PRESS RELEASE

First Image in Space of a Molecule with a Disulfide Bond

A international team of scientists led by the Centro of Astrobiología (CAB), CSIC-INTA, has achieved the first space-based image of S_2H, a key disulfide bond molecule in terrestrial biochemistry, towards the Horsehead Nebula. This finding suggests that complex molecules, possibly related to the origin of life, could form in cold interstellar clouds long before planets. SH^+ and CO^+ have also been detected for the first time in this nebula, revealing the influence of UV radiation on the chemistry of the cosmos.

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An international team led by the Centro de Astrobiología (CAB, CSIC-INTA) has achieved a scientific milestone: capturing the first images of the sulfur-bearing molecule S_2H in the famous Horsehead Nebula. This molecule is, to date, the only species detected in the interstellar medium that contains a disulfide bond (S–S), a type of chemical bond that plays a crucial role in terrestrial biochemistry. In mammalian cells, disulfide bonds are essential for the folding, stability, and solubility of proteins.

In addition to S_2H, the scientists have detected, for the first time in this nebula, other intriguing molecules such as SH^+ and CO^+—highly unstable compounds that do not naturally occur on Earth. In space, these species are only found in regions heavily irradiated by ultraviolet (UV) light, such as the edges of molecular clouds where new stars are born.

By comparing the images of these species with the spatial distribution of S_2H, astrochemists have concluded that S_2H forms on the surfaces of interstellar dust grains. On these icy surfaces—mainly composed of water (H_2O) and containing sulfur atoms—UV radiation from nearby stars triggers chemical reactions that produce S_2H. This formation mechanism has also been confirmed in laboratory experiments performed at CAB by members of the same research team.

The researchers believe that most protoplanetary disks—the environments in which planets form—undergo phases of intense UV irradiation, as star formation often occurs in clusters that include massive, UV-emitting stars. Interestingly, evidence from meteorites suggests that the disk that gave rise to our own Solar System was also exposed to such intense radiation, likely from a now-dead massive companion star of the young Sun.

The discovery of S_2H in space represents a crucial step forward in our understanding of how complex and potentially prebiotic molecules form in the interstellar medium. It suggests that some of the chemical processes essential for life may have begun long before the formation of planets, in the cold clouds where stars and planetary systems are born.

About CAB

Centro de Astrobiología (CAB) is a joint research center of the National Institute of Aerospace Technology (INTA) and the National Research Council (CSIC) of Spain. 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 from a transdisciplinary approach. In 2017, CAB was distinguished by the Ministry of Science and Innovation as "María de Maeztu Unit of Excellence".

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 RAX Raman instruments, which will be launched in this decade on board of ExoMars and MMX missions. In addition, CAB develops 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, PLATO, BepiColombo, DART, Hera, the MIRI and NIRSpec instruments at JWST and the HARMONI instrument at ESO's Extremely Large Telescope (ELT).

More information

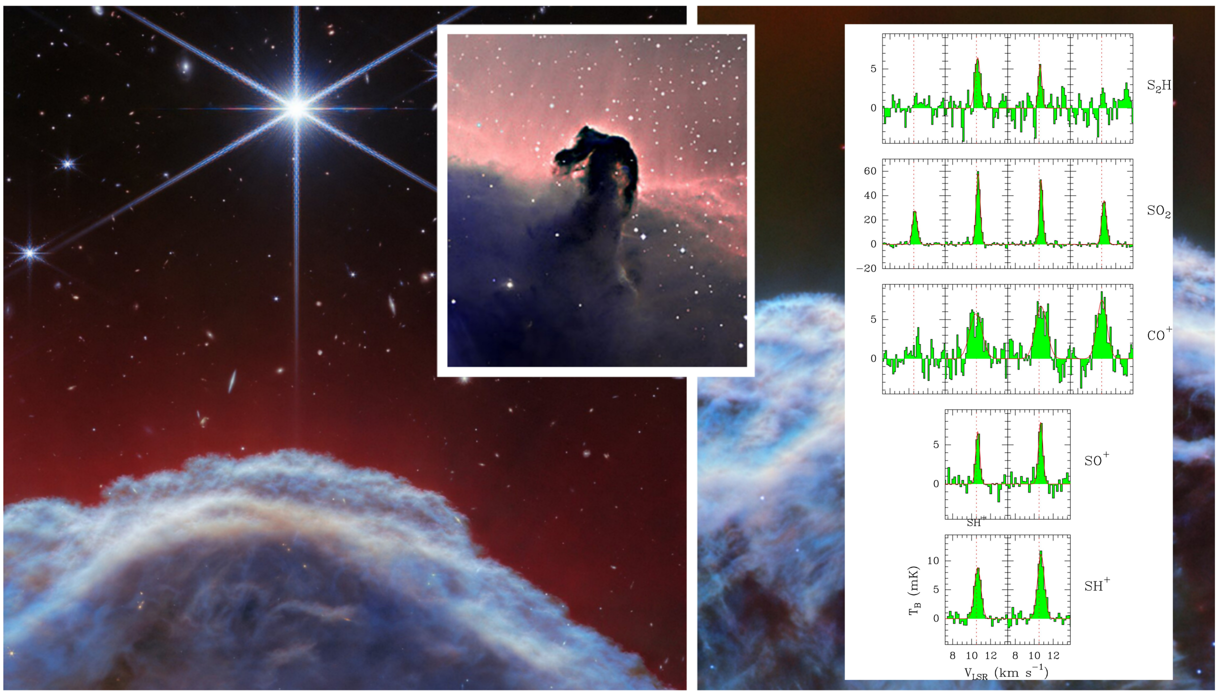

Figure 1.- Spectra of S_2H, SO_2, CO^+, SH^+, and SO as observed towards the Horsehead Nebula. Image credit: ESA/Webb, NASA, CSA, K. Misselt (University of Arizona), and A. Abergel (IAS/ University Paris-Saclay, CNRS).

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“**The sulfur plume in the Horsehead nebula: New detections of S2H, SH+, and CO+**” by Asunción Fuente, Gisela Esplugues, P. Rivière-Marichalar, David Navarro-Almaida, Rafael Martín-Doménech, Guillermo M. Muñoz-Caro, Álvaro Sánchez-Monge, Angèle Taillard, Héctor Carrascosa, Julián José Miranzo-Pastor, Aitana Tasa-Chaveli, Patricia Fernández-Ruiz, Viviana Guzmán, Javier R. Goicoechea, Maryvonne Gerin y Jerome Pety, ApJL 986, L17. DOI: 10.3847/2041-8213/addbd3
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