Dust production in a variety of types of supernovae

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Dust production by supernovae is one of the most important subjects for understanding the origin and evolution of dust in galaxies. In particular, core-collapse supernovae generating from short-lived massive stars are considered to be dominant sources of interstellar dust in the early universe. Therefore, many studies have been devoted to this topic for the last decade to disclose the enrichment history of dust grains from the early epochs through the present times of the universe.

In this talk, I address the current understandings of the composition, size, and mass of dust formed in supernovae, from both theoretical and observational points of view. I show that the formation site and properties of dust are likely to be different, depending on the types of supernovae. For normal core-collapse supernovae, dust grains condense in the inner metal-rich ejecta, where a sub-solar mass of dust can be produced, as was revealed by the observations with *Herschel* and *ALMA*. Theoretical studies predict that the typical size of dust formed in the ejecta is affected by the mass of the outer envelopes; relatively large grains form in Type II-P supernovae with massive hydrogen envelopes, whereas small grains form in envelope-stripped ones such as Type IIb and Ib supernovae. The other site of dust formation in supernovae is the cool dense shell resulting from the interaction between the ejecta and the circumstellar medium. In this case, the mass and size of newly formed dust are not known very well, but the condensation of dust in the cool dense shell is believed to happen for Type IIn supernovae that are surrounded by massive circumstellar gas at the explosions. I will present the observational evidence for dust formation in such dense shells. I will also discuss the dust formation in Type Ia supernovae arising from thermonuclear explosion of white dwarfs.