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FIRST RESULT OF THE BASE PROGRAM: HIP 80646 IS AN ECLIPSING BINARY

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Abstract. HIP 80646 is an astrometric binary with an almost edge-on orientation selected from the Gaia-DR3 astrometric orbit catalogues. We report the first observations of the two eclipses of this system.

Keywords: Binaries: eclipsing, Stars: individual: HIP 80646

1 Introduction

BASE is a programme dedicated to Binary stars that are Astrometric, Spectroscopic and Eclipsing. Such systems are benchmarks for models of stellar structure and evolution, since the double-lined spectroscopic orbital elements supplemented by astrometric elements and photometric observations of eclipses can be used to deduce the masses, luminosities and radii of both components. A preliminary selection of 41 targets was extracted from the catalogues of astrometric orbital elements published with the 3^{rd} Gaia Data Release (Gaia-DR3 hereafter; see Halbwachs et al. 2023, and references therein). These stars are now observed by professional astronomers from the Haute-Provence Observatory (OHP) to select those that are double-line spectroscopic binaries (SB2), while the search for eclipses is entrusted to amateur astronomers.

2 Eclipse prediction uncertainties

The predicted epochs of eclipses derived from the astrometric orbital elements depends on period, eccentricity, periastron epoch, periastron longitude and, to a lesser extent, orbital inclination. However, the observations used to derive the astrometric orbits in Gaia-DR3 were collected during about 1000 days, just over 3000 days ago. As a consequence, the most important source of error is the period since its uncertainty is multiplied by the number of cycles since the Gaia observations were made. As a consequence, eclipses are predicted within error intervals that are generally larger than one month. Fortunately, our sample contains two targets with exceptionally accurate periods. Gaia DR3 1303880881984427136, with a period of 210.22 ± 0.22 days, is one of these two targets. Also known as HIP 80646, HD 148555 or BD +25 3086, this star is a G5-type star of 8.19 mag and absolute magnitude $M_V = 2.6$, which places it in the sub-giant branch.

3 Observations of the eclipses of HIP 80646

3.1 The eclipse of 21 March 2025

An eclipse of HIP 80646 has been predicted around 22 March 2025, within a 2-σ window of 17 days. Thanks to the spectroscopic observations obtained at the OHP, we can infer that this eclipse is due to a transit of the brightest component in front of the faintest one. It was actually observed by one of us (A. Debackère), using the Las Cumbres Observatory (LCO) telescope network. The 35cm-telescopes used were located at the Teide Observatory (Tenerife, Canary Islands), the Mac Donald Observatory (Texas) and the Haleakala Observatory (Hawaii). The photometric observations are presented in the left panel of Fig. 1.

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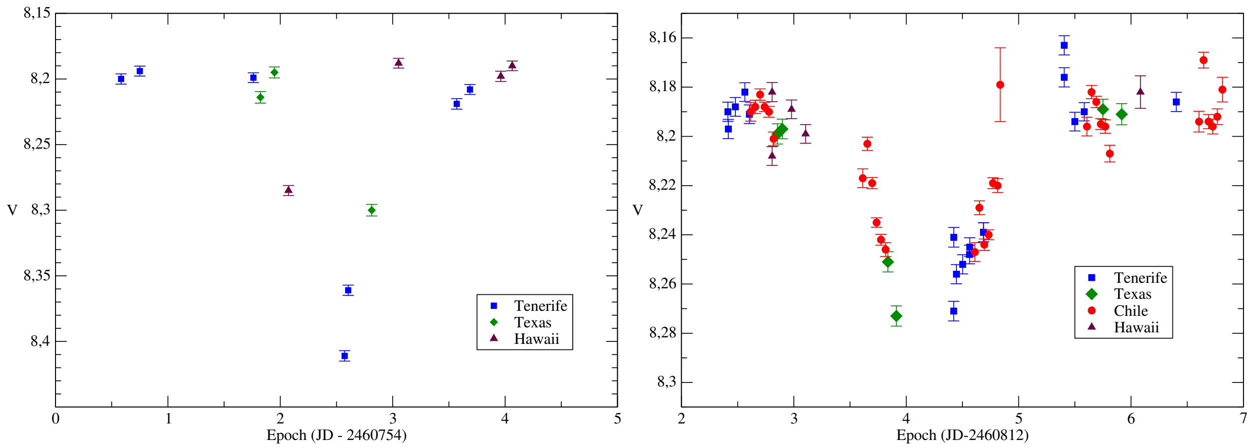

Fig. 1. Left: Eclipse of the secondary component of HIP 80646, observed by the LCO telescopes on the night of 21 March 2025. **Right:** Eclipse of the primary component of HIP 80646, observed by the LCO and ROAD telescopes on 20 May 2025 ; for clarity, ROAD observations (in red) were merged when they were closer than 0.04 days.

3.2 The eclipse of 20 May 2025

Once the eclipse of the secondary component has been detected, it is possible to deduce the epoch of the eclipse of the primary component with fairly good accuracy. To do this, we had to simulate the orbital parameters, taking into account the uncertainties and correlation coefficients, and calculate the time interval between these two eclipses. The result is that the eclipse of the primary component following that of the secondary was likely to occur between 11 and 22 May 2025 (2 σ-interval).

This prediction came true on 20 May 2025, and the eclipse was observed by the LCO 35cm-telescopes, but also by the 40cm-telescope of the Remote Observatory Atacama Desert (ROAD) located at the San Pedro de Atacama Celestial Observatory (SPACEOBS), in Chile, and operated by one of us (F.-J. Hambsch). The observations are in Fig. 1, right panel. This result was not guaranteed a priori, as the apparent separation between the components was twice as great as during the previous eclipse.

4 Conclusion and future prospects

We have found that HIP 80646 is an eclipsing binary, and that both eclipses are observable. Due to the apparent proximity of the Sun, subsequent eclipses will not be visible from Earth, but the next observable eclipse of the secondary component should occur in 2026, between 14 May at 13:00 UT and 18 May at 08:00 UT. For the next eclipse of the primary component, the window extends from 13 July at 13:00 UT to 17 July at 20:00 UT. We encourage you to join the BASE programme to observe them and obtain as much scientific information as possible. For more information, see the BASE website at `https://gemini.obspm.fr/20231207-base/`.

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