Comet Hyakutake spawned from pre-solar material

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Media Contact: Janet Howard, (619) 534-7572

A team of astronomers who observed Comet Hyakutake from a telescope atop Mauna Kea, Hawaii, has discovered the comet is made up of material that existed in the interstellar medium before the formation of the solar system.

The finding, reported in the May 31 issue of Science, should offer scientists new insights into everything from the conditions present some 4.5 billion years ago when the solar system was born to the origin of life on Earth.

Using the three-meter diameter telescope of NASA's Infrared Telescope Facility, the scientists discovered that Hyakutake's nucleus contains large amounts of ethane and methane. This marks the first time astronomers have ever detected the saturated hydrocarbons in a comet.

The ratio of methane and ethane detected indicates the comet probably formed from the icy material found in the interstellar medium rather than inside the solar nebulae, the dense cloud of gas that gave rise to the solar system, said Marina Fomenkova, an astronomer at the University of California, San Diego who participated in the study.

"If the ethane and methane were formed or modified in the solar system, the abundance of ethane should be a few thousand times less than the abundance of methane," Fomenkova said. "In this case, they are almost comparable in abundance, which would be indicative of interstellar chemistry."

The scientists stumbled across the discovery of methane and ethane by accident on March 24, 1996 while studying the comet with a high-resolution spectrometer, said Fomenkova, a member of UCSD's Physics Department and Center for Astrophysics and Space Sciences. They were originally searching for the spectral signature indicating the presence of methyl alcohol, which already had been detected in other comets.

"The discovery of ethane was a blinding surprise," said Michael J. Mumma, of NASA's Goddard Space Flight Center, who served as team leader on the project. "These spectral lines were so bright they seemed to leap off the computer screen at us when the first cometary scan was displayed."

Ethane and methane were found to each make up about 1 percent and carbon monoxide 5 percent of the frozen gases in the comet.

Other scientists participating in the study included Michael A. DiSanti of Goddard Space Flight Center and Catholic University of America; Neil Dello Russo and David X. Xie of Goddard; Karen Magee-Sauer of Rowan College of New Jersey; and Charles D. Kaminski of the NASA Infrared Telescope Facility.

The brightest comet to streak by Earth in two decades, Hyakutake was easily visible to the naked eye. The comet passed within 9.3 million miles of Earth in the spring of 1996, a mere stone's throw compared to the huge distance that separated Halley's Comet from Earth when it made its appearance in 1986.

Despite spending years studying comets, Fomenkova said Hyakutake was the first comet she was able to observe with her own eyes.

"Actually, I saw it just from my own back yard," she said. "Usually, comets are so faint that it is difficult to see them even from a telescope, but this time it was so bright you couldn't miss it. I just looked up at the sky and there it was. It was absolutely spectacular."

Understanding the composition of comets such as Hyakutake provides scientists with important information about conditions of the early Earth.

"Some theories hold that, for example, all the water on Earth could have been brought here by comets when they bombarded the Earth because they are made up of about 50 percent water," Fomenkova said. "The same is true for organic materials. We now know that comets are rich in organic materials and they have some rather complicated organic chemistry, so they could have brought this pre-biotic material to the Earth, which then may have contributed as sort of building blocks to the origin of life."

Both ethane and methane occur naturally on Earth and on some other planets, although ethane is much less abundant than methane. The gases also have been found in primitive meteorites, including the Murchison meteorite which fell to Earth in Australian 1969. Fomenkova conducted an extensive comparison of organic compounds found in Comet Halley with those of the Murchison meteorite.

"It is possible that the gases found in the Murchison meteorite and those found in the comet have a common origin," she said. "However, the diversity of organic material in primitive meteorites and in comets shows that they formed under a wide range of conditions," she cautioned.

To interview a Goddard Space Flight Center scientist, please contact Jim Sahli at (301) 286-0697

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