Unusual chemical process discovered in earth's ozone layer by UCSD chemist casts further doubt on popular theory of solar system formation

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UNUSUAL CHEMICAL PROCESS DISCOVERED IN EARTH'S OZONE LAYER CASTS FURTHER DOUBT ON POPULAR THEORY OF SOLAR SYSTEM FORMATION

Air samples collected from the earth's upper atmosphere by a University of California, San Diego chemist are casting further doubt on a popular theory that an exploding supernova triggered the formation of the solar system.

The research, being presented today by Mark Thiemens at the American Chemical Society meeting in San Francisco, also offers the first evidence for an unusual chemical process taking place in the earth's ozone layer. The evidence, based on the discovery of an unusual distribution of oxygen isotopes, could affect scientists' view of the earth's thinning ozone layer and other global climate conditions. (Isotopes are atoms of the same element with different number of neutrons.)

"This unusual distribution of oxygen is completely identifiable," said Thiemens, a professor of chemistry at UCSD. "It's like giving a guy a tattoo of a snake on his cheek; it's real easy to spot that guy because there aren't many tattoos like that."

The new findings stem from a series of laboratory and atmospheric studies set up to either confirm or discount a once- popular theory that the genesis for the solar system came from some outside force.

According to that theory, proposed in 1973 by Robert N. Clayton of the University of Chicago, a huge explosion from a supernova triggered the collapse of dust and gas to form a large rotating mass of heat and energy--a star. The newly created star swirled with such fury that bits of it were thrown into space; the result was an orbiting family of planets.

The foundation for this theory rested on laboratory observations that showed unusual proportions of certain oxygen isotopes in a primitive meteorite called a carbonaceous chondrite. This meteorite, found in 1969 near the village of Pueblito de Allende in northern Mexico, was considered a "Rosetta Stone" for understanding the early formation of the solar system since it was believed to have solidified during the solar systems' early history.

As described by Clayton, the proportion of oxygen 16 found in the Allende meteorite was significantly larger than oxygen 17 and oxygen 18, when compared to other materials found in the solar system. Clayton suggested the excess oxygen could only be explained if the meteorites came close to a large exploding star during their formation and took on the stellar debris.

Thiemens, formerly one of Clayton's postdoctoral students at the University of Chicago, was an early disciple of this theory. However, in 1983 Thiemens performed a simple laboratory experiment at UCSD that cast the first doubts about the supernova theory. In that experiment, he shot an electric charge through oxygen to create ozone, a heavyweight chemical cousin of oxygen. When Thiemens determined the distribution of oxygen isotopes in the process, he found the identical isotopic pattern as observed in the Allende meteorite. The results suggested the origins of the solar system did not require an outside force, but could instead have been created by normal chemical processes.

Several critics remained unimpressed, however. Clayton conceded the results represented "an interesting phenomenon in the laboratory" but, he said, they "haven't shown that it goes on in nature itself."

To answer this criticism, Thiemens began collecting air samples from the earth's upper atmosphere, with balloons launched from White Sands, New Mexico; Palestine, Texas; and Kiruna, Sweden.

Results from these missions, described during the ACS meeting, show the same "funny isotope distributions" found in the Allende meteorite and the laboratory experiments, he said.

"I would say that all the evidence now is against a star blowing up," Thiemens said. "The basic assumption that the only way we could explain this (chemical anomaly) was through a nuclear process died, no question. The second big argument, that our research was a cute laboratory effect not observed in nature- -that's now dead and gone too."

As a byproduct of these atmospheric studies, Thiemens also found convincing evidence that atmospheric ozone performs an unusual "chemical dance" with carbon dioxide during which the two chemicals merge briefly, exchange oxygen and lose energy.

"We didn't know that carbon dioxide and ozone were interacting although there was some theory on that," said Thiemens. "But the funny isotopic distribution tells you unambiguously, one hundred percent, that the oxygen in carbon dioxide must be coming from the ozone."

Until these findings, atmospheric chemists did not know that ozone reacted with anything in the stratosphere other than manmade chemicals and light, Thiemens said. It's believed that the destruction of the ozone layer over the earth's poles stems from such pollutants as chlorofluorocarbons (from spray cans), methane (from combustion) and nitrous oxide.

Thiemens stressed that no one knows how this newly discovered chemical process involving carbon dioxide affects the life cycle of ozone, or other chemical processes in the atmosphere. Questions about the variability of global measurements for this effect, in terms of location and time of year, also need to be answered. Air samples collected from future balloon flights, already planned, might provide some of these answers, Thiemens said.

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