4.15

10 Micron Silicate Feature Images of the Trapezium Region

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We have imaged the dust associated with the Trapezium in Orion at 5" spatial resolution using a 6-channel, 10% spectral resolution array spectrometer spanning the 10 micron silicate feature. Each pixel in the one arcminute square region mapped was fitted to a model which provided free parameters for the optical depth tau(em) and temperature T of the emitting dust, and the optical depth tau(abs) of absorbing dust at 9.7 microns. An existing CVF spectrum taken at the intensity peak of the Trapezium 10 micron emission was used to represent the nominal emission profile of optically thin silicate material at 250 K. Relative to the peak, tau(abs) increases to about 1 and T increases by about 30 K at distances of 10-20 arcseconds from the peak and the exciting stars. The map of tau(abs) is similar in appearance to an existing map of absorbing dust derived from optical observations, but tau(abs) = 1 corresponds to a visual extinction of several magnitudes, which is much higher than observed. Several possible explanations for the observed spatial distributions of the three parameters of our model are discussed.

4.16

Search for Crystallinity in Astronomical Silicates

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Published 10 micron spectroscopy of a variety of galactic sources exhibiting silicate emission or absorption features contains tantalizing evidence at the 5-10% level for structure in the feature. If this structure were real, it would be diagnostic of the thermal history of the grains. Such structure would only appear if the dust were heated to a temperature high enough, and for a long enough period of time, to result in a phase transition from the amorphous form in which the grains are believed to condense to at least a partially crystalline form. Recent 8-13 micron comet spectra have been shown to contain structure consistent with an olivine-like composition and a small degree of crystallinity (or a small fraction of the grain population being crystalline). This result for solar system dust increased the incentive to search for corresponding spectral structure in the 10 micron features of several bright galactic sources using the 3m NASA IRTF. Sources studied to date are: OH 26.5 +0.6 (= UA 19 = CRL 2205, deep absorption feature), and IRC +10420 and o Cet (silicate emission features). In the case of the two stellar sources especially, one might a priori expect the grains (the smaller grains in particular) to undergo significant heating and high temperature transients. This could occur upon the absorption of a UV photon either close to the star where the grain temperature is observed to be about 500-1000 K, or farther from the star where the 10,000 K interstellar radiation field impinges on the dust in the optically thin shell. The new, stringent limits on the degree of crystallinity and implications for the grains' possible thermal histories will be discussed.

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4.17

DUST GRAINS IN INFRARED REFLECTION NEBULAE

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Infrared reflection nebulae, regions of dust which are illuminated by nearby embedded sources, have been observed in several regions of ongoing star formation. Near infrared observations and theoretical modelling of the scattered light from infrared reflection nebulae can provide information about the dust grain properties in star forming regions. We have modelled infrared reflection nebulae as plane parallel slabs assuming isotropically scattering grains. The intensity of the reflected light is given by $I = I_0 \omega f(\omega) e^{-\tau_{ext}}$ where I_0 is the incident intensity, ω is the albedo, τ_{ext} is the foreground extinction optical depth, and the function $f(\omega)$ includes the geometric factors. In the optically thick case and when ω is small, $f(\omega)$ is independent of ω. In the optically thin limit this equation reduces to the familiar $I = I_0 \tau_{sca} e^{-\tau_{ext}}$ where τ_{sca} is the scattering optical depth. For the grain scattering properties (angle averaged), we use graphite and silicate grains (Draine and Lee, 1984) with a power law grain size distribution (MRN model: $0.005 \leq a \leq 0.25$ and Large grain model:$0.225 \leq a \leq 0.8 \mu m$). The former is the well known Mathis, Rumpl, and Nordsieck (1977;MRN) model which provides a good fit to the visible and UV interstellar extinction curve. Among the free parameters of the model are the stellar luminosity and effective temperature, the optical depth of the nebula, and the extinction by foreground material. Both models can explain the overall near infrared brightness of a typical infrared reflection nebula. Besides polarization, a possible discriminant of grain size is the shape of the 3.08 μm ice band which has been observed in reflection nebulae in OMC-1 (Knacke and McCorkle, 1987,*A. J.*,94, 972), OMC-2 and Cep-A (Pendleton, 1987, Ph.D., UCSC). For an MRN distribution, the addition of ice mantles has little effect on the scattering cross sections. In contrast, for the large grain case, the ice produces a pronounced minimum at about 2.9 μm. Thus, if large ice grains are present in the reflection nebula, the ice band may show structure at this wavelength unless large amounts of foreground ice extinction obfuscate this.

4.18

Solar Wind Effects on Low Frequency Radio Interferometry

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Many important astrophysical questions could be answered with observations at frequencies of a few MHz and angular resolution of an arcminute or better. Such data can be obtained with an interferometer array composed of several small satellites in Earth orbit. Understanding the limitations imposed by interstellar and interplanetary scattering, the extended ionosphere, and interference is an important aspect of planning any low-frequency VLBI mission. As one step toward this understanding, we have modelled the effect of solar wind density fluctuations on the phase coherence of an orbiting radio interferometer as a function of observing frequency, solar elongation, projected baseline length, and integration time. Initial results indicate that aperture synthesis imaging will be possible at elongation angles greater than about 60° for frequencies above 5 MHz and baseline lengths up to 200 km. For elongation angles near 180° frequencies down to 1 or 2 MHz may be useful. Our model assumes that the lines of sight from each telescope are parallel and that both telescopes are located along the same radial vector from the sun. Both assumptions minimize long-term phase differences between the telescopes. Future work will extend the model to include radiation coming from different directions simultaneously and a more general baseline geometry.

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