Discovery of stellar duplicity of TYC 2257-00583-1 during asteroidal occultation by (980) Anacostia

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Abstract

An occultation of TYC 2257-00583-1 by the asteroid (980) Anacostia on 2021 September 27 showed this star to be a double star. The occultation was observed by four observers in Japan and all of them recorded the occultation of both components. In addition five observers at four locations recorded miss observations. The separation of the two components is found to be 0.0136 ± 0.0009 arcseconds at a position angle of 270.1 ± 3.3 degrees. The magnitude of the primary component is estimated to be 11.4 (V) and the magnitude of the secondary component is estimated to be 11.7 (V).

Observation

On 2021 September 27, nine observers occupying or operating sites at eight locations across Japan observed the asteroid (980) Anacostia occult the star TYC 2257-00583-1. See Figure 1 for the path map of the event. Four of the nine observers recorded the occultation and all of the occultation light curves of these four indicates that the star is a double star (see Figures 2, 3, 4 and 5). All recorded occultation times and data from the observers can be found in archived IOTA records for the event. The observations were made by the observers located at the sites and with the equipment shown in Table 1.

Fig.5 Chords	Observer	Location	Prefecture	Telescope		Method	Result
				Type	Dia(cm)		
2, 3	Hiroyuki Watanabe	Tarui	Gifu	SCT	20	Video+GPS Time Inst	Both comp
4, 5	Hayato Watanabe	Inabe	Mie	SCT	20	Video+GPS Time Inst	Both comp
6, 7	Akira Asai	Inabe	Mie	SCT	35.5	Video+GPS Time Inst	Both comp
8, 9	Miyoshi Ida	Higashiomi	Shiga	SCT	20	Video+GPS Time Inst	Both Comp
10	Sadayuki Uchiyama	Inabe	Mie	SCT	30	Video+GPS Time Inst	Miss
11	Toshihiro Nagata & Hidehito Yamamura	Kyoto	Kyoto	SCT	35.5	Video+GPS Time Inst	Miss
12	Minoru Owada	Hamamatsu	Shizuoka	SCT	25	Video+GPS Time Inst	Miss
13	Masaru Yamashita	Ikeda	Osaka	SCT	35.5	Video+GPS Time Inst	Miss

Table 1—Observers, site locations, equipment, methods, and results

The target star is magnitude 10.79 ± 0.07. This is a V magnitude in the Johnson system derived from the Tycho system magnitudes VT and BT given in the Tycho-2 Catalogue by the formula V = VT − 0.090 (BT − VT) [1]. The asteroid magnitude as predicted using the magnitude parameter values H = 7.92 and G = 0.15 was 10.87 (V). The combined magnitude of the asteroid and the star was calculated to be 10.08 (V). The expected magnitude drop at occultation was

calculated to be 0.79 magnitudes. The star is not listed in the Fourth Interferometric Catalog, nor is it listed in the Washington Double Star Catalog.

Analysis

The observations were analysed in the standard manner described by IOTA [2] with the help of the occultation prediction software Occult v4 [3].

The finished plot of the double star fit to the data is shown in Figure 6. Although the major axis is obtained approximately as 92km from the observation data, since all of the obtained chords are on one side of the asteroid, the major axis is not constrained well. Therefore we have fixed the major axis of the ellipse to 92km, and the minor axis of the ellipse, and the separation and the position angle of the double star were solved by the least squares fit. The solution gives the separation of 0.0136 ± 0.0009 arcseconds and the position angle of 270.1 ± 3.3 degrees. All of the four observers Hiroyuki Watanabe, Hayato Watanabe, Akira Asai, and Miyoshi Ida recorded the occultations of both components. Using the light curve data from all these observers, the magnitude drops of the two events were calculated and using the combined V magnitude from the Tych-2 Catalogue and the predicted V magnitude of the asteroid as explained above the magnitudes of the primary and the secondary stars were obtained for each observer as shown in Table 2. By averaging them the magnitudes of the two stars are estimated to be 11.38 ± 0.17 (V) for the primary star and 11.74 ± 0.19 (V) for the secondary star. The event was an ABAB, i.e. both at the disappearance and reappearance the primary event occurred first and then the secondary.

Observer	Phen	Magnitudes	
		Primary	Secondary
Hiroyuki Watanabe	D	11.01	12.65
	R	12.38	11.08
Hayato Watanabe	D	11.31	11.84
	R	11.19	12.06
Akira Asai	D	11.70	11.40
	R	11.36	11.76
Miyoshi Ida	D,R	11.25	11.94
Average		11.38±0.17	11.74±0.19

Table 2 – Calculated magnitudes

Based on the data presented in this report, the double star characteristics as shown in the plot in Figure 6 are:

Star	TYCHO 2257-00583-1 UCAC2 42170398 UCAC4 596-142519 NOMAD 1191-0621743 PPMXL 1969190833036648665 Spectral type rF6V [4]
Coordinates (Gaia EDR3)	RA 23h 43m 56.4790s Dec +29° 11' 35.389" (ICRS, Epoch 2021 Sept 27)
Mag A	11.38 ± 0.17 (Estimated from Tycho-2 V mag)
Mag B	11.74 ± 0.19 (Estimated from Tycho-2 V mag)
Separation	0.0136 ± 0.0009 arcseconds
Position Angle	270.1 ± 3.3 degrees

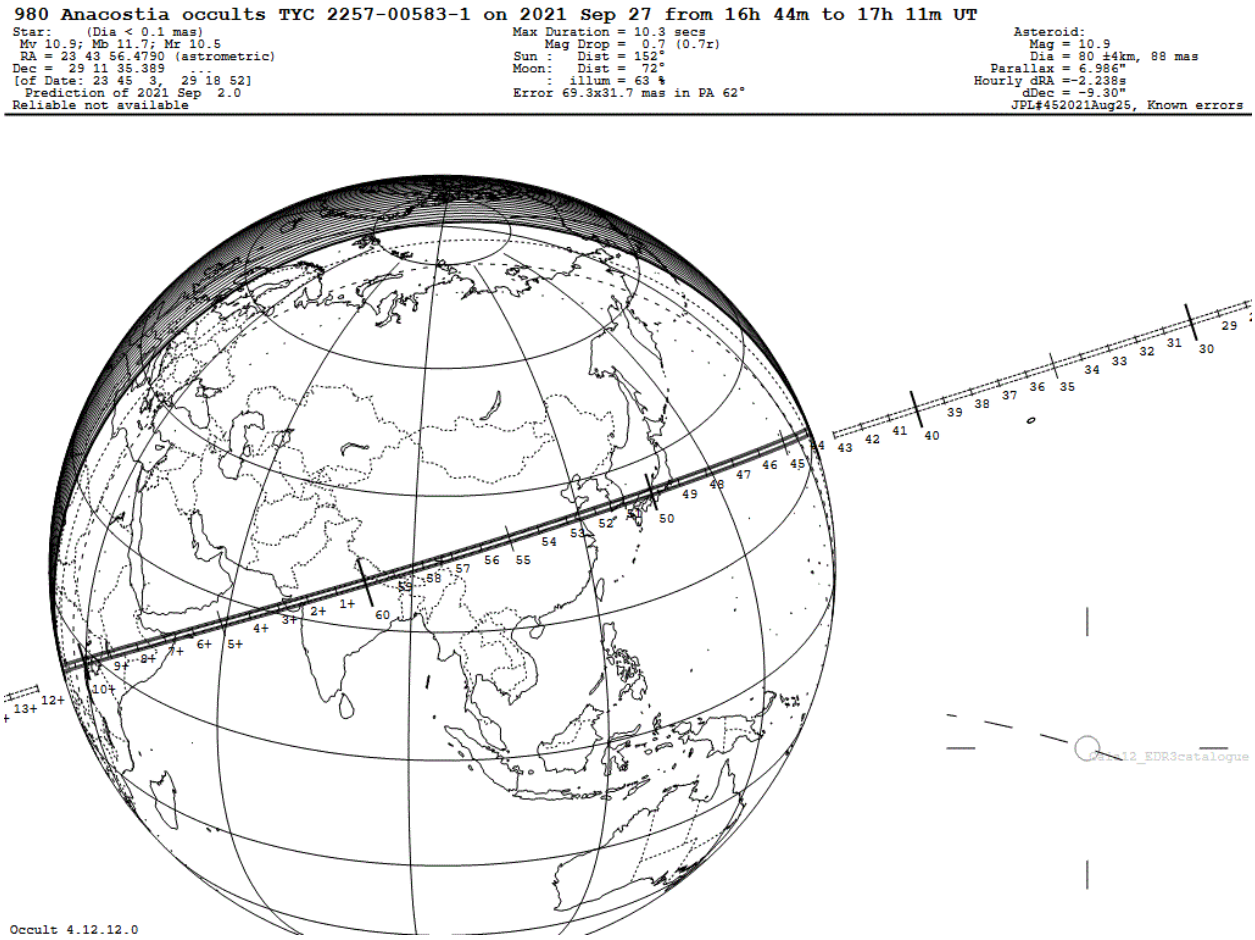

Figure 1 -- Occultation Path

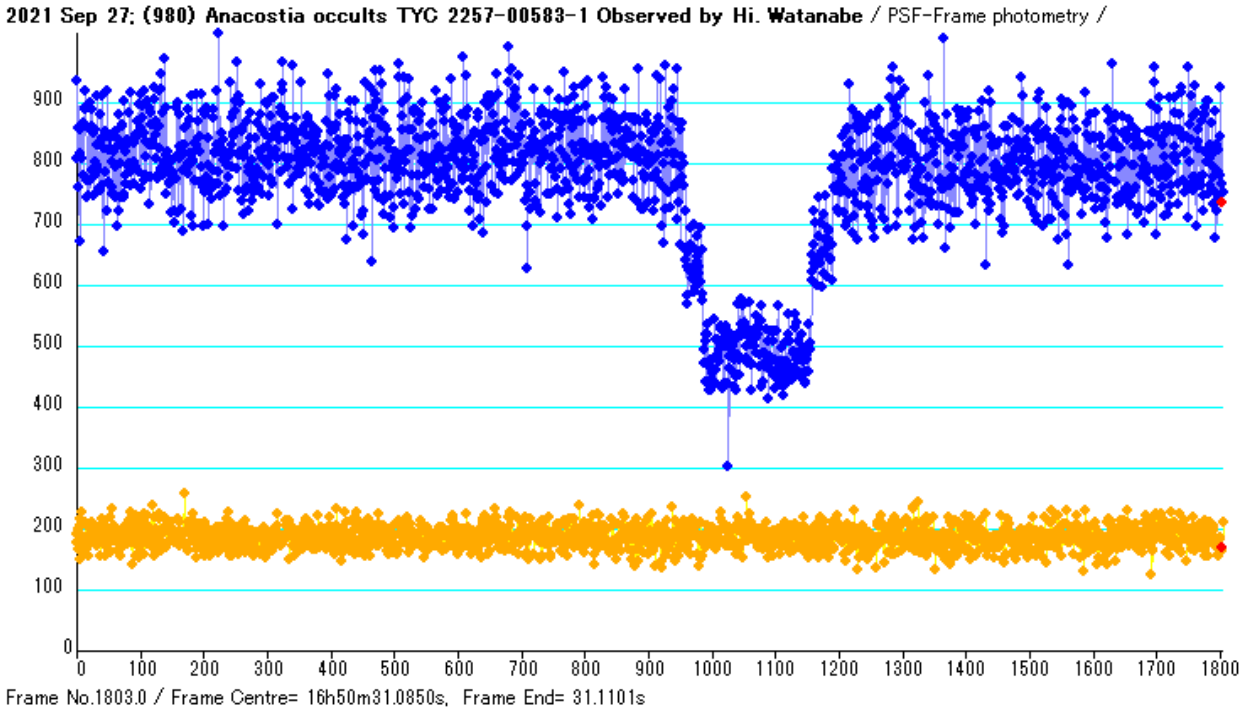

Figure 2 – Light curve obtained by Hiroyuki Watanabe

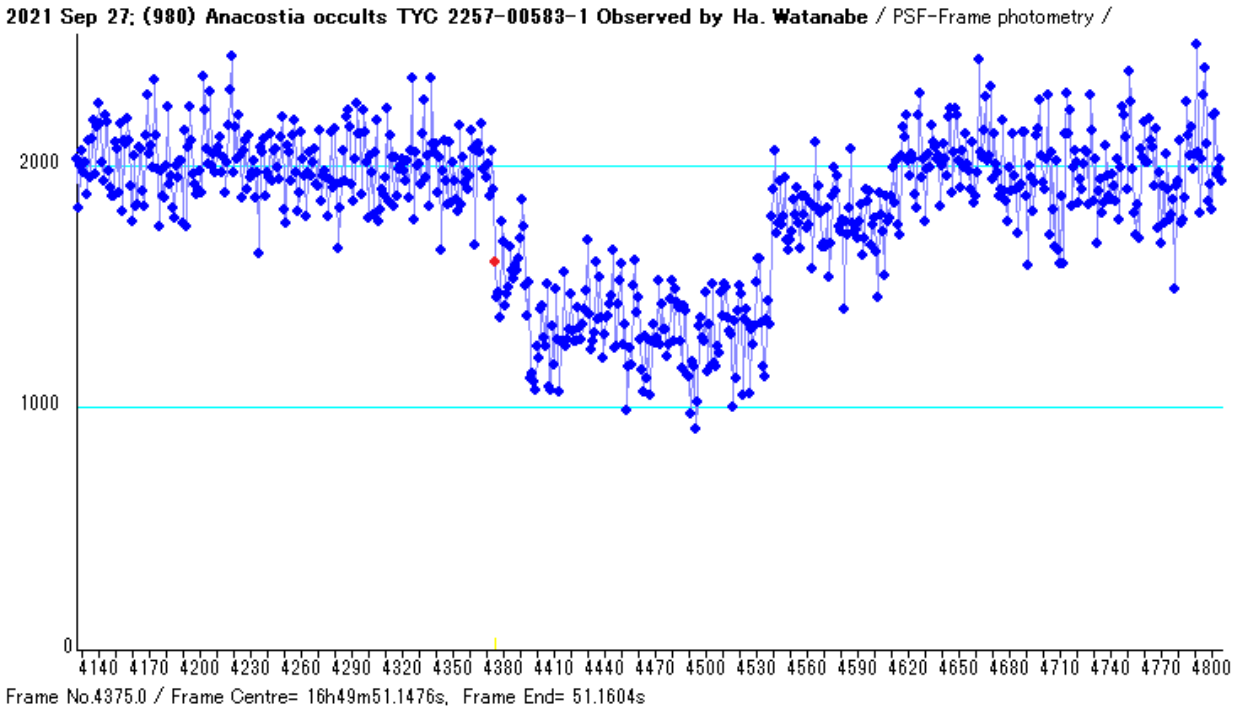

Figure 3 – Light curve obtained by Hayato Watanabe

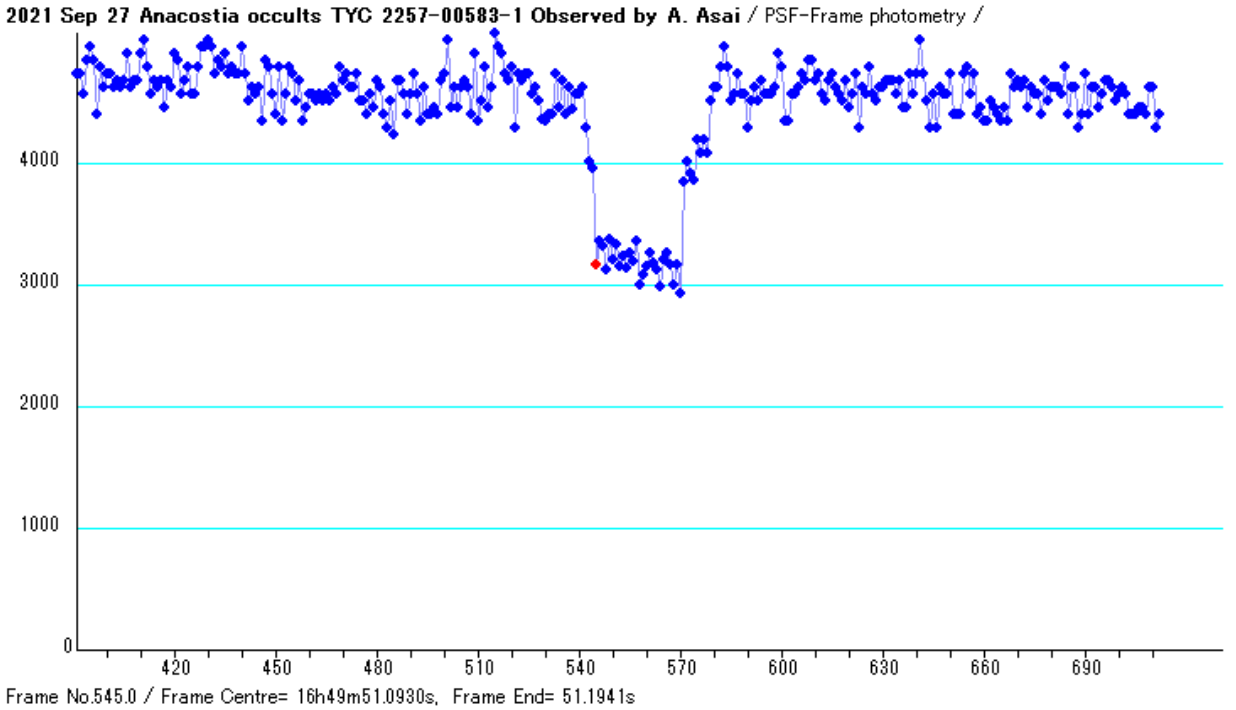

Figure 4 – Light curve obtained by Akira Asai

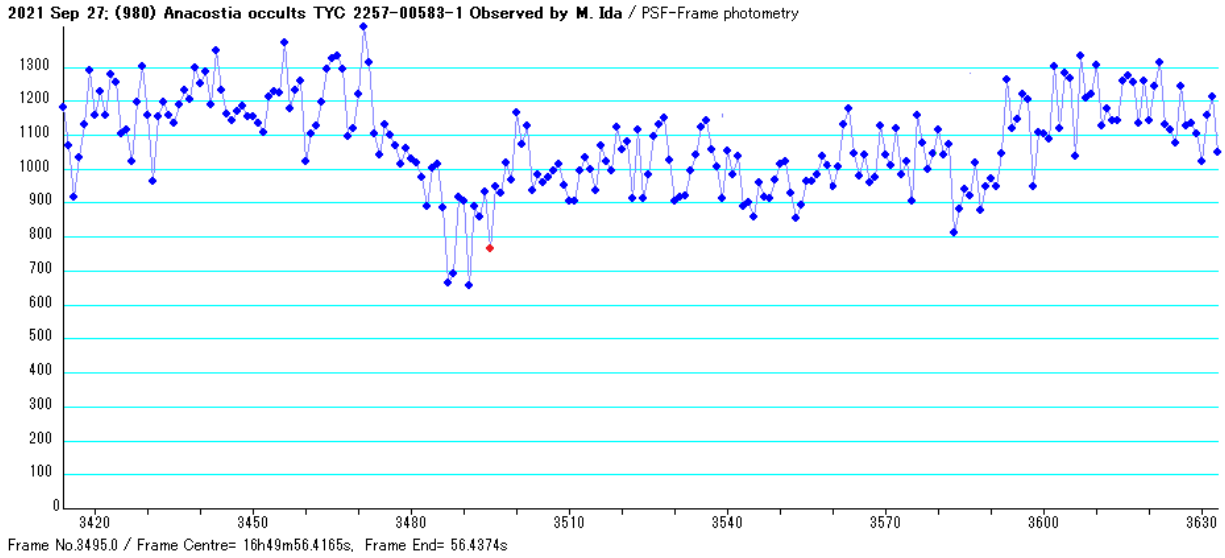

Figure 5 – Light curve obtained by Miyoshi Ida

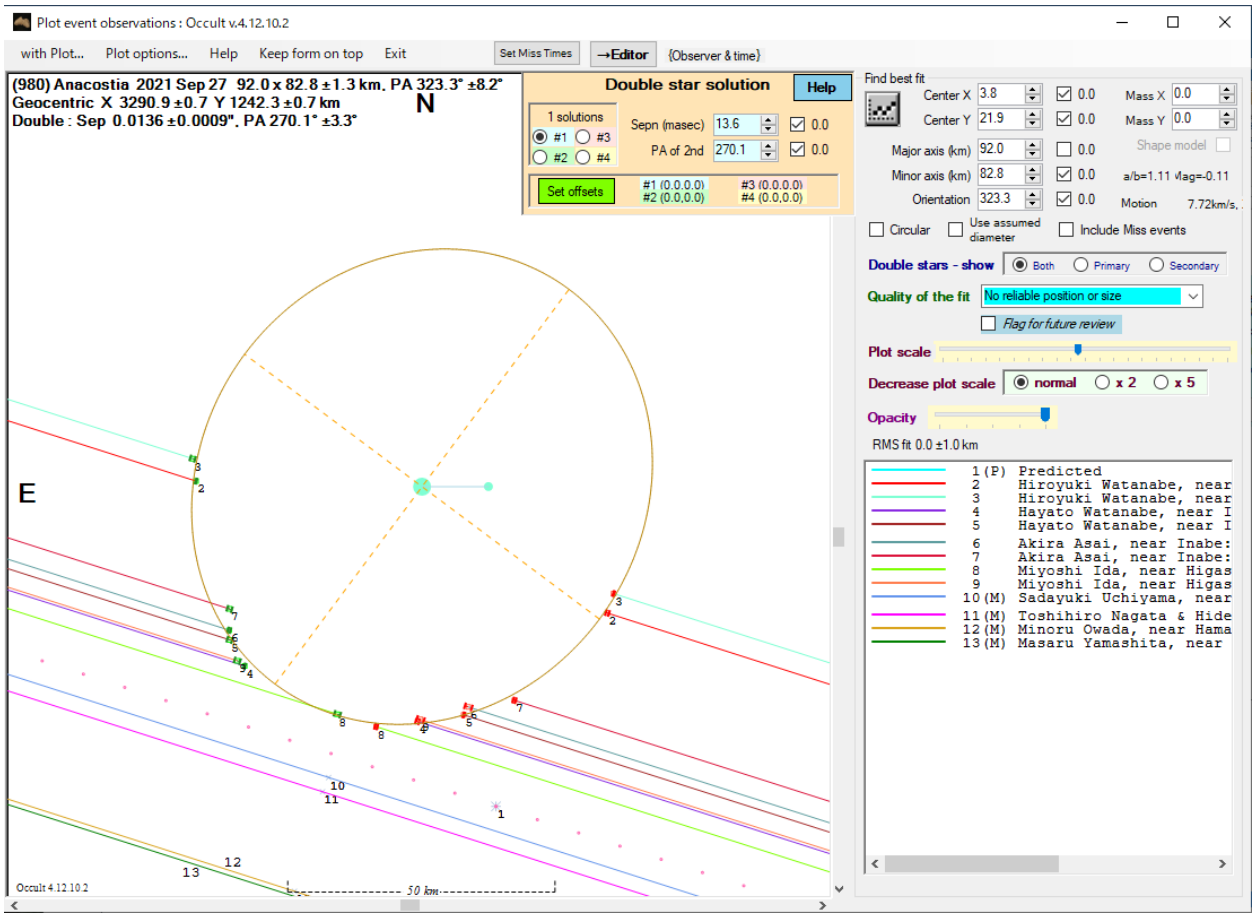

Figure 6: Occultation of TYC 2257-00583-1 by (980) Anacostia

Acknowledgements

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References

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