ERRATUM: THE 2.27 DAY PERIOD OF WR-134 (HD 191765)

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Abstract.
The original temporal analysis of a 12 night spectral timeseries of WR-134 has been
found to be flawed and a re-analysis shows that the line profile variations are indeed
periodic. When combined with a 4 night timeseries taken 45 days earlier, a period near
2.27 d is found in periodograms of the He II $\lambda$5412 line centroid, $rms$ line width, and line
skew variations. When the emission line residuals are ordered as a function of phase, a
sinuous feature appears to “snake” about the line center with an amplitude of $\pm$ 500
km s$^{-1}$. This is $\approx$ 20 larger than the line centroid amplitude; the calculation of which is
heavily weighted by static portions of the line profile. In addition to the “snake,” emission
residuals appear that move away from line center on unbound trajectories and are thought
to result from the interaction of a periodic driver with the unstable flow of the radiation
driven wind. The nature of the periodic driver is a topic for discussion.

Key words: Line: Profiles - Stars: Variable - Stars: Wolf-Rayet

1. Introduction

This paper serves as an erratum to McCandliss (1988) and McCandtiss
(1992) where it was asserted that no convincing evidence existed for peri-
odic line profile variations in a spectral timeseries of the WN6 star WR-134
(HD 191765), consisting of 152 observations taken over 12 nights that cov-
ers 4000 – 6600 Å. The periodic analysis in the above work mistakenly used
an incorrect timeline to compute periodograms from flux and line centroid
timeseries of the He II Pickering series, N IV 4058 and the N III - He II blend at
$\lambda$4100. Not too surprisingly, these periodograms were different for every line
analyzed giving the appearance that the variations were stochastic. In fact,
the periodic analysis of the 12 night timeseries with the correctly ordered
timeline does show periodic variation in all the He II line profiles as well as
the N III– V lines; a result that we will discuss. In addition, we will show
that when a timeseries of He II $\lambda$5412 (Robert 1992), consisting of 35 obser-
vations over 4 nights recorded 45 days previous to the 12 night timeseries, is included in the periodic analysis we derive a period of $\tau = 2.27 \pm 0.04$ d.

The question of whether the line profiles variations (LPV) are periodic or stochastic is important to the debate concerning the duplicity of WR-stars and their possible evolutionary scenarios. We refer the reader to IAU Symposium No. 99 for a good discussion of this topic (c.f. Moffat; Lamontagne & Moffat; Massey; Chiosi; de Loore; and Conti, all 1982). Here, we will limit our remarks to the periodic analysis of the two timeseries, a description of the variation phenomenology, and conclude with a short list of possible physical mechanisms.

2. Time Series: KPNO & CFHT

The CFHT spectral timeseries of the He II $\lambda 5412$ line was recorded on the nights of 8 – 11 August 1987 beginning at 06:01 UT (+2447015.753 J.D.), with the 3.6m coudé spectrograph and a 1872 diode reticon. In all, 35 spectra were obtained covering 5343 – 5533 Å with a resolution of $\approx 20000$. The average integration time of 1080 s produced data with a mean signal-to-noise of 190:1. The reduction to continuum normalized spectra is described in Robert (1991).

The KPNO spectral timeseries was recorded on the 12 nights between 23 September and 4 October 1987 beginning at 03:59 UT (+2447061.666 J. D.), with the coudé feed-telescope Fiber Optic Echelle (FOE) and a 512 x 320 RCA CCD. In all, 152 spectra where obtained spanning 4000 – 6610 Å in 23 orders at a resolution of $R = 10000$. The average integration time was 1200 s and the mean signal-to-noise in a “line free” fiducial region within the middle extracted order was 125:1. The reduction to continuum normalized spectra is discussed in detail in McCandliss (1988).

3. Line Moment Measurements

The LPV in this star are not simple shifts of a static profile about a systemic velocity, rather there are real discrete variations in the shape of the line profile (McCandliss 1988). We wish to perform a simple periodic analysis of the line profiles without having to compute a periodogram for every spectral resolution element. A low resolution study can be conducted with the first four line profile moments; the flux, the centroid, the $rms$ width, and the line skew. In calculating these quantities we restrict the bandpass to $\pm 1300$ km s$^{-1}$, partly because the wings of some lines are blended with nearby features, but mostly because the strongest variations occur in the line cores of the high ionization species He II, and N III – V (McCandliss 1992). Given a set of continuum normalized line profiles $I_{i,j}$ where $i$ is the spectral index and $j$ is the temporal index, we define over the bandpass $n \leq i \leq m$ the $j$-th