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Extremely rare molecule found in interstellar space

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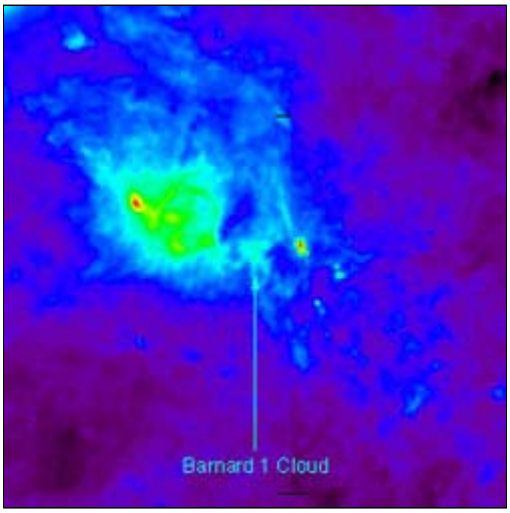

IRAS image of the vicinity of the Barnard 1 cloud in the constellation Perseus, where triply deuterated ammonia was detected at the CSO.

A rare type of ammonia that includes three atoms of deuterium has been found in a molecular cloud about 1,000 light-years from Earth. The comparative ease of detecting the molecules means there are more of them than previously thought.

In a study appearing in the May 20 issue of the Astrophysical Journal Letters, an international team of astronomers reports on the contents of a molecular cloud in the direction of the constellation Perseus. The observations were done with the Caltech Submillimeter Observatory atop Mauna Kea in Hawaii.

The molecule in question is called "triply deuterated ammonia," meaning that each molecule is composed of a nitrogen atom and three deuterium atoms (heavy hydrogen), rather than the usual single nitrogen atom and three hydrogen atoms found in the typical bottle of household ammonia. While not unknown on Earth, the molecules, until recently, were thought by experts to be quite rare-so rare, in fact, that the substance was considered too sparse to even be detectable from Earth.

But now that scientists have detected triply deuterated ammonia in the interstellar medium, they're still wondering why they were able to do so at all, says Tom Phillips, a physics professor at the California Institute of Technology, director of the Caltech Submillimeter Observatory, and leader

of the Caltech team. No other molecules containing three deuterium atoms have ever been detected in interstellar space.

"From simple statistics alone, the chances for all three hydrogen atoms in an ammonia molecule to be replaced by the very rare deuterium atoms are one in a million billion," Phillips explains. "This is like buying a $1 state lottery ticket two weeks in a row and winning a $30 million jackpot both weeks. Astronomical odds indeed!"

The 10.4-meter Leighton telescope of the Caltech Submillimeter Observatory atop Mauna Kea, Hawaii.

As for the reasons the molecules would exist in the first place, says Dariusz Lis, a senior research associate in physics at Caltech and lead author of the paper, the frigid conditions of the dense interstellar medium allow the deuterium replacement of the hydrogen atoms to take place. At higher temperatures, there would be a back-and-forth exchange of the deuterium atoms between the ammonia molecules and the hydrogen molecules also present in the interstellar medium. But at the frosty 10-to-20 degrees above absolute zero that prevails in the clouds, the deuterium atoms prefer to settle into the ammonia molecules and stay there.

The study is important because it furthers the understanding of the chemistry of the cold, dense interstellar medium and the way molecules transfer from grains of dust to the gas phase, Phillips explains. The researchers think the triply deuterated ammonia was probably kicked off the dust grains by the energy of a young star forming nearby, thus returning to the gas state, where it could be detected by the Caltech Submillimeter Observatory.

The study was made possible because of the special capabilities of the Caltech Submillimeter Observatory, a 10.4-meter telescope constructed and operated by Caltech with funding from the National Science Foundation. The telescope is fitted with the world's most sensitive submillimeter detectors, making it ideal for seeking out the diffused gases and molecules crucial to understanding star formation.

In addition to the Caltech observers, the team also included

international members from France led by Evelyne Roueff and Maryvonne Gerin from the Observatoire de Paris, funded by the French CNRS, and astronomers from the Max-Planck-Institut fuer Radioastronomie in Germany.

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