NUCLEATION IN NOVAE

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ABSTRACT. The observation of a deep minimum in the light curves of some novae, accompanied by a simultaneous rise in the infrared some weeks after outburst, is attributed to the rapid formation and growth of dust grains in the ejecta (Clayton & Wickramasinghe 1976). The observed nucleation rate J(obs) ~ 10^{-10} cm^{-3} s^{-1} for typical dusty novae, whereas the expected homogeneous nucleation rate J(hom) ~ 6×10^{-26} cm^{-3} s^{-1}. We suggest that heterogeneous nucleation on ions could be a possible grain forming mechanism. In this case J(het) ~ 3.3×10^{-12} cm^{-3} s^{-1}, which is within an order of magnitude of the observed nucleation rate.

We have calculated ionization times for various species (e.g. Mg, Fe, Si) using the method described in Mitchell & Evans (1984). We find that, for typical nova abundances, several likely species are ionized before carbon, regardless of ejected mass. In fact for all elemental abundances (with the exception of very low hydrogen abundances) carbon is always the last of these elements to be ionized. Thus CI-ion reactions in suitable regions of the ejecta may initiate grain formation.

Observationally only novae of intermediate speed class produce large quantities of dust; this model provides some explanation for this observational phenomenon. Firstly in fast novae no dust is produced because carbon is ionized well within the radius of condensation. At the slowest end of the speed class range (e.g. HR Del), nucleation on ions becomes extremely inefficient as the density is too low by the time the nucleating species are significantly ionized. A more complete discussion may be found in Callus et al. (1987).

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