Results from the recent lunar occultations of upsilon Geminorum and Antares

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Abstract. The lunar grazing occultation of υ Geminorum was observed on 2005 April 16 in the U.S.A. and from its observations it was found that the star is a hitherto unknown double star. The lunar occultation of Antares was observed in March this year in Japan and in the U.S.A., and from the observations the separation of the companion of Antares from the primary was precisely obtained. We present the results of them.

1. Lunar Grazing Occultation of υ Geminorum on 2005 April 16

On 2005 April 16 there was a lunar grazing occultation of the 4th magnitude star υ Geminorum in California, U.S.A., and 14 observers participated in the observations. Among the observers Derek C Breit, Ed Morana, and Richard Nolthenius reported several faint events (mostly just before and after the bright events) which corresponded to events of a star of about 10th magnitude. Fig. 1 is the reduction profile of the observations. The figure shows (see the enlarged portion in Fig. 1) that D. Breit's faint flash with the duration of 0.3 sec gives too steep lunar profile when compared with W. Morgan's bright flash with the duration of 0.7 sec, and D. Breit's faint reappearance is inconsistent by about 0.04 arcsec with the bright reappearances of W. Morgan, W. Cheng, and D. Breit. The star's angular diameter had been estimated to be about 0.006 arcseconds (Ochsenbein & Halbwachs 1982; Wesselink et al. 1972), and therefore the faint events cannot be attributed to the effect of the stellar size or the effect of the Fresnel diffraction. On the other hand if we assume that the faint events were caused by a faint companion of the star, all of the observations can be analyzed consistently. From the analysis of the observations the positions of the companion relative to the primary are estimated to be
separation $0''.04 \pm 0''.01$, and position angle $70^\circ \pm 20^\circ$.

Since the star has been listed in the Catalogue of Stellar Diameters (Pasinetti Fracassini et al. 2001), it should be emphasized that one should notice that this star is a close binary when they use it as one of the standard stars for the stellar diameters.

2. Lunar occultations of Antares in March 2005

In March, 2005, the lunar occultation of Antares (α Scorpii, 1.0 magnitude) was observed in the U.S.A. (on Mar 3) and in Japan (on Mar 30). The star has a companion, whose magnitude is 5.4, and at the reappearance of the lunar occultation the companion appeared prior to the primary by several seconds.

The orbits of the binary have been determined by several authors, and the positions of the companion relative to the primary at the times of the occultations were calculated as follows:

Author	Sep	PA
	arcsec	deg
Heintz (1960)	2.215	276.9
Baize (1978)	2.527	273.7
Pavlovic & Todorovic (2005)	2.677	276.6

(These values are for the 2005 Mar 30 event. For the 2005 Mar 3 event the separation should be larger by 0.001 arcsec for all of the orbits.)

We use here only the observations whose event times were obtained precisely with videos. The observations were reduced using the latest orbit (Pavlovic & Todorovic 2005) and the results are shown in Figs. 3a–3d together with Watts' (1963) lunar limb profile. The figures not only show the large errors in Watts' data, but also show that the reduced positions of the companion are systematically lower than those of the primary. Since the position angles of the events measured counterclockwise from the north point of the Moon's disk range from 255° to 292°, which are not much different from the position angle of the companion relative to the primary, the systematic differences in the reductions indicate that the angular separations of the companion from the primary used in the reductions are too small. This fact indicates that, while the errors of the older orbits were greater than that of the latest one among the three because the latest one gives the largest separation, the latest orbit still has an error in the separation. By averaging the differences between the companion's and primary's reduced results, the correction to the separation obtained from Pavlovic & Todorovic's (2005) orbit is

$$\Delta\mathrm{Sep} = +0''.062 \pm 0''.014.$$

The lunar occultation of Antares will be occurring for a few years, and combining the results of them the positions (both the separation and position angle) of the companion relative to the primary will be improved.

3. Conclusion

From the observations of its lunar grazing occultation on 2005 April 16 the occulted star υ Geminorum is found to be a hitherto unknown double star. This fact is especially important because this star has been used as a standard star for estimating the stellar diameters. The separation of its companion relative to Antares was precisely determined from its lunar occultations observed in March 2005.

References

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Heintz, W.D.: 1960, Veröff. Sternw. München 5, 87.
Ochsenbein, F., Halbwachs, J.L.: 1982, A&AS 47,523.
Pasinetti Fracassini L.E., Pastori L., Covino S., and Pozzi A.: 2001, A&A 367, 521.
Pavlovic, R. & Todorovic: 2005, Inf. Circ. 156.
Watts C.B.: 1963, Astron. Papers Am. Ephemeris 17, U.S. Government Printing Office, Washington, D.C.
Wesselink, A.J., Paranya, K., De Vorkin, K.: 1972, A&AS 7, 257.

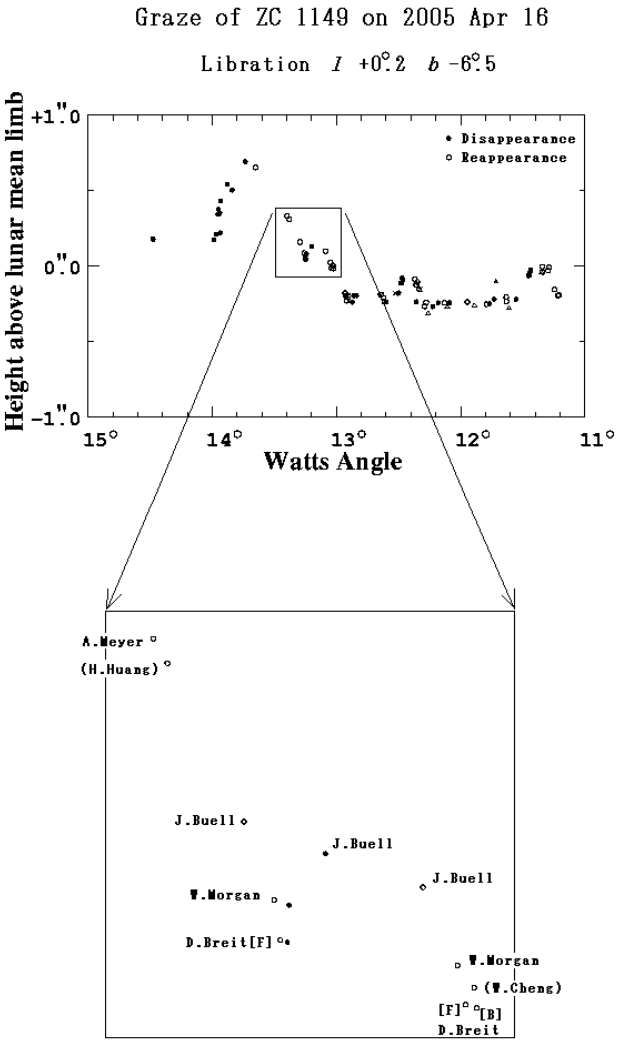

Fig.1 Lunar Limb Profile from Observations

[B] and [F] (given only for D.Breit's events) denote the bright event and faint event, respectively. The parensized names mean that their observations were made visually (i.e. less acculate) while the others were made with videos.

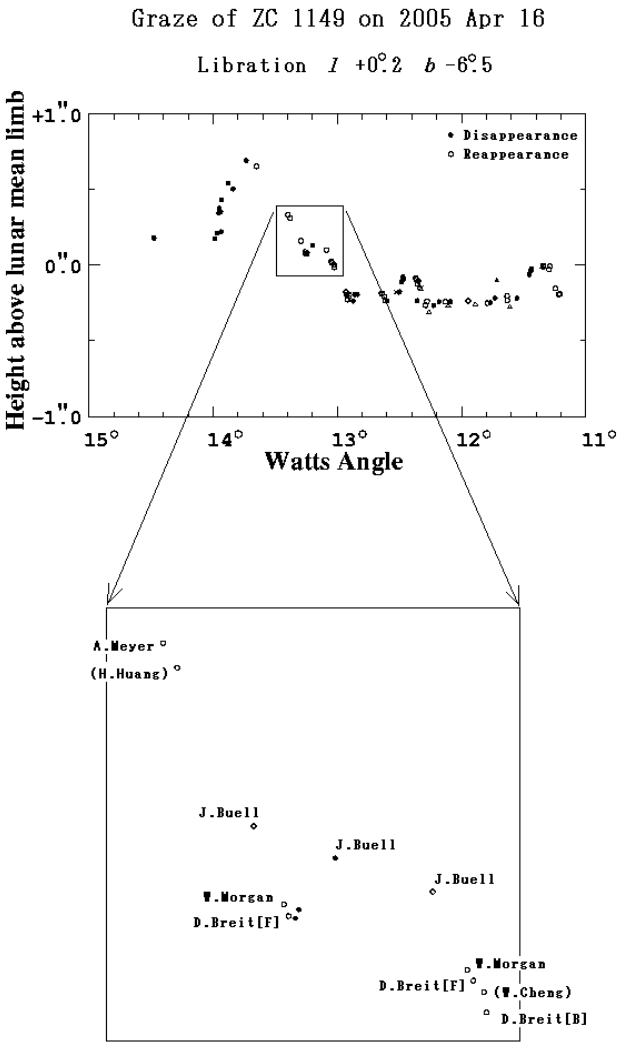

Fig.2 Corrected Lunar Limb Profile

The faint events were analyzed with the assumption that the separation and position angle of the fainter component relative to the primary are 0.04 arcsec and 70 deg, respectively.

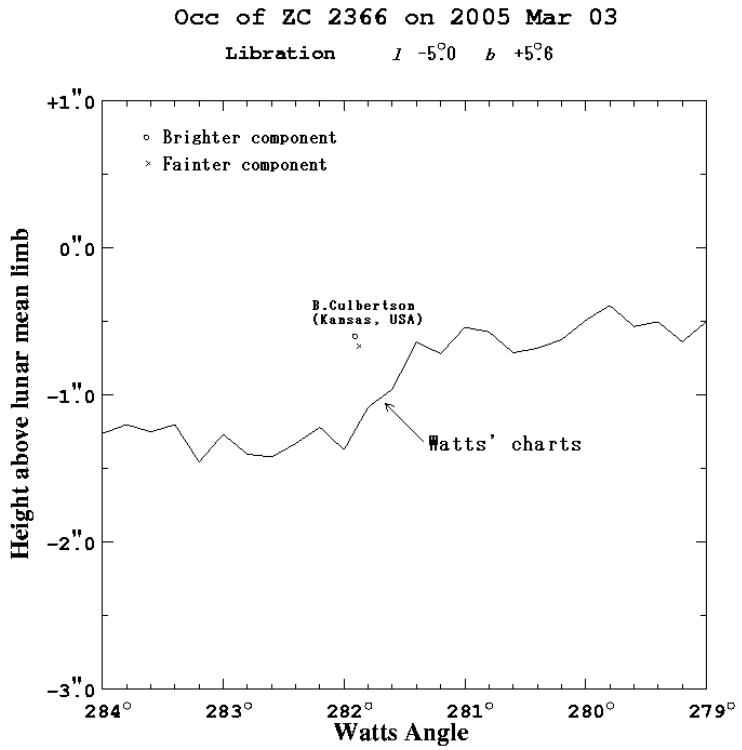

Fig.3a Results of the Lunar Occultation of Antares

Shown are the positions where Antares and its companion appeared from behind the Moon observed from Kansas, U.S.A., on 2005 Mar 3.

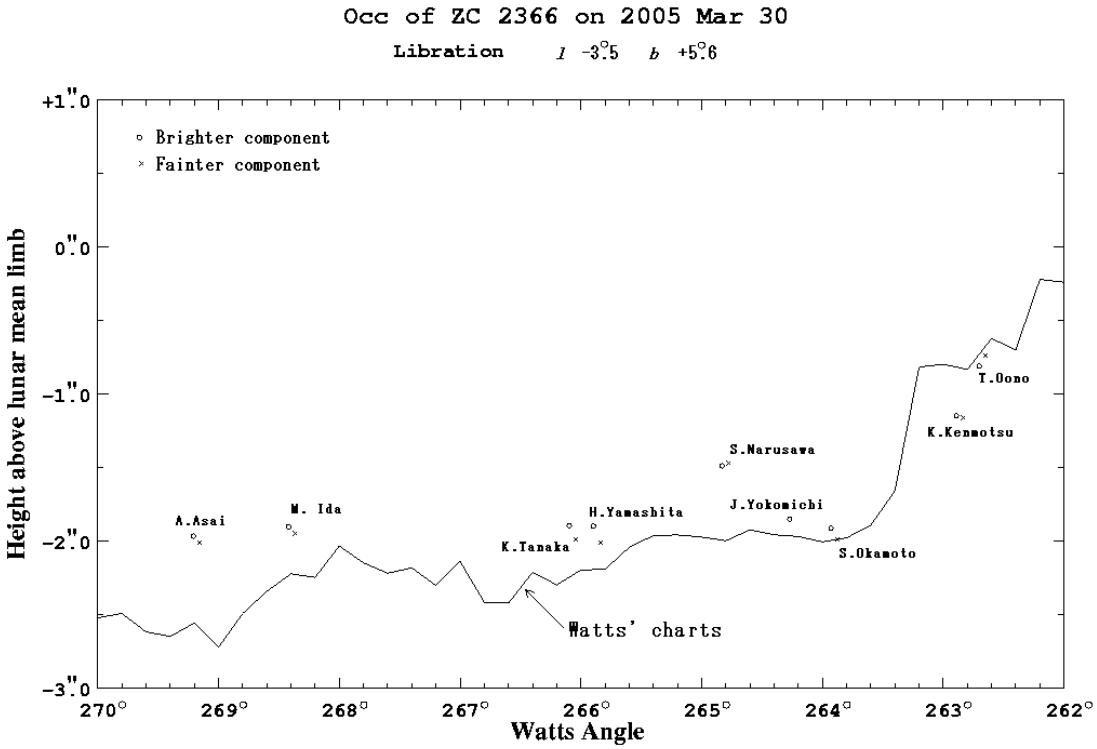

Fig.3b Results of the Lunar Occultation of Antares

This figure is for the event observed in Japan on 2005 Mar 30 for Watts Angle between 262 deg and 270 deg.

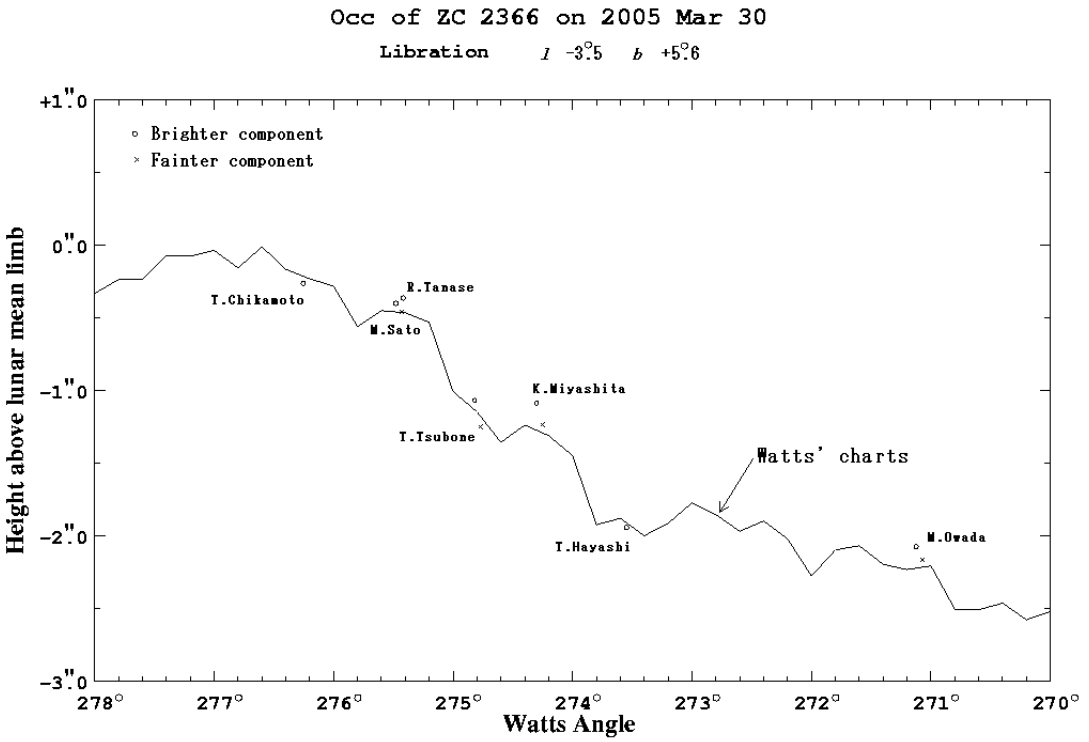

Fig.3c Results of the Lunar Occultation of Antares

This figure is for the event observed in Japan on 2005 Mar 30 for Watts Angle between 270 deg and 278 deg.

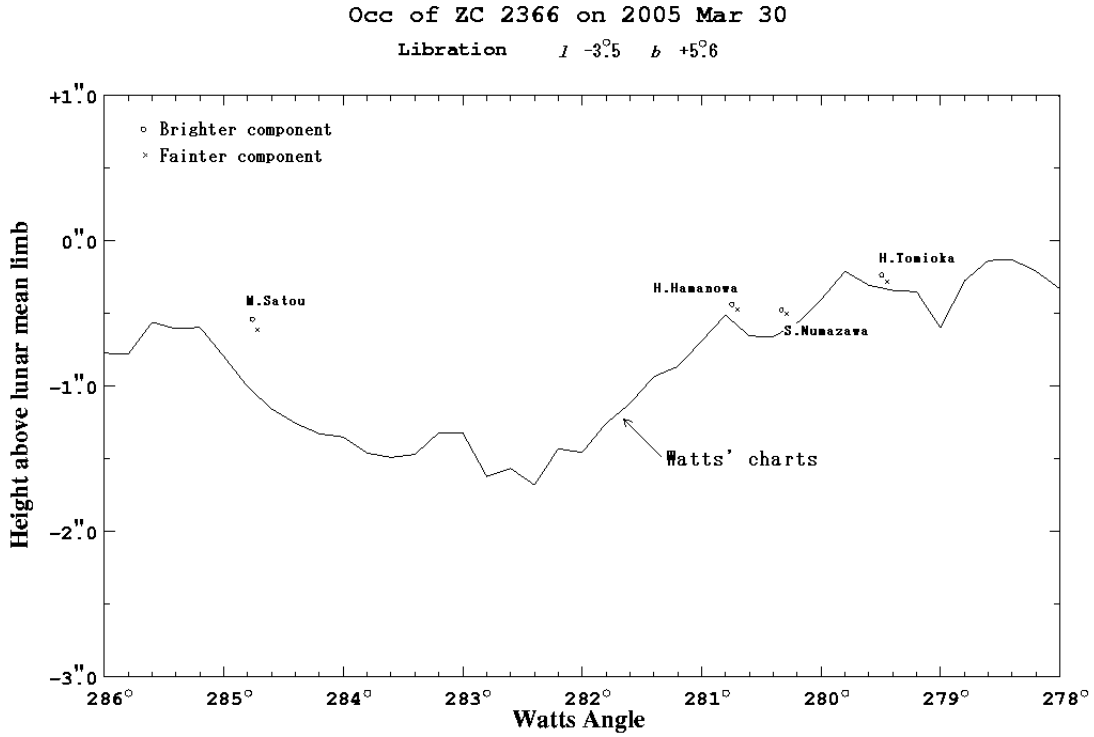

Fig.3d Results of the Lunar Occultation of Antares

This figure is for the event observed in Japan on 2005 Mar 30 for Watts Angle between 278 deg and 286 deg.