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WACK 2134 (= WR 21A): A NEW WOLF–RAYET BINARY

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RESUMEN

Presentamos un estudio de velocidades radiales de la estrella Wack 2134, cuyo espectro óptico muestra líneas de emisión tipo Wolf-Rayet. Esta estrella, catalogada como WR 21a, es una conocida fuente de radiación X. Nuestros espectros muestran una variación de gran amplitud de la velocidad radial estelar. Hemos determinado un período orbital de 31.6 días. Con este período las velocidades radiales de WR 21a describen una órbita sumamente elíptica. El valor de la función de masa determinada de nuestra solución orbital es más de 8 masas solares, indicando que WR 21a es un sistema compuesto por dos estrellas de gran masa. La radiación X entonces bien puede ser resultado de la colisión de los vientos estelares de las componentes del sistema binario.

ABSTRACT

We present a radial velocity study of the star Wack 2134, which shows Wolf–Rayet type emission lines in its optical spectrum. This star, catalogued as WR 21a, is a well kown X–ray source. Our spectra show radial velocity variations of large amplitude, from which we have determined an orbital period of 31.6 days. In this period, the radial velocities of WR 21a describe a rather eccentric orbit. The value of the mass function determined from our orbital solution is high, over 8 solar masses, indicating that WR 21a is a system of two massive stars. The X–ray source therefore could arise in the collision of the stellar winds of the binary components.

Key Words: **STARS: BINARIES, SPECTROSCOPIC — STARS: EARLY–TYPE — STARS: INDIVIDUAL (WACK 2134, WR 21A)**

1. INTRODUCTION AND OBSERVATIONS

The X–ray source 1E 1024.0-5732 detected with the Einstein satellite, was identified by Caraveo et al. (1989) with the emission line star 2134 in the Wackerling (1970) catalogue, and suggested to be a binary system composed of an O star with a compact companion. Further X–ray data of this source obtained with the Rosat satellite were analyzed by Mereghetti et al. (1994), who described the optical spectrum to be of Wolf–Rayet type, and proposed that the X–rays could arise in the colliding winds in a WN+OB binary system. Thus the star was added to the catalogue of galactic Wolf–Rayet stars (Van der Hucht 2001) as WR 21a.

Recent interferometric radio observations detected a weak non-thermal source at the position of WR21a, which was also interpreted as due to a colliding wind region in a WN+OB binary (Benaglia et al. 2005).

However, indications of orbital binary motion have not been found thus far. Here we present a radial velocity study of WR 21a, showing it to be a binary system with an orbital period of 31.6 days.

We have obtained digital optical spectral images of WR 21a between 1994 and 2006 at the following observatories:

- 6 blue spectra were obtained with the 1.9m telescope at the South African Astronomical Observatory (SAAO) between 1994 and 1999.
- 26 spectra were observed between 2001 and 2006 at the Complejo Astronomico El Leoncito (CASLEO[8]), San Juan, Argentina. The spectra were acquired with the REOSC Cassegrain spectrograph attached to the 2.1m reflector.
- In addition, 6 higher resolution echelle spectrograms were obtained in 2005 with the 2.5m DuPont reflector at Las Campanas Observatory (LCO), Chile.

2. RESULTS

2.1. *The spectrum of WR 21a*

The blue optical spectrum of WR 21a is illustrated in Figure 1, which depicts one of our spectra

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[8]CASLEO is operated under agreement between CONICET, SECYT, and the National Universities of La Plata, Córdoba and San Juan, Argentina.

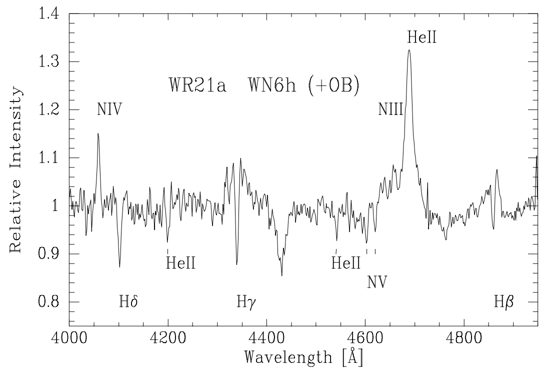

Fig. 1. Continuum rectified blue optical spectrum of WR 21a obtained at CASLEO.

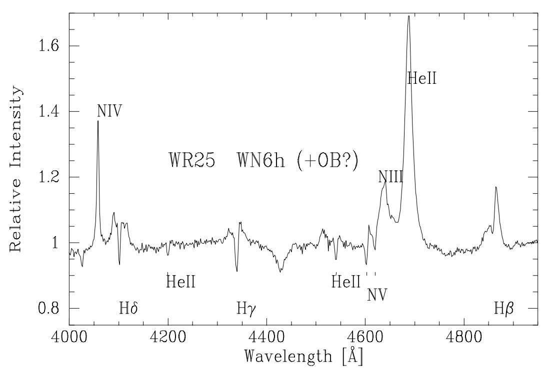

Fig. 2. Continuum rectified spectrum of WR 25 obtained at CASLEO with the same instrumental configuration as that of WR 21a.

obtained at CASLEO. Emission lines of WN type (identified above the continuum) as well as absorption lines corresponding to an early O–type spectrum (identified below the continuum) are observed. We note that the spectrum of WR 21a resembles that of WR 25, (shown in Figure 2), which is the second brightest X–ray source in the Carina Nebula.

2.2. *The radial velocity orbit*

In all of our spectra we have determined radial velocities of the spectral features fitting gaussians within the *splot* routine of IRAF. Only the most intense emission line in the blue spectrum of WR 21a, namely He II λ4686, could be measured in all spectrograms. The radial velocities of this line appeared variable from one observing period to another. With a period search routine applied to the radial velocity variations, we found an orbital period of ~ 32 days. This period was then introduced as an initial value to a program for finding the orbital elements, which are listed in table 1. In Figure 3 we show the radial

TABLE 1

ORBITAL ELEMENTS OF WR 21A

P [days]	31.62±0.01
$a \sin i$ [$R_\odot$]	86±3
K [km s^{-1}]	157±4
V_o[km s^{-1}]	140±3
e	0.48±0.02
ω[deg]	295±3
$F(M)$ [$M_\odot$]	8.6±1
T_o [HJD] 2.450.000+	1184.9±0.30

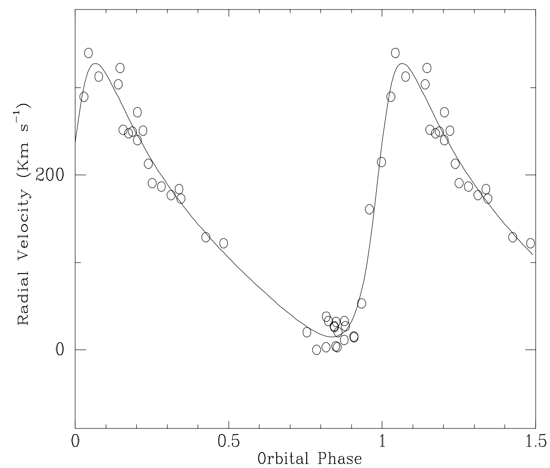

Fig. 3. Radial velocity variations of the He II λ 4686 emission in the WR 21a binary system, phased with the period of 31.62 days. The continuous curve represents the orbital solution from Table 1.

velocity variations phased with the period of 31.62 days.

The high value of the mass function that we have found, implies that both components of the WR 21a binary system must be quite massive, and therefore, the X–ray emission most probably arises in the colliding winds of these massive binary components.

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