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Long term optical spectroscopy of HD 86161 (WR 16)

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Abstract.
We present results of optical spectroscopy of the emission line star HD 86161=WR 16, the central star of an ejecta ring nebula, obtained between 1971 and 2000 in the wavelength domain 3200-7300 Å. The spectrum of type WN8 is rich in He and N lines, in particular HeII 5–n series emission lines are observed up to high quantum numbers. We analyze possible radial velocity variations observed between different epochs, and find stochastic variations with possible superimposed epoch to epoch variations. These last variations could be due to the orbital motion of an eccentric long period binary system.

1. Introduction

HD 86161 ($\alpha_{(2000)}$= 09:54:53; $\delta_{(2000)}$= -57:43:38) is a relatively bright (v=8.4) emission line star located in the Carina region of the southern Milky Way. This star is included in the catalogue of Galactic Wolf–Rayet (WR) stars as WR 16 (cf. van der Hucht 2000). It has an emission line spectrum of type WN8h (Smith et al 1996), and is surrounded by arcs of nebulosity formed by stellar ejecta (Marston et al 1999).

WR 16 is known to be a photometrically variable star, but no unique periodicity has been found in these variations (cf. van der Hucht 2000 and references therein).

Here we present our results of a long term study of the optical spectrum of WR 16.

2. Observations

We have secured 45 spectra of WR 16 during 29 years. Between 1971 and 1994, we used the Cassegrain spectrographs on the 1.5, 1.0 and 0.9-m telescopes

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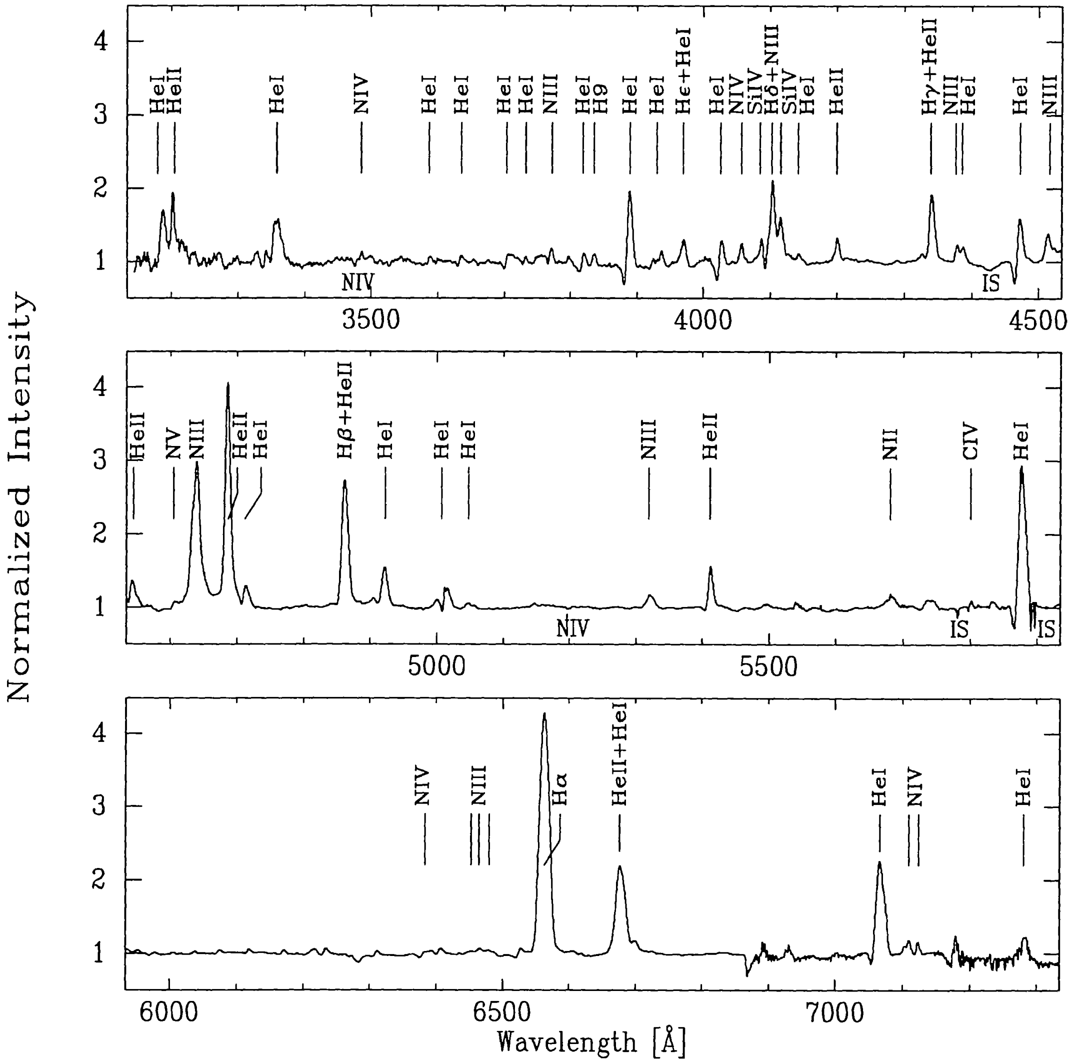

Figure 1. Spectrum of WR 16 with main emission lines identified above, and absorptions below the rectified continuum.

at Cerro Tololo (CTIO), in Chile. The detector was photographic plates until 1979, Image tube + CCD thereafter. Since 1997, we secured spectra with the Cassegrain Boller & Chivens (B&C) and REOSC spectrographs on the 2.15m telescope at the Complejo Astronómico El Leoncito (CASLEO) [1], San Juan, Argentina. PM512 and TEK1024 CCDs were used as detector, respectively.

The photographic spectrograms were digitized with a Grant engine at La Plata Observatory, Argentina. The digital data were processed with IRAF [2] routines.

[1]operated under agreement between CONICET, SeCyT, and the Universities of La Plata, Córdoba and San Juan, Argentina

[2]IRAF is distributed by NOAO, operated by AURA, Inc., under agreement with NSF.

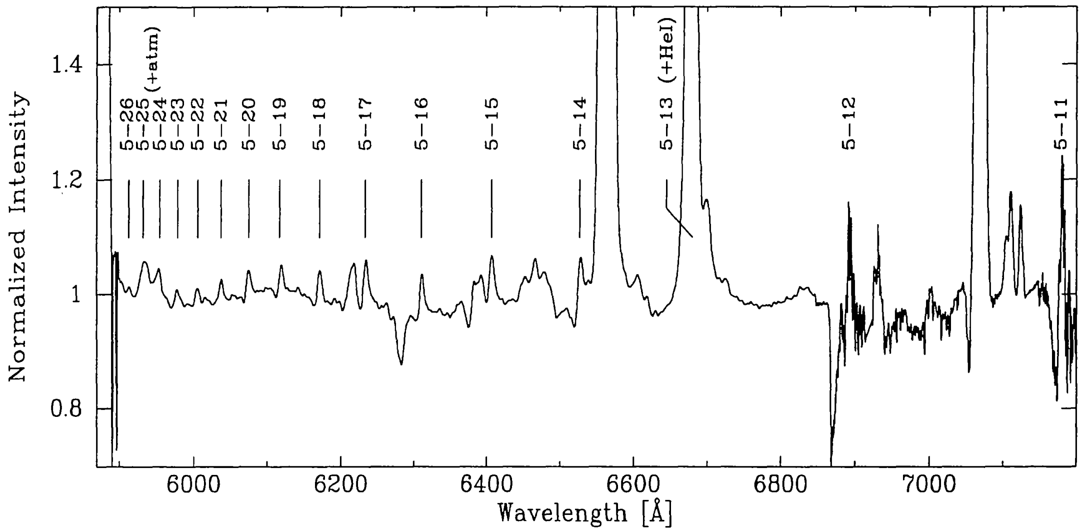

Figure 2. HeII 5–n series emissions are observed up to n=26 in the spectrum of WR 16.

3. Results

3.1. The spectrum of WR 16

The spectrum of WR 16 from λ 3135 to 7335 Å is illustrated in Figure 1. The spectrum consists of emission lines of NII, NIII, NIV, faint NV, HeII, and HeI. Hydrogen is also present as can be seen in the oscillating line strenghts of the Pickering series of HeII caused by coincidence of a H Balmer series line every second Pickering line. Most tabulated neutral He and NIII emission lines are observed. In our spectra, we also detect the HeII 5–n series emissions up to high quantum numbers (See details in Figure 2). Undoubtedly, WR 16 exhibits a spectrum indicating considerable He and N enrichment.

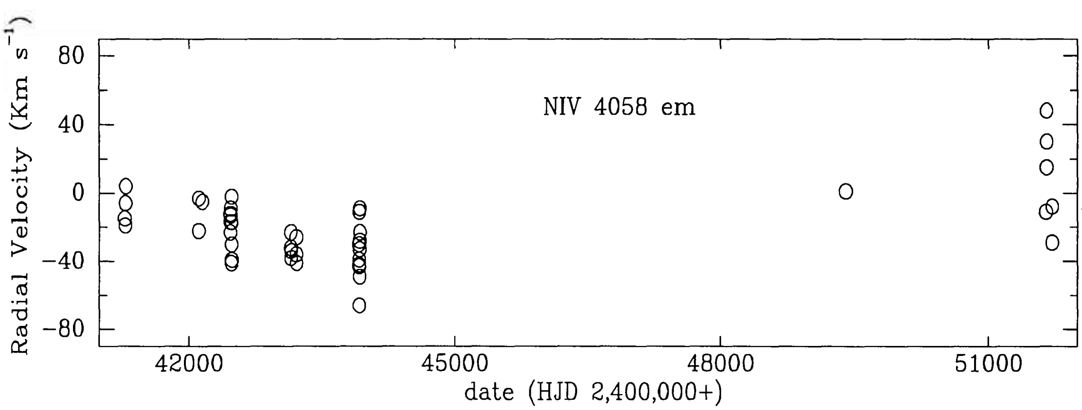

Figure 3. Heliocentric radial velocities of the NIVλ 4058 Å emission in the spectrum of WR 16 in function of time.

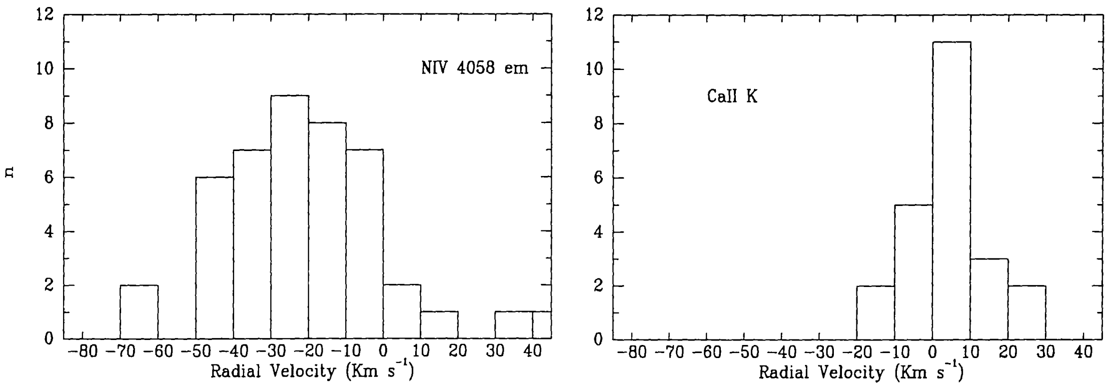

Figure 4. Histograms of the radial velocities of the N IV emission (left) and interstellar Ca II K line (right) measured in our spectra of WR 16.

3.2. Radial velocity variations

We have measured the radial velocities of the N IV λ 4058 Å emission in all our spectra with the purpose to determine if the radial velocity of WR 16 is variable. In Figure 3 we illustrate the radial velocities in function of time for all our observations.

Following the criterion first established by Schlesinger (1915), we compare the distribution of our radial velocities with a random (Gaussian) error distribution. Figure 4 shows a histogram of the radial velocities of WR 16 from N IV emission line. This histogram marginally deviates from an error distribution. As a reference we also show in Figure 4 the histogram of the radial velocities of the interstellar Ca II K line measured in our spectra of WR 16. The radial velocities of the interstellar line show a Gaussian distribution which is much narrower than that of N IV emission. Comparison of both histograms implies that the radial velocity variations of WR 16 are twofold, a stochastic variation of $\sim$ 50 km s^{-1}, and possibly a systematic motion of lower amplitude. Furthermore, Figure 3 suggests a long term (P $\sim$ several years) eccentric radial velocity orbit with superimposed random variations.

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