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FIRST X-RAY FLARE FROM BROWN DWARF OBSERVED

It was as if we were searching for a dim bulb and instead found a bright flash of light. -- Lars Bildsten, professor, University of California, Santa Barbara

Surprised scientists made provocative observations of an X-ray flare from a celestial object called a brown dwarf -- the first ever seen from such an object -- giving them strong hints of the tangled magnetic fields that may exist inside, according to an article to be published in the July 20 issue of the Astrophysical Journal Letters.

"We were most surprised by the fact that it was a flare," said Lars Bildsten, co-author and professor of physics at the Institute for Theoretical Physics at the University of California, Santa Barbara.

"At best we expected a few photons every hour," said Bildsten. "Instead, we saw nothing for nine hours and then a bright flare that lasted nearly two hours. If the observation had been shorter, we would have nothing to report."

"We were shocked," said Robert Rutledge, of the California Institute of Technology in Pasadena, and lead author of the paper. "We didn't expect to see flaring from such a lightweight object. This is really the 'mouse that roared.'"

This first X-ray flare ever seen from a brown dwarf, or failed star, was detected by NASA's Chandra X-ray Observatory, the telescope that was launched nearly a year ago. The bright X-ray flare has implications for understanding the explosive activity

and origin of magnetic fields of extremely low mass stars, according to the team of four who made the discovery.

"It was as if we were searching for a dim bulb and instead found a bright flash of light," said Bildsten.

"Less massive than stars but more massive than planets, brown dwarfs were long assumed to be rare," explained principal investigator Gibor Basri in the April issue of Scientific American. "New sky surveys, however, show that the objects may be as common as stars."

Chandra detected no X-rays at all from the brown dwarf known as "LP 944-20" for the first nine hours of a twelve hour observation, then the source flared dramatically before it faded away over the next two hours. The energy emitted in the brown dwarf flare was comparable to a small solar flare and is believed to come from a twisted magnetic field.

"This is the strongest evidence yet that brown dwarfs and possibly young giant planets have magnetic fields, and that a large amount of energy can be released in a flare," said Eduardo Martin, of Caltech, also a member of the team.

Professor Gibor Basri of the University of California, Berkeley, the principal investigator for this observation, speculated that "the flare could have its origin in the turbulent magnetized hot material beneath the surface of the brown dwarf.

A sub-surface flare could heat the atmosphere, allowing currents to flow and give rise to the X-ray flare -- like a stroke of lightning."

Basri, an expert in brown dwarfs wrote an article describing them in the April issue of Scientific American. In that article he explains:

"A brown dwarf is a failed star. A star shines because of the

thermonuclear reactions in its core, which release enormous amounts of energy by fusing hydrogen into helium. For the fusion reactions to occur, though, the temperature in the star's core must reach at least three million kelvins. And because core temperature rises with gravitational pressure, the star must have a minimum mass: about 75 times the mass of the planet Jupiter, or about 7 percent of the mass of our sun. A brown dwarf just misses that mark -- it is heavier than a gas-giant planet but not quite massive enough to be a star."

The brown dwarf, named LP 944-20, is about 500 million years old and has a mass that is about 60 times that of Jupiter, or 6 percent of the sun's mass. Its diameter is one-tenth that of the sun and has a rotation period of less than five hours.

Located in the constellation Fornax in the southern skies, LP 944-20 is one of the best studied brown dwarfs because it is only 16 light years from Earth.

The researchers explained that the absence of X-rays from LP 944-20 during the non-flaring period is in itself a significant result.

It sets the lowest limit on steady X-ray power produced by a brown dwarf, and shows that million degree Celsius upper atmospheres, or coronas, cease to exist as the surface temperature of a brown dwarf cools below about 2500 degrees Celsius.

"This is an important confirmation of the trend that hot gas in the atmospheres of lower mass stars is produced only in flares," said Bildsten.

Since brown dwarfs have too little mass to sustain significant nuclear reactions in their cores, their primary source of energy is the release of gravitational energy as they slowly contract -- at a rate of a few inches per year. They

are very dim --- one hundredth of 1 percent as luminous as the sun -- and of great interest to astronomers because they are poorly understood and probably a very common class of objects that re-intermediate between normal stars and giant planets.

The 12-hour observation of brown dwarf LP 944-20 was made on December 15, 1999, using the Advanced CCD Imaging Spectrometer (ACIS). The ACIS instrument was built for NASA by the Massachusetts Institute of Technology, Cambridge University, and Pennsylvania State University, University Park.

NASA's Marshall Space Flight Center in Huntsville, Ala., manages the Chandra program. TRW, Inc., Redondo Beach, Calif., is the prime contractor for the spacecraft. The Smithsonian's Chandra X-ray Center controls science and flight operations from Cambridge, Mass.

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