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DISCUSSION OF TWO VISUAL BINARY SYSTEMS

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ADS 12096. The binary ADS 12096 (B 427), discovered by *van den Bos*, is of special interest because of the remarkably short period $P = 2{,}68$ years, figuring in various catalogues. This value was given by *Voronov* who published his orbit for ADS 12096 in 1937 [1]. The corresponding dynamic parallax ($\pi = 0''{,}055$) is, however, relatively large and it seems doubtful whether a star of almost naked-eye brightness and of such considerable annual parallax could have remained unnoticed. Nevertheless, *Baize* classified Voronov's elements in his catalogue [2] as being "médiocre" and *Muller* alone labelled this orbit in the supplements to his catalogue as being "sans grand signification" [3]. It is, in the reality, quite easy to demonstrate that these elements are entirely fallacious and the system ADS 12096 must be cancelled from the list of stars with known orbits.

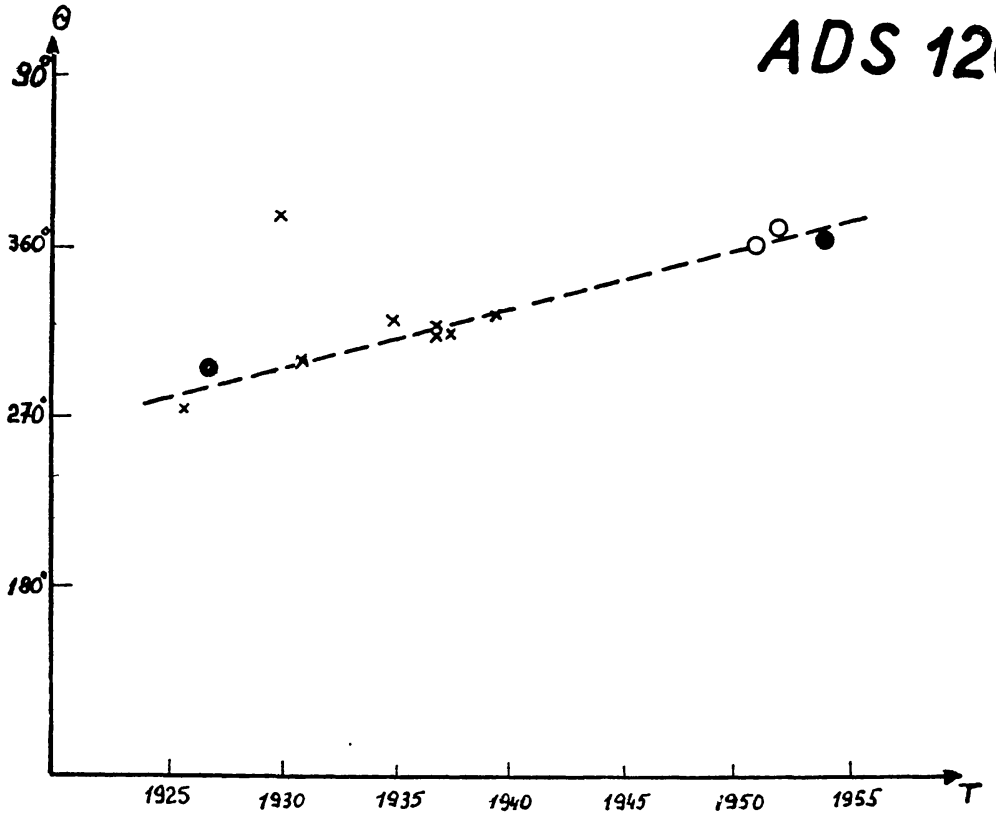
Let us, for instance, consider the following set of observations:

Table 1. (ADS 12096)

Date	Pos. angle	Sep-rtion	Observer	Number of obs.	Remark
1925,7	276°0	0″14	van den Bos	1	Aitken CDS
1926,7	297,2	0,13	Aitken	2	
1929,65	19,4	0,12	van den Bos	2	"Too close for our aperture"
1930,65	300,3	0,14	,,	4	
1934,71	316	0,14	,,	1	
1934,76	329	≦0,117	,,	2	Interferometric
1936,74	319,0	0,13	Finsen	1	
1936,75	315,6	0,13	van den Bos	5	
1937,60	315,7	0,12	,,	3	"Doubtful, too close"
1939,72	325	0,12	,,	1	
1950,61	6,6	0,266	Wilson	3	Interferometric; "Spurious" cf. J. O. *34*. 88.
1950,78	—	<0,117	Finsen	1	Interferometric
1951,65	17,7	0,20	Wilson	3	
1953,68	8±	0,12	Muller	1	Lick 36"-refractor
1953,70	—	<0,117	Finsen	1	Interferometric

The *distances* show no significant variation or rather, no variation can be surely established on the basis of the measurements published till now. With the *position angle*, the situation is sensibly different. This shows a

clear tendency to increase and passed about one quadrant from the date of first observations. It is evident, at first sight, that the star did not yet complete a revolution since its discovery as a binary system and that the period may be of the order of several decades or, perhaps, centuries instead of less than 3 years. The false ground for the previous computation is probably the very discordant observation due to *van den Bos* from the year 1929, the great "advance" in position angle being possibly considered as real by *Voronov*.



These simple considerations seem to deprive the binary of its special interest. We may restrict ourselves to some rough estimates on the possible nature of the system.

Let us assume, first, that the orbit is *circular* and the inclinaton is close to zero. In this case the period is of the order of 120 years, the radius about 0″,13 and, consequently, the dynamic parallax is $\pi = 0''{,}0026$. The visual absolute magnitudes are than $M_1 = -0{,}9$ and $M_2 = -0{,}7$. Of course, the inclination needs not to be zero. Nevertheless, on the basis of the observations tabulated above, we can give a limit for it, being probably less than 40° (if $e = 0$). This would mean that the parallax may be somewhat larger, about 30—40 per cent at most.

Assuming, on the other hand, that the *excentricity is very high*, say $e = 0{,}8$, we can consider two limiting cases. If the observed arc defines the periastron section of the orbit, we may take a period of the order of 1600 years and a semi-axis major about 0″,65. These values give for dynamic parallax

and absolute magnitudes almost identical figures as quoted above. If, however, the observed arc contains the apastron, approximately in the middle, we get for minimal values of period and semi axis-major $P = 50$ years and $a = 0''.15$, respectively, and further, for the dynamic parallax $\pi = 0''.0048$, for the luminosities $M_1 = +0,5$ and $M_2 = +0,7$.

On the ground of these estimates we may conclude that the stars are probably early K-type giants of luminosity class III and of absolute brightness about hundred times that of the Sun. The resulting parallax would be $\pi = 0''.004$ and the relatively large proper motion, mentioned in Aitken's Catalogue would than correspond to a tangential velocity of 85 km/sec, surely a possibility not without any interest.

PROVISORY ORBIT FOR ADS 10196. This rather difficult pair (ADS 10196 = BDS 13353 = A 1141) was discovered more than fifty years ago by *Aitken* and completed almost two revolutions since its discovery. The calculation of any orbit is extremely uncertain because of the large scattering of individual observations and, moreover, because a considerable part of the orbit is practically unattainable for micrometric measurements. The relative positions seem to form a "cloud" rather than an arc of a projected orbit. It is perhaps characteristic that in 1941 the star was measured at the same time by two distinguished observer but the results are entirely discordant. Further, as already remarked, it is hopeless to observe the periastron section of the orbit, and a possible error in the quadrant means another difficulty.

It is, however, relatively easy, in spite of all these difficulties, to give a provisory solution. The observational basis of a solution is given by the fine set of measurements due to *Van Biesbroeck* giving a rather clear picture of the variation of position angle [4]. Thus in the relatively well observed apastron section of the orbit we get some more or less reliable normal points and an independent estimate of the period makes the classical Thiele-Innes-method applicable. Although *Van Biesbroeck* himself cautiously remarked: "A pair to watch carefully" — the very small separation renders the pair, in the reality, unobservable till about 1961 or 1962. It seems not to be worth while to postpone a provisory solution till that date.

The basis of our discussion are the measurements tabulated in Table 2 (together with the $O-C$ values resulting from our solution).* The three normals of van Biesbroeck have been abandoned and replaced by yearly means more suited for studying such a rapidly moving pair.

The period has been taken to 29 years and that on the following grounds. Comparing Aitken's position angle measurements from 1905 with the measurements of the years 1933—35, we must conclude that the period cannot be less than 28 years. On the other hand, Aitken succeeded to measure the pair in 1921 without much difficulty (the error given in L.O.B. 413 is $\pm 0''.01$ for the distance), but in 1951 van den Bos found ADS 10196 "too close" for his $27^1/_2$ inch refractor. This makes it probable that the actual value of the period is less than 30 years. We adopted, therefore, $n = 360°/29^y = 12°.414$ per years for the mean motion.

* The last two (unpublished) measurements were kindly sent to me by Prof. Paul *Muller* (Paris).

Table 2

(ADS 10196)

Date	Pos. angle	Separation	$O-C$ in Θ	$O-C$ in ϱ	Observer	Remark
1905,45	18°8	0″18	—4°7	+0″04	A	
1915,49	4,0	0,18	—2,2	—0,04	A	
1921,48	352,3	0,16	—4,5	—0,01	A	
1925,55	"too close"		(129,8)	(0,05)	A	
1932,58	11,8	0,18	—18,4	+0,06	Finsen	
1933,48	30,4	0,14	+ 3,7	+0,01	VBs	
1933,57	29,5	0,15	+ 3,1	+0,02	A	Quadrant reversed
1934,47	26,3	0,18	+ 2,8	+0,04	VBs	
1934,54	29,6	0,18	+ 6,3	+0,04	A	Quadrant reversed
1935,54	20,2	0,18	— 0,4	+0,02	VBs	
1936,45	13,3	0,16	— 5,3	—0,01	VBs	
1936,61	30,6	0,17	+12,4	0,00	Finsen	
1938,48	14,4	0,15	— 0,3	—0,03	VBs	
1940,42	10,8	0,19	— 0,8	—0,01	VBs	
1941,42	21,6	0,21	+11,4	0,00	B	Quadrant reversed
1941,42	0,7	0,23	— 9,5	+0,02	VBs	
1944,39	6,7	0,22	+ 0,3	0,00	VBs	
1945,34	3,6	0,26	— 1,6	+0,04	VBs	
1949,19	0,1	0,21	+ 0,7	+0,03	VBs	
1951,57	"too close"		(352,8)	(0,105)	B	
1955,48	"simple"		(127,7)	(0,05)	Couteau	

Taking the following normal points :

$t_1 = 1935{,}0$ $\quad \varrho_1 = 0''{,}15$ $\quad \Theta_1 = 22°{,}0$

$t_2 = 1940{,}5$ $\quad \varrho_2 = 0''{,}204$ $\quad \Theta_2 = 11°{,}5$

$t_3 = 1948{,}0$ $\quad \varrho_3 = 0''{,}20$ $\quad \Theta_3 = 1°{,}5$

we obtain the following set of elements (and the corresponding ephemeris).

Table 3.

ADS 10196 elements and ephemeris

$P = 29$ years $\quad A = -0{,}0944$
$a = 0''{,}229$ $\quad F = -0{,}2042$
$T = 1923{,}63$ $\quad B = -0{,}0258$
$e = 0{,}89$ $\quad G = +0{,}0570$
$i = 101°{,}7$
$\Omega = 169°{,}25$
$\omega = 292°{,}6$

t	ϱ	Θ
1958,0	0″07	58°2
1960,0	0,09(5)	38,6
1962,0	0,12(5)	28,5
1964,0	0,15	22,0
1966,0	0,17	17,4
1968,0	0,19	13,6
1970,0	0,21	10,8(5)

The residuals in Table 2 are, in general, quite considerable, but we must keep in mind that all the tabulated measurements are *individual* observations on a rather difficult pair. The observation of *Finsen* from 1932, for

example, is discordant to such an extent that we may take it "spurious" without much scruple. Forming means of some neighbouring measurements in Table 2, the calculated positions would give a much better fit of observational data.

The positive trend in the residuals, indisputable for the years 1933—34, is, however, undoubtedly real. Unfortunately, we did not succeed to reach a better agreement between observation and computation. The 1940 normal is rather well defined and, as a consequence of the remark "too close" from 1951, the relatively small distance in 1948, i. e. at the date of the third normal point seems also to be ascertained. No acceptable position, thereupon, of the first normal led to a real solution.*

Therefore, the present orbit is of only preliminary character. This is perhaps indicated by the resulting dynamic parallax too, which turns out to be $\pi = 0''.0168$, giving the absolute magnitude $M = +4{,}6$. If, than, the orbital elements tabulated above are approximately correct, the system is sensibly subliminous, the difference being about half a magnitude.

Budapest, November 25, 1956.

[1] Tashkent Obs. Circ. 27. 1937 ; [2] J. O. *33.* 1, 1950 ; [3] J. O. *37.* 153, 1954 ; [4] Yerkes Publ. Vol. VIII. Pt. VI.

* In our solution the unsuccessful attempt of measuring the system made in 1951 by van de Bos has obviously a very critical role. But in the author's opinion such negative results due to expert observers are of incomparably greater importance than some uncertain measurements near (or beyond) the limit of actual instrumental capacity.