A new reddening for RR Tel from the HeII Paschen lines

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Abstract. From the available STIS data of RR Tel, that have provided a coverage with absolutely calibrated data in a wide wavelength range, we have obtained a new determination of its reddening (E\textsubscript{B−V}=0.00) from the comparison of the observed HeII Paschen lines decrement relative to HeII $\lambda$ 4686 (for 24 HeII Paschen lines down to the region of the head of the series near lambda 2060 Å) with the theoretical one as given in Storey and Hummer (1995) for case B, T=10,000 K and log N\textsubscript{e}=6. This new E\textsubscript{B−V}=0.0 value has been confirmed from a re-analysis of the IUE low resolution data. We recall that the so far generally adopted value in the literature has been E\textsubscript{B−V}=0.10 as obtained by Penston et al. (1983).

1. The STIS data

We have retrieved from the HST archive all STIS spectra secured on Oct. 10, 2000 by Keenan et al., in particular the echelle and the grating spectra that cover the spectral regions of the HeII Paschen lines. These STIS data have been recently (Dec. 2003) re-calibrated for the effects of increasing charge transfer inefficiency and for the effects of time-dependent optical sensitivity.

2. A new reddening and distance

Following Penston et al (1983) we have updated their method of comparing the observed intensities of the He II recombination lines with the theoretical ones in order to estimate the reddening value. The STIS data provide a full coverage for the whole set of HeII Paschen lines up to the region of the head of the series, near $\lambda$ 2050 Å.

This spectral region of RR Tel has remained "unexplored" so far, because of the low response level of the IUE LW cameras below lambda 2300 Å. Instead, on STIS spectra one can resolve the HeII Paschen lines up to the 37-3 transition at 2064.15 Å, very near to the series limit (see Fig. 1). The observed relative intensities (relative to I($\lambda$ 4686 Å) = 100) have been compared with the theoretical ratios listed by Storey and Hummer (1995) for various log Ne and Te values (case B). In Fig. 2 $I_{\text{obs}}/I_{\text{th}}$ is plotted against wavelength for theoretical values corresponding to log N\textsubscript{e}=6 and T\textsubscript{e}=10,000 K.

The points clearly define a straight line with slope = 0.00 (with some symmetric scatter of less than 10% for the lines near the head of the series), a direct evidence that E\textsubscript{B−V}=0.00.
We recall that Penston et al. obtained $E_{B-V}=0.10$, but their measurements were based on a limited number of He II lines and on more noisy spectra. Penston et al. (1983) confirmed the $E_{B-V}=0.10$ value obtained from the Paschen lines from the alleged presence of an absorption bump near lambda 2175 in the continuum of IUE low resolution spectra. In order to verify this point, we have created an "average" spectrum out of 39 SW and 35 LW IUE low resolution spectra (Fig 3). In this high S/N "average" spectrum there is no evidence of the absorption dip reported by Penston et al (1983). Probably, the "lack" of strong emission features near $\lambda$ 2200 has mimicked the presence of an absorption bump.

The photometric and spectral development of RR Tel during the outburst phases was that of an extremely slow nova with $t_3 \sim$ years. With the assumption that the nova luminosity was near-Eddington during these decay phases one obtains $M_{bol}^{max}=6.1$ and $M_v^{max}=6.0$ (if $BC \sim -0.1$ for an object with $T \leq 10000K$), in good agreement with the estimates from various MMRD relations. Thus, from the observed $m_v^{max}=6.7$ and the new value for the extinction ($A_v=0.0$) a distance of 3.47 kpc is obtained. This value is in good agreement with that of 3.6 kpc obtained by Feast et al (1983) on the assumption that a Mira is present in RR Tel.

References

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