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The density of neutral wind in symbiotic binary and its orbital inclination: the case of Z And

N. Shagatova and A. Skopal

Astronomical Institute of the Slovak Academy of Sciences
059 60 Tatranská Lomnica, The Slovak Republic, (E-mail: nshagatova@ta3.sk)

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Abstract. In this contribution, we measure the orbital inclination i of the symbiotic prototype Z And by modelling the column density n_H of the red giant neutral wind. The method of wind velocity profile derivation was improved by taking the effect of ionization into account. We obtained $i = 60^\circ - 9^\circ / + 6^\circ$.
Key words: binaries: symbiotic – stars: winds – stars: individual: Z And

1. Introduction

Symbiotic stars are understood as long-period ($P_{\rm orb}$ of a few years) interacting binaries consisting of a cool giant (CG) and a white dwarf (WD). The principal process of interaction is the accretion of a fraction of the giant wind by the WD. Z And was considered to be a non-eclipsing binary with $i \approx 47^\circ$ (e. g. Schmid & Schild (1997)). On the contrary, the eclipse-like effect measured in the light curve suggested $i > 76^\circ$ (Skopal, 2003). Also, Isogai et al. (2010) derived by two different methods $i \approx 41^\circ$ and $i \approx 73^\circ$. Large differences in the measured orbital inclination motivated us to determine it by a new approach.

2. Column density from observations and modelling

In the neutral part of the cool component wind, the effect of Rayleigh scattering is present. Accordingly, we can determine the column density of neutral hydrogen n_H at a given orbital phase φ with the CG in front for systems with a high i. The strength of the Rayleigh effect in the IUE spectrum SWP32845 at $\varphi = 0.961 \pm 0.018$ corresponds to $n_H = 3.9 \times 10^{22}\, cm^{-2}$ (see Fig. 1. in Skopal & Shagatova, 2012). We compared this value to that modelled at the same φ.

The n_H on the line of sight passing through the neutral region in the direction of the WD was determined by integrating densities of H^0 atoms at a given φ. Calculations were performed using the continuity equation for a given wind velocity profile, which can be obtained by inverting the integral operator of Abel's type for n_H (Knill et al., 1993). For Z And, there is a lack of observed n_H values for this task, so we did the inversion for the SY Mus ingress and egress data, because its CG is of the same spectral type (M4.5 III) as that in Z And. Values of the observed n_H for SY Mus were adopted from Dumm et al. (1999).

3. Results

Skopal & Shagatova (2012) determined i to be in the range $59° - 75°$ using the wind velocity profile derived by Dumm et al. (1999), who modelled only observed $n_H(\varphi)$ values not affected by ionization. Here, we calculated the $n_H(i, \varphi = 0.961)$ function for more precise wind velocity profiles that we derived by modelling all the observed $n_H(\varphi)$ values. In this way we obtained $i = 60° - 9°/+6°$ (Fig. 1).

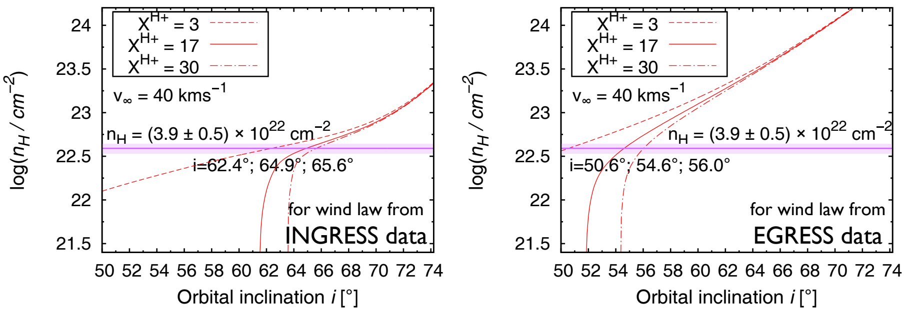

Figure 1. Models of $n_H(i, \varphi = 0.961)$. The horizontal line and the band represent the observed value of n_H and its uncertainty, respectively, v_∞ is the terminal velocity. The range of ionization parameter $3 < X^{H+} \lesssim 30$ was deduced from the uncertainties of Z And parameters (see Skopal & Shagatova (2012)).

4. Conclusion

We modeled the $n_H(i)$ function around the inferior conjunction of the giant for Z And, using SY Mus wind velocity profiles derived by the inversion method, improved by taking into account the effect of ionization. Comparison of theoretical n_H values with the observed one suggests the Z And inclination $i = 60° - 9°/+6°$.

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