PHOTOSPHERES OF MIRA VARIABLES

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Mira variables form an important subgroup of the red giant stars which are typical representatives of stars showing burnt material at their surfaces. Since the photospheres of Miras are not in hydrostatic equilibrium but are characterized by spherically very extended density stratifications, their properties and emitted spectra differ substantially from those of non-Miras, and any attempts to analyse Mira spectra by means of conventional techniques must fail. Non-hydrostatic models are needed for analysis work.

We computed a small set of exploratory M type (solar abundances) Mira model photospheres whose density distributions were taken from an improved modification of a pulsation model proposed by Wood (1979). Besides the fundamental model parameters, i.e. mass, luminosity and radius (or effective temperature), the parameters of the density stratification (e.g. the heights of the density discontinuities at the shock front positions, or the effective gravity acting between two successive shock fronts) must be treated as free parameters within certain limits, owing to insufficient knowledge of the velocity stratification entering the pulsation model. Typical density and temperature stratifications are shown in Fig.1 of Scholz (1987). Both CO lines, measuring the outflow and infall velocities of matter between the shock fronts, and selected molecular band features (colors) were found to react sensitively to adjustments of the model parameters. As an example, Fig.1 shows the differences between CO line profiles computed from the near-maximum model of Fig.1 of Scholz (1987) (Fig.1a) and those computed from a model in which the effective gravity between the shock fronts was increased by a factor of 1.5 (Fig.1b). The same velocity stratification was adopted in both cases. In addition to spectral features,the wavelength dependence of monochromatic radii proves to be a powerful tool of diagnostics of Mira photospheres (Scholz and Takeda 1987; Bessell et al. 1987).

Our exploratory models also predict remarkable differences between the spectra of Miras and non-Miras, in good agreement with observations. In

https://doi.org/10.1017/S0252921100093763 Published online by Cambridge University Press

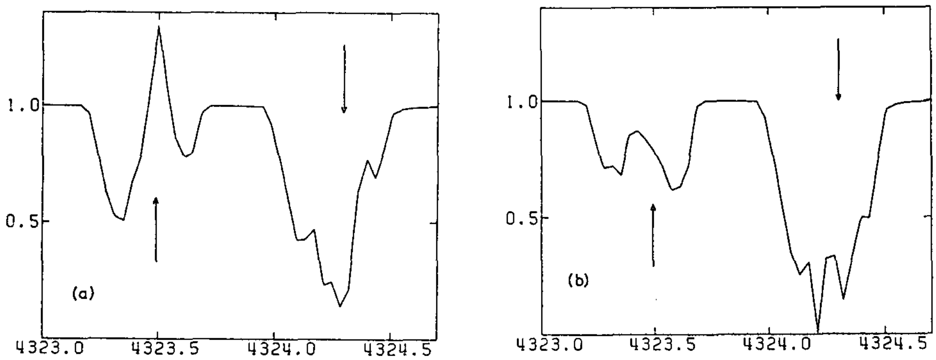

Fig.1 Profiles of two sample absorption lines of the first overtone CO band emerging from two slightly different Mira model photospheres (see text). The line at 4323.5 cm^{-1} has an excitation potential of 1.55 eV and lg gf = -4.92. The line at 4324.3 cm^{-1} has 0.10 eV and -5.69. The unshifted absorption profiles whose centers are indicated by arrows are Voigt profiles with zero microturbulence.

particular, the strengths of TiO bands used for spectral type classification may deviate substantially, and H_2O bands are systematically stronger in Mira spectra. Consequently, Miras and non-Miras which have identical fundamental parameters may have drastically different colors, and color indices which are to measure effective temperatures of both Miras and non-Miras must be selected scrupulously. For instance, the computed J-K versus K-L two color diagram in which J-K approximately measures the temperature and K-L is strongly affected by H_2O absorption in the L filter, shows a clear separation between Mira and non-Mira models in accordance with observations. Most Miras are cooler than non-Miras and, in contrast to non-Miras, their infrared blackbody temperatures are good approximations to the effective temperatures. (See Bessell et al. 1987 for a detailed discussion.)

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