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N86-23519

WHY DO INTERSTELLAR GRAINS EXIST?

C. G. Seab, D. J. Hollenbach
NASA-Ames Research Center

C. F. McKee and A. G. G. M. Tielens
U. C. Berkeley

There exists a discrepancy between calculated destruction rates of grains in the interstellar medium and postulated sources of new grains. We have examined this problem by modelling the global life cycle of grains in the galaxy. The model includes: grain destruction due to supernovae shock waves; grain injection from cool stars, planetary nebulae, star formation, novae, and supernovae; grain growth by accretion in dark clouds; and a mixing scheme between phases of the interstellar medium.

The principal results of calculations of the shock destruction of grains are that large grains (0.1 um) are readily destroyed by thermal sputtering in very fast (200 - 400 kms^{-1}) non-adiabatic shocks. These destruction processes are insensitive to the nature of the grains involved. In particular, grain cores cannot be protected by any kind of mantling. Time scales for this destruction, averaged over the incidence of shocks in the various phases of the ISM, are on the order of 10^7 - 10^8 years. These rates are an order of magnitude smaller than the injection rates for fresh grains from various stellar sources. It is, therefore, difficult to account for the abundance of refractory grains in the ISM within this scheme.

The solution to this dilemma is to either increase the grain formation rate and/or to decrease the shock destruction rate. We are considering grain growth in molecular clouds as a mechanism for increasing the formation rate. To decrease the shock destruction rate, we are including several new physical processes, such as partial vaporization effects in grain-grain collisions, breakdown of the small Larmor radius approximation for betatron acceleration, and relaxation of the steady-state shock assumption.