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COBE DIRBE Infrared Light Curves of Mira Variables

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Abstract. We have used the COBE DIRBE database to derive near-, mid-, and far-infrared light curves for a well-defined sample of 38 infrared-bright Mira variable stars. Of the 31 stars in our sample with 10 or more high S/N datapoints in their 4.9 μm light curve, 29 (94%) are clearly variable at this wavelength, with periods consistent with the optical periods. The amplitude of variability is typically much less in the mid-infrared than in the optical. Over the variability period, $F_{4.9\mu m}/F_{12\mu m}$ remains constant, therefore the average temperature of the dust in the circumstellar shell is not changing dramatically.

1. Introduction and Sample Selection

To understand the mass-loss process of Mira variable stars, we must determine their mass-loss rates and the properties of their circumstellar envelopes, and how these relate to the variability of the star. Most of the previous studies of circumstellar dust emission from Mira stars have been based on time-averaged IRAS fluxes, and have not investigated the mid- or far-infrared variability of these stars (e.g., Sloan & Price 1995; Sloan, Little-Marenin, & Price 1998). At present, evidence for mid-infrared variability has been found for only a handful of Mira stars, and these studies generally sample only a fraction of the infrared light curves, providing little information about changes in the circumstellar shell.

To address these issues, we have used the COBE DIRBE database to look for infrared variability in a larger sample of stars. Our stars were selected from the 12 μm flux-limited sample of variable stars of Sloan & Price (1998) and Sloan et al. (1998). We selected a complete subset of 38 Mira stars from this sample (8 carbon-rich, 30 oxygen-rich), with an IRAS $F_{12\mu m} \geq 1000$ Jy.

2. Results and Summary

Good quality ($\geq 5\sigma$) 4.9 μm fluxes are available from at least one of the DIRBE weekly maps for 36 out of the 38 stars in our sample (95%). For 15 of these stars, good 4.9 μm fluxes are available for $\geq$20 weeks of the 40 week cryogenic DIRBE mission. Almost complete 4.9 μm light curves ($\geq$30 weeks) are available for five stars, while 31 stars (82%) have $\geq$10 good data points. Of these 31 stars, 29 (94%) show $\geq 3\sigma$ variability in their 4.9 μm light curves. In general, the longer the wavelength, the lower the S/N of the DIRBE stellar fluxes. At 12 μm, only 13 out of 38 have $\geq$10 datapoints detected at $\geq 3\sigma$, and 7 have $\geq$20

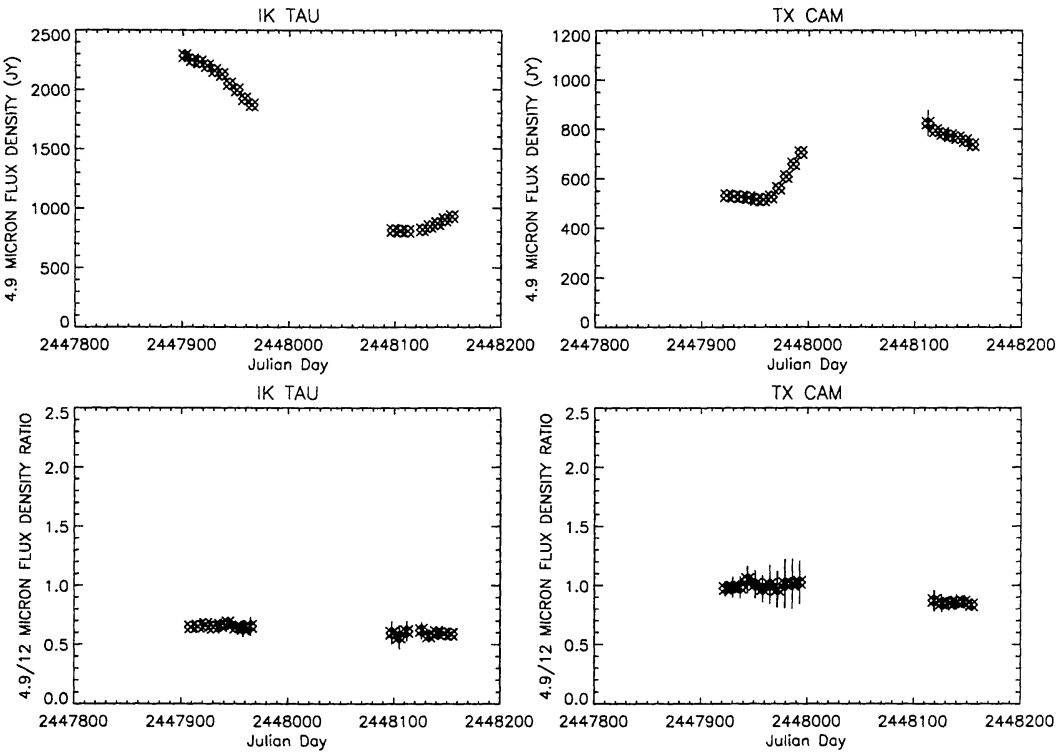


Figure 1. Two representative COBE DIRBE 4.9 μm light curves and $F_{4.9\mu m}/F_{12\mu m}$ ratios, for the Mira stars IK Tau and TX Cam. Note that the flux ratio remains constant throughout the cycle.

good datapoints. Out of the 13 stars with at least 10 good datapoints, 11 show clear 12 μm variability.

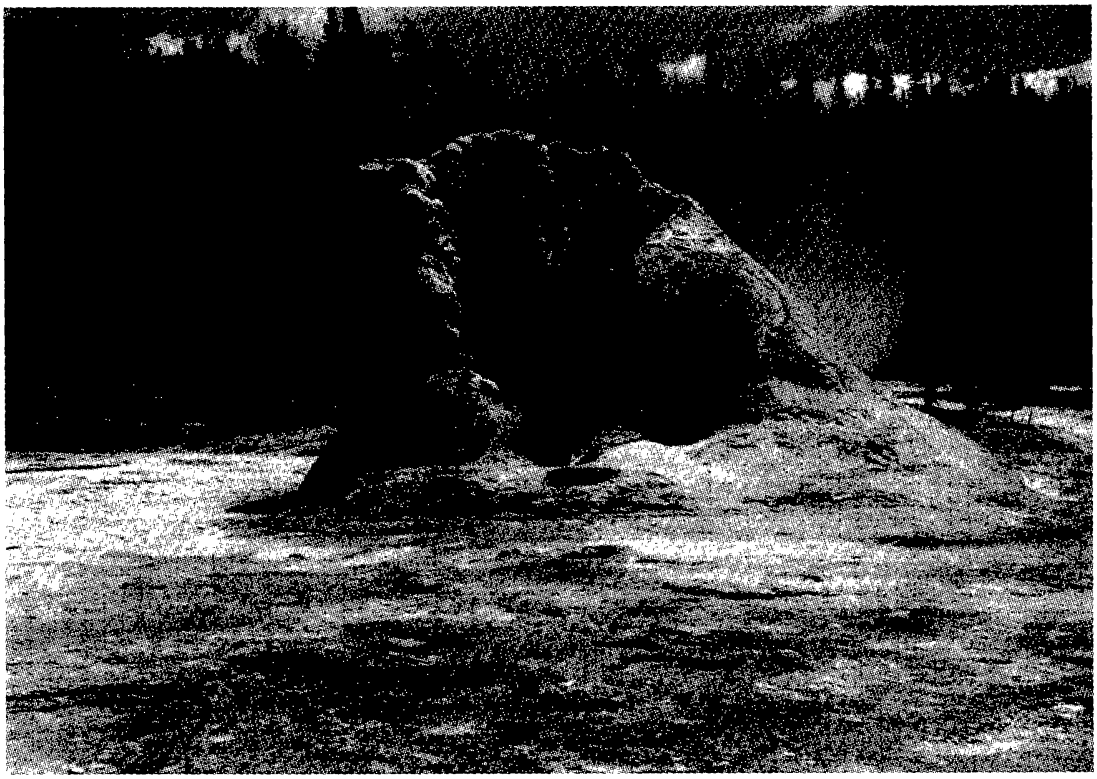
Of our 38 stars, 26 have well-sampled visual (V) light curves for the same time period available from the AAVSO. The period of variability in the mid-infrared is consistent with that in the visible, but the amplitude of variability is typically less in the infrared than in V. For example, for Mira, between JD = 2447890 and 2447930, the optical flux density dropped by a factor of 5, while the 12 μm flux density decreased by only 23%.

The 4.9 μm and 12 μm light curves are typically consistent in period and amplitude (see Fig. 1). This suggests that the average temperature of the dust grains in the circumstellar shell does not change during the period of oscillation of the star.

References

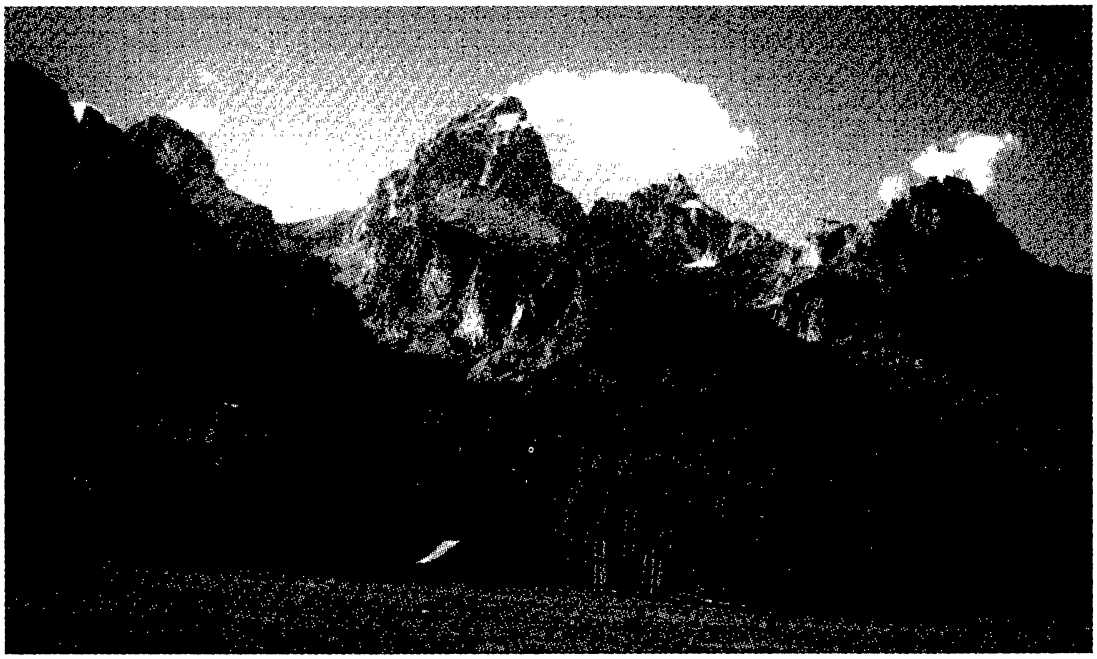
Sloan, G. C. & Price, S. D. 1998, ApJS, 119, 141
Sloan, G. C., Little-Marenin, I. R., & Price, S. D. 1998, AJ, 115, 809

Chapter 7:
Dust and Debris Disks



Yellowstone Geyser

Yellowstone “Wapiti” (Elk)



The Grand Teton viewed near Jenny Lake