New Approaches to Large Molecular Synthesis in the Interstellar Medium

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Organic molecules with six or more atoms have been observed in many regions of space, in particular in the so-called interstellar medium (ISM), which consists mainly of clouds of gas and dust, parts of which are collapsing to form new generations of stars and planets. These organic molecules come in three groups: (1) so-called carbon-chain species, which are very unsaturated (hydrogen-poor) molecules with a linear or near linear structure; (2) COMs (complex organic molecules), which are more standard molecules, often found in an organic laboratory in the form of liquids, whereas they are found in space in their gaseous forms; (3) fullerenes and polycyclic aromatic hydrocarbons.

Until recently it was thought that the synthesis of the first two classes of molecules was well understood, with the chemistry dependent upon differing physical conditions: carbon-chain species are located in very cold clouds (10 K) while COMs are located in warming regions which eventually form stars and planets. The chemistry in cold regions was thought to be dominated by ion-neutral processes in the gas, while the chemistry in warming regions was thought to occur mainly on dust grains followed by near total desorption into the gas at temperatures over 100 K or so [1].

This simple picture is now known to be false. COMs are now also found in cold regions, and carbon-chain molecules are also found in warming regions. This talk will be concerned with the problem of producing COMs in cold regions, for which a number of new chemical mechanisms have been proposed, both in the gas and on the surfaces of dust grains. We will concentrate on a newly considered grain mechanism: radiolysis caused by high energy cosmic rays (mainly protons traveling near the speed of light) bombarding the ice mantles of cold dust grains [2,3].

References

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