

Text 1 "Black holes"

Universe Teeming with Black Holes

Origin: HQ DEEPEST X-RAYS EVER REVEAL UNIVERSE TEEMING WITH BLACK HOLES.

For the first time, astronomers believe they have proof black holes of all sizes once ruled the universe. NASA's Chandra X-ray Observatory provided the deepest X-ray images ever recorded, and those pictures deliver a novel look at the past 12 billion years of black holes. Two independent teams of astronomers today presented images that contain the faintest X-ray sources ever detected, which include an abundance of active super-massive black holes. "The Chandra data show us that giant black holes were much more active in the past than at present," said Riccardo Giacconi, of Johns Hopkins University, Baltimore, and Associated Universities, Inc., Washington, DC. The exposure is known as "Chandra Deep Field South" since it is located in the Southern Hemisphere constellation of Fornax. "In this million-second image, we also detect relatively faint X-ray emission from galaxies, groups, and clusters of galaxies." The images, known as the Chandra Deep Fields, were obtained during many long exposures over the course of more than a year. Data from the Chandra Deep Field South will be placed in a public archive for scientists beginning today. "For the first time, we are able to use X-rays to look back to a time when normal galaxies were several billion years younger," said Ann Hornschemeier, Pennsylvania State University. The group's 500,000-second exposure included the Hubble Deep Field North, allowing scientists the opportunity to combine the power of Chandra and the Hubble Space Telescope, two of NASA's Great Observatories. The Penn State team recently acquired an additional 500,000 seconds of data, creating another one-million-second Chandra Deep Field, located in the constellation of Ursa Major. The images are called Chandra Deep Fields because they are comparable to the famous Hubble Deep Field in being able to see further and fainter objects than any image of the universe taken at X-ray wavelengths. Both Chandra Deep Fields are comparable in observation time to the Hubble Deep Fields, but cover a much larger area of the sky. "In essence, it is like seeing galaxies similar to our own Milky Way at much earlier times in their lives," Hornschemeier added. "These data will help scientists better understand star formation and how stellar-sized black holes evolve." Combining infrared and X-ray observations, the Penn State team also found veils of dust and gas are common around young black holes. Another discovery to emerge from the Chandra Deep Field South is the detection of an extremely distant X-ray quasar, shrouded in gas and dust. "The discovery of this object, some 12 billion light years away, is key to understanding how dense clouds of gas form galaxies, with massive black holes at their centers," said Colin Norman of Johns Hopkins University. The Chandra Deep Field South results were complemented by the extensive use of deep optical observations supplied by the European Southern Observatory in Garching, Germany. More information is available on the Internet at: <http://chandra.harvard.edu> and <http://chandra.nasa.gov>.

More about Black Holes

When a star runs out of nuclear fuel, it will collapse. If the core, or central region of the star, has a mass that is greater than three suns, no known nuclear forces can prevent the core from forming a black hole.

Anything that comes within a certain distance of the black hole, called the event horizon, cannot escape, not even light. The radius of the event horizon (proportional to the mass) is very small, only 30 kilometers for a non-spinning black hole with the mass of suns.

Since a black hole cannot be directly observed, astronomers must use circumstantial evidence to prove its existence. The bottom line is that the observations must imply that a sufficiently large amount of matter is compressed into a sufficiently small region of space so that no other explanation is possible.

How can black holes be located? X-ray observations are extremely useful for finding black holes. The extreme gravity around black holes will produce X-rays when infalling gas is heated to millions of degrees. The best places to look for black holes are regions where large supplies of gas are available, such as double star systems, star forming regions, or the centers of galaxies.

Have different types of black holes been discovered? There is strong evidence for types of black holes: stellar black holes with masses of a dozen or so suns, and supermassive black holes with masses of many millions of suns. Stellar black holes are formed as a natural consequence of the evolution of massive stars (see 1st paragraph). The origin of supermassive black holes is a mystery. They are found only in the centers of galaxies. It is not known whether they formed in the initial collapse of the gas cloud that formed the galaxy, or from the gradual growth of a stellar mass black hole, or from the merger of a centrally located cluster of black holes, or by some other mechanism.

How do astronomers determine the mass of black holes? The mass of a stellar black hole can be deduced by observing the orbital acceleration of a star as it orbits its unseen companion. Likewise, the mass of a supermassive black hole can be determined by using the orbital acceleration of gas clouds swirling around the central black hole. When orbital acceleration cannot be used to establish the mass of a black hole, astronomers can place a lower limit on its mass by measuring the X-ray luminosity due to matter falling into a black hole. The radiation pressure of the X-rays must be less than the pull of the black hole's gravity. In the case of the black hole discovered in M82, this limits its mass to greater than 500 suns. The M82 black hole is much larger than known stellar black holes and much smaller than supermassive black holes, thus it is called a "mid-mass" black hole.

What is the significance of a third type of black hole? Astrophysicists had come to believe that galactic centers were the only places where conditions were right for the formation and growth of large or very large black holes. The discovery of a large, mid-mass black hole away from the galaxy's center shows that somehow - and it is not an easy task theoretically - black holes much more massive than ordinary stellar black holes can form in dense star clusters. Current possible explanations for the formation of mid-mass black holes include such exotica as black hole mergers or the collapse of a hyperstar. An intriguing implication is that mid-mass black holes could prove to be a common feature in star forming regions of galaxies.