INFRARED STRUCTURE OF OMCI

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Although infrared observations are ideal to study a molecular cloud, an infrared spectrum alone is not enough to determine the physical parameters in the source (Rowan-Robinson 1980). An intensity gradient in submillimeter wavelengths was considered by some authors as a measure of the density fall off. But the derived distribution laws are still controversial (Scoville and Kwan 1976, Westbrook *et al.* 1976, Keene *et al.* 1982). Other parameters entering the interpretation of the infrared observations are the emissivity and the temperature distribution of the dust. In most models of molecular clouds, major efforts have been devoted to accurately determine the dust temperature for the assumed density gradient and emissivity (Jones and Merrill 1976, Leung 1976, Unno and Kondo 1977, Rowan-Robinson 1980).

We shall adopt a slightly different approach to the problem of the dust structure of a molecular cloud; all three quantities, the density $\rho(r)$, the temperature $T(r)$, and the emissivity $\kappa(\lambda)$, are taken as power laws,

$$\rho(r) = \rho_i (r/r_i)^{-\alpha} , \qquad r_i < r < r_0 , \tag{1}$$

$$T(r) = T_i (r/r_i)^{-\beta} , \tag{2}$$

and

$$\kappa(\lambda) = \kappa_{100} (\lambda / 100\ \mu\mathrm{m})^{-\gamma} , \tag{3}$$

where suffixes i and $_0$ mean the inner and the outer boundary of the source respectively. The surface brightness $\ell(\lambda,a)$, where a is a distance from the center, is, then given by

$$\ell(\lambda,a) = \int_0^{2\sqrt{r_0^2 - a^2}} B(\lambda,T(r))\ \kappa(\lambda)\rho(r)\ \exp\left[-\int_0^{\ell} \kappa\ (\lambda)\rho(r)\ d\ell\right] d\ell, \tag{4}$$

where $B(\lambda,T)$ is the Plank intensity, and ℓ is related to r by $r^2 = [(r_0^2 - a^2)^{\frac{1}{2}} - 1]^2 + a^2$.

Our model is characterized by seven parameters, namely: α, β, γ, $\tau_c \equiv 2\kappa_{100} \int_{r_i}^{r_\alpha} \rho(r)\ dr$, r_i, T_i and T_0. We rather arbitrarily fixed T_0 and T_i as 25 K and 100 K respectively, since they had minor effects on the model computations. Still, five quantities were left unfixed. With so many parameters included, it would be difficult to find a unique solution to match an observed intensity gradient. To avoid this uncertainty, the intensity profiles at several wavelengths should be fitted altogether at the same time.

Since the Orion Molecular Cloud is among the most intensely studied objects, enough observational data were available for this source. A compilation of the infrared maps is used to construct the intensity profiles of OMC1 at wavelengths ranging from 30 μm to 1 mm. Data are taken from Beichman *et al.* (1978), Keene *et al.* (1982), Lee *et al.* (1983), Werner *et al.* (1976), Westbrook *et al.* (1976), and Wynn-Williams *et al.* (1984). The usual least square method was applied to the model fitting. From 32 data points on five profiles with wavelengths 30, 50, 100, 400, and 1000 μm, the sum of the squares was calculated on each grid point of the remaining five parameters. Considering the observational uncertainty of about 30%, we accepted the sets of parameters with the sum of the squares smaller than 0.5. Consequently, the accepted parameters are determined as $\alpha = 1.8\pm0.3$, $\beta = 0.35\pm0.05$, $\gamma = 1.05\pm0.10$, and $\tau_c = 0.25\pm0.04$.

Scoville and Kwan (1976) inferred the density gradient α to be 1.0, while Westbrook *et al.* (1976) and Keene *et al.* (1982) claimed the higher value of 1.5 - 2.0. The present result apparently supports the latter. We should stress the importance of the temperature gradient β, since it was determined independently of any assumptions about the radiative processes in the energy balance of dust.

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