SHOCK-INDUCED MOLECULAR ASTROCHEMISTRY IN DENSE CLOUDS

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Supernovae have a formidable impact on the dynamics, chemistry and evolution of their local environments. Shocks carve into dense molecular clouds, radiatively cooling the remnant through strong molecular hydrogen and atomic lines. One of important postshock reaction is to convert atomic oxygen to molecular form such as CO, OH and water and these lines fall into THz. I will present observations of a dozen interacting remnants with prominent infrared lines detected by Spitzer, ISO, and ground-based IR telescopes, and show motivation of our granted Herschel and SOFIA observations. Supernovae provide simpler cases of impact of shock than other systems such as protoplanetary disks or protostellar jets where photoionization takes place. In the supernova remnants, the excitation of IR lines of molecular hydrogen requires both a slow shock through dense clumps, and a fast shock through interclump gas. The ortho-to-para ratio is typically much less than LTE, indicating shocks propagating into cold quiescent cloud cores. Evidence of dust grain heating and shattering by the shock is derived from black-body fits to the dust continuum. While radiative cooling and dust processing is beginning to be well understood, the observed oxygen chemistry deviates from equilibrium. We observe enhanced ionization in the shocked gas, which may be by cosmic rays as several of these interacting remnants are prominent GeV gamma-ray sources. The CO, OH and water have been detected from remnants by ISO and water is more than OH, but OH has still elevated abundance compared to theoretical predictions. Finally with Herschel and SOFIA provide opportunity to resolve complicated cooling and astrochemical networks of oxygen-bearing molecules and oxygen chemistry.