# TEMPERATURE FLUCTUATIONS AND EVOLUTION OF DUST GRAINS IN DENSE INTERSTELLAR CLOUDS

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## 1. INTRODUCTION

Interstellar extinction studies (Chlewicki et al, 1984), as well as IR observations (Sellgren et al, 1983) require the presence in the interstellar medium of a substantial number of small ($a \lesssim 0.01$ μm) dust grains. The temperature of such small grains is subjected, because of their small steady-state energy, to large fluctuations as they absorb photons from the incident radiation, which could prevent the accretion on such grains (Greenberg and Hong, 1974).

We present here some preliminary results of a study of the effect of temperature fluctuations on the accretion of small silicate grains in function of the optical depth within a dense cloud.

## 2. METHOD AND MAIN ASSUMPTIONS

Following the approach by Purcell (1976) and Aannestad and Kenyon, 1979), we investigated the thermal behaviour of dust grains in terms of their inverse temperature $\eta = 1/T$. All computations have been carried out for a cloud with edge to center optical depth $\tau_c = 5$, total hydrogen number density $10^3$ cm$^{-3}$, and normal chemical composition. The gas temperature is assumed to be 10 K. In our computation we adopted:

1. The far IR emissivity derived by Draine and Lee (1984) for the "Astronomical silicate";
2. The heat capacity measured by Léger et al (1985) for $SiO_2$;
3. The interstellar radiation field by Mezger et al (1982). The radiation field within the cloud has been computed by solving the transfer equation in spherical symmetry (Aiello et al, 1984). The adopted albedo and asymmetry factors are those by Draine and Lee (1984).

## 3. RESULTS

We computed $G(\eta)$, the probability distribution for inverse grain tem-

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perature for grains of different sizes (0.005 ≦ a ≦ 0.01 μm) at different optical depths. We then computed $t_{ev}^{-1}$, the evaporation rate for an atom absorbed on the grain surface with absorption energy $KT_b$, and vibrating normal to surface with a frequency $\nu_0$ (~$10^{12}$ $sec^{-1}$):

$$t_{ev}^{-1} = \nu_0 \exp(-T_b/T_{eff})$$

Where $T_{eff}$ is an effective temperature for evaporation defined by:

$$\exp(-T_b/T_{eff}) = \int_{\eta Min}^{\infty} \exp(-\eta T_b) G(\eta) d\eta$$

where ηMin is the reciprocal of the peak temperature.

Finally, we computed R, the ratio between $t_{ev}^{-1}$ and $t_c^{-1}$, the rate of collision of heavy elements with grains. The grains accrete if R < 1. In the table below we report the values of R at different optical depths (in units of $\tau_c$) for two values of $T_b$. The effect of fluctuations decreases rapidly with an increase in grain radius.

R in function of τ (brackets indicate powers of 10), a = 5 nm:

| | $T_b$ = 1200 K | | $T_b$ = 800 K | |
|---|---|---|---|---|
| $\tau/\tau_c$ | $T_{eff}$ | R | $T_{eff}$ | R |
| 1 | 24 | 1.38 (-2) | 20.4 | 6.45 (2) |
| 0.7 | 24.6 | 4.30 (-2) | 21.2 | 2.60 (3) |
| 0.5 | 26.1 | 7.74 (-1) | 22.9 | 4.30 (4) |
| 0.2 | 28.1 | 2.15 (1) | 25.3 | 1.34 (6) |
| 0 | 31.8 | 2.54 (3) | 29.1 | 7.74 (7) |

REFERENCES

Aanestad, P.A., Kenyon, S.J.: 1979, *Astrophys. J.*, 230, 771
Aiello, S., Barsella, B., Ferrini, F., Iorio, D., Rosolia, A.: 1984, *Nuovo Cimento*, 7, 840
Chlewicki, G., Greenberg, J.M., Aiello, S., Barsella, B., Patriarchi, P., Perinotto, M.: 1984, *Proc 4th European IUE Conf.*, ESA SP-218, 507
Draine, B.T., Lee, H.M.: 1984, *Astrophys. J.*, 285, 89
Greenberg, J.M., Hong, S.S.: 1974, *IAU Symposium No. 60*, 155
Léger, A., Jura, M., Omont, A.: 1985, *Astron. Astrophys.*, 144, 147
Mezger, J.S., Mathis, J.S., Panagia, N.: 1982, *Astron. Astrophys.*, 155, 372
Purcell, E.M.: 1976, *Astrophys. J.*, 206, 685
Sellgren, K., Werner, M.W., Dinerstein, H.L.: 1983, *Astrophys. J. Lett.*, 271, L13

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