THE DETECTION OF CARBON DIOXIDE AND METHANE ICE IN SPACE

Large amounts of carbon dioxide and methane ice were detected around newly formed stars by an international team of experts consisting of Drs. Doug Whittet (Rensselaer Polytechnic Institute), Thijs de Graauw, Paul Wesselius, and Adwin Boogert (The Dutch Space Research Organization, Groningen), Alexander Tielens (NASA Ames Research Center), and Pascale Ehrenfreund, Willem Schutte and Ewine van Dishoeck (Leiden Observatory Laboratory, The Netherlands). They used the Short Wavelength Spectrometer on board of the Infrared Space Observatory (ISO) to search for the tell tale absorption features of these molecules in the spectra of newly formed stars.

"This is the first strong evidence for these molecules in interstellar space," said Whittet, the team leader, "and our results show that these molecules make up a unexpectedly large fraction of the carbon-bearing molecules in ices in space".

The results were reported in the special issue of Astronomy & Astrophysics on the ISO First Results.

"We have finally seen the spectral signature of something that we have been looking for for years," said de Graauw, who developed the infrared spectrograph used on ISO. "We expected these ices to be present in space but it is very gratifying to actually prove it."

New stars are formed in the extremely cold environments of interstellar clouds and many of the molecules freeze out in the form of ices, much like frost freezes out on a car's windshield on a cold night. The presence of water, carbon monoxide, and methanol molecules in these ices in space was well established from the ground. Searches for carbon dioxide and methane in space are impossible from ground-based observatories because of the large amounts of these molecules in the earth atmosphere which completely mask the much weaker space features. ISO has a unique capability to conduct infrared astronomy above the atmosphere. "This puts the fizz in the interstellar ice cocktail," said Tielens but he is quick to add, "the champagne industry doesn't need to worry. Most of the alcohol in these ices is woodalcohol and not suitable for human consumption".

"We mimick the low temperatures of space in the laboratory," said Ehrenfreund and Schutte, whose extensive laboratory studies on the properties of carbon dioxide and methane ices made the successful detections possible. "The infrared spectra of these molecules depend sensitively on the detailed composition of the ice. Hence, these observations can be used as fingerprints to determine the physical conditions of these ices".

"Many people think that ices in comets in our solar system are made from interstellar ices, and that these comets delivered most of the volatile gasses to the earth and other planets," said Whittet, "Hence, the detection of large amounts of carbon dioxide and methane has implications for understanding the behavior of comets, as well as the origin and evolution of life on earth". "This detection opens up a new area of research on the conditions during the formation and early evolution of stars and planets, including the solar system," said de Graauw and van Dishoeck. "We want to know how these molecules are formed and how they evolve when the newly formed star starts to heat up its environment and using these molecular fingerprints will enable us to do this".

"By measuring the relative amounts of all important carbon–bearing molecules —methanol, methane, carbon monoxide, and carbon dioxide— we can probe the chemistry taking place in space and determine the influence of the newly–formed star on the surrounding cloud material," said Tielens. "These first results show that outgassing of these ices is an important process. In a way, these interstellar ices behave much like comets which upon approaching the sun, heat up, and develop a surrounding coma of released gases. The most volatile molecules such as carbon monoxide are lost first to the gas phase, while the least volatile molecules, including carbon dioxide and water ice itself, stay around longer in the form of an ice."

ISO will be operative for another 12 months and the team plans to extend their observations to a larger sample of stars in various stages of formation to address these questions.

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