N91-15025

INTERSTELLAR EXTINCTION AT 10-20 μm

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The interstellar extinction function is not well determined in the infrared. Typically, for studies of H II regions and molecular clouds, one assumes that the extinction curve has the same shape as the dust emission in the Trapezium of the Orion Nebula from 8 to 13 μm. Models assuming either pure absorption or emission plus absorption are then fit to the observations of the spectra of the H II regions or molecular clouds by least squares (e.g. Gillett et al. 1975). Herter et al. (1981) extended the extinction curve to 20 μm by assuming that the 18 μm feature that is seen in emission in the dust shells surrounding oxygen rich stars (Forrest et al. 1979) has the same shape as the interstellar extinction curve. The Trapezium 10 μm feature gives good agreement with the 10 μm absorption in molecular clouds, although the general interstellar absorption to the Galactic center seems to require a narrower 10 μm feature, such as is found in the star μ Cep (Roche and Aitken 1985).

We have analysed the IRAS LRS spectra of 117 stars of excellent signal/noise with optically thin silicate dust shells. We subtracted the stellar continua (assumed to be a cool black body), and we fit the resulting dust shell spectra with simple models F_λ assuming uniform mass loss and dust temperature T as a function of distance from the star r, calculated using the optical constants for silicates of Draine (1985). That is,

$$F_\lambda = \int_{R_0}^{R_{max}} \kappa_\lambda B_\lambda(T)\rho_0(r/r_0)^{-2}4\pi r^2 dr$$

or in the optically thin approximation,

$$\kappa_\lambda = \frac{F_\lambda}{\int B_\lambda(T)\rho_0(r/r_0)^{-2}4\pi r^2 dr}.$$

From the comparison of the spectra and the models, functions for the emissivity κ_λ were derived. The temperature T_0 at the inner edge of the dust shell R_0 was chosen such that the ratio of $\kappa(18\ \mu\text{m})/\kappa(10\ \mu\text{m})$ equals 0.35 (Draine 1985). The different emissivity functions can be divided into 5 groups, which possibly represent shells of dust of different composition, particle size, or optical depth (Simpson, in preparation). In the different groups, the 10 μm feature peaks at either 9.7 μm or 10 μm, and the width varies. The 18 μm feature has the same appearance in all classes. The average spectra for each group are plotted in Figure 1.

The emissivity function from the class with the shortest wavelength 10 μm peak and the narrowest 10 μm feature is a good match to the Trapezium emissivity function from 9.7 to 13 μm. A composite of the Trapezium feature from 8 to 11 μm and the dust shell feature from 11 to 23 μm is plotted in Figure 2. Using this function, we computed the extinction to 53 H II regions with IRAS LRS spectra by fitting absorption and emission models to the spectra by least squares. Abundances of neon and sulfur were computed for the H II regions from the neon lines at 12.8 and 15.5 μm and the sulfur lines at 10.5 and 18.7 μm. There are decreasing gradients of abundance with galactocentric radius; the abundances of neon and sulfur are also inversely proportional to the luminosities and the excitations of the H II regions. There is an apparant correlation with distance which seems to be due to selection effects on the luminosity such that the low luminosity, high abundance sources are all nearby. Any additional featureless component of the interstellar extinction would have to be less than 0.07 magnitudes/kpc at 12.8 μm and 0.07 magnitudes/kpc at 18.7 μm. These H II regions with similar galactocentric radii as the Sun are plotted in Figure 3.

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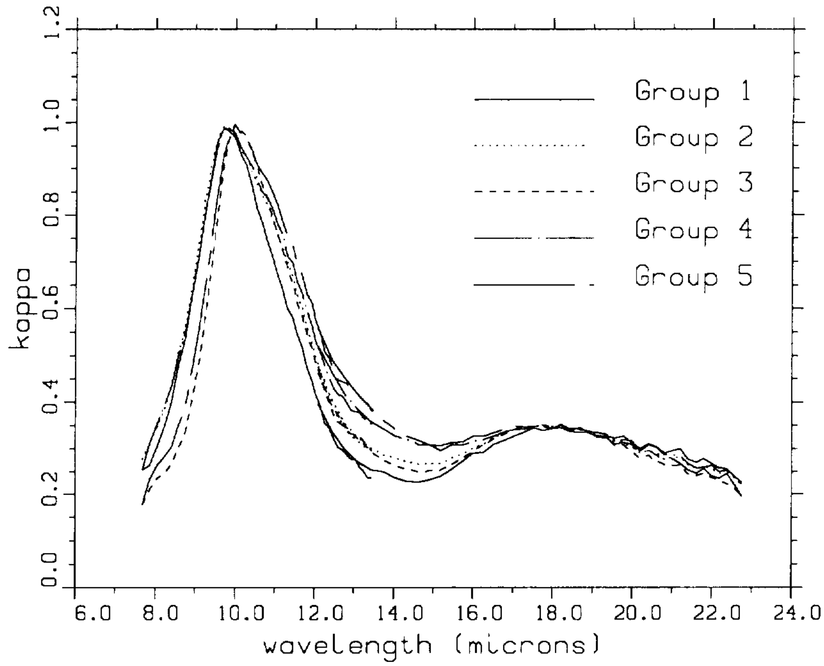

Figure 1. Average dust shell emissivities.

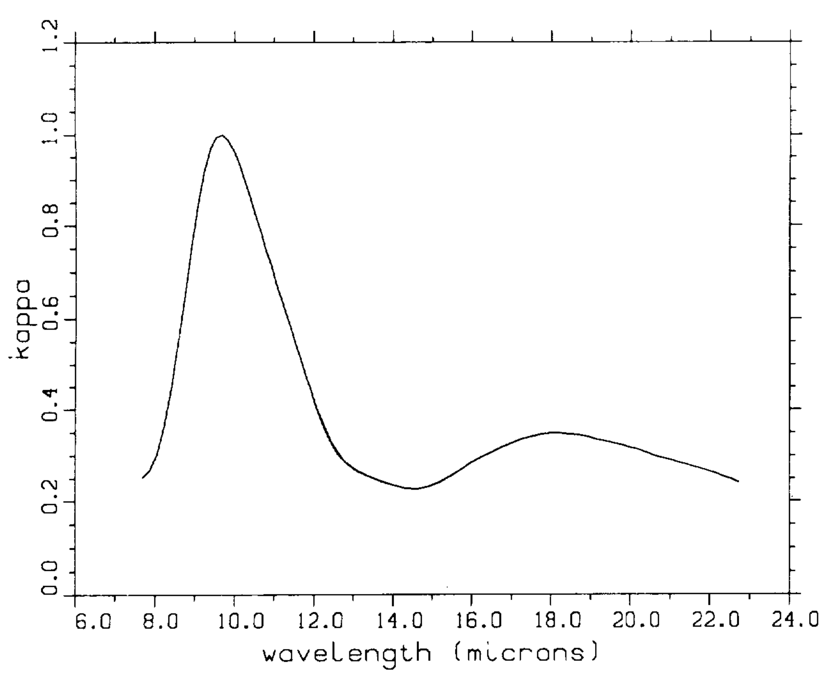

Figure 2. Composite emissivity function.

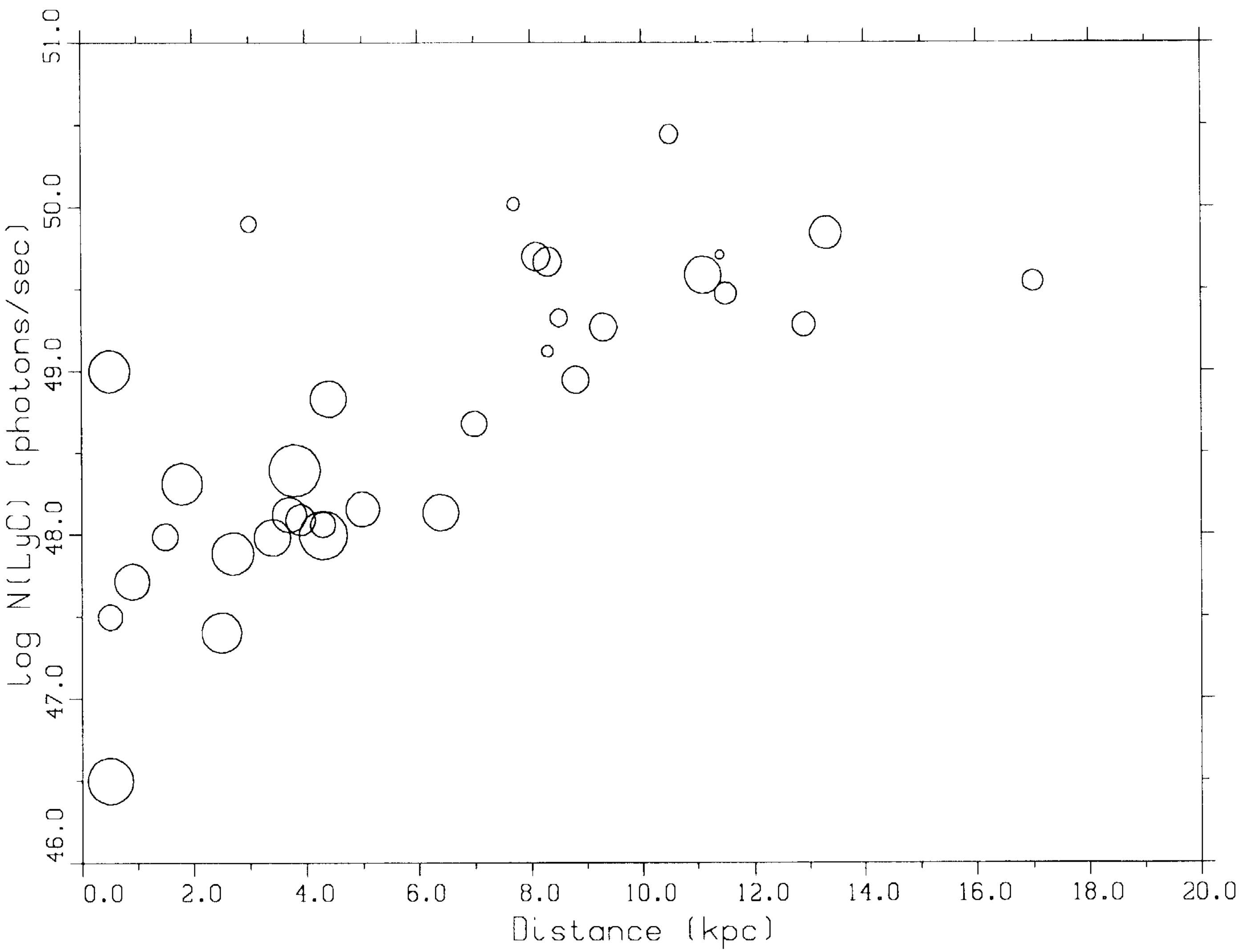

Figure 3. H II regions with similar galactocentric radii as the Sun are plotted against the number of ionizing photons and the distance from the Sun. The diameters of the plotted circles are proportional to the log of the neon abundances, which range from log Ne/H = -5.4 to -3.5.