Dust & molecules in the ejecta of type II-P supernovae

Arkaprabha Sarangi (University of Basel, Switzerland)& Isabelle Cherchneff (University of Basel, Switzerland)

Observations in the infrared (IR) and sub-millimeter (submm) indicate the presence of molecules and dust in the ejecta of type II-P supernova (SNe). The mass of dust formed in the ejecta of a supernova is still uncertain and highly debated: IR observations indicate smaller dust mass (10^{-5} to 10^{-3} M_{sun}) before 500 days post-explosion, compared to submm observations with Herschel revealing supernova remnant as a large reservoir of cool dust (10^{-2} to 0.7 M_{sun}).

We study the ejecta of different type II-P SNe in a chemical kinetic approach. The synthesis of molecules and small clusters (e.g., silicates, carbon, metal oxides, metallic clusters etc.) in the gas phase is considered. The clusters form gradually over time in different ejecta zones, resulting in small dust masses formed before ~ 600 days (~ 10^{-4} solar mass), that gradually increases up to ~ 0.1 Msun at 1500 days post-explosion [1].

The small clusters formed in the gas phase undergo coagulation to form dust grains. We couple our chemical kinetic model to a condensation model that considers coagulation only, using a volume conserving particle growth formalism. Size distribution of dust grains for different species and progenitor masses are studied in detail. We estimate the average radius of dust grains to range between 50 A° to 200 A° depending on the chemical type of the dust. Because of the short dynamic time scales characterizing the explosion, type II-P supernova ejecta form rather small dust grains and our results imply that they are efficient but moderate dust (10^{-2} to $0.1M_{sun}$) producers in the galaxy.

Reference: [1] Sarangi & Cherchneff ApJ. (2013)