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NSV 13679 : A DETAILED INVESTIGATION OF ITS SUSPECTED VARIABILITY

Two previous reports concerning NSV 13679 = BD+ 49°3511 at $21^h21^m07^s$ +50°17'46".7(1950) have been made by D. Hoffleit (1991) and W. Wenzel (1992). D. Hoffleit reported that the star - mentioned by F. Schlesinger to be absent on one of the Allegheny Zone Catalog plates (126.2 arcsec/mm , 6°.3 x 7°) - actually was present but at a fainter magnitude m_{pg}= 11.5 - 12. She investigated about 200 Harvard patrol plates taken between 1898 and 1921 finding no further minima, the star being constant at $9^m.1$. W. Wenzel reported on the inspection of 1148 Sonnenberg patrol plates taken between 1928 and 1990 (except 1934-1935) and an additional 35 plates of the 400/1600mm GC astrograph taken between 1974 and 1982. He also found the star to be constant at $9^m.1$.

To answer the question of whether the star had a real minimum or the plate had a defect required further investigation by microscopic techniques. We have therefore scanned the three overlapping Allegheny Zone Catalog plates (Table 1) with the Yale PDS microdensitometer. The plate with the "minimum image" is plate 2104. The PDS input catalog consisted of 537 Astrographic Catalog of Reference Stars (Corbin and Urban 1989) that are included in a rectangular area covered by the plates and 550 Hubble Space Telescope Guide Star Catalog (Lasker et al. 1990) stars in an area of approximately 1°x 1° centered on the NSV star and having a limiting magnitude of 13^m.

TABLE 1

Allegheny plate	Epoch (1915)	Plate center		NSV 13679 position	
		R.A.(1950) 21^h	DEC. (1950) 52°	R.A.(1950) $21^h\,21^m$	DEC.(1950) 50° 17
2104	Sept. 16	$6^m\,38^s.10$	44' 05"	$6^s.80$	48".68 *
2120	Aug. 31	$22^m\,43^s.10$	44' 26"	$7^s.46$	46".67
2136	Sept. 19	$36^m\,34^s.90$	43' 46"	$7^s.47$	46".97

* position of the highest peaked image on this plate

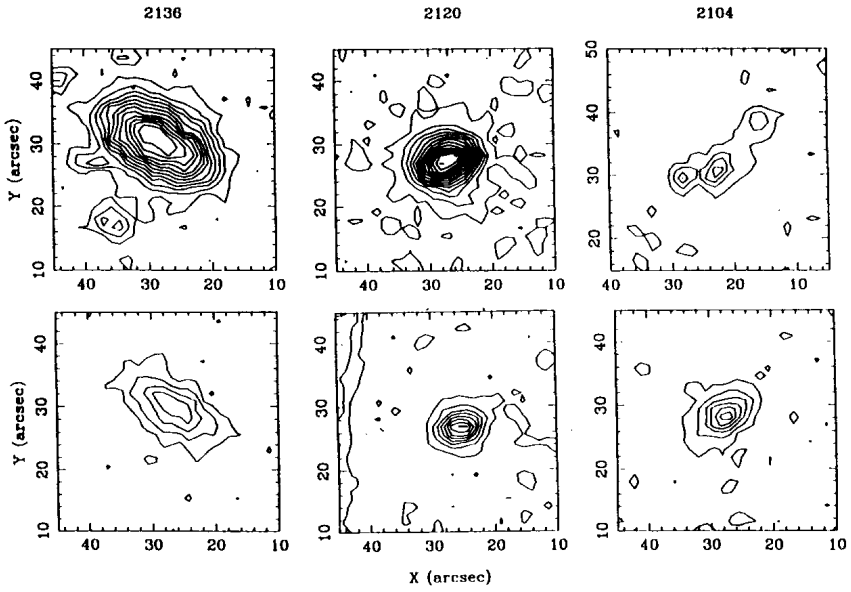

Fig. 1 Density contours of NSV 13679 (top panels) and a nearby star (bottom panels) on the three Allegheny plates. The orientation is north upward and east to the left.

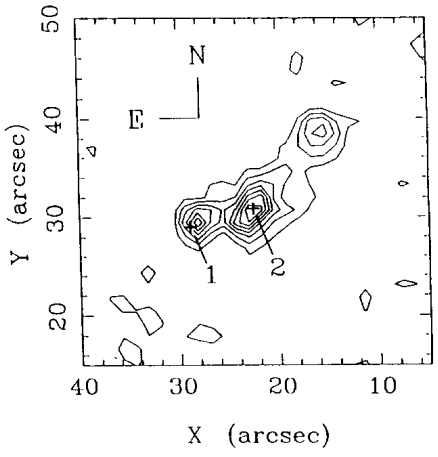

Fig. 2 Density contours of NSV 13679 on plate 2104. The position of the NSV star, as determined from plates 2120 and 2136, is indicated and labeled "1". The centering algorithm converged to the point labeled "2" for the image on plate 2104.

All plates were measured with the PDS and the image centers were obtained with the two dimensional elliptical Gaussian fitting program described by Lee and van Altena (1983). Repeat measures of five stars were made to correct for drifts in the measurement system during the individual plate scans. Also for plate 2104 a raster scan was made of an area of about $1cm^2$ centered on the suspected variable. The linearly spaced density contours for the NSV star on the three plates are shown in the top panels of Fig. 1. For comparison, the density contours of a nearby star are shown in the lower panels. On plates 2104 and 2136 these two stars are near the plate corners; note the elongated images on those plates.

The right ascension and declination of the NSV star were determined – on the system of the ACRS - from images on each of the three plates. The derived positions are given in Table 1. Figure 2 shows the density contours for the star on plate 2104, the position of the star given by the centering algorithm (2) (the centering algorithm converged to the highest peak) and the position of the star based on its average position on the other two plates (1). The separation between the two points is 6.6 arcsec. The position of point (1) seems to be almost coincident with the center of the lower peak. However the actual separation relative to the estimated uncertainty (0.2 arcsec) is very large; the size of the marker is three times the estimated uncertainty.

The centering algorithm also estimates the pseudomagnitudes of the stars as the volume under the Gaussian fit to the data. Assuming that the lower peak on plate 2104 is about 0.5 pseudomagnitudes fainter than the one that centered, we searched for stars with pseudomagnitudes in this range in order to estimate the magnitude of the fainter image. All showed density contours with flatter peaks than that of the "second" star. After calibrating the blue pseudomagnitudes with the V magnitudes of the Guide Star Catalog converted approximately to photographic magnitudes, and assuming a constant (B-V) for the star, the difference between the normal brightness and the minimum was found to be $\Delta m_{pg} \sim 1.9$. For the other two plates the magnitude of the star is $m_{pg} = 9.2$. The derived magnitudes have an estimated uncertainty of 0.3.

Since the star appears to be double on plate 2104 we asked Dr. A. R. Klemola to check on Lick astrograph plates (55.1arcsec/mm) to see if the NSV star showed a companion at this separation. He found on a yellow plate (epoch = Sept. 8, 1975) a well-separated companion at a separation of 6.2 arcsec with position angle 197° - about 90° different from our result - with a visual magnitude difference of about 2^m.

We have also inspected the image of the NSV star given by the quick V Palomar Sky Survey GSC scan (1984) and it appeared elongated in a direction that had a position angle close to the value given by Dr. Klemola (≈ 190°). Though the image was at the edge of the field, other stars of comparable magnitude didn't have the elongated shape.

Another possibility is that the faint companion has a proper motion of about 0.15 arcsec/yr so its position relative to the bright star had changed correspondingly from 1915 to 1975 yielding the different position angles. In order to test this possibility another plate of this region was taken (May 15, 1993) with the Van Vleck 20 inch refractor (24.53 arcsec/mm, 7x5 inch). The NSV star showed a companion at the position angle measured by Klemola from the Lick plate (≈ 190°). We have scanned the Van Vleck plate following a similar procedure as for the Allegheny plates, in order to determine the separation and the position angle. We obtained a separation of 5.8± 0.5 arcsec and a position angle of 193°± 5°. So, the faint companion has not changed-its position from 1975 (Lick plates) to 1993 (Van Vleck plate) as would be expected from a proper motion of 0.15 arcsec/yr.

In summary, the image on the plate that led Schlesinger to suggest that the star was variable, appears to be double, but with a profile that is steeper than those of images on the same plate with approximately the same peak density. The star is double as supported by the Lick astrograph plate and by the quick V Palomar Sky Survey, but its

position angle differs by 90° from that of the image on the suspect Allegheny plate. Interpreting the position angle change as being due to orbital motion leads to the unlikely conclusion that the A7 star has an impossibly large mass, while interpreting the position angle change as being due to the relative proper motion of an optical double is inconsistent with the results given by the 1993 Van Vleck plate. Thus, our conclusion is that the apparently faint image of NSV 13679 on Allegheny plate 2104 is most likely due to a plate defect as opposed to any variability of the star.

Acknowledgments.

We would like to thank Dr. A. R. Klemola for inspecting the Lick astrograph plates and for providing us with useful information. We also thank Dr. M. Lattanzi for making available the digital copy of the GSC scan containing the NSV star and to Dr. A. Upgren and Mr. J. Lee for obtaining the Van Vleck plate.

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