Dust Enrichment by Supernova Explosions

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Supernovae (SNe) are believed to be efficient sources of interstellar dust. Far-infrared observations of high-redshift quasars have suggested that 0.1-1 Msun of dust per SN might be supplied for explaining a huge amount of dust existing in their host galaxies with the ages younger than 1 Gyr. On the other hand, the mass of dust estimated from mid-infrared observations of nearby SNe is less than 10^{-3} Msun. Hence, it has been a matter of controversy what amount of dust grains condense in the expanding ejecta of SNe and what fraction of them can survive against the destruction by the reverse shocks. Since the supply of dust grains by SNe plays a vital role in the evolution history of interstellar dust, it is essential to tackle this matter from both theoretical and observational points of view.

We present the results for a series of our works on the calculations of dust formation in the SN ejecta and destruction in the SN remnants on the basis of the models of various types of SNe. We find that, in Type II SNe that retain massive hydrogen envelopes at the explosions, 0.1-1 Msun of dust can form in the ejecta ([1]), and that 10-80 % of the newly formed dust can survive the reverse-shock destruction to be injected into the interstellar medium ([2]). On the other hand, in Type IIb/Ib/Ia SNe with no massive envelopes, the radii of newly formed dust grains are considerably small, less than 0.01 um, so they are almost completely destroyed in the shocked gas before being injected into the interstellar medium ([3], [4], [5]). This implies that these envelope-stripped SNe are not likely to be dominant sources of dust.

We also mention about the possible causes for the difference in the estimate of dust mass between theoretical studies and observational works and show that the next-generation infrared satellite SPICA will make great advances in understanding the amount of dust that can form in the ejecta of SNe ([6]).

Keywords: dust, extinction; infrared: ISM; ISM: supernova remnants; supernovae: general

References

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