Analysis of meteorite sheds light about how building blocks of life can be created in interstellar space

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ANALYSIS OF METEORITE SHEDS LIGHT ABOUT HOW BUILDING BLOCKS OF LIFE CAN BE CREATED IN INTERSTELLAR SPACE

With the aid of light pulsating from a star, the creation of organic molecules that may ultimately lead to the formation of life could be happening throughout the universe in a relatively simple process.

Clues from a meteorite have prompted researchers to argue in a new study that molecules that may form the building blocks of life, once thought to be nurtured solely through planetary influences, can be generated in space with a simple recipe of certain carbon, sulfur and hydrogen molecules and light.

The report is published by scientists at the University of California, San Diego, and the NASA Ames Research Center in the current issue of the journal Science.

In the study, the researchers analyzed raw organic material from a 4.5 billion year-old meteorite called "Murchison" and discovered that its isotopes (combinations of neutrons and protons that distinguish molecules, or give them "fingerprints") were not only unlike, but uninfluenced, by planetary forces. The researchers also found that the organic molecules were generated from a light source.

"It was extraordinarily unusual," said Mark Thiemens, a UCSD professor of chemistry and chairman of the Department of Chemistry and Biochemistry, about the meteorite sample. "If you look at organic compounds around the solar system: from other meteorites, the earth, plants, water, air, the moon, you know kind of what you're dealing with. This was unlike any of those. So when one thinks about the chemistry and physics environment that might have generated these compounds, it would appear that they were made in interstellar space.

"One could tell from the isotopic distribution that this was a very unusual situation," said Thiemens. "We could tell something specific about how the organic compounds might very well have been made. There's a very good likelihood they were made by interactions with light."

In this study, the researchers extracted pieces of the Murchison meteorite to analyze carbon, hydrogen and sulfonic acids. Specifically, the new report highlights analysis of four isotopes associated with Murchison's sulfur material. Examining the isotopic layout, they found deuterium (a regular hydrogen with one neutron) and carbon distributions that were so anomalous they likely only could have been formed in the low- temperature environment consistent with interstellar space. The isotopic distribution "road map" further led Thiemens and his team to argue that the organic sulfur was likely the product of carbon disulfide subjected to ultraviolet irradiation, or light from a star or comet.

The new study may prove to be a stepping stone for future research on organic molecules now that proof has been uncovered, or a physical "fingerprint" established, that such compounds can be created outside planetary conditions with a light source, including stars or comets.

"Certainly the molecules that one needs for life creation, the fundamental building blocks, are there," said Thiemens. "You're not looking at DNA but you're looking at the pieces in this case carbon disulfide gas-phase molecules - that are needed to build molecules and build bigger molecules for things like amino acids."

Thiemens believes organic compounds, which may be carried to a planet on a vehicle such as a meteorite, may not kick start the life creation process on their own, but can link with biological conditions on a planet to begin creating life.

Meteorites give scientists a unique glimpse into the production of organic matter due to their ability to showcase relatively "raw" compounds, in contrast to those on planetary surfaces that have endured heat and liquid transformations over billions of years.

For the past several decades, researchers have known organic compounds lie within meteorites, but a mystery remained as to where such compounds originated, whether in space or on a planet as a result of interaction with minerals or water. And if they were generated in space, how?

In the Murchison sample, the compounds were created billions of years ago when the solar system was in a gas phase called a nebula. And while the organic carbon and sulfur might have been brought in from another star in another system, the most plausible explanation is that it they were created in our solar system with light from the young sun.

The research suggests that such a creation process, called gas-phase ultraviolet irradiation with light, could be generated in other parts of the universe where such compounds and light sources meet.

"One only needs normal stuff in this case a carbon disulfide gas-phase molecule - that surrounds interstellar space or early solar systems and light, from a sun or a star, and that's it. Then organic compounds can occur," says Thiemens. "What the study is telling us is that there are some fairly widespread pervasive processes that give rise to relatively complicated organic molecules."

Also participating in the study were Teresa Jackson, a researcher in Thiemens' laboratory, and George Cooper and Sherwood Chang of the NASA Ames Research Center.

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