Dust grains from the heart of supernovae

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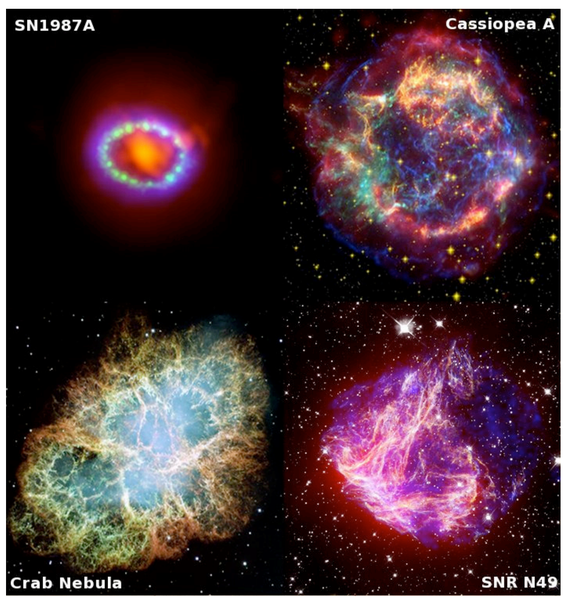
1 Introduction

Dust grains are classically thought to form in the winds of asymptotic giant branch (**AGB**) stars. However, there is increasing evidence today for dust formation in supernovae (**SNe**). To establish the relative importance of these two classes of stellar sources of dust, it is important to know the fraction of freshly formed dust in SN ejecta that is able to survive the passage of the reverse shock and be injected in the interstellar medium.

2 Supernova sample

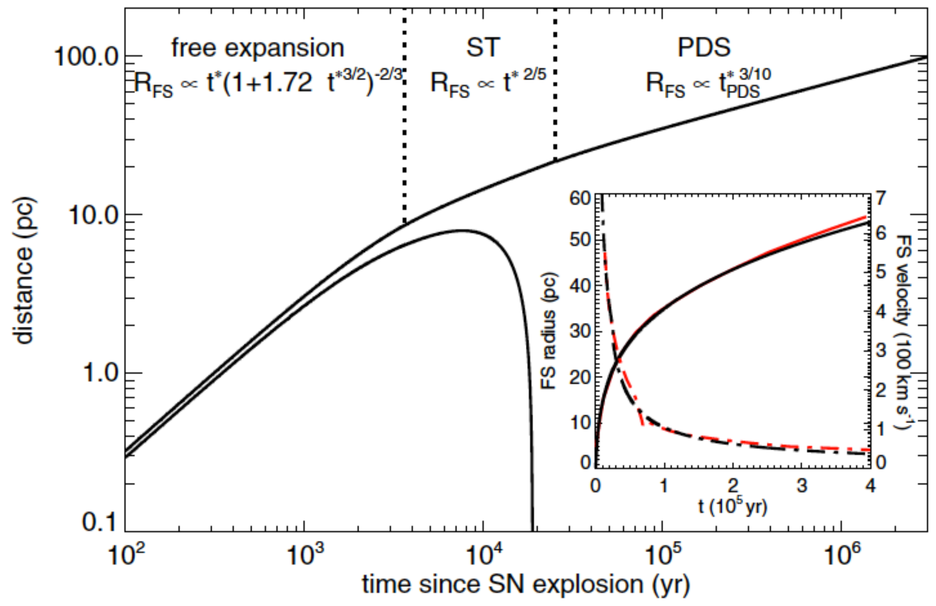
We considered four core-collapse SNRs observed by *Spitzer* and *Herschel*: **SN 1987A**, **Cassiopeia A**, **Crab nebula**, and **SNR N49**. Following Bianchi & Schneider (2007) and Marassi et al. (2015) we apply a steady state nucleation theory to perform dust formation calculations assuming uniformly mixed initial composition of the ejecta.



Relevant parameters:
- Explosion energy
- Mass of ^{56}Ni
- Progenitor mass
- Progenitor metallicity
- Age
- ISM density
- Dust mass

3 Gas dynamics

Analytical solution for the **forward** and **reverse** shock evolution through the three phases of the supernova expansion: free expansion, Sedov-Taylor (ST) and pressure-driven snowplough (PDS).



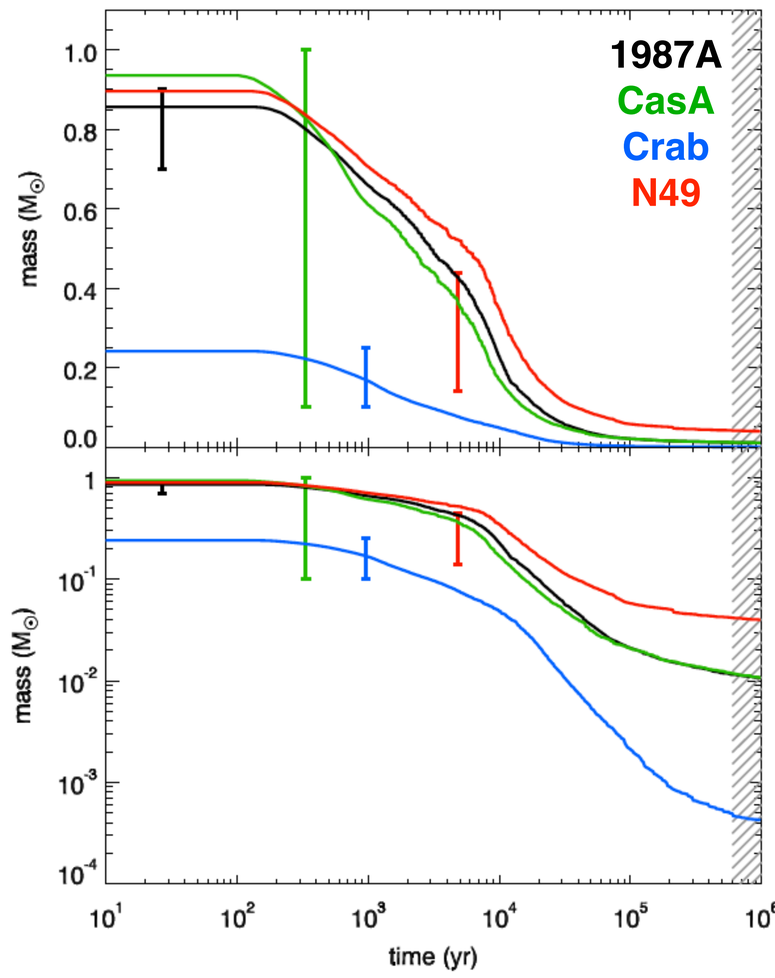
4 Dust dynamics and evolution

Dust coupling
- Collisional drag (gas - grain interaction)
- Plasma drag (charged grain in ionised gas)

Dust processing
- Sputtering (gas - grain)
- Sublimation (heating to high temperatures)
- Shattering (grain - grain)
- Vapourisation (grain-grain)

5 Results

We ran simulations for the four SNe and follow the dust mass evolution. The resulting dust yields depend on the progenitor mass, explosion energy and the age of the SN, and lie in the range 4×10^{-4} - 4×10^{-2} $M_\odot$.



6 Conclusions

Given the rather large uncertainties on measurements of dust masses, our models appear to reproduce the dust masses in the four SNe well. The average effective dust yield is estimated to be $(1.55 \pm 1.48)\ 10^{-2}\ M_\odot$.

When compared to dust destruction efficiencies in SN-driven interstellar shocks that were recently estimated by theoretical models (Bocchio et al. 2014; Slavin et al. 2015) and observations (Lakicevic et al. 2015), this implies that SNe may be net dust destroyers, pointing to grain growth in the ISM as the dominant dust enrichment process both in local galaxies and at high redshifts.

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