

# Modeling dust formation in supernovae in the JWST era

Arkaprabha Sarangi

*Niels Bohr Institute, Copenhagen University*

The formation of molecules, molecular clusters, and their transition to solid grains of dust, control the chemical budget of supernovae (SNe) from their nebular phase to the remnants. By quantifying the mass and composition of dust in SN ejecta, we develop tools that enable us to study the hydrodynamics of the SNe, in terms of the nature of the explosion, geometry of the ejecta, the mass of the ejecta, pre-explosion activities of the massive star, degree of mixing and clumpiness of the layers induced by the explosion. Based on the type of progenitor, theories predict the dominance of C-rich (expected in smaller progenitor stars) or O-rich dust components (expected in larger progenitors). Moreover, the timescales of dust formation for individual species differs based on the densities of the clumps and the cooling rates defined by elements present in those clumps. In recent years, we have realized that the interaction of the SN shock with circumstellar environments influence the physical and chemical evolution of the SN profusely. In many interaction-dominated SNe, dust is assumed to form in the post-shock gas (behind the SN blast wave), with a larger survival rate when merging with the ISM.

The molecules are crucial in determining the pathways to form various dust grains, in addition to being responsible for the rapid cooling of the gas. Possibility of detection of molecules in extragalactic SNe, decades after the explosion, provides the critical evidence for determining the pathways of dust formation. In addition, tracing the rate of dust production until late times helps us understand the mechanism of dust growth, which is connected to the compactness of the core and the mantle of these dust grains. The destruction of these grains by the reverse shock is affected by this outcome.

At any given time, the range of dust temperatures in SNe can vary over a wide range, thereby radiating at all wavelengths from near-IR to submm wavelengths. Several evidence points towards the likely presence of large masses of cold dust, however prior to the JWST era we had no tools to test that. Thanks to the ongoing detections of dust reservoirs in several extragalactic supernovae, using the mid-IR data from the JWST, we now have a much improved understanding of the role of SNe as dust producers in galaxies.

In my talk, I will present the current state-of-the-art in the field of supernova dust, explaining the physics and chemistry of dust formation in such environments and their observational consequences.