PRESS RELEASE

Discovery of dimethyl sulfide (DMS) in the interstellar medium: Is it a good biosignature?

An international team of scientists led by the Centro de Astrobiología (CAB), CSIC-INTA, has discovered the presence of dimethyl sulfide (DMS) in the interstellar medium. This finding shows that DMS can form abiotically in space, challenging its reliability as a biomarker in the search for extraterrestrial life in exoplanet science. It also marks a major step forward in our understanding of interstellar chemistry, as DMS ranks as the most complex sulfur-bearing molecule identified in the interstellar medium to date.

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A recent study conducted by a multidisciplinary and international scientific team led by Miguel Sanz-Novo, a Juan de la Cierva researcher at the Centro de Astrobiología (CAB), CSIC-INTA, presents the first detection of dimethyl sulfide (CH_3SCH_3, DMS) in the interstellar medium. This is the most complex sulfur-containing molecule discovered so far, along with its isomer ethanethiol (CH_3CH_2SH), which had been previously detected by CAB researchers who are also co-authors of this study. On Earth, DMS is the most abundant sulfur-containing volatile compound in surface seawater and plays a key role in both the sulfur cycle and climate regulation. Additionally, in small quantities, this molecule contributes to the distinctive “smell of the sea” that we perceive when approaching the coast.

The discovery of DMS was made in a molecular cloud located near the center of our Galaxy, specifically in the G+0.693–0.027 cloud. The research team used astronomical data from a large observational project led by CAB, obtained with the 30-meter IRAM radio telescope in Pico Veleta (Granada) and the 40-meter telescope at the Yebes Observatory of the National Geographic Institute (Guadalajara), both located in Spain.

Until now, it was believed that terrestrial DMS originated exclusively from marine biological activity, produced by phytoplankton and bacteria in the oceans. Consequently, this molecule had been considered a biomarker or “biosignature” in the atmospheres of potentially habitable exoplanets (i.e., a molecular indicator of the presence of carbon-based life). By definition, biomarkers imply an exclusively biotic origin, meaning they can only be generated through the metabolism of living organisms. Recently, a group of astronomers from Cambridge reported a possible detection of DMS in the atmosphere of K2-18b, a "Hycean" exoplanetary world located in its star’s habitable zone. The group suggested that K2-18b could host an ocean on its surface and that the presence of DMS might be a sign of alien marine life.

However, the new detection of DMS in a "lifeless" molecular cloud confirms that this molecule can be produced through abiotic pathways. This finding aligns with the identification of DMS in late 2024 in the coma of comet 67P/Churyumov–Gerasimenko - located within our Solar System- by ESA's Rosetta mission, as well as with recent laboratory experiments showing that DMS can form via photochemical reactions, without the involvement of living beings. Altogether, these results suggest that DMS is not a good biomarker. "*Our results offer conclusive observational evidence that the chemistry of the cosmos alone is capable of producing large quantities of DMS, abiotically, in the interstellar medium. This underscores the incredible chemical complexity of interstellar space, where increasingly sophisticated molecules are continuously being formed, and DMS stands is a clear example*" says lead author Sanz-Novo.

This study represents a major step forward in understanding the chemical inventory of the interstellar medium and, in particular, the chemistry of sulfur, an essential element for the development of life. In this context, it is believed that a significant portion of the key ingredients for life may have been delivered to the early Earth through the impact of comets and meteorites formed in the same nebula that gave rise to the Solar System. "*Sulfur is present in all major classes of biomolecules: proteins, sugars, nucleic acids, and vitamins*," explains Víctor M. Rivilla, a Ramón y Cajal researcher at CAB and co-author of the study, who adds: "*However, we must be very cautious when interpreting the presence of these molecules as evidence of life per se. Rather than a biomarker -which would imply the presence of living organisms- DMS can be considered a 'bio-seed,' that is, a molecule which, together with others and in the right environment, may have the potential to give rise to prebiotic chemistry.*"

This discovery adds to the significant contributions of CAB to the field of astrochemistry, including the first detections in space of several molecules of key astrobiological interest, such as ethanolamine and glycolamide -the latter being the first known isomer of glycine, the simplest amino acid, ever identified in the interstellar medium.

About CAB

Centro de Astrobiología (CAB), CSIC-INTA is a joint research center of the Spanish National Research Council (CSIC) and the National Institute of Aerospace Technology (INTA). Created in 1999, it was the world's first center dedicated specifically to astrobiological research and the first non-US associate member of NASA's Astrobiology Institute (now the NASA Astrobiology Program). It is an interdisciplinary research center whose main objective is to study the origin, presence and influence of life in the universe. In 2017, CAB was distinguished by the Ministry of Science and Innovation as "María de Maeztu Unit of Excellence" for the period 1 July 2018 to 30 June 2022.

CAB has led the development of the REMS, TWINS and MEDA, instruments, all operational on Mars since August 2012, November 2018 and February 2021, respectively; as well as the science of the RLS and Raman instrument of the ESA's Exomars Mission. In addition, since its inception, the center has been developing the SOLID instrument, aimed at the search for life in planetary exploration. Likewise, CAB participates in different missions and instruments of great astrobiological relevance, such as CARMENES, CHEOPS, BepiColombo, DART, Hera, the MIRI and NIRSpec instruments at JWST and the HARMONI instrument at ESO's Extremely Large Telescope (ELT).

More information

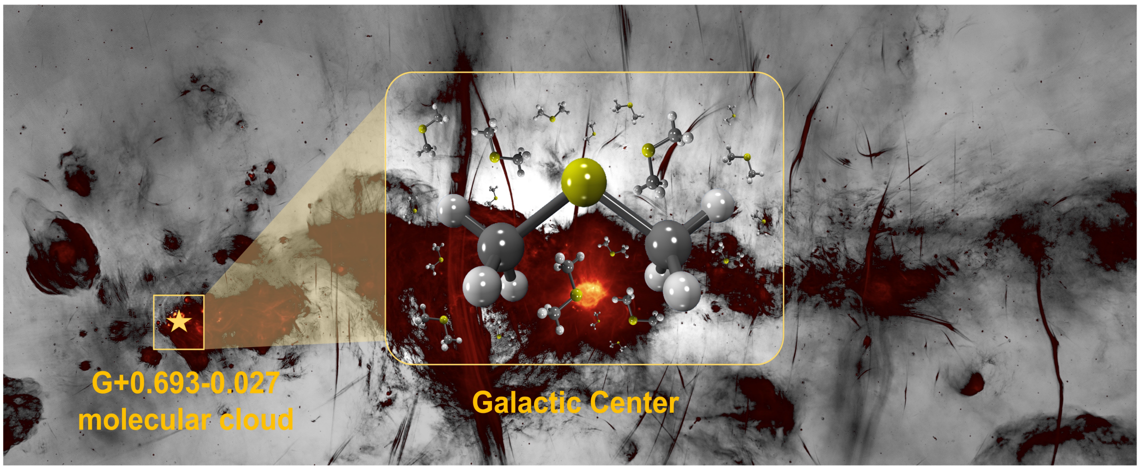

Figure 1. Discovery of dimethyl sulfide (CH_3SCH_3; DMS) in the molecular cloud G+0.693-0.027, located near the center of our Galaxy. Credits: Ian Heywood (Oxford U.), SARAO / Juan Carlos Muñoz-Mateos (ESO) / V. M. Rivilla (CAB) & M. Sanz-Novo (CAB).

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"On the Abiotic Origin of Dimethyl Sulfide: Discovery of Dimethyl Sulfide in the Interstellar Medium", by Miguel Sanz-Novo, Víctor M. Rivilla, Christian P. Endres, Valerio Lattanzi, Izaskun Jiménez-Serra, Laura Colzi, Shaoshan Zeng, Andrés Megías, Álvaro López-Gallifa, Antonio Martínez-Henares, David San Andrés, Belén Tercero, Pablo de Vicente, Sergio Martín, Miguel A. Requena-Torres, Paola Caselli, and Jesús Martín-Pintado, *ApJL,* 980, L37. DOI: 10.3847/2041-8213/adafa7

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