TEMPERATURE AND BRIGHTNESS VARIATIONS ON BETELGEUSE

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ABSTRACT. Changes in TiO band strengths correlate well with the brightness changes of α Orionis, thus supporting the hypothesis of Schwarzschild that the irregular luminosity variations of red giants are due to temperature changes in a few extremely large convective elements on their surface.

Schwarzschild (1975) suggested that because of the large depth of the outer convection zone in red giants, the dominant convective element diameter is comparable to the radius of the star. This was confirmed quantitatively by Antia, Chitre, and Narasimha (1984). Thus, the surface may contain only a few granules, and changes in the character of just one might produce changes in the integrated light of the star. It is well-known that the spectral type of α Ori is variable. To investigate whether this variation correlates with the brightness changes, I have used a 61-cm telescope and scanning spectrophotometer to obtain high-resolution (0.3Å) spectra of α Orionis at frequent intervals during the period March 1984 to April 1985. I determined the temperature from the strength of the R- and Q-branch bandheads of the β(0,0) system of TiO, measuring the equivalent width of the absorption beneath a pseudo-continuum drawn between the relative maxima at 5596A and 5609Å.

For such a low temperature star, the V and B magnitude effective wavelengths lie on the short-wavelength side of the Planck function maximum, where the intensity varies rapidly with temperature. Therefore a fairly accurate calibration of the spectra is required. To make such a calibration, I obtained spectra at approximately the same resolution of several red giants, ranging in spectral type from M1.5 to M4.0, using the stellar spectrograph and Reticon detector of the McMath telescope at the National Solar Observatory on Kitt Peak. The spectral types (Wing 1978) were converted to effective temperature using the calibration given in Table 4 of Ridgway et al. (1980). This procedure is similar to that used by Ramsey (1981).

The effective temperature for α Orionis was determined for each of the 28 nights of observation. Means calculated for each successive 64-day

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period are plotted in the Figure, along with B-magnitudes of α Orionis as observed by E. Guinan (1985) at Villanova University over the same period. The magnitude and temperature scales have been matched so that a black body of constant area undergoing a temperature change indicated by the right scale would show the change in intensity at 4500 Å indicated on the left scale. Thus the data can be directly compared in terms of the following question: can the brightness changes on α Orionis be explained solely by a change in temperature, with no change in surface area? The temperature is indeed lower when the luminosity is lower, and by about the right amount, giving some weak support to Schwarzschild's hypothesis that the irregular light variations of red giants are due to temperature changes of only a few supergranules on their surface.

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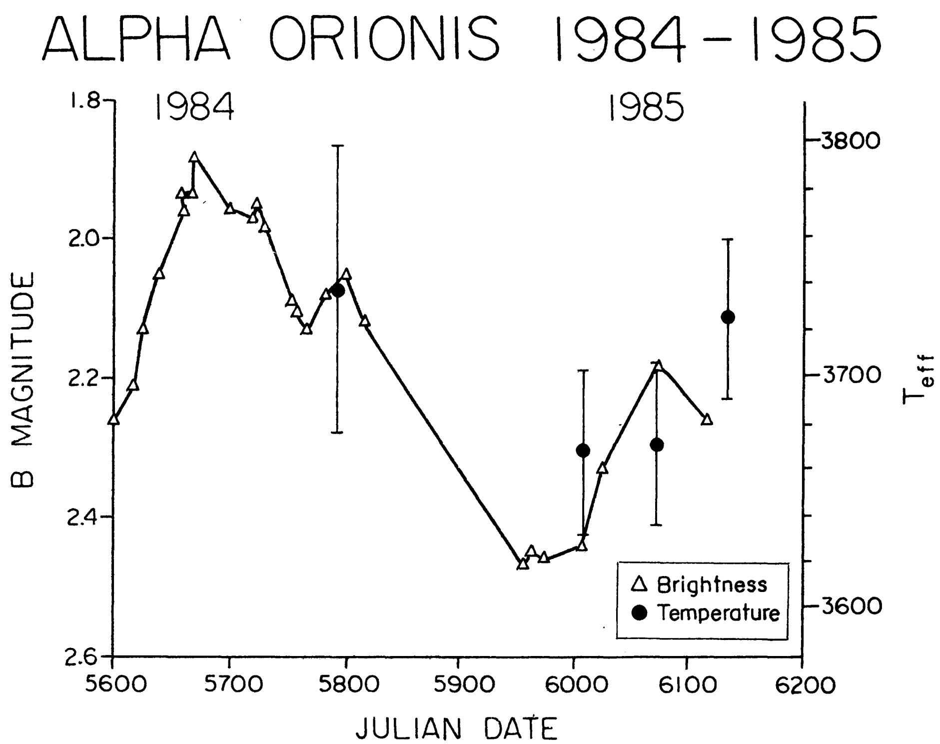

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