ASTRONOMICAL RESEARCH CENTER (A. R. C.)

Issue 13

Rajab 17, 1428
Mordad 10, 1386
August 01, 2007

neither is it allowable to the sun that it should overtake the moon, nor can the night outstrip the day; and all float on in a sphere

Holy Qur'an 36:40

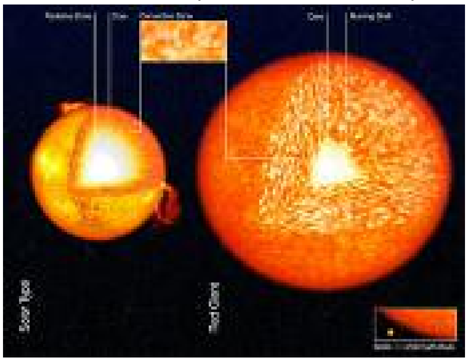
A. R. C. NEWS

Latest Astronomical News on the Internet

Inside This Issue :

Star surface polluted by planetary debris

Looking at the chemical composition of stars that host planets, astronomers have found that while dwarf stars often show iron enrichment on their surface, giant stars do not. The astronomers think that the planetary debris falling onto the outer layer of the star produces a detectable effect in a dwarf star, but this pollution is diluted by the giant star and mixed into its interior.



"It is a little bit like a Tiramisu or a Capuccino," says Luca Pasquini from ESO, lead-author of the paper reporting the results. "There is cocoa powder only on the top!' Just a few years after the discovery of the first exoplanet it became evident that planets are preferentially found around stars that are enriched in iron. Planet-hosting stars are on average almost twice as rich in metals than their counterparts with no planetary system. The immediate question is whether this richness in metals enhances planet formation, or whether it is caused by the presence of planets. The classic chicken and egg problem. In the first case, the stars would be metal-rich down to their centre. In the second case, debris from the planetary system would have polluted the star and only the external layers would be affected by this pollution. When observing stars and taking spectra, astronomers indeed only see the outer layers and can't make sure the whole star has the same composition. When planetary debris fall onto a star, the material will stay in the outer parts, polluting it and leaving traces in the spectra taken. A team of astronomers has decided to tackle this question by looking at a different kind of stars: red giants. These are stars that, as will the Sun in several billion years, have exhausted the hydrogen in their core. As a result, they have puffed up, becoming much larger and cooler. Looking at the distribution of metals in fourteen planet-hosting giants, the astronomers found that their distribution was rather different from normal planet-hosting stars.

Looking at the various options, the astronomers conclude that the most likely explanation lies in the difference in the structure between red giants and solar-like stars: the size of the convective zone, the region where all the gas is completely mixed. In the Sun, this convective zone comprises only 2% of the star's mass. But in red giants, the convective zone is huge, encompassing 35 times more mass. The polluting material would thus be 35 times more diluted in a red giant than in a solar-like star.

"Although the interpretation of the data is not straightforward, the simplest explanation is that solar-like stars appear metal-rich because of the pollution of their atmospheres," says co-author Artie Hatzes, Director of the Thuringer Landessternwarte Tautenburg (Germany) where some of the data were obtained.

When the star was still surrounded by a proto-planetary disc, material enriched in more heavy elements would fall onto the star, thereby polluting its surface. The metal excess produced by this pollution, while visible in the thin atmospheres of solar-like stars, is completely diluted in the extended, massive atmospheres of the giants.

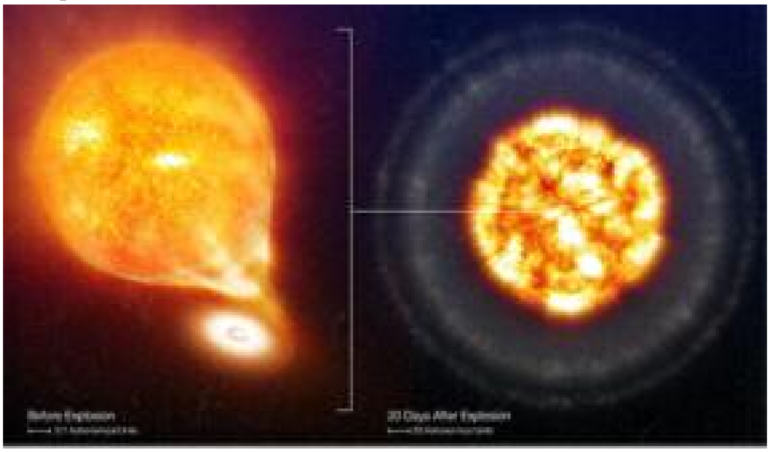
July 21, 2007
www.eso.org

Just a few years after the discovery of the first exoplanet it became evident that planets are preferentially found around stars that are enriched in iron.

Evidence provided for type of supernova scenario

A unique set of observations, obtained with the European Southern Observatory's VLT, has allowed astronomers to find direct evidence for the material that surrounded a star before it exploded as a Type Ia supernova. This strongly supports the scenario in which the explosion occurred in a system where a white dwarf is fed by a red giant.

Because Type Ia supernovae are extremely luminous and quite similar to one another, these exploding events have been used extensively as cosmological reference beacons to trace the expansion of the Universe.



However, despite significant recent progress, the nature of the stars that explode and the physics that governs these powerful explosions have remained very poorly understood.

In the most widely accepted models of Type Ia supernovae the pre- explosion white dwarf star orbits another star. Due to the close interaction and the strong attraction produced by the very compact object, the companion star continuously loses mass, 'feeding' the white dwarf. When the mass of the white dwarf exceeds a critical value, it explodes.

The team of astronomers studied in great detail SN 2006X, a Type Ia supernova that exploded 70 million light-years away from us, in the splendid spiral Galaxy Messier 100 (see ESO 08/06). Their observations led them to discover the signatures of matter lost by the normal star, some of which is transferred to the white dwarf.

The observations were made with the Ultraviolet and Visual Echelle Spectrograph (UVES), mounted at ESO's 8.2-m Very Large Telescope, on four different occasions, over a time span of four months. A fifth observation at a different time was secured with the Keck telescope in Hawaii. The astronomers also made use of radio data obtained with NRAO's Very Large Array as well as images extracted from the NASA/ESA Hubble Space Telescope archive.

"No Type Ia supernova has ever been observed at this level of detail for more than four months after the explosion," says Ferdinando Patat, lead author of the paper reporting the results in this week's issue of Science Express, the online version of the Science research journal. "Our data set is really unique."

The most remarkable findings are clear changes in the absorption of material, which has been ejected from the companion giant star. Such changes of interstellar material have never been observed before and demonstrate the effects a supernova explosion can have on its immediate environment. The astronomers deduce from the observations the existence of several gaseous shells (or clumps) which are material ejected as stellar wind from the giant star in the recent past.

"The material we have uncovered probably lies in a series of shells having a radius of the order of 0.05 light-years, or roughly 3 000 times the distance between Earth and the Sun", explains Patat. "The material is moving with a velocity of 50 km/s, implying that the material would have been ejected some 50 years before the explosion."

Such a velocity is typical for the winds of red giants. The system that exploded was thus most likely composed of a white dwarf that acted as a giant 'vacuum cleaner', drawing gas off its red giant companion. In this case however, the cannibal act proved fatal for the white dwarf. This is the first time that clear and direct evidence for material surrounding the explosion has been found.

"One crucial issue is whether what we have seen in SN 2006X represents the rule or is rather an exceptional case," wonders Patat. "But given that this supernova has shown no optical, UV and radio peculiarity whatsoever, we conclude that what we have witnessed for this object is a common feature among normal SN Ia. Nevertheless, only future observations will give us answers to the many new questions these observations have posed to us."

July 18, 2007
www.eso.org

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Satellites discover biggest collisions in the Universe

The orbiting X-ray telescopes XMM-Newton and Chandra have caught a pair of galaxy clusters merging into a giant cluster. The discovery adds to existing evidence that galaxy clusters can collide faster than previously thought.

When individual galaxies collide and spiral into one another, they discard trails of hot gas that stretch across space, providing signposts to the mayhem. Recognising the signs of collisions between whole clusters of galaxies, however, is not as easy.

Undaunted, Renato Dupke and colleagues from the University of Michigan, Ann Arbor, have used ESA's XMM-Newton and NASA's Chandra orbiting X-ray observatories, to disentangle the puzzling galaxy cluster, Abell 576.

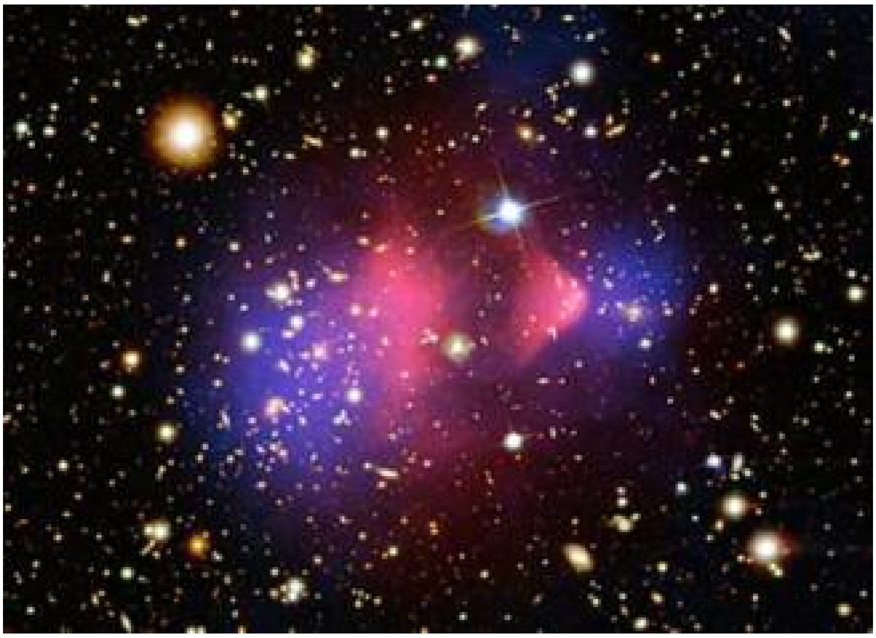
Previous X-ray observations had hinted that the gas was not moving uniformly across the cluster. Using the superior sensitivity and spectral resolution of XMM-Newton and Chandra's high spatial resolution, Dupke took readings from two locations in the cluster and saw that there was a distinct difference in the velocity of the gas. One part of the cluster seemed to be moving away from us faster than the other.

The puzzle was that the moving gas itself was cold by astronomical standards. If this gas moved at such high speeds, it should have had a temperature of more than double the measured 50 million degrees Celsius. "The only explanation was to take the Bullet Cluster and turn it in the line of sight, such that one galaxy cluster is directly behind the other" says Dupke.

The Bullet Cluster is a much-studied pair of galaxy clusters, which have collided head on. One has passed through the other, like a bullet travelling through an apple. In the Bullet Cluster, this is happening across our line of sight, so we can clearly see the two clusters.

Dupke realised that Abell 576 is also a collision, but seen head on, so one cluster is now almost directly behind the other. The 'cold' clouds of gas are the cores of each cluster, which have survived the initial collision but will eventually fall back together to become one.

The data reveals that the clusters have collided at a speed of over 3300 km/s. This is interesting because there are some computer models of colliding galaxy clusters that suggest that such a high speed is impossible to reach. Nevertheless, the Bullet Cluster is estimated to have a collision speed similar to the Abell 576 system. "There is now a growing body of evidence that these high collision velocities are possible," says Dupke. The job of explaining these high speeds now rests with the cosmologists.



Major cluster-cluster collisions are expected to be rare, with estimates of their frequency ranging from less than one in a thousand clusters to one in a hundred. On collision, their internal gas is thrown out of equilibrium and if unrecognised, causes underestimation of its mass by between 5 and 20 percent.

This is important because the masses of the various galaxy clusters are used to estimate the cosmological parameters that describe how the Universe expands. So, identifying colliding systems is extremely important to our understanding of the Universe.

Dupke and colleagues are already investigating a number of other clusters that also appear to be interacting.

July 18, 2007
www.esa.int

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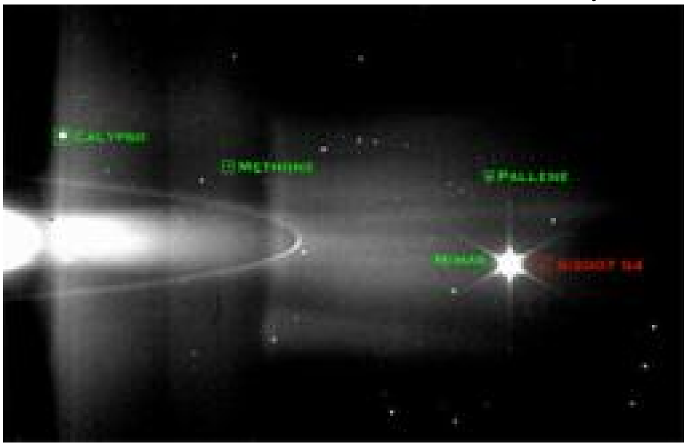
Issue 13 Rajab 17, 1428 Mordad 10, 1386 August 01, 2007

A. R. C. News

From dark obscurity: New Saturn moon comes to light

Like a hawk's eyes, the high resolution cameras on NASA's Cassini spacecraft have spotted yet another small, previously unknown moon circling giant Saturn and one which may indicate the existence of other small bodies in the same region.

The tiny world -- presently thought to be only about 2 kilometers (1 mile) wide -- orbits at 197,700 kilometers (122,800 miles) from Saturn. Until a name for the moon is chosen by the International Astronomical Union, the moon has been given the provisional designation S/2007 S 4.



The moon was first spotted in Cassini images taken on May 30, 2007. Subsequent searches through images taken by Cassini over the previous three years turned up additional detections of the moon and helped researchers refine their calculations of its orbital path.

S/2007 S 4 orbits Saturn between the paths of Methone and Pallene, two small moons, about 4 kilometers (2.6 miles) wide, also discovered in Cassini images in 2004. All three moons orbit between much larger Mimas and Enceladus.

Moons surrounding the giant planets generally are not found where they originally formed because tidal forces from the planet can cause them to drift from their original locations. In drifting, they may sweep through 'resonances' -- i.e., locations where other moons disturb them -- and suffer orbit-changing perturbations. The new moon, like Methone, is in such a resonance with Mimas and appears to have undergone such an evolution.

"The fact that both Methone and S/2007 S 4 are dynamically locked with Mimas gives us a clue about their orbital history," said Carl Murray, a professor at Queen Mary, University of London, and the member of the Cassini Imaging Team leading the work on the new moon. "There are numerous examples of these resonant mechanisms between moons in the Saturn system and they probably arise due to tides. In the case of these two small moons, the resonance ensures that they cannot hit Mimas, at least in the short term."

Because the orbits of all three small moons lie close together, researchers think they may be remnants of a larger population.

"This trio of objects could be remnants of a collision or perhaps they are the lucky survivors of a larger population of material that failed to form a moon," said Murray. "Either way there does seem to be a family connection. If we could get good data about their surfaces with Cassini, we could begin to unravel some of these mysteries."

Cassini imaging scientists are already busy looking for future opportunities to zoom in on the new moon and refine its orbit, and to search for other companions.

"We've already identified times in the near future when we can take some pre-planned images and re-target them to get a closer look at this new body," said Carolyn Porco, imaging team leader and director of CICLOPS at the Space Science Institute. "And of course we're always on the lookout for additional moons. There are likely to be more of these very small bodies out there, and we hope to find them."

By chance, Cassini will approach the newly discovered moon at a distance of 11,700 kilometers (7,300 miles) at the end of December 2009, assuming the mission is extended beyond the summer of 2008, its nominal end. Images taken at that time could be useful for understanding the moon's shape, composition, and history.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. The Jet Propulsion Laboratory (JPL), a division of the California Institute of Technology in Pasadena, manages the Cassini-Huygens mission for NASA's Science Mission Directorate, Washington. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The imaging team consists of scientists from the U.S., England, France, and Germany. The imaging operations center and team leader (Dr. C. Porco) are based at the Space Science Institute in Boulder, Colo.

July 19, 2007
www.ciclops.org

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Chandra observatory catches 'piranha' black holes

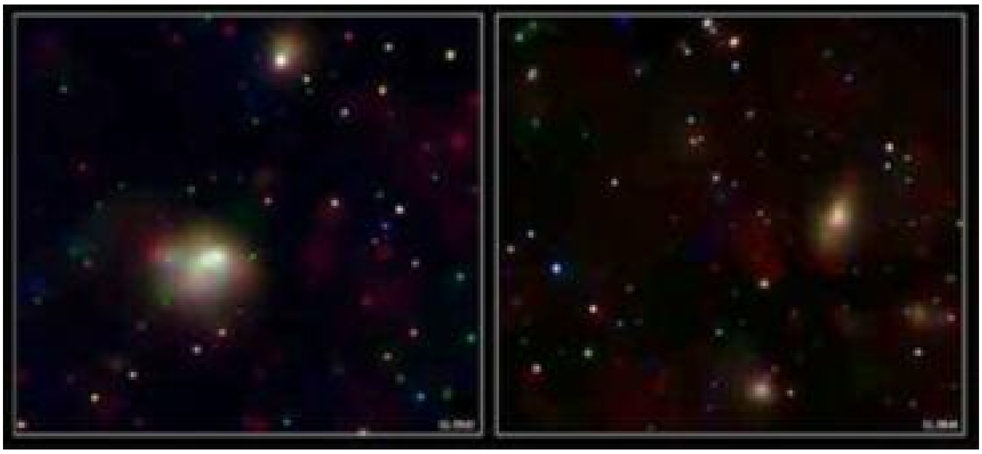
Supermassive black holes have been discovered to grow more rapidly in young galaxy clusters, according to new results from NASA's Chandra X-ray Observatory. These "fast-track" supermassive black holes can have a big influence on the galaxies and clusters that they live in.

Using Chandra, scientists surveyed a sample of clusters and counted the fraction of galaxies with rapidly growing supermassive black holes, known as active galactic nuclei (or AGN). The data show, for the first time, that younger, more distant galaxy clusters contained far more AGN than older, nearby ones.

Galaxy clusters are some of the largest structures in the Universe, consisting of many individual galaxies, a few of which contain AGN. Earlier in the history of the universe, these galaxies contained a lot more gas for star formation and black hole growth than galaxies in clusters do today. This fuel allows the young cluster black holes to grow much more rapidly than their counterparts in nearby clusters.

"The black holes in these early clusters are like piranha in a very well-fed aquarium," said Jason Eastman of Ohio State University (OSU) and first author of this study. "It's not that they beat out each other for food, rather there was so much that all of the piranha were able to really thrive and grow quickly."

The team used Chandra to determine the fraction of AGN in four different galaxy clusters at large distances, when the Universe was about 58% of its current age. Then they compared this value to the fraction found in more nearby clusters, those about 82% of the Universe's current age.



The result was the more distant clusters contained about 20 times more AGN than the less distant sample. AGN outside clusters are also more common when the Universe is younger, but only by factors of two or three over the same age span.

"It's been predicted that there would be fast-track black holes in clusters, but we never had good evidence until now," said co-author Paul Martini, also of OSU. "This can help solve a couple of mysteries about galaxy clusters."

One mystery is why there are so many blue, star-forming galaxies in young, distant clusters and fewer in nearby, older clusters. AGN are believed to expel or destroy cool gas in their host galaxy through powerful eruptions from the black hole. This may stifle star formation and the blue, massive stars will then gradually die off, leaving behind only the old, redder stars. This process takes about a billion years or more to take place, so a dearth of star-forming galaxies is only noticeable for older clusters.

The process that sets the temperature of the hot gas in clusters when they form is also an open question. These new results suggest that even more AGN may have been present when most clusters were forming about ten billion years ago. Early heating of a cluster by large numbers of AGN can have a significant, long -lasting effect on the structure of a cluster by "puffing up" the gas.

"In a few nearby clusters we've seen evidence for huge eruptions generated by supermassive black holes. But this is sedate compared to what might be going on in younger clusters," said Eastman.

These results appeared in the July 20th issue of The Astrophysical Journal Letters. NASA's Marshall Space Flight Center, Huntsville, Ala., manages the Chandra program for the agency's Science Mission Directorate. The Smithsonian Astrophysical Observatory controls science and flight operations from the Chandra X-ray Center in Cambridge, Mass.

July 24, 2007
chandra.harvard.edu

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6

Issue 13 Rajab 17, 1428 Mordad 10, 1386 August 01, 2007

A. R. C. News

Planets with four parents?

Before Spitzer set its gaze on HD 98800, astronomers had a rough idea of the system's structure from observations with ground-based telescopes. They knew the system contains four stars, and that the stars are paired off into doublets, or binaries.

How many stars does it take to "raise" a planet? In our own solar system, it took only one -- our Sun. However, new research from NASA's Spitzer Space Telescope shows that planets might sometimes form in systems with as many as four stars.

Astronomers used Spitzer's infrared vision to study a dusty disk that swirls around a pair of stars in the quadruple-star system HD 98800. Such disks are thought to give rise to planets. Instead of a smooth, continuous disk, the telescope detected gaps that could be caused by a unique gravitational relationship between the system's four stars. Alternatively, the gaps could indicate planets have already begun to form, carving out lanes in the dust.

"Planets are like cosmic vacuums. They clear up all the dirt that is in their path around the central stars," said Dr. Elise Furlan, of the NASA Astrobiology Institute at the University of California at Los Angeles. Furlan is the lead author of a paper that has been accepted for publication in The Astrophysical Journal.

HD 98800 is approximately 10 million years old, and is located 150 light-years away in the constellation TW Hydrae.

Before Spitzer set its gaze on HD 98800, astronomers had a rough idea of the system's structure from observations with ground-based telescopes. They knew the system contains four stars, and that the stars are paired off into doublets, or binaries. The stars in the binary pairs orbit around each other, and the two pairs also circle each other like choreographed ballerinas. One of the stellar pairs, called HD 98800B, has a disk of dust around it, while the other pair has none.

Although the four stars are gravitationally bound, the distance separating the two binary pairs is about 50 astronomical units (AU) -- slightly more than the average distance between our Sun and Pluto. Until now, technological limitations have hindered astronomers' efforts to look at the dusty disk around HD 98800B more closely.

With Spitzer, scientists finally have a detailed view. Using the telescope's infrared spectrometer, Furlan's team sensed the presence of two belts in the disk made of large dust grains. One belt sits at approximately 5.9 AU away from the central binary, HD 98800B, or about the distance from the Sun to Jupiter. This belt is likely made up of asteroids or comets. The other belt sits at 1.5 to 2 AU, comparable to the area where Mars and the asteroid belt sit, and probably consists of fine grains.

With Spitzer, scientists finally have a detailed view. Using the telescope's infrared spectrometer, Furlan's team sensed the presence of two belts in the disk made of large dust grains.

"Typically, when astronomers see gaps like this in a debris disk, they suspect that a planet has cleared the path. However, given the presence of the diskless pair of stars sitting 50 AU away, the inward-migrating dust particles are likely subject to complex, time-varying forces, so at this point the existence of a planet is just speculation," said Furlan.

Astronomers believe that planets form like snowballs over millions of years, as small dust grains clump together to form larger bodies. Some of these cosmic rocks then smash together to form rocky planets, like Earth, or the cores of gas-giant planets like Jupiter. Large rocks that don't form planets often become asteroids and comets. As these rocky structures violently collide, bits of dust are released into space. Scientists can see these dust grains with Spitzer's supersensitive infrared eyes.

According to Furlan, the dust generated from the collision of rocky objects in the outer belt should eventually migrate toward the inner disk. However, in the case of HD 98800B, the dust particles do not evenly fill out the inner disk as expected, due to either planets or the diskless binary pair sitting 50 AU away and gravitationally influencing the movement of dust particles.

"Since many young stars form in multiple systems, we have to realize that the evolution of disks around them and the possible formation of planetary systems can be way more complicated and perturbed than in a simple case like our solar system," Furlan added.

July 24, 2007
spitzer.caltech.edu

Interstellar chemistry gets more complex with discovery

Astronomers using data from the National Science Foundation's Robert C. Byrd Green Bank Telescope (GBT) have found the largest negatively-charged molecule yet seen in space. The discovery of the third negatively-charged molecule, called an anion, in less than a year and the size of the latest anion will force a drastic revision of theoretical models of interstellar chemistry, the astronomers say.

"This discovery continues to add to the diversity and complexity that is already seen in the chemistry of interstellar space," said Anthony J. Remijan of the National Radio Astronomy Observatory (NRAO). "It also adds to the number of paths available for making the complex organic molecules and other large molecular species that may be precursors to life in the giant clouds from which stars and planets are formed," he added. Two teams of scientists found negatively-charged octatetraynyl, a chain of eight carbon atoms and one hydrogen atom, in the envelope of gas around an old, evolved star and in a cold, dark cloud of molecular gas. In both cases, the molecule had an extra electron, giving it a negative charge. About 130 neutral and about a dozen positively-charged molecules have been discovered in space, but the first negatively-charged molecule was not discovered until late last year. The largest previously-discovered negative ion found in space has six carbon atoms and one hydrogen atom. "Until recently, many theoretical models of how chemical reactions evolve in interstellar space have largely neglected the presence of anions. This can no longer be the case, and this means that there are many more ways to build large organic molecules in cosmic environments than have been explored," said Jan M. Hollis of NASA's Goddard Space Flight Center (GSFC). Ultraviolet light from stars can knock an electron

off a molecule, creating a positively-charged ion. Astronomers had thought that molecules would not be able to retain an extra electron, and thus a negative charge, in interstellar space for a significant time. "That obviously is not the case," said Mike McCarthy of the Harvard- Smithsonian Center for Astrophysics (CfA). "Anions are surprisingly abundant in these regions."

Remijan and his colleagues found the octatetraynyl anions in the envelope of the evolved giant star IRC +10 216, about 550 light-years from Earth in the constellation Leo. They found radio waves emitted at specific frequencies characteristic of the charged molecule by searching archival data from the GBT, the largest fully-steerable radio telescope in the world.

Another team from the Harvard -Smithsonian Center for Astrophysics (CfA) found the same characteristic emission when they observed a cold cloud of molecular gas called TMC-1 in the constellation Taurus. These observations also were done with the GBT. In both cases, preceding laboratory experiments by the CfA team showed which radio frequencies actually are emitted by the molecule, and thus told the astronomers what to look for. "It is essential that likely interstellar molecule candidates are first studied in laboratory experiments so that the radio frequencies they can emit are known in advance of an astronomical observation," said Frank Lovas of the National Institute of Standards and Technology (NIST).

Both teams announced their results in the July 20 edition of the Astrophysical Journal Letters.

"With three negatively-charged molecules now found in a short period of time, and in very different environments, it appears that many more probably exist. We believe that we can discover more new species using very sensitive and advanced radio telescopes such as the GBT, once they have been characterized in the laboratory," said Sandra Bruenken of the CfA.

"Further detailed studies of anions, including astronomical observations, laboratory studies, and theoretical calculations, will allow us to use them to reveal new information about the physical and chemical processes going on in interstellar space," said Martin Cordiner, of Queen's University in Belfast, Northern Ireland. "The GBT continues to take a leading role in discovering, identifying and mapping the distribution of the largest molecules ever found in astronomical environments and will continue to do so for the next several decades," said Phil Jewell of NRAO.

July 26, 2007
www.nrao.edu

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A. R. C. NEWS

Internal, Scientific, Cultural, latest astronomical news on the Internet

Astronomical Research Center Activities

Some of the activities:

- Educational Facilities
- Research Facilities
- Receive and Transmit Atomic-Clock waves
- Institution of a virtual observatory
- Cosmic radio observation project
- Calculation and distribution of timings of religious duties
- Organizing scientific conferences with invitations to scholars and experts
- Publishing new titles on the field of Astronomy
- Building an observatory and a big planetarium

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SPECIAL REPORT

Satellites unveil new type of active galaxy

An international team of astronomers using NASA's Swift satellite and the Japanese/U.S. Suzaku X-ray observatory has discovered a new class of active galactic nuclei (AGN). By now, you'd think that astronomers would have found all the different classes of AGN - extraordinarily energetic cores of galaxies powered by accreting supermassive black holes. AGN such as quasars, blazars, and Seyfert galaxies are among the most luminous objects in our Universe, often pouring out the energy of billions of stars from a region no larger than our solar system.

But by using Swift and Suzaku, the team has discovered that a relatively common class of AGN has escaped detection...until now. These objects are so heavily shrouded in gas and dust that virtually no light gets out.

"This is an important discovery because it will help us better understand why some supermassive black holes shine and others don't," says astronomer and team member Jack Tueller of NASA's Goddard Space Flight Center in Greenbelt, Md.

Evidence for this new type of AGN began surfacing over the past two years. Using Swift's Burst Alert Telescope (BAT), a team led by Tueller has found several hundred relatively nearby AGNs that were previously missed because their visible and ultraviolet light was smothered by gas and dust. The BAT was able to detect high-energy X-rays from these heavily blanketed AGNs because, unlike visible light, high-energy X-rays can punch through thick gas and dust. To follow up on this discovery, Yoshihiro Ueda of Kyoto University, Japan, Tueller, and a team of Japanese and American astronomers targeted two of these AGNs with Suzaku. They were hoping to determine whether these heavily obscured AGNs are basically the same type of objects as other AGN, or whether they are fundamentally different. The AGNs reside in the galaxies ESO 005-G004 and ESO 297-G018, which are about 80 million and 350 million light-years from Earth, respectively. Suzaku covers a broader range of X-ray energies than BAT, so astronomers expected Suzaku to see X-rays across a wide swath of the X-ray spectum. But despite Suzaku's high sensitivity, it detected very few low- or medium-energy X-rays from these two AGN, which explains why previous X-ray AGN surveys missed them.

According to popular models, AGNs are surrounded by a donut-shaped ring of material, which partially obscures our view of the black hole. Our viewing angle with respect to the donut determines what type of object we see. But team member Richard Mushotzky, also at NASA Goddard, thinks these newly discovered AGN are completely surrounded by a shell of obscuring material. "We can see visible light from other types of AGN because there is scattered light," says Mushotzky. "But in these two galaxies, all the light coming from the nucleus is totally blocked."

Another possibility is that these AGN have little gas in their vicinity. In other AGN, the gas scatters light at other wavelengths, which makes the AGN visible even if they are shrouded in obscuring material. "Our results imply that there must be a large number of yet unrecognized obscured AGNs in the local universe," says Ueda.

In fact, these objects might comprise about 20 percent of point sources comprising the X-ray background, a glow of X-ray radiation that pervades our Universe. NASA's Chandra X-ray Observatory has found that this background is actually produced by huge numbers of AGNs, but Chandra was unable to identify the nature of all the sources.

By missing this new class, previous AGN surveys were heavily biased, and thus gave an incomplete picture of how supermassive black holes and their host galaxies have evolved over cosmic history. "We think these black holes have played a crucial role in controlling the formation of galaxies, and they control the flow of matter into clusters," says Tueller. "You can't understand the universe without understanding giant black holes and what they're doing. To complete our understanding we must have an unbiased sample."

The discovery paper will appear in the August 1st issue of the Astrophysical Journal Letters.

July 31, 2007
www.nasa.gov