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ASTRONOMY AND ASTROPHYSICS

# New binary stars discovered by lunar occultations. III*

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**Abstract.** We report on a total of 20 occultation events of 16 binary sources, observed in the near infrared in the course of routine lunar occultation programs at the TIRGO and Calar Alto observatories. The results consist in either discoveries of new binaries, or in re-observations of known or suspected binaries where only incomplete information was available. This paper is the third in a series of similar reports (see Richichi et al. 1994 and 1996, hereafter Papers I and II).

For the following 9 stars, we detected a companion for the first time: SAO 160179, DO 10593, DO 11286, SAO 96515, SAO 96547, SAO 164323, SAO 164360, SAO 164371, SAO 128391. Of these, SAO 96515 was a suspected lunar occultation binary, while SAO 160179 and SAO 96547 (as well as SAO 146402 below) belong also to wider binary pairs. For the following 4 stars, we confirm previous reports of binarity: SAO 161153, SAO 95419, SAO 146402, SAO 96810; for these stars, our IR measurements complement existing visual information: Finally, in the case of the three stars SAO 93777, SAO 162050 and SAO 95456, a companion had also been previously observed or suspected, but we could not detect it. Our negative detection in these cases provides a constraint on the characteristics of the companion. The projected separations in our positive results cover a range of two orders of magnitude, from $\approx 0\farcs006$ to $\approx 0\farcs6$.

**Key words:** occultations – stars: binaries: close – stars: binaries: spectroscopic – stars: binaries: visual – astrometry

## 1. Introduction

With this work we continue our reports on discoveries of new binary stars, or on re-observations of known systems, started with Papers I and II. As before, these observations were obtained mainly in the course of ongoing lunar occultation (LO) programs in the near infrared at the TIRGO and Calar Alto observatories. We refer the reader to Paper II for a detailed description of our observational and data reduction methods, and of the instruments and telescopes used.

The log of the occultation observations described in this paper is reported in Table 1, which follows the same format of Paper II. In summary, columns (1) through (3) list the source identification, the date of the event and the telescope used. In this latter column, the symbols identify the telescopes which were used: T for 1.5m TIRGO telescope (both InSb photometer and IR array, see Paper II), C2 and C3 for the Calar Alto 2.2m and 3.5m telescopes respectively (InSb photometer and speckle-graph, see Paper II), W for the 2.3m telescope of the Wyoming Infrared Telescope (InSb photometer, Stecklum et al. 1994). Column (4) lists the aperture of the diaphragm in the case of photometers, or the size of the subarray in the case of observations by a panoramic detector. Columns (5) and (6) list the sampling time of the lightcurves, and the integration time for each data point (where applicable). Columns (7) and (8) list the total magnitude of the star in the $V$ filter and in the filter of our observation, which was always in the $K$ band (with characteristics given in Paper II) with the exception of the TIRGO observation of SAO 96547 for which we used a $H$ filter having $\lambda_0$=1.61$\mu$m and $\Delta\lambda$=0.34$\mu$m. The photometric values are listed only for general reference and are not intended to be accurate. We extracted them from the literature when available, or estimated them on the basis of the intensity of the signal during the event, or of the expected $V$-$K$ color for the given spectral type. Such estimate is very crude and should be assigned an error of at least 0.1-0.2 mag. Only in the case of SAO 96515 the $K$-band magnitude was actually obtained by us at TIRGO and is relatively accurate. In columns (9) and (10) we report the spectra and distances, again extracted when available from the literature; in the case of multiple determinations, the most frequent or most recent were used. Finally, the last column reports a short comment on whether the binary was previously known or not.

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* Based on observations collected at TIRGO (Gornergrat, Switzerland), and at Calar Alto (Spain). TIRGO is operated by CNR-CAISMI Arcetri, Italy. Calar Alto is operated by the German-Spanish Astronomical Center.

**Table 1.** List of the occultation events and the circumstances of their observation

| (1) Source | (2) Date UT | (3) Tel. | (4) D ″ | (5) Δt ms | (6) $\tau$ ms | (7) $V$ mag | (8) Obs. mag | (9) Sp. | (10) Dist. pc | (11) Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| SAO 161153 | 11-07-95 | W | 6 | 2.0 | – | 6.4 | 6.4 | A2V | 77 | visual and speckle binary |
| SAO 160179 | 02-09-95 | T | 21 | 10.5 | 10.0 | 8.3 | 7.2 | B7V | 45 | new detection |
| SAO 162050 | 04-09-95 | T | 14 | 3.4 | 3.0 | 6.4 | 5.3 | G5II | | LO binary, not detected |
| SAO 93777-A | 15-09-95 | T | 28 | 2.4 | 2.0 | 5.9 | 2.3 | K5III | | LO binary, not detected |
| DO 10593 | 13-10-95 | T | 21 | 2.4 | 2.0 | 10.4 | 4.7 | M2 | | new detection |
| DO 11286 | 14-10-95 | C2 | 17 | 2.0 | – | 9.7 | 4.2 | M3 | | not detected |
| DO 11286 | 14-10-95 | T | 21 | 2.4 | 2.0 | 9.7 | 4.2 | M3 | | new detection |
| SAO 95419 | 15-10-95 | T | 21 | 2.4 | 2.0 | 5.9 | 5.1 | A6m | | visual and speckle binary |
| SAO 95456 | 15-10-95 | T | 21 | 2.4 | 2.0 | 6.6 | 2.9 | K2III | | LO binary, not detected |
| SAO 96515 | 16-10-95 | C2 | 17 | 2.0 | – | 9.0 | 7.8 | F8 | | suspected LO binary, detected |
| SAO 96547 | 16-10-95 | C2 | 17 | 2.0 | – | 7.5 | 4.9 | K3III | 65 | visual binary, no new detection |
| SAO 96547 | 16-10-95 | T | 21 | 4.4 | 4.0 | 7.5 | 5.2 | K3III | 65 | visual binary, new detection |
| SAO 164323 | 31-10-95 | T | 21 | 4.4 | 4.0 | 7.9 | 5.5 | K0 | | new detection |
| SAO 164360 | 31-10-95 | T | 21 | 4.4 | 4.0 | 9.2 | 6.5 | G5 | | new detection |
| SAO 164371 | 31-10-95 | T | 21 | 4.4 | 4.0 | 9.1 | 6.5 | K0 | | new detection |
| SAO 146402 | 29-11-95 | T | 16 | 8.1 | 7.0 | 6.6 | 6.6 | A0 | | LO binary |
| SAO 128391 | 30-11-95 | T | 16 | 8.1 | 7.0 | 9.2 | 9.1 | A3 | | new detection |
| SAO 95456 | 04-01-96 | T | 16 | 8.1 | 7.0 | 6.6 | 2.9 | K2III | | LO binary, not detected |
| SAO 96810 | 29-02-96 | T | 16 | 8.1 | 7.0 | 8.6 | 6.4 | K2V | | spectroscopic and LO binary |
| SAO 95419 | 26-03-96 | C3 | 6 | 2.0 | – | 5.9 | 5.1 | A6m | | visual and speckle binary |

**Table 2.** Cross identifications and coordinates

| SAO | HD | Other Identifications | |
|---|---|---|---|
| SAO 161153 | 166393 | ADS 11127 | HR 6798 |
| SAO 160179 | | ADS 10266 B | |
| SAO 162050 | 176123 | | HR 7164 |
| SAO 93777 | 26038 | ADS 3006 AB | HR 1280 |
| DO 10593 | Coord.(2000): | $04^h36^m30^s.81$ | $+17°55'56''.8$ |
| DO 11286 | Coord.(2000): | $05^h28^m29^s.09$ | $+18°34'28''.0$ |
| SAO 95419 | 42954 | | HR 2214 |
| SAO 95456 | 43185 | IRC +20141 | 06127+1818 |
| SAO 96515 | | | |
| SAO 96547 | 54244 | ADS 5816 A | |
| SAO 164323 | 203160 | | |
| SAO 164360 | 203616 | | |
| SAO 164371 | 203750 | | |
| SAO 146402 | 216931 | ADS 16392 A | |
| SAO 128391 | 223334 | | AG+002932 |
| SAO 96810 | 57339 | | AG+16761 |

A list of cross-identifications is provided in Table 2. All the sources have accurate and unambiguous coordinates, that can be retrieved from the usual catalogues. Only in the case of the two DO stars, the original catalogue (Lee et al. 1943) has a large uncertainty in the positions. In Table 2 we report the coordinates for DO 10593 and DO 11286 that we obtained by cross-identification with the HST Guide Star Catalogue.

## 2. Results

### 2.1. Stars with positive binary detection

The stars for which we could positively detect a companion are listed in Table 3, where the entries follow the style introduced in Paper I. In particular, the columns list the absolute value of the fitted angular rate of the event V in ″/s, its deviation from the predicted rate $V_t$ as computed by us, the local lunar limb slope $\psi$, the true position and contact angles, the signal-to-noise ratio, the projected separation, the brightness ratio and finally the $K$ magnitudes of the two components in each star, based on the values given in Table 1. Only in the case of the TIRGO observation of SAO 96547, the last two columns actually report the $H$ magnitudes of the components. A more detailed explanation and discussion of these quantities is given in Paper II.

#### 2.1.1. SAO 161153

Given its relatively wide separation and small brightness ratio, this star has long been known as a visual binary (Van den Bos 1959, Van Biesbroek 1974, Holden 1975) and more recently has been followed by speckle interferometry (McAlister et al. 1984). A significant orbital motion has been measured over more than one century since the first determination reported in the Aitken Double Star Catalogue (ADS). The most recent determination, at epoch 1985.5, yielded PA=193°.9 and $\rho$=1″.26. Our result shows further motion, however it is more interesting to note the brightness ratio at $K$, which indicates that the secondary is redder than the primary: $\Delta K$ is only 0.04 mag,

**Table 3.** Summary of binary detection results

| (1) Source | (2) \|V\| | (3) V/V$_t$-1 | (4) $\psi$ | (5) PA | (6) CA | (7) SNR | (8) Sep. (mas) | (9) Br. Ratio | (10) $m_1$ | (11) $m_2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| SAO 161153 | 0.458 | −2% | −10° | 69° | −11° | 51.9 | 546.2 ± 11.3 | 1.041 ± 0.002 | 7.1 | 7.2 |
| SAO 160179 | 0.331 | +12% | +8° | 55° | −38° | 9.0 | 16.8 ± 1.5 | 1.8 ± 0.2 | 7.7 | 8.3 |
| DO 10593 | 0.347 | +2% | *i* | :264° | : 180° | 24.7 | 6.6 ± 0.5 | 6.7 ± 0.4 | 4.9 | 6.9 |
| DO 11286 | 0.322 | +16% | −18° | 106° | 196° | 38.3 | 7.0 ± 1.7 | 7.6 ± 0.4 | 4.3 | 6.5 |
| SAO 95419 | 0.340 | +2% | +2° | 237° | 149° | 18.8 | 34.2 ± 0.8 | 1.35 ± 0.02 | 5.7 | 6.0 |
| SAO 96515 | 0.356 | *not fitted* | | :112° | :198° | 3.5 | 60.4 ± 1.7 | 3.64 ± 0.22 | 8.1 | 9.5 |
| SAO 96547 | 0.344 | 0% | 0° | 266° | 171° | 63.8 | 212.2 ± 0.3 | 1.619 ± 0.003 | 5.4 | 5.9 |
| SAO 96547 | 0.348 | +5% | *i* | :114° | : 196° | 49.6 | 15.8 ± 0.8 | 7.0 ± 0.2 | 5.3 | 7.5 |
| SAO 164323 | 0.281 | −17% | 12° | 112° | 46° | 24.8 | 17.4 ± 1.3 | 8.3 ± 0.4 | 5.6 | 7.9 |
| SAO 164360 | 0.362 | +4% | 3° | 32° | −34° | 11.9 | 9.4 ± 1.4 | 5.5 ± 0.9 | 6.7 | 8.5 |
| SAO 164371 | 0.398 | +12% | −11° | 92° | 26° | 11.9 | 31 ± 13 | 7.3 ± 0.8 | 6.6 | 8.8 |
| SAO 146402 | 0.146 | +5% | 1° | 174° | 289° | 7.8 | 50.8 ± 7.2 | 6.3 ± 0.3 | 6.8 | 8.6 |
| SAO 128391 | 0.408 | 0% | 0° | 228° | 48° | 6.6 | 23.5 ± 2.3 | 1.4 ± 0.2 | 9.7 | 10.0 |
| SAO 96810 | 0.090 | +12% | +2° | 25° | −74° | 12.7 | 15.3 ± 4.2 | 6.1 ± 0.3 | 6.6 | 8.5 |
| SAO 95419 | 0.278 | −11% | +18° | 125° | 29° | 26.5 | 423.6 ± 7.5 | 1.0 ± 0.2 | 5.9 | 5.9 |

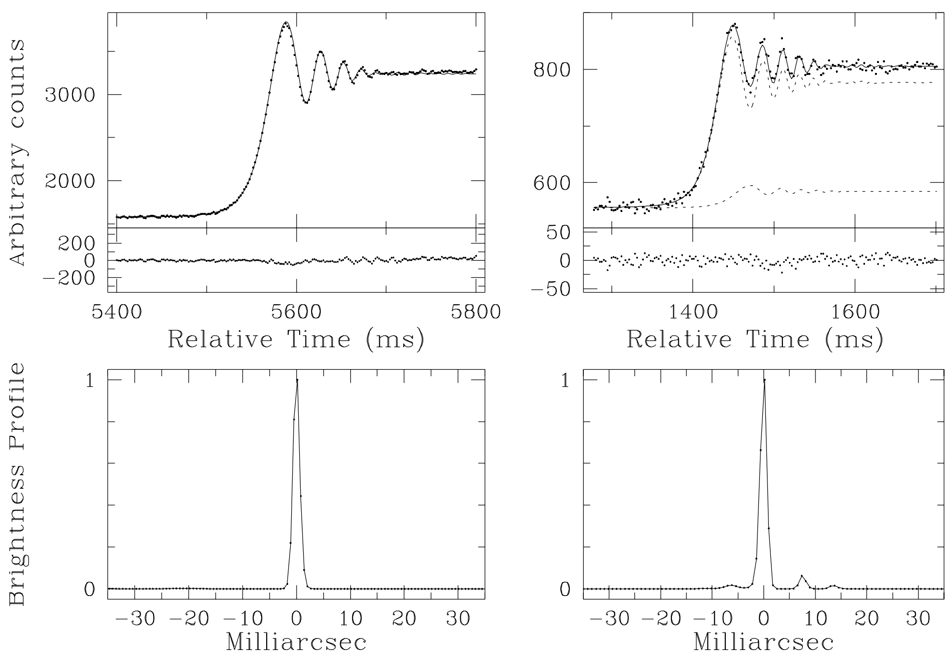


**Fig. 1.** The binarity of DO 11286. The upper panels show the data (dots) of the two occultation events observed in the same night along two different PAs at Calar Alto (*left*) and at TIRGO (*right*). Our best fits are shown as solid lines. As explained in Sect. 2.1.2, only the TIRGO data show the presence of a nearby companion. To aid interpretation, in the case of the TIRGO data also the model lightcurves for the two individual components are shown as dashed lines. Immediately below, the residuals of the fits are shown. The lower panels show the respective brightness profiles, reconstructed by the model-independent method mentioned in the text.

while in the visual range magnitude differences between 0.4 and 0.7 were published.

### 2.1.2. DO 11286

This star has no entries in the literature available to us, and has to be considered a new discovery. We observed two events in the same night at TIRGO and Calar Alto. Although both lightcurves are of good quality, the companion was detected only in one of the two lightcurves (see Fig. 1). By using our model-independent method (see Paper II, and Richichi 1989), we are confident that in the lightcurve with no detection the companion must be closer than 0.″002 to the primary. Using this upper limit, and combining the PA's of the two measurements, we deduce that the true separation of the companion must be confined to ≈0.″01-0.″03 and that it must lie in a southerly direction.

### 2.1.3. SAO 95419

This star is a well known visual and speckle binary, with an extensive list of measurements available in the literature over a long range of years. Some of the most recent measurements can be found in McAlister et al. (1990, 1989). Also previous occultations have been observed (Fekel et al. 1980, Radick & Lien 1980). The star is a spectroscopic binary with a period of 23.8 years (Pédoussaut et al. 1988). We recorded two different events of this star, both at the wavelenght of 2.2$\mu$m. The two measurements were separated by 0.44 years, not completely negligible in comparison to the spectroscopic period. On the basis also of recent interferometric measurements, it seems however that at least in the present part of the orbit the apparent motion is $\approx$1°/year, so at least to a first approximation we can combine our two measurements to obtain PA=151° and $\rho$=0.″472. Further refinements are clearly possible, but in view of the star being an easy target for other methods we do not consider it worthy. More interesting is the fact that ours is the first determination of the brightness ratio at infrared wavelengths. Our most reliable lightcurve shows $\Delta K\approx$0.3 (the other lightcurve is more affected by scintillation and has a large uncertainty). Visual and previous LO observers generally reported $\Delta V$=0.0, therefore it would appear that the two components have similar colors.

#### 2.1.4. SAO 96515

Two previous LO events of this star were reported by Africano et al. (1978), who commented that the star might be "*just possibly double*" in their red channel. Our lightcurve has a relatively poor SNR, so that also our detection is somewhat less than certain. However, it is interesting to note that the PA of our observation fell close to that of Africano et al. and in both cases the projected separation results in $\approx$0.″06. Also, the magnitude difference at 2.2$\mu$m seems to be quite appreciable ($\Delta K$=1.4), which seems consistent with the negative detection of the secondary by Africano and co-authors in their blue channel.

#### 2.1.5. SAO 96547

This star is ADS 5816A, with the secondary component just 0.1 mag fainter and lying about 7″ approximately to the north (PA=355°). Occultations of both components in this wide pair were observed in the same night at Calar Alto and TIRGO. Only one entry for each observatory is made in Table 1. Note that at TIRGO the wavelength of observation was 1.65$\mu$m ($H$ filter). The geometry of the occultation at Calar Alto was such, that the projected separation between ADS 5816 A and B was relatively small, and we have entered the corresponding result in Table 3. At TIRGO, on the other hand, the projected separation was quite large ($>$ 3″), and in fact no reliable measurement could be made because of the gaps between data blocks in the system in use at that telescope (Richichi 1988). Therefore no entry for the wide pair observed at TIRGO is made in Table 3.

However, the TIRGO lightcurve revealed that ADS 5816A is itself a small-separation binary, and it is the result for this pair that is entered in Table 3. After this finding we searched thoroughly the lightcurve from Calar Alto around the primary star, but no companion could be identified. Analysis by our model-independent method showed that in the Calar Alto trace any companion (with the requested brightness ratio) must lie closer than 0.″0015 from the primary. The SNR in the two cases is quite comparable, and the difference in wavelength between the $H$ and $K$ filters is not large enough to presume that the non-detection might be due to a strong difference in color between SAO 96547 A and B. Our best explanation is that the reason must be sought in the different scan angle in the two cases, $\Delta$PA$\approx$30°. By simple geometrical considerations, it appears that SAO 96547 B lies probably in a southerly direction with $\rho\approx$0.″03.

#### 2.1.6. SAO 146402

This star is listed as a LO binary by Hartkopf & McAlister (1984), who tried repeatedly to resolve it by speckle interferometry but did not succeed, with an upper limit of 0.″03. We could not find the original report of the detection of the secondary by LO. It is to be noted that this star is also the brightest in the triple system ADS 16392, but based on the brightness ratios of components B and C and on their position angles, and partly on the size of our field of view, we can exclude that our detected companion coincides with any of them.

#### 2.1.7. SAO 96810

This star is a spectroscopic binary, with a period of 7.25 years (see for instance Pédoussaut et al. 1988). The companion was detected in a lunar occultation by Edwards et al. (1980), with $\rho$=0.″175 along PA=276°. The authors could reveal it in both their blue and red channels, and estimated $\Delta B$=1.4 $\pm$ 0.5 and $\Delta R$=2.2 $\pm$ 0.5. Given the short spectroscopic period, it is not possible to combine our measurement with that of the authors above. However, we note that the brightness ratio that we derive is in agreement with one star being much redder than the other.

#### 2.1.8. SAO 160179, DO 10593, SAO 164323, SAO 164360, SAO 164371 SAO 128391

For all these stars, literature is very scarce or absent, and in any case without any previous hint of binarity. In the case of SAO 160179, which belongs to the wide binary system ADS 10266, we recorded an occultation of the brighter component SAO 160180 as well, without detecting any deviation from a point source.

### 2.2. *Stars with negative binary detection*

The stars for which we could not detect a companion are listed in Table 4. To facilitate a comparison with previous reports of a companion, we list the true PA of our observation in column (3); this includes the limb slope $\psi$ measured from the fringe speed, listed in column (2). The SNR of the data, listed in column (4), gives a direct estimate of the minimum magnitude difference of a companion that would have been consistent with our data. In column (5), we list the possible reason for non-detection by us. The entry for SAO 96547 is for the BC pair not detected in the CA lightcurve.

#### 2.2.1. SAO 162050

This star was suspected to be binary because of its fading under grazing occultation conditions (Appleby 1980). However, several LO events have been published (Antal 1962, Bouška 1962, Edwards et al. 1980), all without special comments. Also

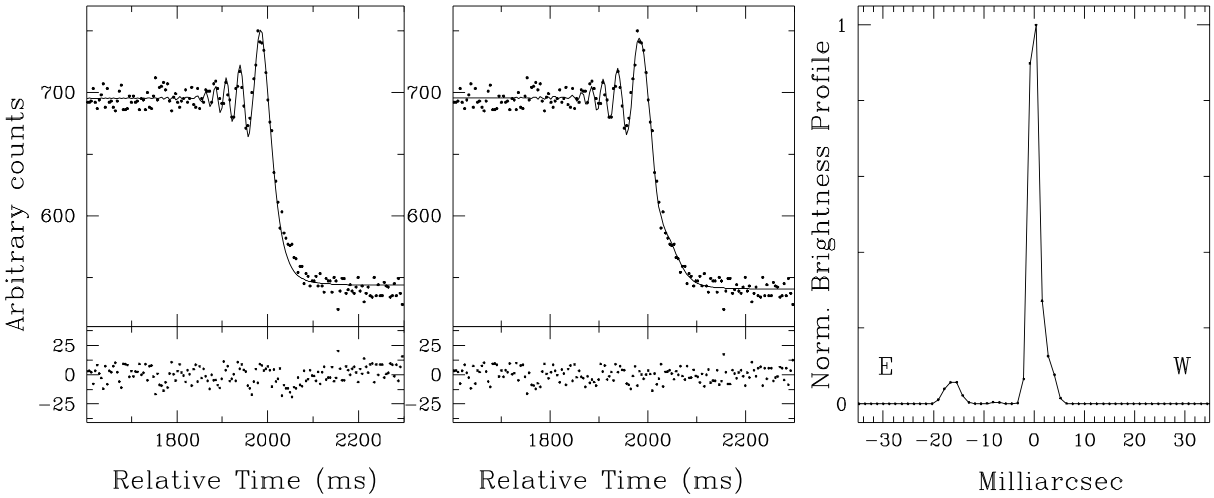


**Fig. 2.** Example of a new detection. *Left*: Occultation data (dots) for SAO 164323, and best fit (solid line) by a single point source model. The residuals are shown in the lower panel. *Center*: Same, for a model with two point sources (see parameters in Table 3). *Right*: Brightness profile of SAO 164323, reconstructed by the model-independent method mentioned in the text.

**Table 4.** Summary of negative detection results

| (1) Source | (2) $\psi$ | (3) PA | (4) SNR | (5) Notes |
|---|---|---|---|---|
| SAO 162050 | +1° | 74° | 41.9 | uncertain |
| SAO 93777 | – | :255° | 102.7 | doubtful |
| SAO 95456 | −6° | 346° | 58.7 | comp. very blue? |
| SAO 96547 | 0° | 86° | 41.9 | geometry? |
| SAO 95456 | – | :83° | 3.2 | insuff. SNR |

repeated observations by speckle interferometry (Hartkopf & McAlister 1984) gave negative results. Our lightcurve is of sufficient quality to exclude the presence of a companion with $\Delta K \lesssim 3.5$ mag within a projected separation of $0\farcs07$.

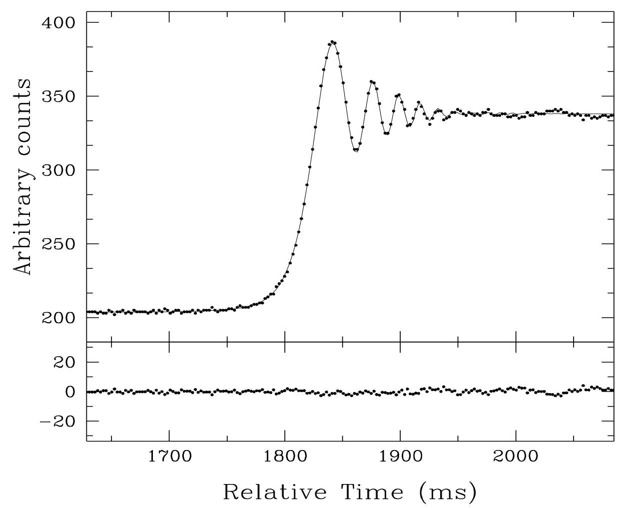


**Fig. 3.** Example of a negative detection. Shown are the occultation data (dots) for SAO 93777, and the best fit by a single point source model (solid line). The fit residuals are shown in the lower panel. An upper limit of $\Delta K \gtrsim 5$ mag can be set on the presence of the companion, reported in a grazing event in the visual (Dunham 1977).

### 2.2.2. SAO 93777

This star is a known wide binary system, ADS 3006 AB. Because of its relatively large separation, we do not concern ourselves with ADS 3006 B. However, the primary star was observed to be double in a grazing occultation event in the visual (Dunham 1977), with a projected separation $\rho=0\farcs05$ along PA=358°, and equal brightness components. Repeated speckle measurements failed to detect the companion (Hartkopf & McAlister 1984). The primary star is a bright infrared source (IRC +20071), and we could obtain an occultation lightcurve of good quality, which however does not show evidence of duplicity (see Fig. 3). We used our model-independent analysis to derive limits on the presence of a companion: this should have $\Delta K > 5.0$ if its projected separation had been in the range $0\farcs0015$-$0\farcs1$ from the primary. The lower limit is set by the fact that the angular diameter of the primary is resolved.

One possible explanation to reconcile our negative result with the older finding could be that the companion is a main sequence star much bluer than the primary. However, the difference between the $\Delta V$ of the reported detection and our limit on the $\Delta K$, together with the spectral type of the primary, leads us to conclude that the companion should have the $V$-$K$ color of a B star or earlier. This should have made it well detectable already on the basis of spectroscopic investigations. Also the negative detection by speckle interferometry is puzzling. In summary, the evidence against a companion is rather convincing. Also in view of the fact that the 1977 binary detection was obtained under grazing conditions, we then conclude that it should be considered with caution.

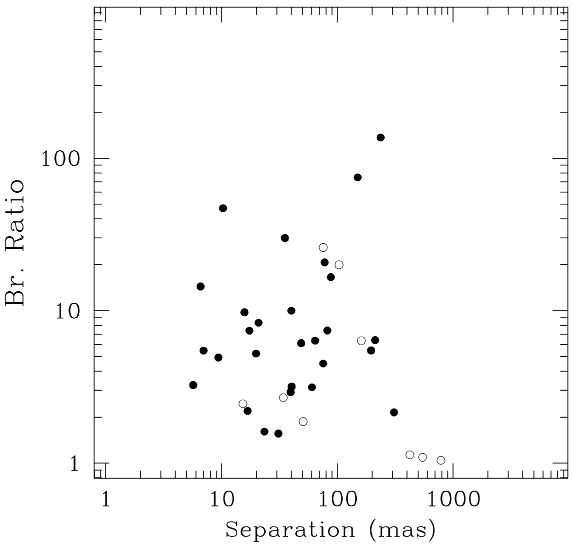


**Fig. 4.** The binaries of Table 5, shown in a projected separation-brightness ratio (at $K$) diagram. Repeated observations of the same system are shown independently. The filled circles mark the systems discovered by us, the open circles those which were known prior to our observation.

2.2.3. SAO 95456

An occultation of SAO 95456 was observed by Africano et al. (1978), who reported it to be binary with $\rho$=0.″014 along PA=64°. Interestingly, they detected it in their blue channel only, with $\Delta B$=1.3 $\pm$ 0.5, and not in their red channel. This star is a bright infrared source, IRC +20141. We observed two events for this star, but the second lightcurve is of poor quality because it was obtained close to full Moon and through clouds. We shall discuss only our first lightcurve, which on the contrary is of good quality. The SNR listed in Table 4 reflects the fact that it was not possible to fit accurately the fringe pattern. The reason for this is that the event took place at a very high contact angle and some change of the rate across the lightcurve is apparent. Apart from this, the data are very convincing and analysis by our model-independent method shows in fact that no companion with $\Delta K \lesssim 5$ mag is present within 0.″07 from the central star. On the base of this, and of the evidence that also the authors above could not detect the companion in the red, we suggest tentatively that it might be a main sequence star much bluer than the primary.

## 3. Conclusions

Summing up the results of this paper with those presented in Papers I and II, a total of 40 binary stars have been observed in the course of our LO program. The sample, albeit small, already allows us to draw some statistical conclusions. One first consideration concerns the frequency of binary systems detectable among the field stars. From the data of Table 5, it appears that a fraction of $\approx$10% of the stars observed in our program turned out to be binaries. It is interesting that the percentage is very similar in the subsamples of Paper II and of this paper (11.6% and 11.8% respectively), and in good agreement with a figure obtained in a more extensive program at different wavelengths (Evans 1983). In the case of the subsample from Paper I, the percentage appears considerably lower but this is not surprising, since in those early years our target stars were strongly biased towards candidates for angular diameter measurements, and with little consideration for field stars with presumably unresolvable diameters (based on luminosity and spectral types). For what concerns triple (and multiple) stars, there were a few in our sample, but they were generally systems in which a relatively wide pair was already known, and in which we discovered one of the two components to be itself a binary. Only this latter is counted among our results. In one case, a star which appears to be a quadruple was encountered (SAO 77819, Paper I). At any rate, the numbers involved are still too small for any significant conclusion on the frequency of multiple systems.

**Table 5.** Statistics of the LO binaries

| | Paper I | Paper II | this paper |
|---|---|---|---|
| Date of last observation | 03-02-93 | 03-04-95 | 26-03-96 |
| Sample size | 152 | 129 | 136 |
| Binary occurrences | 9 (5.9%) | 15 (11.6%) | 16 (11.8%) |
| New binaries | 7 | 8 | 9 |
| Re-observations | 2 | 2 | 4 |
| Non detections | 0 | 5 | 3 |

In Fig. 4 we show the positive detections in a projected separation-brightness ratio diagram. It can be noted that many, if not all, of the most difficult systems (i.e. with high brightness ratio and/or small separation) are new discoveries. Many of them had been probed before by speckle interferometry, with negative results. Reversely, a large fraction of the easier systems is constituted by stars which were previously known to be visual or speckle binaries. This makes clear that LO are at present a very competitive technique for the discovery of binary systems that would go undetected by other techniques.

It would be very interesting to compare the results on binaries among field stars obtained by LO, from this as well as from other programs, with the recent studies about multiplicity among main sequence stars (Duquennoy & Mayor 1991), expecially in view of the possible deficiency of binary systems with respect to pre-main sequence stars (Simon et al. 1995). In principle it should be possible to use the results of LO to test the degree of completeness of binary surveys in the solar neighbourhood, or to check the effect of a distance from the Sun which is in general much larger than for the stars in the above mentioned surveys. However, this approach is complicated by the need to account for the effects of projection, of the large range of distances (often imprecisely known), and of the large spread in spectral types and mass ratios. The amount of bias corrections that would be needed, and the small number statistics involved, make this a task for the future.

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