus the Hero. If you trace the paths of the meteors backwards, they seem to stream from this constellation. You don't need to identify Perseus to enjoy the meteor shower. The Perseids are a especially rich and dependable meteor shower. They shoot all across the sky – often leaving persistent trains – and occasionally lighting things up with bright fireballs. To watch the show, find a dark, open sky. Get away from city lights, and give your eyes at least 20 minutes to adapt to the dark. The Perseid shower favors northern hemisphere skywatchers. Again, the best time to watch: Sunday morning, late Sunday night and Monday morning before dawn. At its peak, the Perseids typically produce 60 or more meteors per hour

If you have any suggestions for talks, speakers, or public events, please feel free to contact us, particularly Rick Heschmeyer (rcjbm@sbcglobal.net), the events coordinator for the club. Hope to see you at the observing on Memorial Stadium later this month**.** ALL for now.

(Continued from page 1)

inside glass with a laser-sculpting technique that offers three-dimensional detail. The stanchion also displays a storyboard that provides information about the planet. "You can see people reading it all the time," Goldstein said.

One of the visitors to the Mall last year was Dennis Cheek, vice president for education at the Kauffman Foundation. When he learned the Center for Space Science Education was hoping to replicate the Voyage display elsewhere, Cheek decided it was a "no-brainer" for Kansas City. "We thought we could use it as an anchor for the new downtown," he said. "We offered to make it a gift to the city and the city eagerly embraced it."

The Kauffman Foundation decided to add a couple of extra stops: for example, the Eris dwarf planet, which orbits beyond Pluto, and Voyager spacecraft. "In some ways, this is better than D.C.," Cheek said. Voyager was launched in 1977 on a mission to explore the planets and beyond. The nuclear-powered probe carries humanity's greeting to the universe on a gold LP record. It is now 9.3 billion miles from Earth and is expected to reach interstellar space within 10 years at a speed of one million miles per day.

The celestial layout calls for the sun to be near 13th and Baltimore on the east side of the street. That starting point also allows a powerful visual anchor for the project because it's near the Power & Light Building, an art deco landmark topped by a shiny, sunlike beacon. Visitors will quickly discover how comparatively bunched the first stretch of the solar system is because seven stanchions — the sun, Mercury, Venus, Earth, Mars, the asteroid belt and Jupiter — will be between 13th and 14th streets. The Earth is about 50 feet from the sun.

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 lcvargas@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

Some black holes are 'closet eaters'

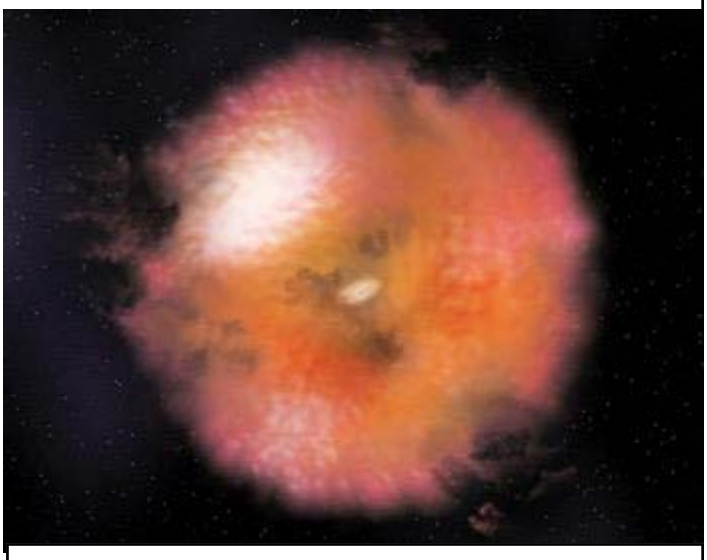
NewScientist.com

Black holes that are devouring their surroundings are among the brightest objects in the universe, shining like beacons from billions of light years away. But astronomers have found a strange new class of these objects that behave completely differently – 'closet eaters' that emit virtually no detectable radiation as they wolf down nearby matter.

The research may shed light on why the colossal black holes at the centres of some galaxies are gluttons, while others, such as the one inside the Milky Way, fast most of the time.

Until now, the enthusiastic eaters – known as active galactic nuclei, or AGN – were all thought to share the same essential structure. In this 'unified model', a doughnut-like disc of gas and dust, or torus, surrounds the supermassive black hole.

The AGN shine so brightly because matter from the torus is drawn towards the black hole, emitting radiation as it heats up and its magnetic fields twist and reconnect. Any differences in the nature of the radiation astronomers observe from the objects have been attributed to the angle at which they were viewed (see illustration below).



Newly discovered 'active galactic nuclei' appear to be surrounded by a cloud of gas and dust that blocks most wavelengths of light from escaping (Illustration: Aurore Simonnet/ Sonoma State University)

Now, about eight AGN have been found that do not fall into this unified model. They were initially discovered using the Burst Alert Telescope on NASA's Swift space observatory, which observes high-energy X-rays. Follow-up observations with Japan's Suzaku satellite, which detects a wider range of X-rays, then confirmed that the objects did not radiate X-rays at lower energies.

'Filled doughnut'

Only AGN can emit X-rays at the energies Swift observed, suggesting the new objects are indeed ravenous black holes. But the fact that Suzaku did not detect them at lower energies suggests they are completely surrounded by gas and dust – which absorbs lower-energy X-rays – rather than a relatively flat, dusty torus.

"We're finding objects that don't have the shape of a doughnut . . . that don't have this hole in the middle," says team member Richard Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Maryland, US. "The dust and gas is in a big mish-mosh in the centre. This is unexpected."

Jack Tueller, another team member at Goddard, suggests several explanations for this structure. The black hole may in fact be surrounded by a torus, but the torus-black hole combination may be embedded in a huge cloud of dust and gas that absorbs most wavelengths of light.

Another possibility is that the particles of gas and dust surrounding the black hole are heated in such a way that they have random velocities, producing a very thick disc of material that does not have a hole in its centre. "It's like a filled doughnut," Tueller told **New Scientist**.

High-energy glow

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NASA's Space Place

Omit Needless Bytes!

by Patrick Barry and Tony Phillips

Now is an exciting time for space enthusiasts. In the history of the Space Age, there have never been so many missions "out there" at once. NASA has, for example, robots on Mars, satellites orbiting Mars, a spacecraft circling Saturn, probes en route to Pluto and Mercury—and four spacecraft, the two Voyagers and the two Pioneers, are exiting the solar system altogether.

It's wonderful, but it is also creating a challenge.

The Deep Space Network that NASA uses to communicate with distant probes is becoming overtaxed. Status reports and data transmissions are coming in from all over the solar system—and there's only so much time to listen. Expanding the network would be expensive, so it would be nice if these probes could learn to communicate with greater brevity. But how?

Solving problems like this is why NASA created the New Millennium Program (NMP). The goal of NMP is to flight-test experimental hardware and software for future space missions. In 1998, for instance, NMP launched an experimental spacecraft called Deep Space 1 that carried a suite of new technologies, including a new kind of communication system known as Beacon Monitor.

The system leverages the fact that for most of a probe's long voyage to a distant planet or asteroid or comet, it's not doing very much. There's little to report. During that time, mission scientists usually only need to know whether the spacecraft is in good health.

"If you don't need to transmit a full data stream, if you only need some basic state information, then you can use a much simpler transmission system," notes Henry Hotz, an engineer at NASA's Jet Propulsion Laboratory who worked on Beacon Monitor for Deep Space 1. So instead of beaming back complete data about the spacecraft's operation, Beacon Monitor uses sophisticated software in the probe's onboard computer to boil that data down to a single "diagnosis." It then uses a low-power antenna to transmit that diagnosis as one of four simple radio tones, signifying "all clear," "need some attention whenever you can," "need attention soon," or "I'm in big trouble—

This artist's concept shows the New Horizons spacecraft during its planned encounter with Pluto and its moon, Charon. The spacecraft is currently using the Beacon Monitor system on its way to Pluto. Credit: Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute (JHUAPL/SwRI)

need attention right now!"

"These simple tones are much easier to detect from Earth than complex data streams, so the mission needs far less of the network's valuable time and bandwidth," says Hotz. After being tested on Deep Space 1, Beacon Monitor was approved for the New Horizons mission, currently on its way to Pluto, beaming back a simple beacon as it goes.

Discover more about Beacon Monitor technology, as well as other technologies, on the NMP Technology Validation Reports page, http://nmp-techval-reports.jpl.nasa.gov.

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Arizona Sky Village: a town built for astronomy lovers

NewScientist.com

When night falls over the empty desert, retiree Jim Algots climbs the wooden steps to his observatory, dims the lights and rolls back the roof to reveal an ink-black sky. Until dawn, he can train his telescope on a rich field of stars, knowing that despite living in one of the most remote spots in the US he is very far from being alone.

The former laboratory technician is among scores of passionate astronomers who have beaten a path to Arizona Sky Village, a purpose-built community for star-gazers in southern Arizona more than two hours drive southeast of Tucson. Laid out on 450 acres (180 hectares) beside the Chiricahua Mountains, the community has attracted residents from Britain, South Korea and Russia as well as the farthest corners of the US in the past five years. The graded access roads – with names like Skyview Drive, South Milky Way and Starlight Trail – link a low-density community of astronomy enthusiasts, each with their own 4-acre (1.6-hectare) plot.

Shared interests

A number of houses have sprung up among the mesquite brush, most with one or two observatories equipped with powerful reflector telescopes, while some other newcomers to the project are still marking out land and building. "When I retired, I thought I was looking for an isolated place for myself to view the stars," said Algots, 68. "Then I realised that wasn't what I wanted. Here I am surrounded by like-minded people."

The US has more than 1 million amateur star-gazers and there are several dedicated villages catering to them, including Deerlick Astronomy Village in Georgia and Chiefland Astronomy Village in neighboring Florida. The communities are all located in remote areas, far from flaring city lights that spoil views of the night sky. Residents abide by rules forbidding bright lights anywhere from dusk till dawn to preserve optimum viewing. With its stable weather conditions, bone-dry air and isolated location, the Arizona Sky Village offers a near-perfect setting for astronomers, allowing them to see even faint objects like the swirling clouds of gas that make up nebulae and the spiral arms of far-off galaxies in transparent detail.

'Dead dark'

"It's ink-black, dead-dark, one of the darkest places in the country," says Gene Turner, an amateur astronomer and one of the project's developers. "The Milky Way is so bright here, it's three-dimensional. In 1500 you could see it everywhere like this, but now that's very rare."

Turner acquired the spot after roaming the desert state at night searching for the darkest skies. He and business partner Jack Newton then put in roads, power lines and a fast Internet connection. The buyers include some astronomers around the country and world who operate sophisticated telescopes robotically, gazing into the dense star field from different time zones.

"Last week, I was sitting in a hotel room in Australia, looking at the night sky over Arizona," said California-based software engineer David Churchill, whose computerized observatory at Arizona Sky Village is equipped with Web cams and cloud sensors to aid remote viewing. "I can play with it from anywhere in the world."

Wheeling stars

Some villagers are passionate amateur astronomers who tirelessly search for objects such as asteroids and supernovae that are sometimes missed by professionals. Most, however, are devoted hobbyists who spend their nights viewing for pleasure from their own well-equipped observatories under dimmed red lights, some getting into the mood with a Beethoven symphony or ambient guitar music. Retired engineer Rick Beno originally is from California. He used to trek out to remote areas with a portable telescope for the occasional evening taking pictures of the stars, although having his own two-story observatory now allows him to take photographs year round.

"The sky always comes back. This way I don't need to get it in one night, I can just wait until next year," he says of the constellations and planets he snaps as they wheel over the desert horizon with the progression of the seasons. The development has proved very popular and Turner says that all 85 lots sold out fast. All that now remain are fractional shares in homes in the subdivision in the remote corner of Arizona, which last year overtook Nevada to become the fastest growing state in the country.

But despite strong demand, he is cautious about further development in the remote area, which is also very popular with hikers and bird watchers."We are considering it but we are very sensitive to over-population," Turner said. "It doesn't take too long to get to the other world but we want to keep this pristine."

Universe mostly forgets its past during cosmic rebirth

Some cosmologists think that our universe has been cycling through an endless series of big bangs and big crunches. If so, it implies the universe is doomed to repeat the same thing over and over. A new study, however, suggests that with each big bang, the universe mostly forgets its past and starts anew.

The accepted wisdom in modern cosmology is that it is meaningless to ask what came before the big bang. That's because the big bang is what physicists call a "singularity" – a moment at which the equations of physics break down. "No one is happy with the big bang singularity," says Martin Bojowald, a theorist at the Pennsylvania State University, University Park.

Bojowald works on loop quantum gravity (LQG) – a theory that seeks to unify the otherwise incompatible theories of general relativity and quantum mechanics. In LQG, space-time is made of tiny interconnected loops, each only 10^{-35} metres across, that form a smooth fabric much like a shirt's fabric is smooth even though it is woven from separate threads. Bojowald and his colleagues have run the equations of LQG backwards and shown that they can avoid the singularity. They showed that as the universe collapses, it reaches a point at which it bounces back in a big bang, and the process repeats.

Does that mean that one day we can, either mathematically or via observations, know about the pre-big bang universe? To answer this question, Bojowald developed a simple LQG model to determine the limits of what we can know. In his model, he assumed that the physical properties of the universe were the same everywhere and that the kind of matter it contained did not interact with itself. The model included gravity but not radiation.

The model showed that most, but not all, of the information about what came before the big bang gets irretrievably lost through the big bang transition. And in a perpetual cycle of big bangs and crunches, this information loss means no two universes are ever the same. Bojowald calls this "cosmic forgetfulness".

Cosmologist Paul Steinhardt of Princeton University says that Bojowald's model is right in principle. "It's important to lose some information, but not everything," he says. Thomas Thiemann of the Max Planck Institute for Gravitational Physics in Golm, Germany, says that although some of Bojowald's assumptions may turn out to be too simple, the model is "the cleanest derivation of a pre-big bang scenario that any physical theory has delivered so far".

Giant planets rare in outer solar systems

TUCSON (UPI) -- International astronomers using telescopes in the United States and Chile have determined extrasolar giant planets are very rare in outer solar systems.

University of Arizona astronomers, in collaboration with scientists at the Max Planck Institute for Astronomy in Germany, Italy's Arcetri Observatory, the European Southern Observatory in Chile, the W.M. Keck Observatory in Hawaii and the Harvard-Smithsonian Center for Astrophysics conducted a benchmark three-year survey using direct detection techniques sensitive to extrasolar planets far from their stars.

The findings suggest extrasolar planets more massive than Jupiter at distances beyond five astronomical units from their suns are extremely rare. One AU is the distance between the Earth and the sun.

The survey failed to detect even one giant extrasolar planet in the outer part of any nearby system. A total of 236 known extrasolar planets, or exoplanets, of any size have been detected, according to the answers.com Web site.

Circumstellar Space: Where Stars Are Born

Science Daily

Picture a cool place, teeming with a multitude of hot bodies twirling about in rapidly changing formations of singles and couples, partners and groups, constantly dissolving and reforming.

If you were thinking of the dance floor in a modern nightclub, think again.

It's a description of the shells around dying stars, the place where newly formed elements make compounds and life takes off, said Katharina Lodders, Ph.D., research associate professor of earth and planetary sciences in Arts & Sciences at Washington University in St. Louis.

Chemistry for the very first time

"The circumstellar environment is where chemistry happens for the very first time," said Lodders. "It's the first place a newly synthesized element can do chemistry. It's a supermarket of things from dust to gas and dust grains to molecules and atoms. The circumstellar shells enable a chemistry that produced grains older than our sun itself. It's generated some popular interest, and this year marks the 20th anniversary of the presolar grain discoveries."

After the discovery of presolar diamonds in a meteorite in 1987 — the first stardust found in a meteorite — researchers at Washington University in St. Louis have been prominent in finding and analyzing pre-solar grains made of silicon carbide, diamonds, corundum, spinel, and silicates. The latest discovery — a silicate grain that formed around a foreign star and became incorporated into a comet in our solar system — was captured and returned by the STARDUST space mission in 2006.

The nebula RCW49 is a nursery for newborn stars and exists in circumstellar space, where chemistry is done for the very first time. (Credit: NASA/JPL-Caltech/ E.Churchwell (U. of Wisconsin))

Lodders said that nucleosynthesis — the creation of atoms — takes place in a star's interior, made of a plasma far too hot for any molecular chemistry to take place. The event that enables chemistry is the death of a star, when elements are spewed out of the core, creating a shell around the star. As this circumstellar shell cools, the elements react to form gas molecules and solid compounds.

A star comes of age

Our sun and other dwarf stars of less than about ten solar masses burn hydrogen into helium in their cores. As they come of age, they become Red Giant stars and burn the helium to carbon and oxygen. But many heavy elements such as strontium and barium, even heavier than iron, are also produced, albeit in much smaller quantities than carbon. At the same time, the star begins to eject its outer layers into the interstellar medium by stellar winds, building up a circumstellar shell. So eventually, most of a star's mass, including the newly produced elements, is ejected into the interstellar medium through the circumstellar shell. Most interstellar grains come from such stars.

Heavyweight stars go out more spectacularly, in violent supernovae such as SN2006gy, first observed late last year, which has turned out to be the most massive supernova ever witnessed. But no matter what, all stars like the sun and heavier ones like SN2006gy empty their elements into their circumstellar environments, where gaseous compounds and grains can form. From there, the gas and grains enter the interstellar medium and provide the material for new stars and solar systems to be born.

Lodders presented a paper on circumstellar chemistry and presolar grains at the 233rd American Chemical Society National Meeting, held March 25-29 in Chicago, where a special symposium was held to track the evolution of the elements across space and time. A book of proceedings is being prepared for publication.

(Continued on page 8)

Lodders said that just one percent of all known presolar grains come from supernovas. She said that several million stars have been catalogued and several thousand individual presolar grains have now been analyzed.

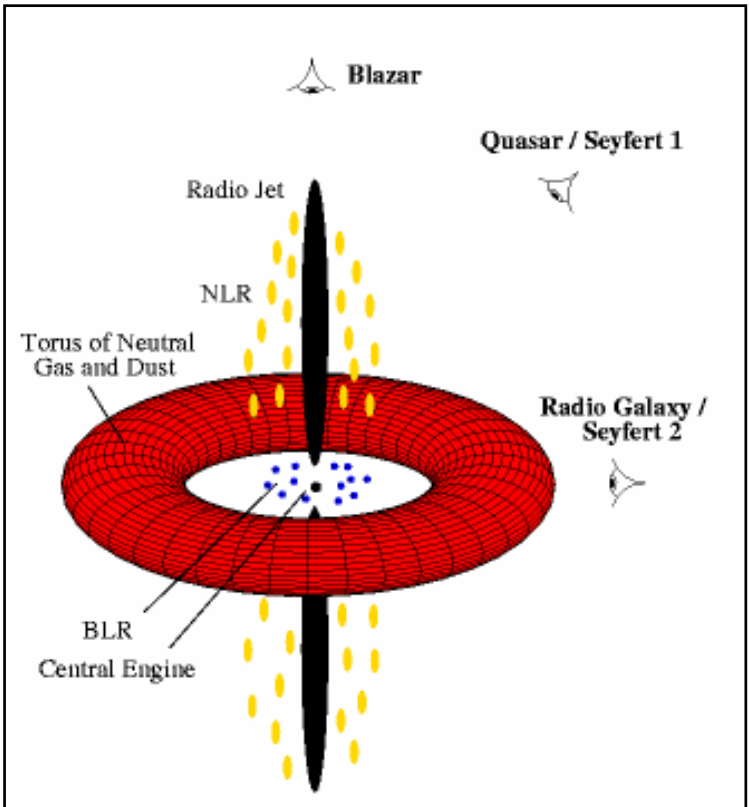
"Back in the 1960s, astronomers didn't know that presolar grains existed in meteorites," Lodders said. "They were discovered when researchers were looking at meteorite samples and studying noble gases. They asked what is the mineral carrier of the noble gases."

By separating minerals from samples of meteorites, they eventually found the carriers of the noble gases — presolar diamonds, graphite and silicon carbide — and thus started the study of presolar grains 20 years ago.

"So the genuine, micron-size star dust survived despite the potential chemical and physical processing in the interstellar medium, during solar system formation, and in the meteorite's parent asteroid," she said. "Since the star dust preserved in meteorites must have been already present before the solar system and the meteorites formed, researchers call this star dust presolar grains."

"Laboratory astronomy of stardust has revealed much about stellar element and isotope production, and about gas and dust formation conditions in giant stars and supernovae."

Note: This story has been adapted from a news release issued by Washington University in St. Louis.



In the 'unified model' of AGN, all share a common structure and only appear different to observers because of the angle at which they are viewed. The newly found black holes do not fit into this model, however, since they do not appear to be surrounded by a doughnut-like "torus" of gas and dust (Illustration: Aurore Simonnet/ Sonoma State University)

(Continued from page 3)

The discoveries of these black holes – which have evaded detection till now because they do not radiate at most wavelengths of light – suggest astronomers have underestimated the number of AGN in the universe by perhaps 20%, says Mushotzky. This could help astronomers better account for the source of diffuse, energetic radiation that pervades the universe, called the cosmic high-energy background, agrees Tueller.

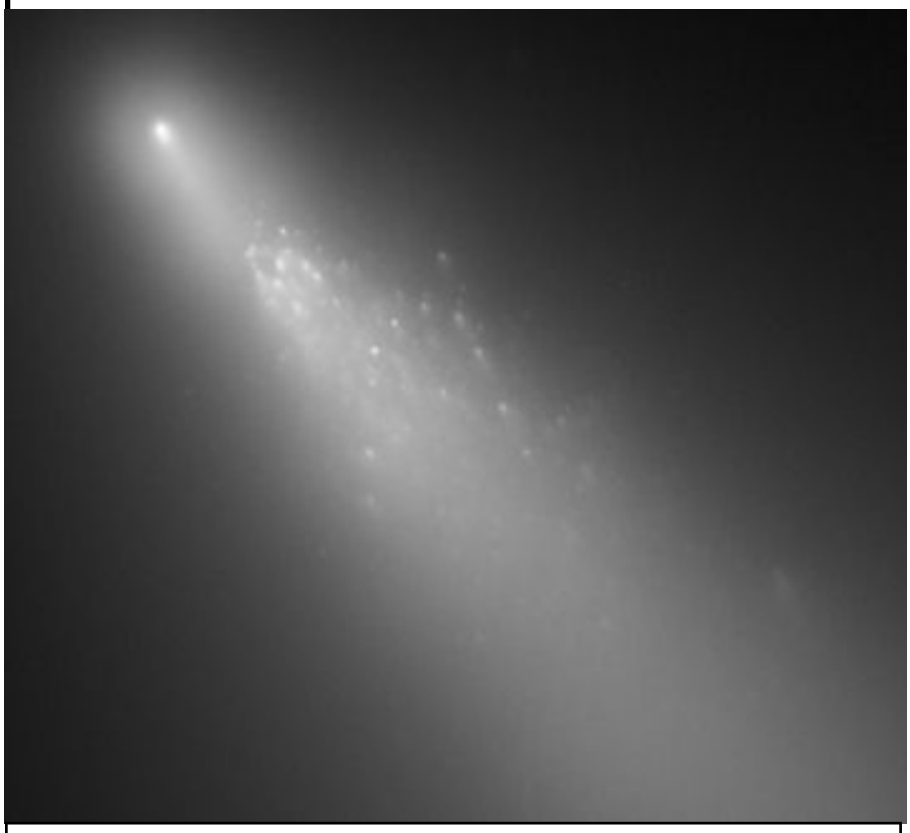
"Another big mystery we don't understand is why are some black holes radiating and others not?" says Mushotzky. "If you don't observe all the objects that are radiating – and we are finding hidden ones – we can't test these ideas out properly."

Current theories suggest mergers betweengalaxies push gas into their cores, igniting the black holes there as AGN. "If that idea is correct, as we do our survey, we should find that many of the objects we're detecting also have the signature of mergers about them – they'll have either close companions, or be highly distorted, or have tidal tails," he says. The team hopes to get clues about the structure of the objects by observing their spectra with the Spitzer Space Telescope, which detects infrared light. The dust and gas around them should absorb the objects' high-energy radiation and re-emit it at infrared wavelengths that would be more energetic in warmer regions close to the black hole and less energetic at greater distances.

Shattering Find? Comet fragments show surprising uniformity

Ron Cowen, Science News

When comets pass close to the sun, solar radiation can bake and chemically alter their outer layers. Yet new observations of fragments of a comet that broke apart almost in front of astronomers' eyes suggest that its interior was remarkably similar to its exterior.



COMET CHIP. Fragment B of comet 73P/Schwassmann-Wachmann 3, observed last spring with the Hubble Space Telescope. The fragment is casting off boulder-size chunks.

For comets, breaking up isn't hard to do. Relics of the solar system's formation, these fragile amalgams of ice, rock, and dust can burst into fragments when the sun's heat vaporizes some of their icy material. By observing such fragments, astronomers can compare material disgorged from a comet's core with the presumably sun-altered material at its surface. Theory suggests that these changes ought to be significant, especially for comets that frequently pass near the sun. That's why scientists were surprised to find that two recently separated chunks have highly similar compositions.

If that observation is representative of comets in general, it suggests that at least some of these frozen bodies may preserve much more of their primordial composition than astronomers have generally believed, says Neil Dello Russo of the Johns Hopkins University's Applied Physics Laboratory in Laurel, Md. He and his colleagues describe their study of two large fragments of a comet called 73P/Schwassmann-Wachmann 3 (SW3) in the July 12 Nature.

The comet, which orbits the sun every 5.34 years, split into at least five chunks in 1995. In June 2006, it passed within 11.7 million kilometers of Earth, just as it further disintegrated into 68 identifiable pieces.The two largest chunks, dubbed B and C, are each several hundred meters in diameter. Russo are his colleagues took spectra of these fragments with NASA's Infrared Telescope Facility and the Keck II telescope, both on Hawaii's Mauna Kea. The measurements, the most accurate ever obtained for a disintegrating comet, reveal that B and C have virtually identical relative abundances of many simple compounds, including water, the hydroxyl molecule, and carbon dioxide.

"We were really lucky" that the comet came close enough for astronomers to make observations soon after a breakup, says Russo. Because such compositional information hasn't been obtained for other fragmenting comets, it's difficult to determine how broadly the findings apply, he cautions.

Previous measurements of other fragmenting comets had hinted at a uniform composition, says comet scientist Michael F. A'Hearn of the University of Maryland at College Park. Researchers are trying to determine whether the diversity of dust particles observed after NASA's Deep Impact spacecraft blasted a hole in Comet Tempel-1 is the result of recent exposure to the sun or represent primordial variations in the comet's composition. The bottom line, says A'Hearn, is that while the new findings on SW3 "may [indeed] be suggesting that comets might be homogeneous . . . I'm not yet ready to tilt in favor of that hypothesis."

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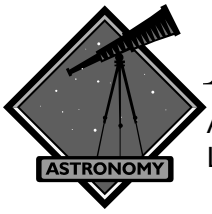

AAL

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