RECONSIDERING RADICAL-RADICAL REACTIONS ON GRAIN SURFACES: A NEW INTERSTELLAR CHEMICAL MODEL

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Early interstellar chemical models considered complex molecule formation on grains, but current models assume that simple molecules form on grains and subsequent gas phase ion-molecule reactions produce the more complex species. It has been shown, however, that gas phase ion-molecule reactions are insufficient for the production of such complex organic species as ethanol (CH_3CH_2OH) and methyl formate (CH_3OCHO). Organics such as acetaldehyde (CH_3CHO), ethanol, methyl formate, acetic acid (CH_3COOH), and glycolaldehyde (CH_2OHCHO) have also been detected in high abundance in regions of grain mantle disruption, indicating that these species are formed on grain surfaces. The mechanisms for complex molecule production on grains are clearly much more important, and much more complex, than has been recognized.

Recent observational studies of these species have offered insight into the mechanisms for their possible grain surface synthesis. The relative hot core abundances of the 2C structural isomers methyl formate, acetic acid, and glycolaldehyde (52:2:1, respectively) indicate that if they form on grains it is not from kinetically-controlled single-atom addition reactions. Likewise, the 3C aldose sugar, glyceraldehyde ($CH_2OHCHOHCHO$), was not detected in Sgr B2(N-LMH) while the 3C ketose sugar, dihydroxyacetone ($CO(CH_2OH)_2$) was detected in this source. All of these species can be formed from reactions involving the abundant grain mantle constituents CO, HCOOH, and CH_3OH and their radical precursors. A model has been developed to investigate this chemical network, and the results of this study will be presented.