R 81: P CYGNI OF THE LMC

O. STAHL, B. WOLF, Landessternwarte, Königstuhl
D-6900 Heidelberg 1
M.J.H. DE GROOT, Armagh Observatory,
Armagh BT 61 9DG, N. Ireland
C. STERKEN, Astrophysical Institute,
Vrije Universiteit Brussel, Brussel, Belgium

ABSTRACT:

Extensive photometric UBV observations and spectroscopic high dispersion (20 Å/mm and 38 Å/mm) coudé observations of the very luminous (M_V = -8.2) B2.5 eq supergiant R81 of the LMC were carried out between 1970 and 1980 at ESO, La Silla. In addition the IUE satellite was used to obtain a high resolution (0.2 Å) spectrogram in the ultraviolet wavelength range 1200 < λ < 1950 Å. The most prominent features of the visual spectrum are P Cygni profiles of the Balmer lines, indicating a shell with an expansion velocity of about 140 km s^{-1}. The ultraviolet spectrum of R 81 is dominated by blue-shifted absorption resonance lines (Si II, Si IV, C II, C IV, Al III etc.) and Fe III absorption lines originating from metastable lower levels. From the UV resonance lines a very high mass loss rate ($\dot{M}$ = 5 10^{-5} $M_\odot$ yr^{-1}) was estimated. The early Balmer lines show very broad shallow emission wings (total width 40 to 50 Å), attributed to electron scattering. The mass loss is highly variable and presumably occurs in the form of sudden ejections of discrete shells. Irregular brightness variations of a few tenths of a magnitude in V on timescales of weeks were found. An absolute bolometric magnitude $M_{bol} \approx -10$ and a photospheric radius $R \approx 70\ R_\odot$ were estimated. A comparison with theoretical evolutionary tracks indicates a stellar mass $M > 50\ M_\odot$. The observed spectroscopic properties lead us to suggest that the LMC star R 81 is a close counterpart of the galactic star P Cyg, representing a short lived transient stage in the evolution of the most massive stars.

A more detailed presentation of the results has already been submitted to Astronomy and Astrophysics.

M. Jaschek and H.-G. Groth (eds.), Be Stars, 201–203.

DISCUSSION

Ballereau: In P Cyg, He I lines have "P Cyg" profiles. Why in your star only H has P Cyg profiles and not He I?

Stahl: We suppose that the temperature of R81, which seems to be slightly lower than the temperature of P Cyg is too low to produce P Cyg profiles of the He I lines.

Viotti: I would like to know more about these absorption lines which could originate in the deepest layers of the atmosphere of this star, since they could help us to determine its effective temperature. Are the radial velocities of excited lines like He I violet shifted or unshifted with respect to the expected radial velocity of the star and did you find excited lines, like HeII, NIII, in UV? Finally it would be important to compare your mass loss rate with that one that would be determined from the IR.

Stahl: The He I lines are indeed violet shifted with respect to the system velocity. HeII and NIII lines could not be detected in the UV. There are no IR observations available for R81. However, we plan such observations in order to derive the mass loss rate independently from the IR free-free radiation.

Snow: I have a comment and a question. The comment is that IUE spectra show very complex interstellar absorption lines towards the Magellanic Clouds, with numerous velocity components. In particular, highly ionized species, such as C IV have this appearance. Therefore I am not convinced that your IUE spectra of this star reveal any evidence for highly ionized species in the circumstellar envelope; all of the CIV you see may well be interstellar.
My question has to do with your derivation of the mass-loss rate by fitting the Castor and Lamers theoretical profiles. If you did not allow for photospheric contribution to the lines, you may have overestimated $\dot{M}$. On the other hand, this could account for the difficulty of matching the emission portion of the profiles. How did you treat this problem?

Stahl: I agree that a great deal of the observed CIV lines may be of interstellar origin, but it is hard to decide this from our IUE spectrogram. As far as the fitting of the profiles is concerned: we did not allow for a photospheric contribution to the lines, because the photospheric profiles are not known. It is true, that the observed emission may be reduced by absorption in the photosphere. We think that the mass-loss rate is not much affected by the photospheric absorption, as we fitted the shortward wings of the observed line profiles, which are probably not affected by the photospheric absorption.

Divan: From our spectra taken in Dec. 1971, R81 shows emission in the Balmer continuum like ordinary Be stars. It is the only supergiant

which shows such emission. The star P Cyg does not show any Balmer discontinuity, neither in emission nor in absorption. The spectral classification of R81 is given as B2.5eq. If its absolute magnitude were not known from its distance, I wonder what luminosity class would be inferred for its spectrum.

https://doi.org/10.1017/S0074180900037827 Published online by Cambridge University Press