LOW TEMPERATURE GAS-PHASE AND SURFACE REACTIONS IN INTERSTELLAR CLOUDS

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Molecules are known to exist in both diffuse and dense interstellar clouds, mainly at temperatures well below 100 K. Indeed, the sources with the largest inventory of molecules are typically very cold (10 K) and have densities very low by terrestrial standards (10,000 cm^{-3}). Under these conditions, molecules must be synthesized by very efficient reactions that possess no activation energy barriers. In the gas-phase, exothermic positive ion-molecule reactions constitute the dominant type of process for the formation and destruction of molecules, although the role of neutral-neutral reactions is now recognized to be much more important than previously thought. Molecular ions are neutralized by dissociative recombination reactions, which have recently been studied in storage rings. On the surfaces of tiny interstellar dust grains, another type of chemistry is thought to occur, in which atoms and radicals diffuse rapidly on surfaces and eventually recombine to form larger species. The most important process occurring on cold surfaces in space is the formation of molecular hydrogen from two hydrogen atoms. In my talk, I will discuss all of the types of chemical processes, both in the gas and on dust-grain surfaces, that are important in the chemical balance of interstellar clouds. I will emphasize the current state of knowledge of these processes, and what still needs to be learned.

A basic reference is ``The chemistry of interstellar space", by Eric Herbst (Chemical Society Reviews, vol. 30, 168-176 [2001]). Other information can be obtained on our web site (http://www.physics.ohio-state.edu/~eric/) and the web site http://astrochemistry.net, maintained by Dr. Andrew Markwick.