THE ABSOLUTE SPECTRAL FLUX DISTRIBUTION 
FROM $\gamma^2$ VEL

W. M. Burton, R. G. Evans and W. G. Griffin

Astrophysics Research Division of the Appleton Laboratory, Culham Laboratory, 
Abingdon, Oxfordshire

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SUMMARY

New measurements of the far-ultraviolet spectral flux distribution from $\gamma^2$ Vel between 1000 and 2300 Å are presented and related to observations at longer wavelength and also to model atmosphere calculations.

The absolute spectral flux distribution from $\gamma^2$ Vel ($m_v \approx 2\cdot2$), the brightest observable Wolf–Rayet star, is of special interest. Separated by 45 arcsec from a fainter companion ($\gamma^1$ Vel, $m_v \approx 4\cdot1$; B1 IV), $\gamma^2$ Vel is a double-lined spectroscopic binary classified as WC8 + O8 by Baschek & Scholz (1971) and as WC8 + O9 I by Conti & Smith (1972). Because of the high temperature of the component stars in the $\gamma^2$ Vel system, the spectral flux distribution peaks in the far-ultraviolet wavelength region where observations from above the Earth’s atmosphere are necessary for both photometric and spectroscopic studies. The first measurements of the absolute flux from $\gamma^2$ Vel shortward of 3000 Å were obtained by Stecher (1970) in the wavelength region 1100–3000 Å with a spectral resolution of 10 Å, but residual atmospheric absorption modified the observed spectrum very significantly shortward of 1700 Å. More recently, observations obtained with the S2/68 spectrophotometer on the TDI A satellite provided data on the spectral flux distribution of $\gamma^2$ Vel in the wavelength region 1350–2550 Å with a spectral resolution of $\sim 35$ Å (Boksenberg et al. 1973). Considerable attention was devoted to the photometric calibration of this experiment with the aim of obtaining absolute flux measurements within $\pm 20$ per cent error limits.

The far-ultraviolet spectrum of $\gamma^2$ Vel was also observed during a ‘Skylark’ rocket flight (Skylark SL 1111) in 1973 June, when three Wadsworth spectrographs were used to record photographic spectra in the wavelength region 920–2300 Å with a spectral resolution of $\sim 0\cdot3$ Å (Burton, Evans & Griffin 1975). In this communication, we present new results obtained from the continuing analysis of data from the 1973 rocket flight and relate these results to the earlier studies mentioned above.

The photometric calibration of the rocket instrumentation was based on separate measurements of the spectrograph transmission efficiency and the absolute sensitivity of the photographic film (Burton, Hatter & Ridgeley 1973). A Joyce–Loebl microdensitometer was used to measure the specular density of the stellar spectra which were recorded on Kodak 101-01 film. These density measurements were converted to stellar fluxes by using measured values for the optical transmission of the spectrographs at selected wavelengths, together with the photographic film sensitivity for each wavelength range which was measured using several samples.
of film from the same batch used for the rocket flight. Fig. 1 presents the absolute energy spectral distribution from $\gamma^2$ Vel, the estimated error limits being ± 30 per cent, as derived from the data obtained during the Skylark rocket flight. Also shown are the corresponding absolute flux data from the Stecher (1970) rocket flight and the S2/68 satellite spectrophotometer. The absolute calibrations of the three experiments are completely independent and the agreement of the three sets of data within ≅ 0.3 mag is very satisfactory. The continuum flux distribution of $\gamma^2$ Vel in the optical region of the spectrum 3500–6000 Å obtained by Aller & Faulkner (1964) is also shown in the figure curve ‘d’.

The continuum slope in the visible corresponds to a colour temperature of 32 000 K but it is known that Wolf–Rayet energy distributions cannot be well represented by a single colour temperature. A better representation of the emergent flux is provided by the extended spherical model atmosphere computed by Cassinelli (1971) which is shown as curve ‘e’ in Fig. 1. The particular model used has a temperature of 48 900 K at $\tau = 0.67$ in the visible continuum and an extension parameter $R_{(\tau=10^{-3})}/R_{(\tau=0.67)} = 1.89$. Of the models described by Cassinelli, both this model and one with $T_{(\tau=0.67)} = 94 700$ K and an extension parameter of 1.51 represent the visible data extremely well, but the temperature of 94 700 K is probably too high, even for a WC8 star.

Both Baschek & Scholz (1971) and Conti & Smith (1972) deduced that at least in the visible portion of the spectrum the O star component of $\gamma^2$ Vel is about
1.5 mag brighter than the WC8 component, so that the observed flux distribution will relate mainly to the O star. For this reason, and also because of the probable interaction of the two stars in the $\gamma^2$ Vel system, the model flux distribution is intended purely as a comparison curve and may not be a good description of the atmosphere of either star. Shortward of about 1200 Å, the measured flux is reduced by $\sim 1$ mag relative to the model calculation. This probably results from the effect of line blanketing by the many strong lines in this part of the spectrum, since it is difficult to detect any continuum level, even with a resolution of 0.3 Å. Comparison of the different observations is complicated by the variation of emission flux with the orbital phase of the $\gamma^2$ Vel binary system. At the time of the Skylark rocket observations the phase was 0.67 and the TD1 observations were also made at approximately this phase. However, the earlier rocket observations were obtained at almost exactly the opposite phase ($\sim 0.11$) when the star positions were reversed. This difference might be expected to modify the line spectrum, but it is less probable that the continuum levels would be significantly modified.

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REFERENCES