Winds of Stars and Exoplanets
Proceedings IAU Symposium No. 370, 2023
A. A. Vidotto, L. Fossati & J. S. Vink, eds.
doi:10.1017/S1743921322003465

Rapid orbital precession of the eclipsing binary HS Hydrae

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Abstract. We investigated the evolution of HS Hya system's inclination based on analysis of its light curves in the period 1964–2021. HS Hya is EA type eclipsing binary star, belonging to separate group with changing orbital inclination. We used our recent observations as well as the data from sky surveys.

Keywords. (stars:) binaries: eclipsing, methods: data analysis, techniques: photometric

1. Introduction

HS Hydrae was classified as EA type eclipsing binary star (EBs) based on observations of Strohmeier et al. (1965) and has been studied in detail as a normal binary system by Gyldenkerne et al. (1975). Torres et al. (1997) first suggested the presence of a third body in the system and determined its orbital period as 190 days. Zasche & Paschke (2012), analysing long-term photometric data, found that HS Hya changes its orbital inclination with $P_{\mathrm{nodal}} \sim 631$ yr and predicted that eclipses for HS Hya would cease around 2022. Based on analysis of the unique data set for 125 years, created from the DASCH photographic plate database, Davenport et al. (2021) derived HS Hya's precession period as 1194±20 years. According to their estimations, its eclipses will appear again around 2195±3 which is consistent with Vokrouhlický & Zasche (2022).

2. Observation & Data Reduction

The observations were performed during May 17–20, 2020 at the Maidanak observatory (Uzbekistan) using the 60-cm telescope Zeiss-600 equipped with FLI IMG ProLine 1024×1024 CCD, the scale is 0.372″ per pixel. In total 1138 images in Johnson-Cousins R band with 5 second exposure were obtained during these observations. CCD images were processed and analyzed by aperture photometry using the IRAF packages.

3. Discussion & Conclusions

For comprehensive study of the HS Hya orbital inclination evolution we have collected all available photometric data since its discovery. The light curves of Gyldenkerne et al. (1975) and that of based on Hipparcos Perryman et al. (1997) and ASAS Pojmanski (2002) databases are shown in Figure 1. Based on analysis of the data for 1964-2020, we found that the HS Hya orbital inclination has changed $i \geq 17.5$ deg. Light curves based on HS Hya (TIC434479378) data obtained by TESS mission Keivan et al. (2018) and on our data obtained at Maidanak observatory are shown in Figure 2. According our analysis the eclipses in this system will reappear again in 165 years. It is also noteworthy

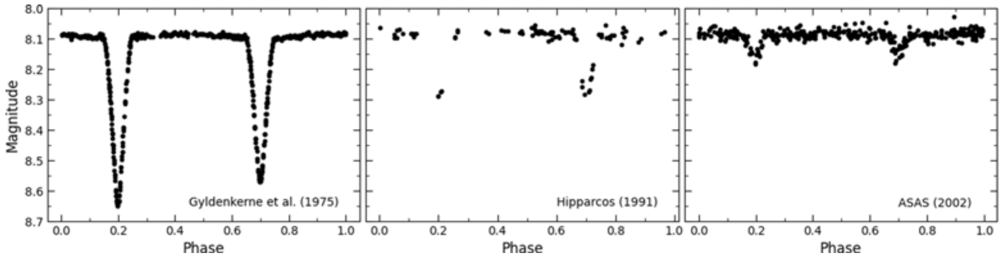

Figure 1. The light curves of HS Hya in the V band. The figure shows clearly the change in the depth of both minima. Three panels have the same scale.

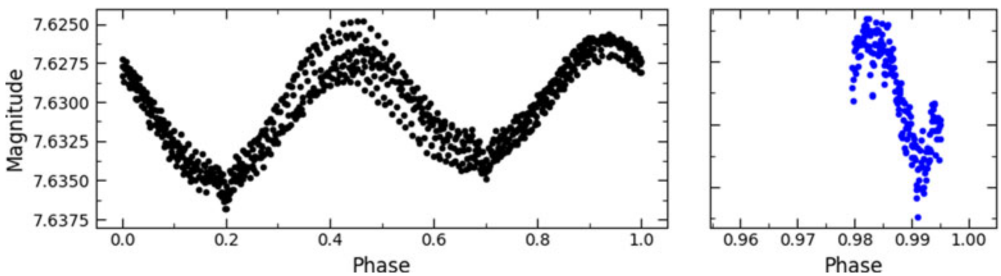

Figure 2. TESS Sector 9 (left)and Maidanak (right) phase-folded light curves for HS Hya: The figure shows amplitude of primary (Phase$\sim$0.2) and secondary (Phase$\sim$0.7) minima are small.

that according to analysis of the data from TESS Sector 35 (February 9 - March 7, 2021), Davenport et al. (2021) have found no eclipses.

Until our investigation HS Hya belonged to the detached binary systems and classified as EA type EBs. The new analyses of all existed data including our and TESS data revealed that in addition to the eclipses the binary system has superposition of different modes of variability including an ellipsoidal variation out of eclipses. The last may be due to the ellipsoidal shape of at least one of the components of the HS Hya, a thin changing shell around this binary system, and the flows from the Lagrange points of the Roche lobe. Investigations of changes of orbital inclination (nodal motion) effect could allow us to determine the presence of third body around EBs including the black hole. Thus, the study of this phenomenon is very essential for further research in the field. We plan to continue studying this effect in other EBs.

Acknowledgements

We thank the International Grant Uzb-Ind-2021-99 for financial support. This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France, NASA's Astrophysics Data System Bibliographic Services and the Mikulski Archive for Space Telescopes (MAST).

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https://doi.org/10.1017/S1743921322003465 Published online by Cambridge University Press

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