Astrometry of COU 606 and COU 929 at Mt. Wilson Observatory

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Abstract

We used the 60” Hale telescope at Mount Wilson Observatory to perform speckle interferometry on two close binary star pairs: COU 929 and COU 606. We took several hundred short exposures of both systems and reduced the data using Speckle Toolbox 1.16 written by Dave Rowe. COU 929 had an observed position angle of 54.13° and an observed separation of 0.149″ on March 25, 2022 (ephemeris position angle 58.65°, separation 0.145″). COU 606 had an observed position angle of 62.46° and observed separation of 0.245″ on June 14, 2022 (ephemeris position angle 62.28°, separation 0.253″.)

1. Introduction

COU 929 and COU 606 are both binary systems that were discovered by Paul Couteau (Couteau, 1972). In both cases, the small separation between the primary and secondary stars exceeds the resolving power of the Gaia space telescope, so only the primary star is listed in the third data release (Gaia Collaboration, 2016; Gaia Collaboration, 2022). This makes both systems particularly salient as targets for speckle interferometry. A brief explanation of the speckle process is given in Upson, 2022.

COU 929 was observed at Mt. Wilson via speckle interferometry in 2007 (Hartkopf and Mason). Its orbital solution (Figure 1) predicted a separation of 0.145″ and a position angle of 58.65° on March 25, 2022.

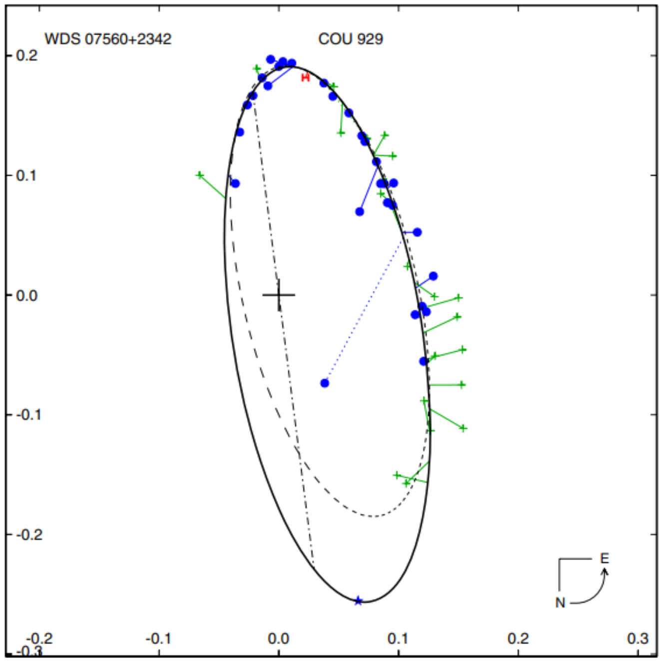

Figure 1: COU 929 Orbital Solution courtesy of the Washington Double Star Catalog.

The orbit of COU 606 was solved by Docobo et al. in 2008. Based on its Sixth Orbit Catalog ephemeris, the predicted position angle for the night of June 14, 2022 was 62.28° with a separation of 0.253″ (Docobo et al., 2008).

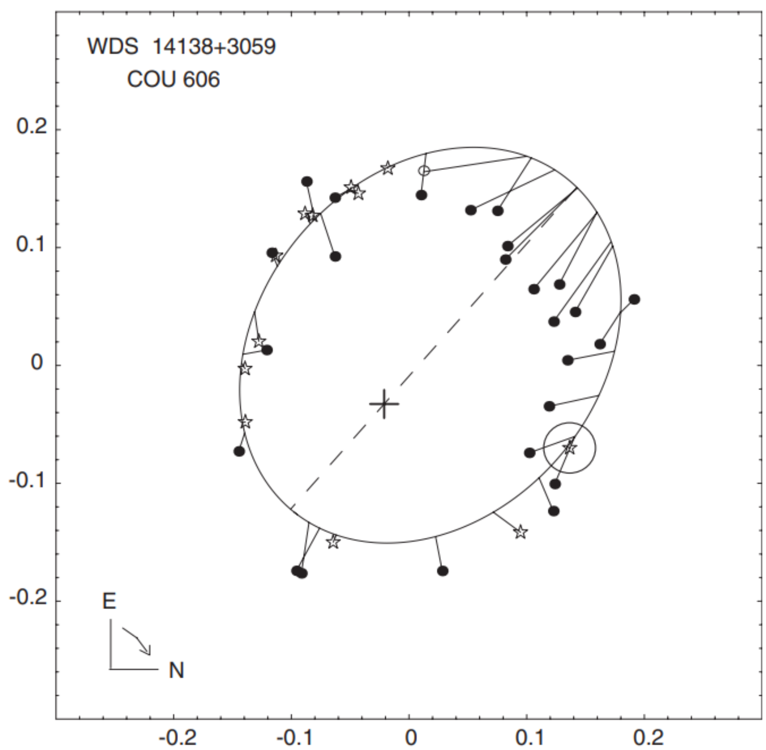

Figure 2: Orbital Solution of COU 606 from Docobo et al. 2008.

The ephemeris predictions for both star systems were made using a simple linear interpolation as demonstrated by Bush et al., 2017. For example, the approximations for position angle and separation for COU 606 were found by taking the fraction of 365 days (2022 was not a leap year) from the 2022.0 ephemerides to the June 14, 2022 observation date (0.452) and multiplying that value by the difference in predicted value between 2022.0 and 2023.0. This value was then added to the 2022.0 predicted value. For both position angle and separation, we can perform such an interpolation using the equation below:

Predicted value(s) on [fractional year from Jan 1 2022] = [2022 value] + [fractional year from Jan 1 2022]([2023 value] - [2022 value])

COU 929 was observed on March 25th 2022 (fractional date: 0.23) and COU 606 was observed on June 14th 2022 (fractional date: 0.452).

2. Equipment and Methods

The targets studied in this paper were observed using the historic 60-inch Hale telescope situated at Mount Wilson Observatory in Pasadena California. The telescope is of a modified Cassegrain design with an F/16 focal ratio and a 60-inch (1.524m) aperture and thus a 24.384m focal length. Observations were recorded using a ZWO ASI6200 camera hosting a SONY IMX455 CMOS sensor. The resulting field of view is 5.08′ x 3.38′. This setup was coupled with an Astronomik Proplanet-642 BP IR pass filter which has a central wavelength of 745nm, and a full width at half maximum of 200 nm, as illustrated in Figure 3.

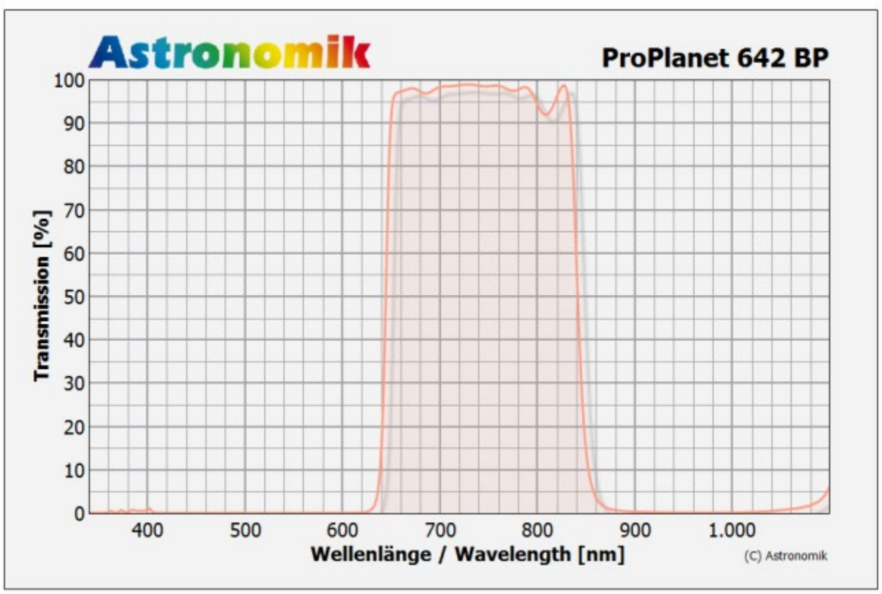

Figure 3: Transmission curve for filter used from Astronomik website.

As speckle interferometry requires hundreds of short exposures, images were cropped to 256px square surrounding the primary star. The camera binning was kept at 1x1. This gave an effective FOV of 8.14″ square.

The data were analyzed using Speckle Toolbox 1.16, written by Dave Rowe (Harshaw et al, 2017). The three mirrors in the telescope optical train introduced a 360º discrepancy in the measurements which we corrected by subtracting the software's measured position angle from 360º. Bispectrum phase reconstruction was performed on the data and the result was measured via the in-built astrometry tool in Speckle Toolbox 1.16. K-space filter settings were visually determined such that the autocorrelogram consisted of two very distinct patches representing the double stars in question. The same method was used for both COU 929 and COU 606. The Speckle Toolbox settings for each system are shown in Figures 4 and 5.

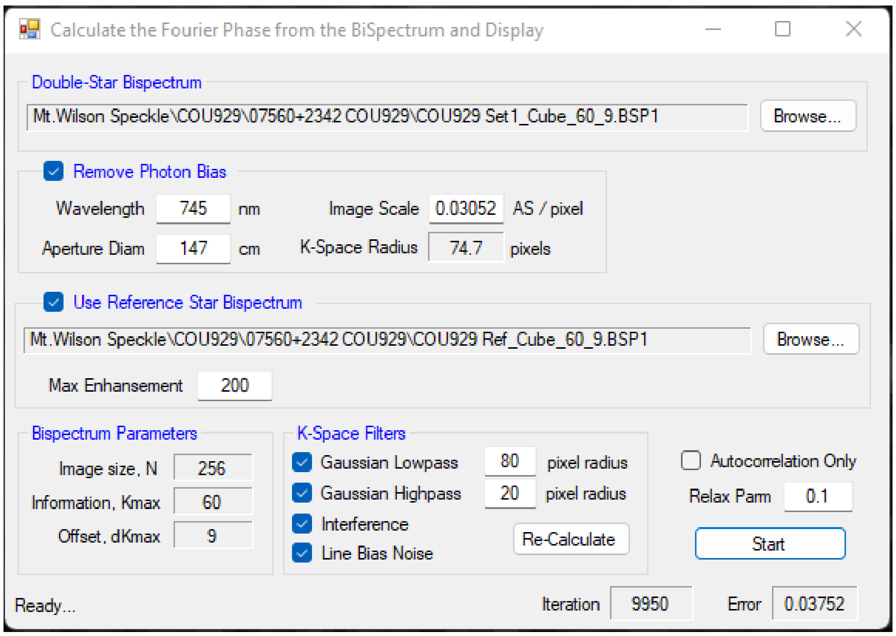

Figure 4: Dialog window showing specifications used for the reduction of COU 929 data.

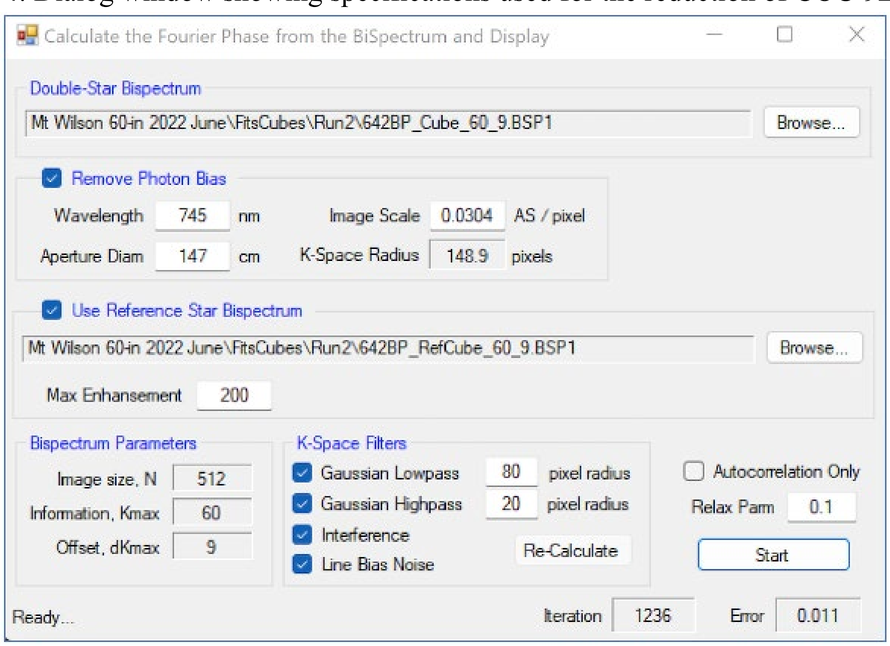

Figure 5: Dialog window showing specifications used for the reduction of COU 606 data.

3. Data and Results

Astrometry on the autocorrelogram indicated a position angle and separation for COU 929 of 54.13° and 0.149″ on March 25, 2022. Similar reduction for COU 606 produced measurements for position angle and separation of 62.46° and 0.245″ on June 14, 2022. The bispectrum phase reconstruction of COU 929 is shown in Figure 6 and that of COU 606 is shown in Figure 7.

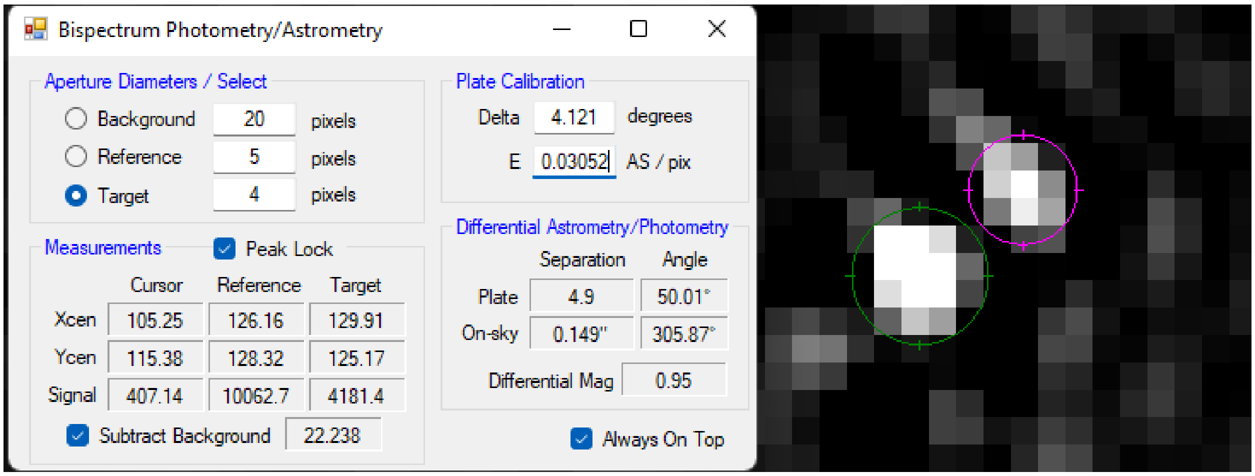

Figure 6: Dialog window showing Bispectrum Phase Reconstruction and Astrometry of COU 929.

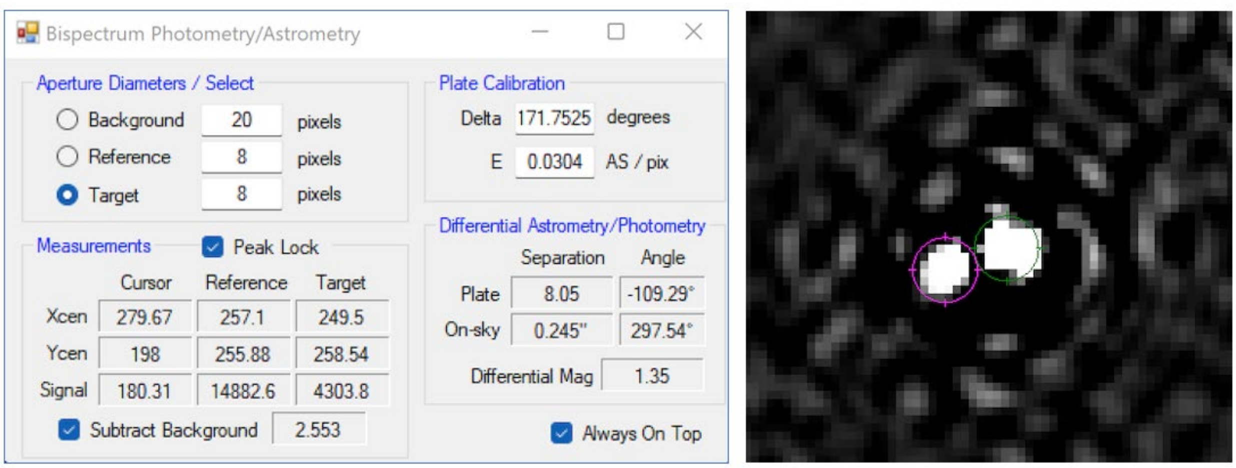

Figure 7: Dialog window showing Bispectrum Phase Reconstruction and Astrometry of COU 606.

4. Discussion

As shown in Table 1 and in Figure 7, the measurements of COU 606 agree closely with the orbital solution and ephemeris. The COU 929 separation measurement is in similar close agreement, but the measurement of position angle deviates. Because our speckle reduction yielded a single measurement of each system, we have not evaluated these discrepancies for their statistical significance. However, if the departures from the respective ephemerides are confirmed, this might suggest the need for a new orbital solution for one or both systems.

Table 1. Measured and predicted parameters for COU 929 and COU 606

Star, Date	Measured PA	Ephemeris PA	Measured Sep	Ephemeris Sep
COU 929 March 25, 2022	54.1°	58.7°	0.15″	0.15″
COU 606 June 14, 2022	62.5°	62.3°	0.25″	0.25″

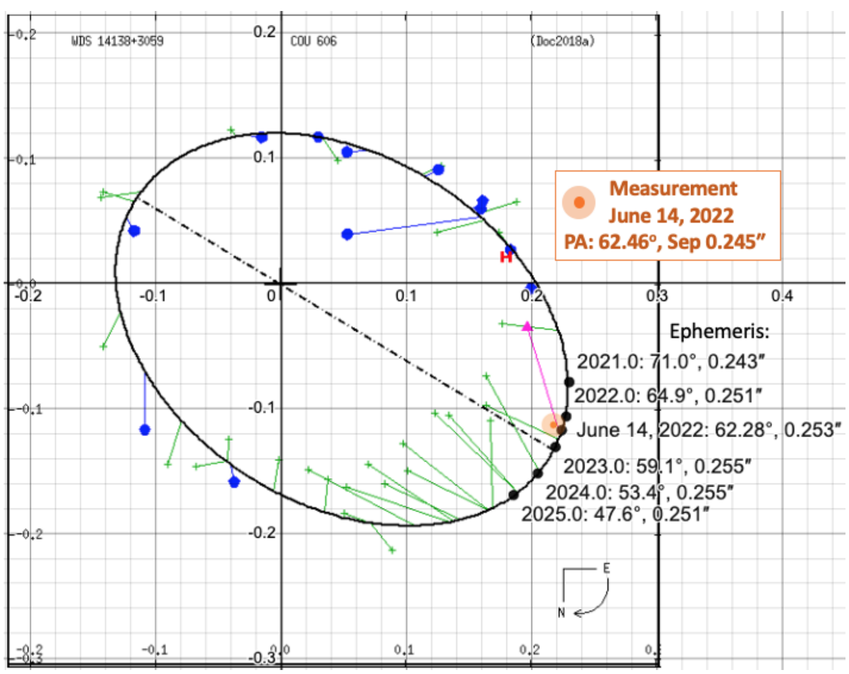

Figure 7: Orbital plot of COU 606 with data from the June 2022 Mount Wilson data overlaid in orange.

5. Conclusions

We present the following measurements to the Washington Double Star Catalog: COU 929 had a position angle of 54.13° and separation of 0.149″ as measured on the 25th of March 2022. COU 606 had a position angle of 62.46° and a separation of 0.245″ as measured on the 14th of June 2022.

Acknowledgements

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