SAO 97883 - A New Double Star

Dave Herald

Canberra, Australia
International Occultation Timing Association (IOTA)
Email: drherald@bigpond.net.au

Robert Sandy

Blue Springs, Missouri
IOTA
Email: bobgraze@sbcglobal.net

Abstract: Observations at a lunar grazing occultation show the 8th magnitude star SAO97883 to be a hitherto unknown close double star that is probably increasing in separation.

Background

It has long been known that when there is a lunar occultation of a close double star, the light level will drop to an intermediate level when one component is occulted, with the star completely disappearing shortly afterwards when the other component is occulted. In recent years occultation observers have developed the use of video with GPS time insertion for recording such events. This allows for a precise determination of relative magnitudes, and potentially the accurate measurement of separation and position angle.

Here we report the detection of a new double star, detected during a lunar grazing occultation.

The Observations

The star was observed in grazing occultation conditions on 1 May 2009, at a location north of Canberra, Australia. In grazing occultation conditions, the star is seen to just clip the edge of the moon as it moves past, with the star disappearing and reappearing behind hills and mountains on the lunar limb. The graze occurred at a position angle of about 29°. It was seen visually by three observers, and recorded on video by one observer.

Figure 1 shows the video recording, made using a 20 cm SCT with a Watec 120N+ video camera. The recording shows three distinct light levels, characteristic of a double star, with one or both of the components being occulted. One (but only one) of the visual observers also noted the light change to the intermediate light level.

The star SAO 97883 = TYC 1387-971-1 = HD 72093 (8 31 41.2, +19 27 39) is not previously identified as a double star. It is not in the WDS, the Fourth Catalog of Interferometric Measurements of Binary Stars, or the Tycho Double Star Catalogue (2002).

A review of past occultations showed that the star had been observed on 17 previous occasions – but only the last of those (an observation on 6 June 2000) included any indication that the star might be double (with the observer - Robert Sandy - reporting that ‘the star was SLOW in disappearing’). By good fortune, that observation was recorded on video, and Robert Sandy still had the recording. Nine years ago our ability to ‘measure’ a video recording was very limited, so we measured the recording with modern measurement tools. Figure 2 shows the light curve that was obtained.

A video of the two observations has been posted on YouTube, at:

http://www.youtube.com/watch?v=_S83iUfkC3Y

Analysis

The PA of the lunar limb at the points corresponding to the first and last events in the light curve of the grazing occultation differed by almost 12 degrees – due largely to the lunar topography. This enabled the PA and separation to be computed from the observation: 0.121" ± 0.002" in PA 220° ± 6°.

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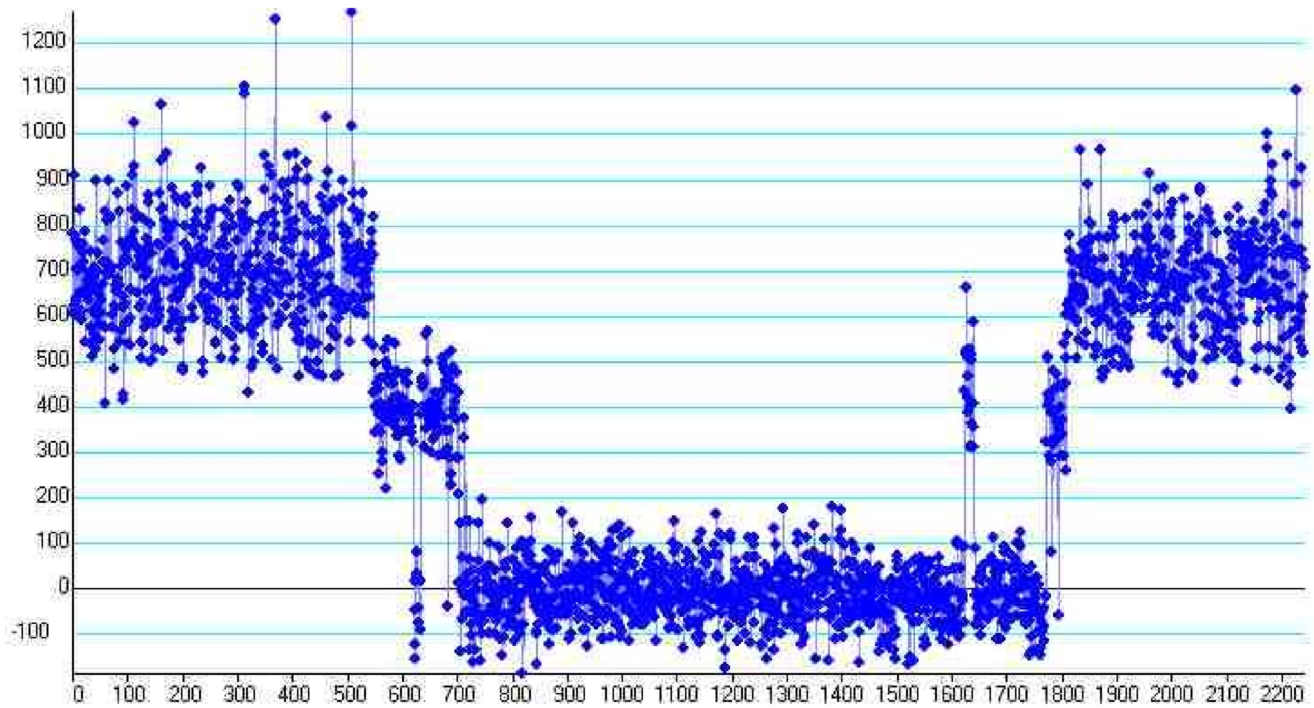

Figure 1: Light curve of the lunar grazing occultation of SAO 97883, extending for 90 seconds. The horizontal axis is the frame number in the video recording. The vertical axis is the intensity, in arbitrary units.

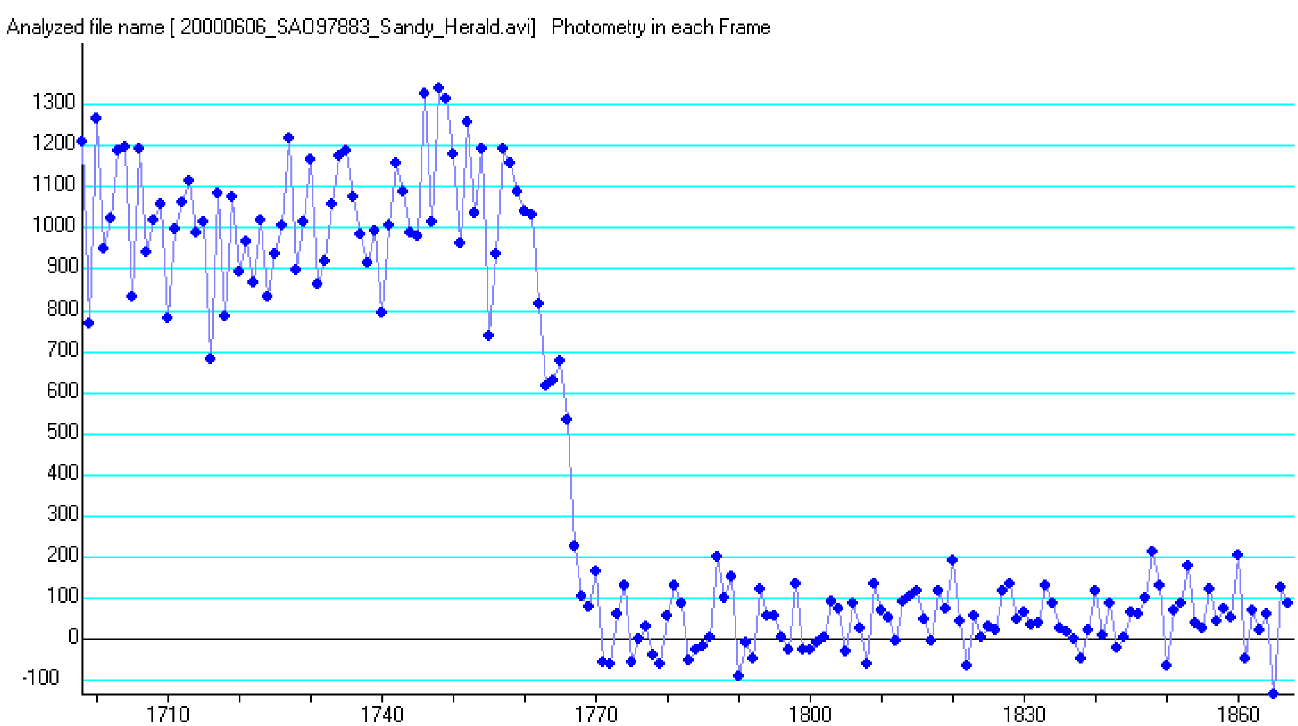

Figure 2: Light curve of the lunar occultation of SAO 97883, observed by Bob Sandy on 2000 June 6 with a 15 cm Newtonian. The light curve extends for 5.6 seconds. The step at about 1760 lasts for 4 frames, or 0.12 sec.

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For the June 2000 occultation there was only one observation, and consequentially a solution for the PA and separation is not possible. The position angle of the event against the moon was 33.9°, which is almost the same PA as for the grazing occultation (29°). If there was no change in the PA and separation of the star over the 9-year period, the expected separation normal to the lunar limb would be 0.120". However the separation of the stars derived from the duration of the step event was only 0.025". Clearly the separation and/or position angle of the pair has changed significantly over the last 9 years. Speckle interferometry should enable its motion to be determined.

The Tycho-2 VT magnitude for the star is 7.86. In figure 1 the full light is at 700 units, intermediate light is at 400 units, and zero light is at -10 units – giving 8.80 and 8.46 as the magnitudes of the two components. In figure 2 the full light is at 1050 units, intermediate light is at 630 units, and zero light is at 50 units – giving magnitudes 8.80 and 8.45. That is, the V magnitudes of the components are 8.45, and 8.80 – with an uncertainty of a few hundredths of a magnitude.

Conclusion

SAO 97883 is a hitherto unknown double star, magnitudes 8.45 and 8.80, with a separation of 0.121" ± 0.002" in PA 220° ± 6° at 2009.3. There has been a considerable change in separation and/or position angle since 2000.

Appendix 1 – deriving PA and separation from a lunar occultation

A lunar occultation is analyzed to determine the PA and separation on the following basis:

1. Assume the lunar limb is a straight line at the point of occultation. In general, the lunar topography results in the 'local' lunar limb being inclined to the mean lunar limb.

2. The observed height of the companion of a double star above the lunar limb is given by duration of a step event multiplied by the rate of motion of the moon in a direction normal to the lunar limb. [The direction of the lunar limb is derived using past lunar occultations made at the same part of the moon, or (for a grazing occultation) using the observations of the other observers. The rate of motion of the moon normal to that direction is computed from the observation.]

3. The height of the companion of a double star above the lunar limb is given by:

$$\text{Height} = \text{Separation} * \text{Cos}(PA_{star} - PA_{event} - \text{limb slope})$$

where *limb slope* is the inclination of the local lunar limb to the mean lunar limb (with a positive value indicating the local limb is decreasing in height as the position angle increases).

4. The equations of condition for the solution of Separation and PA_{star} are based on the condition that the heights determined under (2) and (3) should be equal. A minimum of two independent observations are required for a solution, with the PA_{event} needing to be significantly different. Preferably a least squares solution is performed, using multiple observations.

Appendix 2 – deriving magnitudes from an occultation

An occultation recording is not suited for obtaining an absolute measurement of the brightness of a star. However it will accurately show the relative brightness of the component stars. The magnitudes of the two components are simply derived from the requirements that the total magnitude must correspond with the catalogue value for the star, and their relative brightness must correspond to the ratio of the step heights in the video recording.

The magnitudes determined by the relative brightness will accurately represent the magnitudes of the two stars in the magnitude band used for the total magnitude of the star – provided the component stars are not greatly different in color. When the stars are of greatly different color, the magnitude measurement will be affected by the difference in response of the video camera compared to the color band used for the star magnitude. The unfiltered video cameras used for the observations have a spectral response somewhere between the V and R magnitude bands. Consequently, by using magnitudes in the V or R band, the magnitudes derived from the video recording are a reliable measure of the magnitudes of the components in that band, even when the components have a large difference in color.