Searching for oxygen in space

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A Hubble image of a region of the Orion Nebula. A new search for molecular oxygen in space - this time in the Orion Nebula - has come up empty-handed, leading to some new ideas on what is wrong in the chemical models. Credit: NASA/Hubble Space Telescope

(Phys.org) -- Searches for interstellar molecular oxygen, O2,have a long history, and the motivation for these searches has evolved. Prior to the late 1990's, efforts to detect O2 were driven by a desire to confirm its predicted role as a major reservoir of elemental oxygen within dense molecular clouds and as the most important gas coolant of typical clouds

after carbon monoxide (CO). But O2 was never found. The SAO-led Submillimeter Wave Astronomy Satellite (SWAS) in 1998 and the Odin satellite in 2001 both failed to detect O2 toward a large number of sources at levels of a few percent of the abundances predicted by equilibrium gas-phase chemical models. Something in the chemical models was wrong, but what?

The conclusion forced a shift in the emphasis of searches. Today, interest in O2 no longer lies in its being a significant reservoir of elemental oxygen or in its cooling power. Instead, the searches have become an important way to test our current understanding of interstellar chemistry, and the various key formation, destruction, and depletion processes for O2 and the balance between them.

CfA astronomers Gary Melnick and Volker Tolls led a team of nineteen astronomers using the Herschel Space Observatory in study of O2 in the Orion nebula, a location well known for its rich chemistry. Herschel instruments have both high sensitivity and the broad wavelength coverage needed to search for the molecule in several of its emission lines. Writing in the *Astrophysical Journal*, the scientists report that they still did not find O2. The improved sensitivity, however, allows them to reach some general, if preliminary conclusions about four issues: the way oxygen clings to ice in the interstellar medium (perhaps stronger than previously suspected), the amount of total material in the Orion region (less than had been thought), the way O2 clumps together (smaller clumps), and the location of these molecules in the clouds (buried deeper than previous estimates). Further modeling and additional observations will clarify the situation further, but the present work goes a long way to narrowing the possible explanations for the mysterious absence of this life-giving molecule.

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