Massive Stars Across Redshifts in the Era of JWST and Large Surveys
Proceedings IAU Symposium No. 402, 2026
A. Wofford, N. St Louis, M. García, S. Simón-Díaz & L. M. Oskinova, eds.
doi:10.1017/S1743921325105401

Could the Luminous Blue Variable Candidate WR 31a be a Binary?

C. Erba[1], R. Ignace[2] and F. Simmons[2]

[1]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
email: christi.erba@gmail.com

[2]Department of Physics and Astronomy, East Tennessee State University, Johnson City, TN 37663, USA

Abstract. WR 31a (also identified as Hen 3-519) is an evolved massive star that displays a Wolf-Rayet (WR) emission line spectrum and is surrounded by a 1' diameter ring nebula. It may be a post-luminous blue variable (LBV) star that is evolving towards a classical WR star. Multicolor (UBVR) photopolarimetry of WR 31a was obtained over a span of ten nights in early 2007, revealing a "loop" structure in the Stokes Q-U diagram. Such loops often indicate the presence of a binary companion, although one has not yet been observed in WR 31a. We test the binary hypothesis with a set of models and produce constraints on the expected orbital parameters of a possible companion within the context of our assumptions. The prevalence of massive stars in multiple systems is well-established; thus, the potential to detect a binary companion during the post-LBV state of WR 31a adds to the emerging narrative of diverse interactions between massive components as a function of evolutionary stage.

Keywords. Wolf-Rayet stars, Luminous blue variable stars, Stellar winds, Polarimetry, Stellar mass loss

---

Luminous blue variable stars are a post-Main-Sequence evolutionary stage for massive stars that may be a precursor to a later Wolf-Rayet (WR) phase (Humphreys and Davidson 1994, e.g.,). These stars are characterized by the rapid loss of mass, either via stellar winds depositing $\sim 10^{-5}$ $M_\odot$ yr^{-1} into the local interstellar medium, or by periodic eruptive bursts during which the surface photospheric layers are shed. Such intense mass loss directly contributes to dust production and to the chemical enrichment of the immediate stellar neighborhood (Vink 2018; Agliozzo et al. 2021).

This poster reports the work of Erba et al. (2025), who examined optical linear polarimetry of WR 31a, a purported post-LBV object in transition to its WR stage. The loop structure visible in the polarized light is characteristic of cyclical variability which may be due to an as-yet unseen binary companion or co-rotating interaction region. Erba et al. (2025) primarily explore the binary hypothesis. Using a simplified analytic prescription in the style of Brown et al. (1982), they find an elliptical orbit with an eccentricity of $e \sim 0.5$ and a viewing inclination of $i \sim 75°$ offer a reasonable fit to the data, implying a possible orbital period of ~ 70 d with periastron at ~ 3 R_* (0.06 mas) and apastron at ~ 9 R_* (0.2 mas). The solution is not unique, but offers an initial interpretation that provides constraints for future observing programs.

Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1743921325105401.

© The Author(s), 2026. Published by Cambridge University Press on behalf of The International Astronomical Union.

https://doi.org/10.1017/S1743921325105401 Published online by Cambridge University Press

References

Agliozzo, C., Phillips, N., Mehner, A., Baade, D., Scicluna, P., Kemper, F., Asmus, D., de Wit, W. J., & Pignata, G. 2021, The contribution by luminous blue variable stars to the dust content of the Magellanic Clouds. *A&A*, 655, A98.

Brown, J. C., Aspin, C., Simmons, J. F. L., & McLean, I. S. 1982, The effect of orbital eccentricity on polarimetric binary diagnostics. *MNRAS*, 198, 787–794.

Erba, C., Ignace, R., Simmons, F., & Davies, B. 2025, Variable Polarization of WR 31a: Binary Companion or Corotating Interaction Region? *AJ*, 170(1), 10.

Humphreys, R. M. & Davidson, K. 1994, The Luminous Blue Variables: Astrophysical Geysers. *PASP*, 106, 1025.

Vink, J. S. 2018, Very massive stars: a metallicity-dependent upper-mass limit, slow winds, and the self-enrichment of globular clusters. *A&A*, 615, A119.

https://doi.org/10.1017/S1743921325105401 Published online by Cambridge University Press