Formation and Evolution of Molecules in Dense Clouds Formation Behind Shocks

George Hassel[1], Eric Herbst[1,2], & Ted Bergin[3]

1. Dept. of Physics, The Ohio State University, Columbus, OH 43210
   Email: ghassel@mps.ohio-state.edu
2. Depts. of Astronomy & Chemistry, The Ohio State University, Columbus, OH 43210
3. Dept. of Astronomy, University of Michigan, Ann Arbor, MI 48109

Abstract:

We explore the initial formation of molecules in the gas and on grain surfaces during the formation of a dense molecular cloud forming behind a shock in the diffuse ISM. Specifically, we incorporate previous hydrodynamic simulations as the physical inputs for the solution of a detailed gas-grain chemical reaction network. The resulting abundances are then compared with observations of the molecular composition of both the gas-phase and icy grain mantles within dark clouds. In such simulations, the column density and extinction grow from initially low values to those more closely associated with a dark cloud, and photodesorption processes play an important role in the composition of ices at low to intermediate values of the extinction. We find that simple ices, in particular the water ice mantle, forms as the cloud is born, while CO is found in the gas. Thus the initial state of dense cloud chemistry does not start with the atoms as typically assumed, but rather is one where molecules exist in the gas and also on grain surfaces. Further, we investigate the subsequent formation of complex gas phase molecules following the creation of the dark cloud.