GRAIN COOLING IN COLLAPSING CLOUDS

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If the grains in pre-collapsing clouds are due to the contribution of winds from previous generations of stars and supernovae ejecta, they already contain a fraction if not all, of the heavy elements. The far infrared spectrum of Bok globules, which are at relatively early contraction stages, has been attributed to dusty material.

However, the actual grain content and distribution in contracting clouds can be very different from the initial one: during the contraction process itself, under low temperatures, there is a possibility of additional grain growth, owing to condensations and coagulation processes. Calculations of the grain growth in collapsing clouds are given in Rossi et al. (1991).

In the present work, grain cooling is computed and compared to molecular hydrogen cooling for clouds of different metallicities. We considered the isothermal phase of the diagrams (density, temperature) (n,T) for different metallicities, as simple as possible, adopting the relation by Silk (1977c) between gas temperature and metallicity: $\log T = 1 - 1/3(\log z)$. A grain cooling function parametrized by Silk (1977b) was employed. H_2 cooling was computed assuming no UV external field, and that H_2 is formed on grain surfaces. The gas temperatures 10, 20, 50, 100, 215 and 415, for densities $\log n = 2, 3, 4$ were considered.

The aim of these calculations was to find a temperature - density - metallicity condition where grain cooling and H_2 are of the same order. Silk (1977a) suggested a threshold value at $z = Z/Z_\odot \approx 4\,10^{-5}$, whereas Yoshii & Sabano (1980) suggested $z \approx 1.5\,10^{-5}$.

The present study shows that the threshold value depends critically on the dust temperature T_d: for a cloud of $z = 10^{-5}$, with gas temperature $T = 465$ K, for $T_d = 20$ K or 35 K, at $\log n = 2$, grain cooling or H_2 cooling respectively will dominate. A detailed transfer work is necessary, where the external radiation will be a main parameter.

Rossi, S.C.F., Benevides-Soares, P., Barbuy, B.: 1991, A&A, in press
Silk, J.: 1977a, ApJ 211, 638
Silk, J.: 1977b, ApJ 214, 152
Silk, J.: 1977c, ApJ 214, 718
Yoshii, Y., Sabano, Y.: 1980, PASJ 32, 229