THE QUASI-CEPHEID NATURE OF RHO CASSIOPEIAE

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Rho Cassiopeiae (HR 9045, HD 224014) is a bright yellow supergiant (F8pIa). If it is a member of the association CAS OB5, it has an Mv of about -9.5, and is therefore one of the most luminous yellow supergiants known (Humphreys 1978).

The brightness of ρ Cas varies in two ways: (i) it undergoes semi-regular cycles with amplitudes of about $0^m.2$ and time scales of about a year, perhaps due to pulsation, and (ii) in the 1940's, it faded by more than a magnitude for 660 days (Gaposchkin 1949); as a result, it is often classified as "R CrB?". Although various writers have pointed to a dissimilarities between ρ Cas and the R CrB stars, it should be noted that R CrB itself undergoes semi-regular cycles as well as fadings. Thus the scientific interest of ρ Cas lies in the nature of its variations, their possible relationship to each other and to the mass loss and extreme luminosity of the star.

To follow the variations in brightness of ρ Cas, it would be desirable to have many decades of continuous photoelectric photometry. Such photometry, unfortunately, has been sporadic. Visual observations, on the other hand, have been made almost continuously by the British Astronomical Association (BAA) and the American Association of Variable Star Observers (AAVSO). These observations are numerous and accurate enough so that they can be combined into 30-day means whose formal standard deviations are typically $0^m.03$ - comparable with those of photoelectric observations. The BAA observations have already been published (Bailey 1978). In this paper, we discuss these observations and (in a preliminary way) the AAVSO observations, particularly as they relate to the Cepheid nature of the star.

We have compared the BAA and AAVSO 30-day means with each other and with available photoelectric photometry as listed by Bailey (1978) and Arellano Ferro (1983). The 30-day means are of comparable accuracy. There is an offset m_v - V of about $0^m.30$ between the visual and the photoelectric observations. Bailey (1978) notes that the BAA means are on a system which is fainter by about $0^m.1$ than V magnitudes, and he attributes the rest of the offset to the colour difference between the comparison stars (which are blue) and the variable star (which is red). In fact, we find some preliminary evidence that the offset depends on the instantaneous colour of the star and on the individual visual observer. This could also be understood in terms of the difference in colour sensitivity between the V filter and the individual human eye.

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In principle, the offset can be corrected for: to first order by applying a constant correction to the visual means, or to second order by applying a colour-dependent correction. Conversion of m_v to V magnitudes, however, should not be done without considerable thought.

The motivation for using the visual data was to investigate the power spectrum. We therefore wished to reassure ourselves that there were no systematic seasonal effects caused by the visual observing methods. Bailey (1978) applied various tests to the BAA data, and found no such effects. We have applied other tests to the BAA and AAVSO data: (i) we find no obvious correlation between the time of year and the occurrence of maxima or minima (ii) there is no peak in the power spectrum at a period of one year (iii) the light curve obtained by folding the data with a period of one year has insignificant amplitude and (iv) the observations follow the photoelectric observations (e.g. Arellano Ferro 1983) well.

The BAA (1964-1976) and AAVSO (1975-1983) observations both show semi-regular cycles of amplitude about $0^m.2$ and time scale about a year. We determined the power spectra of each data set using Deeming's (1975) and Scargle's (1982) methods for unequally-spaced data, and using the standard Fast Fourier Transform (FFT) method for equally-spaced data. The 30-day means are equally-spaced, and the FFT proved to be quite adequate. The BAA data show a mildly significant (P=0.9) peak in the power spectrum at 275 $\pm$ 25 days. The AAVSO data show a less significant peak at the same period.

We have compared this period with that predicted by infrared (J and K) period-luminosity relations for Cepheids in clusters and associations (Welch 1983), assuming that ρ Cas is a member of CAS OB5 and has a distance modulus (12.0) and absorption (Av = 2.1) consistent with such membership (Humphreys 1978). The star lies within $0^m.2$ of these P-L relations. This, together with the position of the star near the Cepheid instability strip, suggests that it is related to the Cepheids. It is also similar to the "Leavitt variables" in the Magellanic Clouds, described by Grieve et al. elsewhere in these proceedings.

Acknowledgements. We thank the AAVSO observers and staff (especially Dr. Janet A. Mattei) for providing their observations, and the Natural Sciences and Engineering Research Council of Canada for a research grant.

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