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Preliminary report

ORBITAL ELEMENTS OF 13 DOUBLE STARS

G. M. Popović and R. Pavlović

Astronomical Observatory, Volgina 7, 11050 Belgrade, Yugoslavia

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SUMMARY: The orbital elements and the corresponding astrophysical quantities are given for the following double stars: ADS 1359 = β 870, ADS 2755AB = β 536, ADS 3390 = Σ 577, ADS 8128 = Σ 1527, ADS 9989 = A 2181, ADS 10017 = Hu 481, ADS 10699 = Σ 2199, ADS 10769 = Σ 2205, ADS 10795 = Σ 2215, ADS 11010 = β 1127, ADS 11998 = A 2992, ADS 12577 = Hu 951 and ADS 14666 = OΣ 527.

1. INTRODUCTION

The article presents the results of analysis of 13 double stars. In addition to the orbital elements presented are the orbital parallaxes, masses and the absolute magnitudes of the components.

The Thiele–Innes elements A, B, F and G are here determined as functions of the coordinates of the apparent-ellipse centre (x_c, y_c), of the apparent-ellipse semiaxes (a_1, b_1) and of the inclination angle (α) between the apparent ellipse and the rectangular coordinate system centred on the main component, namely:

$$A = f_1(x_c, y_c, a_1, b_1, \alpha)$$
$$B = f_2(x_c, y_c, a_1, b_1, \alpha)$$
$$F = f_3(x_c, y_c, a_1, b_1, \alpha)$$
$$G = f_4(x_c, y_c, a_1, b_1, \alpha)$$

In this way one avoids "taking off" the constants A, B, F and G as it has been the case until now in the geometrical application of the Thiele–Innes–van-den-Boss method. The procedure of determination of the Thiele–Innes constants as functions of the parameters of the ellipse position will be presented in more details in the next issue of this Bulletin. With the values of A, B, F and G calculated here one obtains the Campbell elements by using the well-known formulae. The orbital elements thus obtained are further used as initial in applying Eichhorn's method (Eichhorn and Xu, 1990) based on the minimisation of the sum $(O - C)$.

In some cases the application of Eichhorn's method yields better results, but there are also cases when this is not achieved. In order to decide whether the elements corrected by applying Eichhorn's method should be accepted or not a subjective judgement of the orbits authors was necessary.

In Table 1 are presented the basic data concerning the systems treated here, their Campbell and Thiele–Innes elements, as well as the corresponding astrophysical quantities. The orbital elements are given for the epoch 2000.00. The parallaxes and absolute magnitudes are determined according to Angelov (1993). It appeared that this method does not yield essentially different results compared to the procedure used earlier (Popović and Angelov, 1970).

In Table 2 are presented the measurements and deviations from the calculated orbits. For the pair ADS 2755 calculated are both the elliptical orbit and the rectilinear trajectory. For this reason Table 2 contains the deviations corresponding to both cases.

Table 3 gives the ephemeris covering the period 1995 – 2009.

The comments (Section 3) concerning the analysed systems are given after the tabular presentations.

The measurements as well as the apparent orbits are presented graphically too (Section 4). In each Figure are showed the line of nodes(Ω) and the periastron position (Π).

2. ORBITAL ELEMENTS, MEASUREMENTS, EPHEMERIS

Table 1 Orbital elements, masses and parallaxes

Name	β 870	β 536	Σ 577	Σ 1527	A 2181
ADS	1359	2755AB	3390	8128	9989
IDS	01377N5702	03403N2353	04355N3719	11138N1449	16118N0126
m	6.4–7.8	8.6–9.6	8.6–8.6	6.9–8.1	10.3–10.3
Sp.	A2	A3	F8	G0	G0
$P(y)$	304.037	1421.57	826.65	593.36	285.69
$n(°/y)$	1.18407	0.25324	0.43549	0.60672	1.26010
T	2032.90	1980.20	2026.67	2028.26	1962.37
$a('')$	1.0149	1.9296	1.6530	3.1084	0.4331
e	0.2992	0.6599	0.2550	0.4764	0.1259
$i(°)$	124.48	99.97	150.10	76.58	11.94
$\Omega(°)$	17.41	2.06	88.0	16.82	137.33
$\omega(°)$	117.65	175.20	103.70	130.71	245.12
A	-0.29713	-1.92059	1.37770	-2.09898	0.39451
B	-0.62655	-0.09706	-0.43984	-0.06297	0.15914
F	-0.93759	-0.17332	-0.39523	-2.11927	-0.16807
G	-0.01457	0.32689	-1.59315	-1.13214	0.39738
C	±0.74107	±0.15902	±0.80055	±2.29181	∓0.08129
H	∓0.38824	∓1.89380	∓0.19515	∓1.97207	∓0.03770
T_1	1961.78	1338.60	1856.10	1899.06	2042.75
T_2	2062.62	1983.12	2140.16	2055.75	1920.66
M_A	2.1	3.5	4.4	4.6	4.8
M_B	3.5	4.5	4.4	5.8	4.8
$\mathcal{M}_A\odot$	1.7	1.3	1.1	1.0	1.0
$\mathcal{M}_B\odot$	1.3	1.1	1.1	0.8	1.0
$\pi('')$	0.016	0.012	0.015	0.036	0.008

Table 1 (continued)

Name	Hu 481	Σ 2199	Σ 2205	Σ 2215
ADS	10017	10699	10769	10795
IDS	16170N2314	17368N5549	17413N1745	17427N1744
m	8.0–9.9	7.8–8.4	8.5–8.9	5.8–7.8
Sp.	F8	F8	K0	A0
$P(y)$	150.16	1298.54	2482.86	853.14
$n(°/y)$	2.39750	0.27723	0.14499	0.42481
T	2008.47	2073.65	2019.37	2187.93
$a('')$	0.5721	2.2230	4.0832	0.7166
e	0.2772	0.0973	0.6240	0.3752
$i(°)$	121.72	136.40	49.09	138.59
$\Omega(°)$	1.57	34.40	133.93	164.69
$\omega(°)$	341.92	355.07	243.96	28.18
A	0.54106	1.74928	2.97382	-0.54223
B	0.10821	1.36543	0.37563	0.41158
F	0.18531	1.06377	-1.69988	0.45149
G	-0.28092	-1.21545	3.45641	0.36758
C	∓0.15102	∓0.13174	∓2.77264	±0.22384
H	±0.46261	±1.52735	∓1.35495	±0.41781
T_1	2012.60	2088.21	2299.85	2159.18
T_2	1946.04	1445.89	1924.62	2484.38
M_A	4.0	3.5	4.5	-1.0
M_B	5.9	4.1	4.9	1.0
$\mathcal{M}_A \odot$	1.1	1.3	1.0	3.6
$\mathcal{M}_B \odot$	0.8	1.1	1.0	2.2
$\pi('')$	0.016	0.014	0.018	0.004

Table 1 (continued)

Name	β 1127	A 2992	Hu 951	OΣ 527
ADS	11010	11998	12577	14666
IDS	17596N4414	18598N2633	19298N6324	21030N0445
m	7.4–9.3	9.8–9.8	9.4–9.6	6.9–8.4
Sp.	F2	F8	F	A2
$P(y)$	345.25	1162.50	208.76	561.15
$n(°/y)$	1.04271	0.30968	1.72447	0.64153
T	2163.73	1943.00	1953.47	1950.18
$a('')$	1.0776	0.7398	0.2563	0.5576
e	0.5781	0.6678	0.3017	0.4192
$i(°)$	121.77	113.18	39.68	117.09
$\Omega(°)$	7.51	78.18	147.57	91.30
$\omega(°)$	103.89	95.38	250.10	240.24
A	-0.18448	0.26956	0.17310	-0.21410
B	-0.57986	-0.12729	0.10977	-0.28170
F	-1.05492	-0.17761	-0.16741	-0.13699
G	-0.00169	-0.71538	0.18591	0.48108
C	±0.88935	±0.67714	∓0.15388	∓0.43095
H	∓0.21993	∓0.06378	∓0.05570	∓0.24641
T_1	2128.80	1871.99	1997.08	2061.92
T_2	2183.90	1999.63	1930.08	1911.13
M_A	3.5	3.2	3.0	0.1
M_B	5.4	3.2	3.2	1.6
$\mathcal{M}_{A\odot}$	1.3	1.4	1.4	2.8
$\mathcal{M}_{B\odot}$	0.9	1.4	1.4	1.9
$\pi('')$	0.017	0.005	0.005	0.005

Table 2 Measurements and $(O - C)$

ADS 1359 = IDS 01377N5702 = β 870						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1880.81	68°.9	1″.02	3	β	4°.76	0″.12
1888.82	59.5	0.76	3	Sp	1.49	-0.19
1891.60	59.7	1.11	3	β	3.66	0.14
1898.61	54.4	1.20	1	β	3.06	0.19
1900.80	52.5	1.14	2	A	2.55	0.12
1900.91	52.3	1.17	4	Doo	2.42	0.15
1901.85	53.6	1.14	2	Doo	4.30	0.11
1908.49	48.9	1.20	5	Lau1,Dob3,Sto1	3.59	0.14
1913.67	40.5	1.23	3	Fox	-1.87	0.15
1916.67	41.9	1.12	1	Gui	1.18	0.02
1920.62	40.0	1.13	8	Sto1,Chan4,GrO3	1.40	0.02
1923.03	39.2	1.08	3	VBs	1.87	-0.04
1923.89	38.2	0.98	8	B5,GrO3	1.32	-0.14
1944.34	27.0	1.02	2	VBs	0.52	-0.11
1948.893	24.2	1.204	3	R	0.04	0.08
1949.830	25.4	1.26	2	Markowitz	1.73	0.14
1950.866	25.4	1.04	1	Markowitz	2.26	-0.08
1950.016	22.08	1.154	5	R	-1.50	0.03
1953.961	18.46	1.182	7	R	-3.05	0.07
1954.824	20.5	0.90	2	Domm	-0.55	-0.21
1956.031	15.20	1.104	6	R	-5.21	0.00
1956.92	20.2	1.05	4	Wor	0.27	-0.05
1959.02	19.2	0.99	1	Woolley	0.42	-0.10
1961.716	18.8	1.12	4	Bos	1.53	0.05
1963.871	14.8	0.95	3	Dju	-1.23	-0.11
1964.835	12.7	0.87	1	Walker, Jr.	-2.77	-0.18
1967.528	15.5	0.92	3	Zul	1.64	-0.11
1967.873	14.4	0.91	1	Dju	0.76	-0.12
1967.873	11.3	1.00	1	Pop	-2.34	-0.03
1971.704	9.5	1.00	1	Behall	-1.72	0.00
1972.390	12.5	1.20	4	Wor	1.73	0.20
1977.79	5.5	0.91	2	hz	-1.51	-0.03
1979.874	10.0	1.04	3	Wor	4.57	0.12
1981.7008	5.1	0.922	1	Mc Alister	1.11	0.02
1985.8430	1.0	0.875	1	Mc Alister	0.57	0.03
1987.7571	359.5	0.861	1	Mc Alister	0.87	0.04

Table 2 (continued)

ADS 2755AB = IDS 03403N2353 = β 536								
t	θ_t	ϱ	n	Obs.	$\Delta\theta$ (elliptic. orb.)	$\Delta\varrho$ (elliptic. orb.)	$\Delta\theta$ (rectilin. traj.)	$\Delta\varrho$ (rectilin. traj.)
1878.69	336°.4	0″.44	3	β	6°.22	0″.04	6°.29	0″.09
1890.81	322.4	0.19	3	β	5.44	-0.09	4.78	-0.05
1891.74	317.1	0.19	3	β	1.61	-0.08	0.95	-0.04
1892–93	Single with 36-in		2	β	–	–	–	–
1899.70	301.6	0.15	3	A	3.24	-0.06	3.52	-0.02
1900.88	296.4	0.16	3	A	1.41	-0.04	2.07	0.00
1902.05	292.2	0.17	2	Bryant	0.77	-0.03	1.91	0.02
1912.82	245.6	0.18	2	A	-6.21	-0.00	1.17	0.04
1914.15	272.6	0.23	1	GrO	25.58	0.04	33.39	0.08
1914.69	228.0	0.19	2	A	-17.15	0.00	-9.21	0.04
1917.80	217.4	0.20	3	A	-17.82	-0.00	-9.56	0.03
1921.08	211.7	0.24	5	A	-14.78	0.01	-6.74	0.05
1924.27	200.8	0.28	4	A1,Fox3	-18.77	0.03	-11.22	0.06
1924.96	210.8	0.27	1	Plq	-7.45	0.01	-0.04	0.05
1930.65	195.6	0.28	4	VBs	-13.76	-0.03	-7.45	0.00
1933.64	196.6	0.29	5	B	-9.20	-0.04	-3.33	-0.02
1937.67	195.1	0.35	4	Voûte	-6.75	-0.02	-1.60	0.00
1941.20	191.6	0.35	3	VBs	-7.41	-0.06	-2.92	-0.03
1943.74	190.9	0.36	4	Voûte	-6.33	-0.07	-2.23	-0.05
1943.78	190.9	0.37	3	VBs	-6.31	-0.06	-2.21	-0.04
1945.49	194.0	0.46	2	Baize	-2.12	0.01	1.81	0.03
1946.12	186.2	0.46	2	Kuiper	-9.54	0.01	-5.70	0.03
1950.20	185.6	0.55	4	Baize	-7.89	0.06	-4.61	0.08
1950.87	190.6	0.46	3	Markowitz	-2.55	-0.03	0.56	-0.02
1951.03	189.9	0.42	3	VBs	-3.17	-0.07	-0.08	-0.06
1951.92	189.8	0.50	1	Markowitz	-2.84	-0.00	0.14	0.01
1956.39	190.2	0.55	3	Cou	-0.43	0.01	1.96	0.01
1957.74	185.4	0.57	4	Muller	-4.68	0.02	-2.46	0.02
1959.06	186.0	0.51	3	Cou	-3.56	-0.05	-1.51	-0.05
1961.04	191.1	0.62	2	Wor	2.29	0.05	4.09	0.03
1961.12	186.1	0.60	4	Baize	-2.68	0.03	-0.89	0.01
1961.97	189.6	0.65	4	Bos	1.13	0.07	2.81	0.05
1964.08	189.6	0.66	3	Cou	1.88	0.07	3.29	0.04
1964.14	186.9	0.67	3	Heintz	-0.80	0.08	0.61	0.05
1968.763	185.2	0.55	1	Dju	-0.97	-0.07	-0.17	-0.12

Table 2 (continued)

ADS 2755AB = IDS 03403N2353 = β 536

t	θ_t	ϱ	n	Obs.	Δθ (elliptic. orb.)	Δϱ (elliptic. orb.)	Δθ (rectilin. traj.)	Δϱ (rectilin. traj.)
1975.93	182°.8	0″.74	3	hz	-1°.21	0″.10	-1°.37	-0″.00
1976.052	183.1	0.75	3	Holden	-0.87	0.10	-1.06	0.01
1978.116	183.7	0.76	3	Wor	0.32	0.11	-0.16	-0.01
1985.727	180.6	0.84	3	Wor	-0.65	0.18	-2.30	-0.01

ADS 3390 = IDS 04355N3719 = Σ 577

t	θ_t	ϱ	n	Obs.	Δθ	Δϱ
1829.57	98°.7	1″.58	3	Σ	2°.50	-0″.14
1842.80	90.9	1.53	3	Gsh	-0.84	-0.16
1843.90	90.8	1.73	2	OΣ	-0.56	0.05
1863.47	84.5	1.60	5	Δ	0.17	-0.02
1870.75	79.7	1.61	2	OΣ	-1.87	0.02
1872.42	80.9	1.41	2	Δ	-0.02	-0.18
1879.30	79.0	1.45	3	Hl	0.79	-0.11
1883.34	78.6	1.76	6	En	2.03	0.21
1888.68	72.7	1.70	3	Nis	-1.64	0.17
1890.97	75.6	1.49	3	Hl	2.23	-0.03
1892.92	73.2	1.34	2	Jones	0.67	-0.17
1894.04	70.8	1.66	2	Big	-1.25	0.16
1898.09	69.6	1.60	2	A	-0.67	0.11
1904.39	68.2	1.79	6	Dob5.Pos1	0.79	0.33
1905.03	61.6	1.69	1	Frm	-5.51	0.23
1910.57	64.6	1.46	23	Dob4,Doo3,Has1,Vou4,GrO10,A1	0.11	0.03
1914.99	61.1	1.40	8	VBs3,Phl3,Gui1,Hzg1	-1.24	-0.01
1923.67	57.8	1.57	7	Chan3,Rong2,Krz2	-0.12	0.20
1926.12	57.2	1.67	4	Schem	0.58	0.31
1932.168	54.0	1.44	3	GΣ	0.68	0.11
1936.971	49.8	1.61	1	d	-0.80	0.30
1939.162	51.1	1.51	3	d	1.77	0.21
1944.72	46.0	1.29	3	Voûte	-0.00	0.02
1950.151	41.7	1.252	7	R	-0.93	0.00
1951.152	41.1	1.288	5	R	-0.89	0.05
1952.156	40.1	1.235	6	R	-1.24	-0.00
1953.150	40.0	1.283	9	R	-0.70	0.05

Table 2 (continued)

ADS 3390 = IDS 04355N3719 = Σ 577						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1954.10	39°.1	1″.23	2	Mul	-0°.98	0″.00
1955.09	40.4	1.25	3	Wor	0.97	0.02
1954.10	39.1	1.23	2	Mul	-0.98	0.00
1955.09	40.4	1.25	3	Wor	0.97	0.02
1955.147	39.5	1.278	4	R	0.10	0.05
1957.072	39.0	1.14	4	Djk2,Dc2	0.88	-0.08
1959.63	36.9	1.12	2	GrO	0.50	-0.09
1959.90	35.9	1.40	3	Wor	-0.32	0.20
1960.10	36.2	1.26	4	hz	0.12	0.06
1961.17	36.3	1.15	3	Bz	0.95	-0.05
1961.144	36.6	1.20	5	d1,hi1,p5	1.23	0.00
1962.810	36.5	1.09	4	Bos	2.28	-0.10
1963.168	35.3	1.21	4	Pop2,Djk1,Zul1	1.33	0.02
1963.924	34.1	1.10	4	Wor	0.66	-0.09
1964.150	30.8	1.16	2	Pop1,Djk1	-2.48	-0.03
1964.91	33.1	1.32	4	VBs	0.35	0.14
1965.00	32.3	1.19	4	hz	-0.38	0.01
1966.021	33.5	1.14	2	Zul	1.54	-0.04
1966.159	30.9	1.14	1	Djk	-0.96	-0.04
1970.956	28.9	1.13	3	Wor	0.50	-0.03
1977.729	23.3	1.02	3	Wor	-0.03	-0.12
1989.047	14.4	1.10	1	Zul	-0.01	-0.00

ADS 8128 = IDS 11138N1449 = Σ 1527						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1820.30	10°.1	3″.88	4	Σ	0°.09	0″.02
1842.97	11.3	3.48	3	Gsh	-0.54	-0.40
1866.25	13.7	3.65	3	A	-0.05	-0.15
1866.25	13.7	3.65	3	A	-0.05	-0.15
1875.30	14.4	3.43	4	Dn	-0.12	-0.31
1880.69	15.0	3.77	3	Sp	0.01	0.08
1884.21	14.6	3.61	5	Per	-0.71	-0.05
1889.45	16.8	3.75	1	Krug	1.01	0.15
1890.52	15.7	3.54	18	Nis2,Cel8,Sp8	-0.19	-0.05
1893.41	18.5	3.73	3	Lewis	2.34	0.17
1897.29	16.8	3.52	3	Doo	0.26	0.01

Table 2 (continued)

ADS 8128 = IDS 11138N1449 = Σ 1527

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1903.25	18°.0	3''.31	4	Bowyer	0°.86	-0''.12
1903.98	15.8	3.43	11	WashO4,Lau1,...	-1.41	0.01
1909.32	17.8	3.19	23	Lau4,GrO6,Vou4,...	0.02	-0.14
1916.34	17.4	3.69	3	J	-1.17	0.48
1918.68	18.7	3.11	28	Rabe6,VvS4,...	-0.15	-0.06
1920.8	18.7	3.12	13	Hopmann	-0.41	-0.01
1924.90	19.8	2.94	27	Fox3,UrO3,B4,Lv4,...	0.17	-0.10
1928.278	19.6	2.80	5	GΣ	-0.48	-0.17
1930.8	20.7	2.83	23	Hopmann	0.27	-0.08
1935.3	21.4	2.73	14	Hopmann	0.31	-0.07
1938.1	22.2	2.70	26	Hopmann	0.67	-0.03
1938.130	21.94	2.656	1	Adams	0.40	-0.08
1938.360	22.04	2.624	1	Jeffers	0.47	-0.10
1941.9	22.6	2.51	9	Hopmann	0.43	-0.12
1943.19	23.0	2.35	3	Voûte	0.61	-0.25
1948.3	22.7	2.43	10	Hopmann	-0.66	-0.02
1950.352	23.88	2.381	8	R	0.10	-0.01
1951.3	24.2	2.35	11	Hopmann	0.22	-0.01
1951.349	23.98	2.371	7	R	-0.01	0.01
1953.316	24.49	2.317	9	R	0.06	0.02
1955.337	24.45	2.264	9	R	-0.45	0.03
1957.23	22.5	2.37	3	Clouet	-2.87	0.20
1958.2	24.8	2.34	5	Hopmann	-0.82	0.20
1961.21	26.5	2.06	4	hz	0.06	0.02
1961.21	26.5	2.06	4	hz	0.06	0.02
1961.31	26.9	2.03	2	Cou	0.43	-0.01
1963.962	28.26	1.910	1	Bohuski T.J	0.98	-0.03
1964.259	28.0	1.82	4	Wor	0.63	-0.11
1965.297	28.4	1.85	5	Walker, Jr.	0.69	-0.05
1966.263	28.10	1.866	1	Bement R.	0.06	0.00
1966.353	27.1	1.75	4	Walker, Jr.	-0.97	-0.11
1967.143	28.35	1.828	1	Mirenian M.	-0.00	-0.00
1967.33	28.6	1.82	3	Valbousquet	0.18	-0.00
1967.368	27.8	1.69	4	Walker, Jr.	-0.63	-0.13
1973.250	30.6	1.63	4	Wor	-0.25	0.03

Table 2 (continued)

ADS 8128 = IDS 11138N1449 = Σ 1527						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1973.353	30°.3	1″.45	3	Pop	-0°.60	-0″.14
1973.945	31.1	1.71	5	Walker, Jr.	-0.09	0.14
1975.31	32.2	1.52	3	Muller	0.33	0.00
1977.219	34.8	1.53	4	Holden	1.88	0.09
1977.30	32.8	1.57	3	hz	-0.17	0.13
1980.26	34.0	1.32	3	hz	-0.84	0.00
1981.225	34.4	1.29	4	Pop	-1.13	0.01
1981.225	35.9	1.41	4	Zul	0.37	0.13
1985.260	40.4	1.15	2	Zul	1.46	0.04
1985.343	41.3	1.12	3	Pop	2.28	0.02
1986.804	40.0	1.13	4	Wor	-0.54	0.09
1990.210	45.0	1.03	2	Zul	0.12	0.13
1990.211	46.6	1.01	1	Pop	1.71	0.11

ADS 9989 = IDS 16118N0126 = A 2181						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1910.44	299°.6	0″.43	2	A	-4°.26	0″.01
1918.59	308.6	0.38	2	A	-6.26	-0.03
1923.43	316.8	0.43	2	A	-4.83	0.03
1925.63	334.3	0.45	1	A	9.54	0.05
1926.51	323.4	0.41	1	A	-2.63	0.01
1933.59	340.6	0.41	2	A	4.18	0.02
1938.40	344.0	0.36	2	VBs	0.30	-0.03
1944.32	355.1	0.37	6	Voûte	2.21	-0.01
1946.23	358.9	0.40	4	VBs	2.99	0.02
1957.37	16.9	0.37	4	B	2.98	-0.00
1958.522	17.3	0.37	4	B	1.49	-0.00
1958.63	18.1	0.36	2	VBs	2.11	-0.01
1961.01	20.0	0.40	8	VBs	0.09	0.03
1962.304	24.2	0.36	4	B	2.15	-0.01
1975.488	40.8	0.35	3	Holden	-3.05	-0.02
1975.603	42.7	0.38	4	Walker, Jr.	-1.34	0.01
1978.526	47.6	0.31	1	Walker, Jr.	-1.22	-0.06
1979.597	46.4	0.38	3	Walker, Jr.	-4.16	0.00
1981.447	51.8	0.38	3	Wor	-1.75	0.00

Table 2 (continued)

ADS 10017 = IDS 16170N2314 = Hu 481						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1902.49	227°.5	0″.51	3	Hu	-3°.41	0″.10
1903.49	226.9	0.41	2	GrO	-1.75	-0.02
1905.4	227.5	0.46	9	GrO	2.84	0.01
1908.58	218.5	0.56	5	Doo	-0.38	0.07
1912.9	213.1	0.48	12	GrO	0.76	-0.06
1921.37	202.1	0.64	11	VBs7,Plq3,A1	-0.29	0.01
1925.54	197.0	0.67	6	GrO	-1.37	0.01
1929.39	190.4	0.63	2	VBs	-4.58	-0.06
1930.614	193.5	0.68	2	G.Struve	-0.45	-0.01
1933.619	191.4	0.58	2	Kui	-0.10	-0.13
1935.24	192.4	0.73	3	Bs	2.19	0.02
1941.51	189.2	0.81	6	R	3.84	0.09
1943.21	182.0	0.67	3	Voute	-2.05	-0.05
1946.27	181.9	0.66	5	VBs	0.21	-0.06
1946.27	181.8	0.80	3	Eggen	0.11	0.08
1950.493	185.9	0.70	1	Arend	7.55	-0.00
1950.541	181.2	0.73	6	Rabe	2.89	0.03
1950.586	179.6	0.52	2	Markowitz	1.32	-0.18
1951.506	178.64	0.76	6	R	1.11	0.06
1953.52	173.5	0.66	4	Bz	-2.35	-0.03
1954.48	175.2	0.65	3	Cou	0.17	-0.03
1955.549	168.25	0.75	3	R	-5.85	0.08
1956.54	170.6	0.66	3	Wor	-2.62	-0.01
1958.231	180.8	0.66	2	B	9.13	0.01
1958.44	169.4	0.62	3	Cou	-2.07	-0.03
1958.513	174.0	0.66	3	B	2.59	0.01
1958.62	174.9	0.70	3	VBs	3.60	0.05
1959.40	169.8	0.59	2	Cou	-0.76	-0.05
1959.509	174.4	0.68	1	Hintze	3.95	0.04
1959.509	169.4	0.59	1	Pauscher	-1.05	-0.05
1959.52	171.0	0.74	5	hz	0.56	0.10
1959.624	165.56	0.62	2	Djk	-4.78	-0.02
1960.11	176.0	0.71	4	VBs	6.13	0.07
1961.48	167.6	0.65	4	Bz	-0.89	0.03
1962.35	162.1	0.67	3	Cou	-5.48	0.06
1962.364	166.0	0.62	4	B	-1.57	0.01

Table 2 (continued)

ADS 10017 = IDS 16170N2314 = Hu 481						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1962.455	159°.6	0″.52	4	Wor	-7°.87	-0″.09
1963.53	167.3	0.66	4	hz	0.99	0.06
1966.40	158.3	0.59	3	Cou	-4.66	0.02
1967.415	159.45	0.64	2/1	Pop	-2.22	0.09
1967.425	155.90	0.56	3	Zul	-5.76	0.01
1971.712	157.2	0.50	4	Wor	1.74	0.00
1975.37	149.2	0.50	2	Muller	0.39	0.06
1977.50	140.6	0.43	3	hz	-3.49	0.02
1978.526	135.5	0.40	1	Walker, Jr.	-6.04	0.01
1979.614	141.9	0.42	4	Walker, Jr.	3.31	0.05
1986.4555	114.2	0.3045	2	Blazit...	1.80	0.02
1986.472	112.1	0.29	2	Wor	-0.21	0.01

ADS 10699 = IDS 17368N5549 = Σ 2199						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1830.94	116°.4	1″.67	3	OΣ	0°.03	0″.10
1843.50	111.4	1.50	4	Ma	0.15	-0.08
1857.64	106.9	1.56	2	Se	1.35	-0.03
1857.64	106.9	1.56	2	Se	1.35	-0.03
1864.00	101.8	1.51	7	Δ	-1.21	-0.09
1872.52	101.2	1.60	2	OΣ	1.55	-0.01
1873.57	98.7	1.47	2	Δ	-0.54	-0.14
1879.47	98.5	1.67	3	Hl	1.56	0.05
1885.59	95.2	1.54	3	Hl	0.61	-0.09
1890.55	92.0	1.63	2	Gla	-0.71	-0.01
1894.64	92.7	2.10	1	Nis	1.53	0.45
1895.62	91.8	1.54	2	Collins	0.99	-0.11
1898.33	88.9	1.56	3	Doo	-0.90	-0.09
1903.65	87.2	1.65	2	Biesbroeck	-0.64	-0.02
1904.42	86.2	1.72	5	Pos2,Frm1,Lau2	-1.36	0.05
1910.83	83.9	1.69	24	Dob3,Roe3,Has3,...	-1.34	0.01
1916.98	82.2	1.58	9	Phl3,Roe2,Ol3,Guil	-0.85	-0.12
1920.66	79.0	1.68	5	Es2,B3	-2.76	-0.03
1925.25	78.4	1.80	15	Peek4,Dob2,GrO4,...	-1.77	0.08
1925.750	78.6	1.90	2	GΣ	-1.40	0.18
1927.467	80.0	1.76	4	GΣ	0.59	0.04

Table 2 (continued)

ADS 10699 = IDS 17368N5549 = Σ 2199

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1932.490	78°.1	1″.73	4	GΣ	0°.40	-0″.01
1945.67	74.9	1.80	3	Bz	1.57	0.03
1948.576	73.02	1.821	5	Rabe	0.64	0.04
1949.623	71.63	1.801	6	Rabe	-0.42	0.02
1950.493	71.1	1.70	1	Arend	-0.67	-0.08
1950.593	70.63	1.833	6	Rabe	-1.11	0.05
1951.573	70.27	1.761	10	Rabe	-1.15	-0.02
1952.556	69.12	1.798	6	Rabe	-1.99	0.01
1953.28	73.2	1.85	3	Prêtre	2.32	0.06
1953.53	72.5	1.73	3	VBs	1.70	-0.06
1953.617	69.78	1.730	5	Rabe	-0.99	-0.06
1954.437	69.2	1.79	3	Dju	-1.31	-0.00
1954.598	69.03	1.726	7	Rabe	-1.43	-0.07
1954.72	71.0	1.97	2	Muller	0.58	0.18
1956.608	67.40	1.749	7	Rabe	-2.42	-0.05
1958.518	70.7	1.83	3	Bos	1.48	0.03
1958.57	70.6	1.83	3	VBs	1.40	0.03
1959.47	70.6	1.80	5	GrO	1.68	-0.00
1960.59	68.2	1.80	4	hz	-0.37	-0.01
1962.436	69.6	1.85	4	Bos	1.61	0.04
1962.64	67.0	1.83	5	hz	-0.93	0.02
1962.984	68.6	1.84	4	Wor	0.78	0.03
1966.436	66.5	1.76	4	Walker, Jr.	-0.26	-0.06
1966.455	65.8	1.67	2	Dju	-0.95	-0.15
1966.455	67.8	1.77	2	Zul	1.05	-0.05
1968.411	66.6	1.82	4	Walker, Jr.	0.45	-0.01
1968.432	65.6	2.00	2	Pop	-0.55	0.17
1972.804	64.6	1.78	3	Pop	-0.22	-0.06
1973.294	64.3	1.93	1	Ole	-0.37	0.09
1973.950	64.6	1.90	4	Wor	0.13	0.06
1974.624	63.1	1.72	3	Walker, Jr.	-1.17	-0.12
1976.55	64.0	1.86	2	hz	0.31	0.01
1978.243	63.8	1.78	3	Pop	0.61	-0.07
1985.576	61.5	1.76	3	Zul	0.48	-0.11
1994.479	60.6	1.88	2	Pav	2.16	-0.01
1994.479	59.0	1.86	2	Pop	0.56	-0.03

Table 2 (continued)

ADS 10769 = IDS 17413N1745 = Σ 2205						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1830.87	291°.0	2''.52	3	Σ	-0°.48	0''.05
1844.33	294.9	2.48	5	Ma	0.70	0.07
1867.10	297.7	2.19	3	Δ	-1.43	-0.12
1869.31	301.6	2.19	3	Du	1.97	-0.11
1878.62	305.1	2.30	1	β	3.29	0.05
1883.50	303.6	2.28	2	Per	0.61	0.06
1884.56	302.4	2.21	3	Hl	-0.85	-0.01
1887.64	302.0	1.86	2	Cel	-2.02	-0.34
1894.54	306.5	2.18	3	Gla	0.72	0.02
1894.59	307.4	2.15	1	Nis	1.61	-0.01
1901.26	307.6	2.27	7	KgsO4,Hu3	0.04	0.15
1902.3	306.6	2.07	15	GrO	-1.24	-0.04
1902.57	306.9	2.10	2	β	-1.01	-0.01
1905.54	307.9	2.10	3	Doo	-0.83	0.01
1905.69	306.9	2.01	6	Th1,Doo3,Frm2	-1.87	-0.08
1906.76	312.8	2.46	3	Ino	3.73	0.38
1907.4	306.8	2.04	9	GrO	-2.45	-0.04
1909.50	310.6	2.14	14	Dob3,Has3,Roe4,Wz4	0.76	0.08
1913.2	310.1	2.04	15	GrO	-0.81	0.00
1914.90	310.8	1.72	6	Acs3,FBn3	-0.61	-0.31
1922.41	314.0	2.01	11	Chan2,VBs4,GrO4,Plq1	0.31	0.04
1924.87	315.4	1.91	10	Dob4,SprO2,B4	0.94	-0.05
1930.549	317.3	1.96	4	GΣ	0.99	0.05
1938.387	318.65	1.889		Adams	-0.35	0.04
1940.354	319.06	1.869		Adams	-0.65	0.04
1942.36	320.9	1.88	3	Voûte	0.46	0.06
1945.535	321.61	1.824		Hansen	-0.02	0.03
1946.706	322.4	1.70	4	Lyons	0.33	-0.08
1948.598	321.97	1.799	6	Rabe	-0.84	0.03
1950.587	321.45	1.682	5	Rabe	-2.15	-0.06
1952.580	321.54	1.765	6	Rabe	-2.86	0.04
1954.703	321.87	1.620	8	Rabe	-3.41	-0.09
1955.54	325.5	1.73	4	Wor	-0.13	0.03
1955.631	322.84	1.615	6	Rabe	-2.83	-0.09
1957.69	327.4	1.78	3	Wor	0.86	0.10
1960.44	328.0	1.82	4	Wor	0.26	0.16

Table 2 (continued)

ADS 10769 = IDS 17413N1745 = Σ 2205

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1960.48	326°.4	1″.66	2	Cou	-1°.36	0″.00
1961.63	328.5	1.67	5	hz	0.22	0.02
1962.406	327.7	1.66	4	Bos	-0.93	0.02
1963.358	329.0	1.68	4	Wor	-0.06	0.05
1965.581	333.4	1.64	1	Zul	3.30	0.03
1965.595	331.2	1.55	2	Pop	1.10	-0.06
1968.525	333.6	1.65	1	Pop	2.09	0.07
1971.378	333.8	1.52	4	Wor	0.88	-0.04
1971.452	332.5	1.28	1	Ole	-0.46	-0.27
1971.452	333.6	1.57	1	Pop	0.64	0.02
1975.45	336.2	1.59	2	Muller	1.17	0.07
1976.186	338.7	1.50	2	Pop	3.27	-0.01
1980.673	339.4	1.49	4	Wor	1.49	0.02
1985.576	341.4	1.40	4	Wor	0.60	-0.02
1988.559	342.5	1.43	2	Zul	-0.15	0.04

ADS 10795 = IDS 17427N1744 = Σ 2215

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1831.53	310°.6	0″.75	7	Σ	-0°.22	-0″.11
1841.56	311.6	0.86	4	OΣ	2.90	0.01
1855.92	304.6	0.67	3	Se	-0.93	-0.16
1868.75	302.8	0.87	5	Δ	0.24	0.06
1876.22	300.2	0.93	3	Sp	-0.56	0.14
1879.60	298.4	0.77	3	Hl	-1.53	-0.02
1884.04	300.3	0.79	6	Per	1.48	0.01
1892.64	295.5	0.71	11	Sp	-1.10	-0.06
1901.05	294.0	0.70	2	A	-0.35	-0.05
1902.44	296.3	0.71	3	Hu	2.33	-0.04
1902.57	296.0	0.69	2	β	2.07	-0.06
1906.54	298.8	1.46	1	Ino	5.97	0.72
1906.94	291.1	0.77	17	Frm1,Doo4,GrO9,Dob3	-1.62	0.03
1910.59	289.3	0.71	5	Vdk1,J1,Wz3	-2.39	-0.02
1913.2	286.9	0.66	15	GrO	-4.04	-0.07
1922.77	286.2	0.69	13	Chan2,GrO4,B4,Mag3	-1.90	-0.02
1924.81	289.0	0.77	8	Prz2,Dob4,Plq2	1.53	0.06
1932.656	283.9	0.70	3	GΣ	-1.12	0.01

Table 2 (continued)

ADS 10795 = IDS 17427N1744 = Σ 2215						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1932.656	283°.9	0″.70	3	GΣ	-1°.12	0″.01
1942.32	280.3	0.80	3	Voûte	-1.54	0.13
1945.47	280.0	0.66	4	VBs	-0.77	-0.01
1948.598	275.64	0.722	6	Rabe	-4.05	0.06
1950.597	276.05	0.718	6	Rabe	-2.94	0.06
1950.712	280.8	0.54	1	Markowitz	1.85	-0.12
1951.720	280.4	0.56	1	Markowitz	1.80	-0.10
1952.580	274.72	0.765	6	Rabe	-3.57	0.11
1953.54	280.3	0.57	3	VBs	2.35	-0.08
1954.486	275.0	0.62	3	Dju	-2.61	-0.03
1954.703	273.79	0.789	7	Rabe	-3.74	0.14
1954.73	277.6	0.65	4	Baize	0.08	-0.00
1955.62	273.3	0.64	3	Muller	-3.90	-0.01
1955.631	273.26	0.747	6	Rabe	-3.93	0.10
1956.296	275.3	0.61	2	Camichal	-1.65	-0.04
1957.62	277.1	0.66	3	Wor	0.63	0.01
1958.348	279.5	0.79	1	Bos	3.30	0.14
1958.441	278.0	0.52	1	Bos	1.83	-0.13
1958.649	278.5	0.63	1	Bos	2.41	-0.01
1959.66	275.4	0.57	7	GrO	-0.32	-0.07
1961.696	279.2	0.61	4	Bos	4.24	-0.03
1961.81	274.8	0.65	5	hz	-0.12	0.01
1962.406	273.7	0.65	4	Bos	-0.99	0.01
1963.413	274.3	0.66	4	Wor	-0.01	0.02
1963.414	274.3	0.66	4	Wor	-0.01	0.02
1964.45	274.5	0.61	3	Couteau	0.58	-0.02
1966.433	271.5	0.55	1	Walker, Jr	-1.66	-0.08
1967.425	272.2	0.51	4	Walker, Jr	-0.58	-0.12
1968.69	274.3	0.61	4	Bz	2.01	-0.02
1969.566	269.4	0.50	4	Walker, Jr.	-2.55	-0.13
1971.518	271.5	0.58	4	Walker, Jr.	0.32	-0.04
1973.538	271.6	0.65	4	Wor	1.22	0.03
1975.50	270.7	0.61	4	hz	1.11	-0.00
1977.530	268.1	0.52	2	Walker, Jr.	-0.66	-0.09
1978.696	270.9	0.58	1	Pop	2.62	-0.03

Table 2 (continued)

ADS 10795 = IDS 17427N1744 = Σ 2215						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1979.3626	268°.0	0″.573	1	McAlister & Hendry	-0°.01	-0″.04
1979.5319	268.1	0.573	1	McAlister & Hendry	0.16	-0.03
1980.662	270.6	0.47	4	Wor	3.13	-0.14
1986.300	268.0	0.50	4	Wor	2.92	-0.10
1988.559	261.5	0.62	2	Zul	-2.61	0.03

ADS 11010 = IDS 17596N4414 = β 1127						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1889.53	144°.7	0″.80	3	β	0°.17	-0″.03
1895.65	147.4	0.86	3	A	7.52	0.03
1897.71	130.5	0.88	3	A	-7.81	0.05
1898.61	139.6	0.74	1	Bowyer	1.97	-0.09
1898.77	141.4	0.70	3	Lewis	3.90	-0.13
1905.38	133.8	0.87	4	Doo	1.34	0.04
1912.1	132.1	0.79	6	GrO	4.77	-0.04
1923.49	113.2	0.99	3	Fox	-5.43	0.16
1924.98	119.9	1.03	3	GrO	2.41	0.20
1930.80	111.7	0.93	6	GrO3,Bonnet3	-1.39	0.09
1935.66	110.2	0.95	5	Rabe	0.76	0.11
1936.64	104.7	1.07	3	Bz	-4.01	0.23
1937.71	107.2	1.07	4	Rabe	-0.72	0.23
1942.65	104.2	0.84	5	Duruy4,Arend1	-0.07	-0.01
1944.38	98.9	0.97	3	Voûte	-4.11	0.12
1946.54	99.5	0.61	2	Arend	-1.94	-0.24
1947.52	98.8	0.96	5	Bz	-1.93	0.11
1950.687	97.2	0.72	2	Markowitz	-1.27	-0.14
1951.653	96.2	0.82	2	Wilson, Jr.	-1.58	-0.04
1952.94	96.4	0.89	2	VBs	-0.47	0.03
1956.32	93.1	0.95	9	Wor3,Bz3,B3	-1.40	0.08
1959.69	89.6	1.08	4	Wor	-2.57	0.20
1960.47	94.3	0.94	2	Cou	2.66	0.06
1961.51	90.0	0.95	4	hz	-0.93	0.07
1962.56	91.2	0.72	3	Holden	0.98	-0.16
1962.70	89.3	0.88	4	VBs	-0.83	-0.00
1962.71	89.4	1.01	3	Bz	-0.72	0.13

Table 2 (continued)

ADS 11010 = IDS 17596N4414 = β 1127

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1964.55	87°.8	1″.06	5	hz	-1°.09	0″.17
1967.52	86.2	0.94	3	Cou	-0.72	0.05
1969.393	86.5	0.82	1	Pop	0.81	-0.08
1969.396	88.5	0.80	1	Zul	2.81	-0.10
1972.603	86.2	0.96	4	Wor	2.58	0.05
1973.613	82.7	0.93	4	Walker, Jr.	-0.28	0.02
1975.54	83.9	0.82	1	Ole	2.14	-0.10
1975.542	82.1	0.74	1	Pop	0.34	-0.18
1975.72	83.7	0.89	1	Zul	2.05	-0.03
1978.216	86.5	0.90	3	Wor	6.41	-0.02
1980.49	83.5	0.92	2	hz	4.80	-0.01
1983.561	74.8	0.91	2	Zul	-2.04	-0.03
1985.502	76.0	0.85	2	Pop	0.32	-0.09
1989.485	73.0	0.81	1	Pop	-0.35	-0.15
1989.523	69.7	0.99	2	Zul	-3.63	0.03

ADS 11998 = IDS 18598N2633 = A 2992

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1916.44	59°.7	0″.23	3	A	4°.68	0″.02
1920.82	43.0	0.20	5	A	-6.53	0.02
1923.70	42.0	0.16	2	A	-2.96	-0.00
1954.80	300.5	0.14	2	VBs	4.72	-0.01
1958.567	110.4	0.14	3	Bos	1.75	-0.03
1958.62	290.6	0.14	2	VBs	2.04	-0.03
1960.58	117.5*	0.21	3	VBs	11.96	0.03
1962.513	282.2	0.23	4	Bos	-0.72	0.04
1976.56	270.1	0.20	3	hz	-0.19	-0.07
1976.582	80.1*	0.19	3	Holden	-10.18	-0.08
1976.610	84.7*	0.17	1	Walker Jr.	-5.56	-0.10
1980.49	273.6	0.20	2	hz	5.66	-0.09
1981.623	267.4	0.27	4	Wor	0.08	-0.02
1985.620	274.1	0.26	4	Wor	8.80	-0.05

* – quadrant reverse.

Table 2 (continued)

ADS 12577 = IDS 19298N6324 = Hu 951

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1904.61	287°.1	0".24	3	Hu	-0°.26	0".00
1923.52	313.9	0.22	4	VBs	-2.31	-0.00
1934.60	344.0	0.20	2	VBs	7.43	0.00
1941.12	349.1	0.18	2	VBs	-2.54	0.00
1943.74	352.0	0.20	3	VBs	-6.76	0.03
1954.18	42.4	0.12	4	VBs	7.04	-0.02
1960.11	60.1	0.15	4	VBs	-0.43	0.01
1962.757	75.4	0.13	4	Bos	3.94	-0.01
1977.470	113.5	0.18	4	Wor	-2.79	-0.02
1981.59	(359.5)	0.17	2	Muller	–	-0.04
1982.70	ronde	< 0.16	1	Muller	–	–

ADS 14666 = IDS 21030N0445 = OΣ 527

t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1845.68	322°.0	0".3	1	Ma	16°.58	-0".08
1846.85	306.2	0.45	1	OΣ	1.45	0.07
1851.72	306.8	0.45	1	Ma	4.75	0.06
1852.64	295.1	0.33	1	OΣ	-6.44	-0.06
1859.65	290.6	0.46	1	OΣ	-7.20	0.06
1878.35	285.0	0.52	3	β	-3.38	0.11
1884.78	283.6	0.49	1	Hl	-1.64	0.08
1886.75	277.8	0.33	2	Hl	-6.47	-0.08
1888.86	280.7	0.45	2	Sp	-2.54	0.04
1891.17	296.8	0.33	5	Sp	14.70	-0.08
1893.28	284.0	0.37	2	Com	2.95	-0.04
1898.52	281.5	0.39	5	Hu	3.09	-0.01
1900.55	269.5	0.43	2	β	-7.87	0.03
1901.71	267.4	0.29	2	Bryant	-9.37	-0.11
1907.75	279.2	0.42	5	MCO4,Bow1	5.66	0.03
1913.44	266.2	0.37	8	Fox4,Wz1,GrO1,Lv2	-4.09	-0.00
1914.86	279.3	0.40	2	R	9.86	0.03
1923.47	264.6	0.39	5	A2,Mag2,Plq1	0.80	0.05
1923.95	256.3	0.35	4	Fur	-7.16	0.01
1934.31	254.8	0.33	3	VBs	-0.02	0.04
1955.77	219.5	0.13	3	VBs	-0.81	-0.05

Table 2 (continued)

ADS 14666 = IDS 21030N0445 = OΣ 527						
t	θ_t	ϱ	n	Obs.	$\Delta\theta$	$\Delta\varrho$
1957.62	209°.7	0″.12	2	VBs	-5°.61	-0″.05
1958.588	209.6	0.17	3	B	-2.92	0.00
1960.31	200.8	0.14	3	VBs	-6.48	-0.02
1961.690	200.2	0.15	4	B	-2.65	-0.01
1963.91	204	< 0.2	3	Djk2,Pop1	8.64	0.05
1972.154	160.0	0.14	2	Wor	-6.99	-0.02
1973.604	160.7	0.23	5	Walker Jr.	-1.76	0.07
1975.748	153.8	0.15	3	Wor	-2.41	-0.02
1978.806	154.7	0.13	3	Wor	6.40	-0.06
1979.067	146.8	0.18	4	Wor	-0.88	-0.01
1983.4232	140.8	0.209	1	Mc Alister...	2.32	-0.00
1983.7101	139.7	0.216	1	Mc Alister...	1.76	0.00
1984.7040	137.9	0.221	1	Mc Alister...	1.75	0.00
1986.802	131.0	0.22	4	Wor	-1.67	-0.01
1986.8910	134.4	0.232	1	Mc Alister...	1.87	0.00
1987.7566	133.4	0.237	1	Mc Alister...	2.20	0.00

Table 3 Ephemeris

	ADS 1359		ADS 3390		ADS 8128		ADS 9989	
t	θ_t	ϱ	θ_t	ϱ	θ_t	ϱ	θ_t	ϱ
1995.0	350°.66	0″.72	9°.56	1″.09	53°.96	0″.70	74°.77	0″.39
1997.0	348.02	0.69	7.88	1.09	59.38	0.63	77.79	0.39
1999.0	345.13	0.66	6.19	1.08	66.24	0.56	80.77	0.39
2001.0	341.96	0.63	4.49	1.08	74.95	0.50	83.72	0.40
2003.0	338.47	0.60	2.78	1.08	85.83	0.45	86.63	0.40
2005.0	334.60	0.57	1.06	1.08	98.79	0.42	89.50	0.40
2007.0	330.32	0.54	359.34	1.07	112.95	0.41	92.34	0.40
2009.0	325.56	0.51	357.61	1.07	126.76	0.43	95.14	0.41

Table 3 (continued)

	ADS 10017		ADS 10699		ADS 10769		ADS 10795	
t	θ_t	ϱ	θ_t	ϱ	θ_t	ϱ	θ_t	ϱ
1995.0	62°.27	0″.26	58°.24	1″.89	346°.90	1″.33	261°.23	0″.58
1997.0	51.51	0.28	57.69	1.89	348.32	1.31	260.34	0.58
1999.0	42.06	0.30	57.14	1.90	349.78	1.29	259.43	0.58
2001.0	33.90	0.32	56.60	1.90	351.29	1.27	258.52	0.57
2003.0	26.84	0.35	56.05	1.91	352.83	1.26	257.60	0.57
2005.0	20.64	0.37	55.51	1.91	354.42	1.24	256.67	0.57
2007.0	15.09	0.39	54.97	1.92	356.06	1.22	255.73	0.56
2009.0	10.01	0.40	54.43	1.92	357.75	1.20	254.78	0.56

	ADS 11010		ADS 11998		ADS 12577		ADS 14666	
t	θ_t	ϱ	θ_t	ϱ	θ_t	ϱ	θ_t	ϱ
1995.0	70°.18	0″.97	261°.30	0″.35	144°.96	0″.25	122°.06	0″.28
1997.0	69.09	0.98	260.58	0.36	147.47	0.26	120.04	0.29
1999.0	68.01	0.98	259.88	0.37	149.90	0.26	118.18	0.30
2001.0	66.94	0.99	259.21	0.37	152.25	0.27	116.47	0.32
2003.0	65.88	1.00	258.57	0.38	154.54	0.27	114.88	0.33
2005.0	64.84	1.00	257.94	0.39	156.77	0.27	113.41	0.34
2007.0	63.82	1.01	257.34	0.39	158.95	0.28	112.03	0.35
2009.0	62.80	1.02	256.76	0.40	161.09	0.28	110.75	0.36

Table 3 (continued)

	ADS 2755 (elliptic. orb.)		ADS 2755 (rectilin. traj.)	
t	θ_t	ϱ	θ_t	ϱ
1995.0	178°.65	0″.64	181°.99	0″.95
1997.0	178.06	0.64	181.81	0.97
1999.0	177.44	0.63	181.63	0.99
2001.0	176.82	0.62	181.46	1.01
2003.0	176.17	0.61	181.30	1.03
2005.0	175.51	0.60	181.13	1.06
2007.0	174.82	0.59	180.99	1.08
2009.0	174.10	0.58	180.86	1.10

3. ADDITIONAL PARTICULARS CONCERNING THE ANALYSED SYSTEMS

β 870 = ADS 1359 = IDS 01377N5702

The orbital elements of this pair were calculated of the first time in 1972 from the observed arc of 54°. It was concluded then that the measurements fitted satisfactorily a circular orbit with a 573.52 *yr* period. The orbital elements were published in Popović (1972) and Popović (1973). The interferometric measurements from 1981, 1985 and 1987 (McAlister, Hartkopf W., 1988) display significant deviation from a circular orbit reducing the semimajor axis by an amount of ~ 0″.20. This was the reason to revise the orbit from 1972. The period given here is significantly shorter and its new value is 304.04 *yr*. The change in parallax also followed to increase from 0″.010 to 0″.018 (Fig. 1).

β 536 = ADS 2755AB = IDS 03403N2353

The first orbital elements of this pair were calculated as early as 1942 (Hertzsprung, 1942). Hertzsprung corrected the position angle of his two normal places from before 1895 by subtracting 180°. In this way with other four normal places formed, between 1900 and 1932, Hertzspung obtained an elliptical orbit with a period of 102.8 *yr*. It turned out that this quadrant correction had not been justified and in 1956 significantly different orbital elements were obtained by Wierzbinski (1956). He found a 1000 *yr* period. This orbit also failed. In his series Worley (1989) gives the $(O-C)$ residuals for the moments of his own observations from 1978 and 1985:

$$1978.116 : +13°.7, +0''.45$$

$$1985.727 : +26°.1, +0''.65$$

where one finds the comment: "This orbit fails entirely."

Our attempt to obtain satisfactory orbital elements did not completely succeed. We could not avoid significant residuals in the position angle, especially in the period 1914 - 1924. The distribution of the measurements gives rise to justification of questioning the existence of an elliptical orbit. The elliptical orbit which could be obtained by us results in the lenghtening of the period to 1421.6 *yr*. The measurements covering an arc of ~ 156° can be also fitted by a rectilinear trajectory. This is just what has been done here. The residuals obtained by assuming a rectilinear trajectory are acceptable in our opinion. The elements of the rectilinear trajectory found here are:

$$\varrho \cos(263°.68 - \theta) = 0''.137$$

$$\varrho \sin(263°.68 - \theta) = 0''.01083\,(t - 1908.518),$$

while in Table 2 are presented also the $(O-C)$ residuals with respect to this trajectory. In Section 4, in Fig. 2, are presented both the elliptical and rectilinear orbits. The rectilinear trajectory given here agrees well with Hertzsprung's (1958) rectilinear trajectory. The measurements with respect to the rectilinear trajectory show an oscillatory motion with a period of ~ 65 *yr* not mentioned by Hertzsprung.

The pair deserves the attention of observers in order to decide finally whether it is a physical or an optical one. Our results are more in favour of the latter possibility. (Fig. 2).

Σ 577 = ADS 3390 = IDS 04355N3719

As yet four set of orbital elements have been communicated for this pair: (Popović, 1963), (Hock, 1966), (Hock, 1968) and (Hock and Flinner, 1970). The orbit period has varied from 1138 *yr* to 655 *yr*. The first orbital elements were based on an observed arc of ~ 64°, whereas the elements presented here are based on an arc of ~ 85°. The orbit is treated within the framework of the revision of Popović's old orbits. We find 826.65 *yr* for the period being in a good agreement with the result of Hock and Flinner (1970 - P = 849.00 *yr*). The most recent measurement by Zulević from 1989 used here does not deviate essentially from the position–angle ephemeris for the orbit by Hock and Flinner (1970) so that the present orbit should be accepted as a possible variant. The parallax amount is unchanged compared to the first calculated value. The 0″.014 value is confirmed (Fig. 3).

Σ 1527 = ADS 8128 = IDS 11138N1449

The first orbital elements of this binary were published by Hopmann (1958). He found 1148 *yr* for the period and 80°.07 for the inclination. The more recent measurements have yielded systematically smaller values for the separation compared to the ephemeris ones and also higher amounts of the position angle. This clearly indicated that the orbital elements are unsatisfactory. The inclination of the orbit obtained by us is slightly diminished, but, on the other hand, the period has been halved. The separation is decreasing rapidly and therefore the observations of this pair should be ranged among those having priority. According to the elements presented here we are nearing the periastron passage (Fig. 4).

A 2181 = ADS 9989 = IDS 16118N0126

The first orbital elements of this binary were published in 1964 (Popović, 1964) and they were derived from an arc of $\sim 84°$. They were published again with a corrected period by the same author (Popović, 1969). Worley's (1989) observations of 1981.447 yield a residual in the position angle from the ephemeris value of $\sim 12°$. This has been the reason for undertaking a revision of these elements. Now an observed arc of $\sim 112°$ was available. The period is increased from 224 *yr* to 285 *yr*, whereas the parallax is decreased from 0″.009 found in 1969 to 0″.008. No other orbital elements exist for this system. (Fig. 5).

Hu 481 = ADS 10017 = IDS 16170N2314

The orbital elements of this system were obtained for the first time in 1967 (Popović, 1967). After two years the system was treated completely by the same author (Popović, 1969). The first orbital elements were derived from an observed arc of $\sim 72°$. For the period it was found 141.44 *yr*, and 0″.014 for the parallax. According to the measurements before 1986 there was no serious disagreement between the ephemeris and observations. However, Worley's measurements from 1986 (Worley, 1989), as well as the interferometric ones by Blazit and others (McAlister and Hartkopf, 1988), yield a residual of $\sim 14°$ in the position angle. New orbital elements based on an observed arc of $\sim 115°$ were published by Baize (1990). He found 192.0 *yr* for the period.

Under the revision programme for Popović's old orbits this system was also analysed. Since we obtain more significant residual of the period value than that obtained by Baize, we accepted them as a possible variant. The elements presented here are based on the same observed arc as Baize's ones. By adopting these elements the system's parallax is corrected to become 0″.016 (Fig. 6).

Σ 2199 = ADS 10699 = IDS 17368N5549

Since the discovery in 1830 up to 1994 the position angle of this bright Struve's pair has decreased by about 57° clearly indicating the existence of an orbital motion of the components. The system is easy for measuring so that there is no significant scattering in the measurements and the observed arc is satisfactorily covered by the observations. This enabled the first calculation of the orbital elements for it to be made. The $(O - C)$ data for both the separation and position angle do not exceed the accuracy of the measurements. The orbital elements indicate that this system is a long period one. The orbital parallax is in this case 0″.014 correcting downwards the known dynamical parallaxes derived from the observed arc: ADS: dp. 0″.023 (J & F) and 0″.019 (R & M).

The system deserves further systematic observations (Fig. 7).

Σ 2205 = ADS 10769 = IDS 17413N1745

Since the discovery in 1830 the position angle of this, easily observable, Struve's pair has increased by about 51° unambiguously demonstrating an orbital motion. The observed arc is well covered by the observations which enabled the orbital elements of the system to be calculated for *the first time*. This pair is also a long period one. According to the elements the time of the periastron passage is near (T = 2019) when ρ will fall below 1″. Now is the time to observe this system intensively and systematically. The orbital parallax is somewhat smaller compared to the values of the dynamical ones (ADS: dp=0″.024 (J & F) and 0″.020 (R & M))) and its amount is 0″.017 (Fig. 8).

Σ 2215 = ADS 10795 = IDS 17427N1744

The orbital elements of this pair have not been calculated until now. Although the change in the position angle from the discovery in 1831 till now is $\sim 50°$ only, the covered area is almost 1/5 of the total area of the ellipse defined by the orbital elements and the observed ellipse arc is covered well by the measurements, especially by the more recent ones. Thanks to this circumstance it is possible to calculate for *the first time* the orbital elements without any problem.

This bright Struve's pair also belongs to the long-period systems. The orbital parallax is here 0″.004 being a somewhat lower value compared to the known dynamical parallaxes (ADS: dp=0″.009 (J & F) i 0″.005 (R & M)) (Fig. 9).

β 1127 = ADS 11010 = IDS 17596N4414

The first orbital elements of this system were calculated in 1970 (Popović, 1970a; 1970b). The measurements performed after 1970 have indicated a systematic deviation of the observations from the ephemeris for the separation. The orbit systematically yielded higher values for the separation. On account of this a revision of the orbital elements from 1970 is carried out (Fig. 10).

A 2992 = ADS 11998 = IDS 18598N2633

In the case of this system two sets of orbital elements have been known as yet (Knipe, 1961; Dommanget, 1979). Both calculations have resulted in a short period of the system. It is $P = 63.79$ *yr* according to Knipe, resp. $P = 86.68$ *yr* according to Dommanget. However, the measurements show both sets of orbital elements to be failing. Worley (1989) compared his series of measurements with the ephemeris of Dommanget's orbit and found for $(O - C)$

$$\text{Dommanget, 1979} : +7^{\circ}\!.9, +0''\!.01 \quad -- \ 1981.623$$
$$+19^{\circ}\!.3, 0''\!.00 \quad -- \ 1985.620$$

remarking "Quadrant in doubt. The orbit fails".

The new orbit is calculated by accepting a correction in the position angle by 180° for three cases: van Biesbroeck's observations from 1960.58, Holden's observations from 1976.582 and Walker Jr's ones from 1976.610. In favour of a correct choice of the quadrant is van den Bos in his measurements from 1962.513, announced the quadrant (adopted by us) estimating the apparent magnitudes of the components - 9.6, i. e. 10.0. The adoption of the measurements with the mentioned quadrant correction yields significantly different orbital elements, transforming this system, known as short-period as yet, into a long-period one (Fig. 11).

Hu 951 = ADS 12577 = IDS 19298N6324

The first orbital elements of this system were calculated in 1964 from an observing arc of ~ 148° (Popović, 1964; 1969). It was found then 182 *yr* for the period and $0''\!.005$ for the parallax. New orbital elements for this system were obtained in 1983 – 1984 (Costa and Docobo, 1983; Baize, 1984).

In Worley's (1989) series one finds the measurement corresponding to 1977.470 followed by this statement: "This is the first positive measure since 1962; not used in either computation. Two recent measures by Heintz give large residuals from both predictions, and a measure by Muller is completely anomalous." In the further text it is stated that the residuals from the latter two orbits referred to 1977.470 are the following:

$$\text{Costa and Docobo, 1983} : -9^{\circ}\!.7, +0''\!.06$$
$$\text{Baize, 1984} : -8^{\circ}\!.3, +0''\!.01$$

For this reason the calculation of new elements is undertaken in the framework of the revision of Popović's old orbits.

Compared to all the three orbits existing to date the period given here is significantly longer ($P = 205.48$ *yr*), while the parallax remains unchanged (Fig. 12).

OΣ 527 = ADS 14666 = IDS 21030N0445

The first orbital elements of this system were derived by Djurković (1964). Two sets of orbital elements derived from an arc of ~ 112° were given by him then. In the first set the period was equal to 195.0 *yr* and in the second one to 189.9 *yr*. A new set was obtained by Heintz (1975). The period was corrected by him to $P = 177.0$ *yr*. By his measurements Worley (1989) showed Heintz's orbit to be failing, stating their accordance with the interferometric measurements.

At computing new orbital elements we had at our disposal an arc of ~ 189°. We obtain significantly higher values for the period and semimajor axis – $P = 561.2$ *yr*, $a = 0''\!.56$ being in a perfectly satisfactory agreement with the interferometric measurements of McAlister and Hartkopf (1988). The parallax of the system remains practically unchanged – $\pi = 0''\!.0049$ (Fig. 13).

4. PLOTS OF THE ORBITS

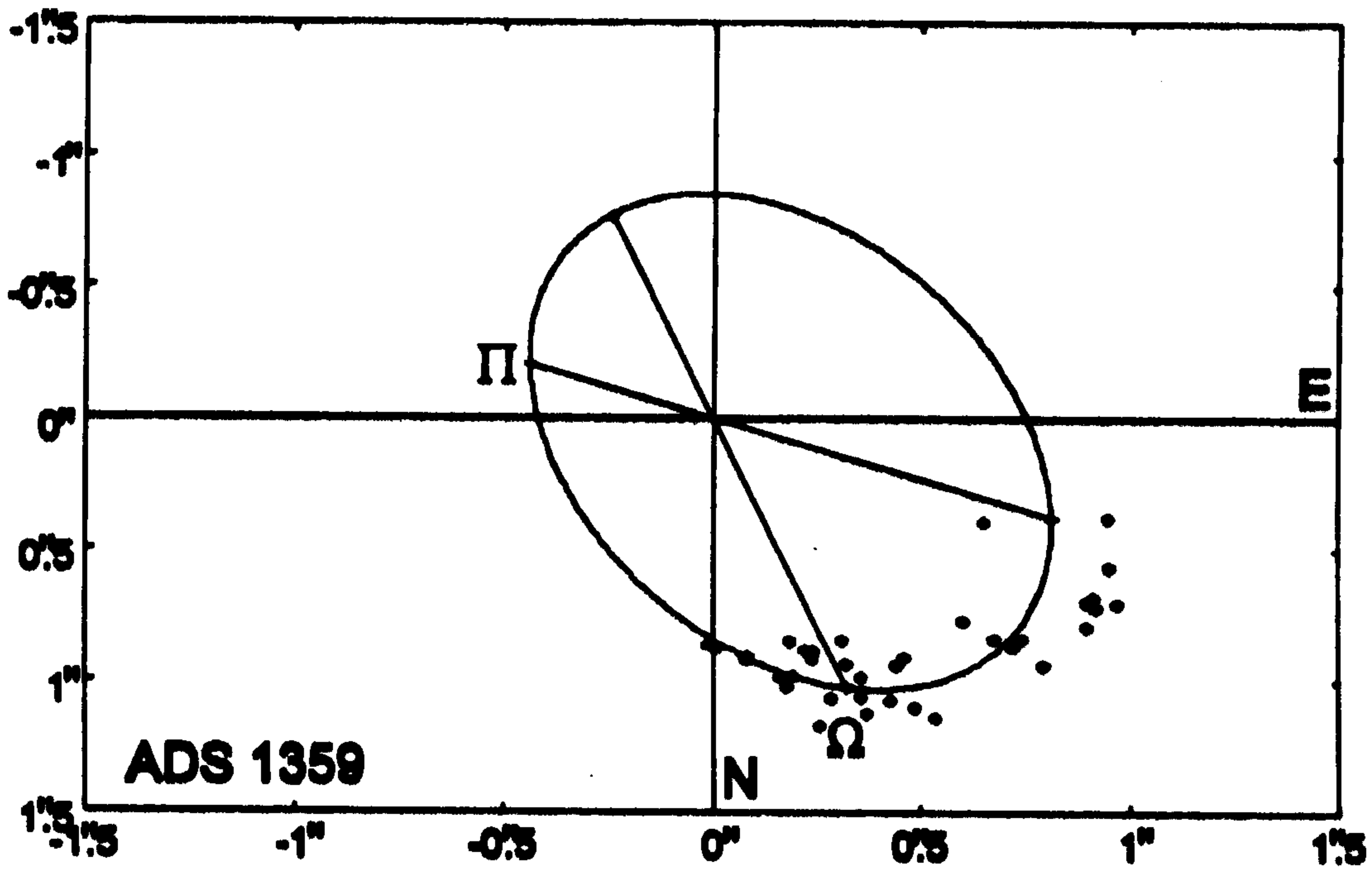

Fig. 1.

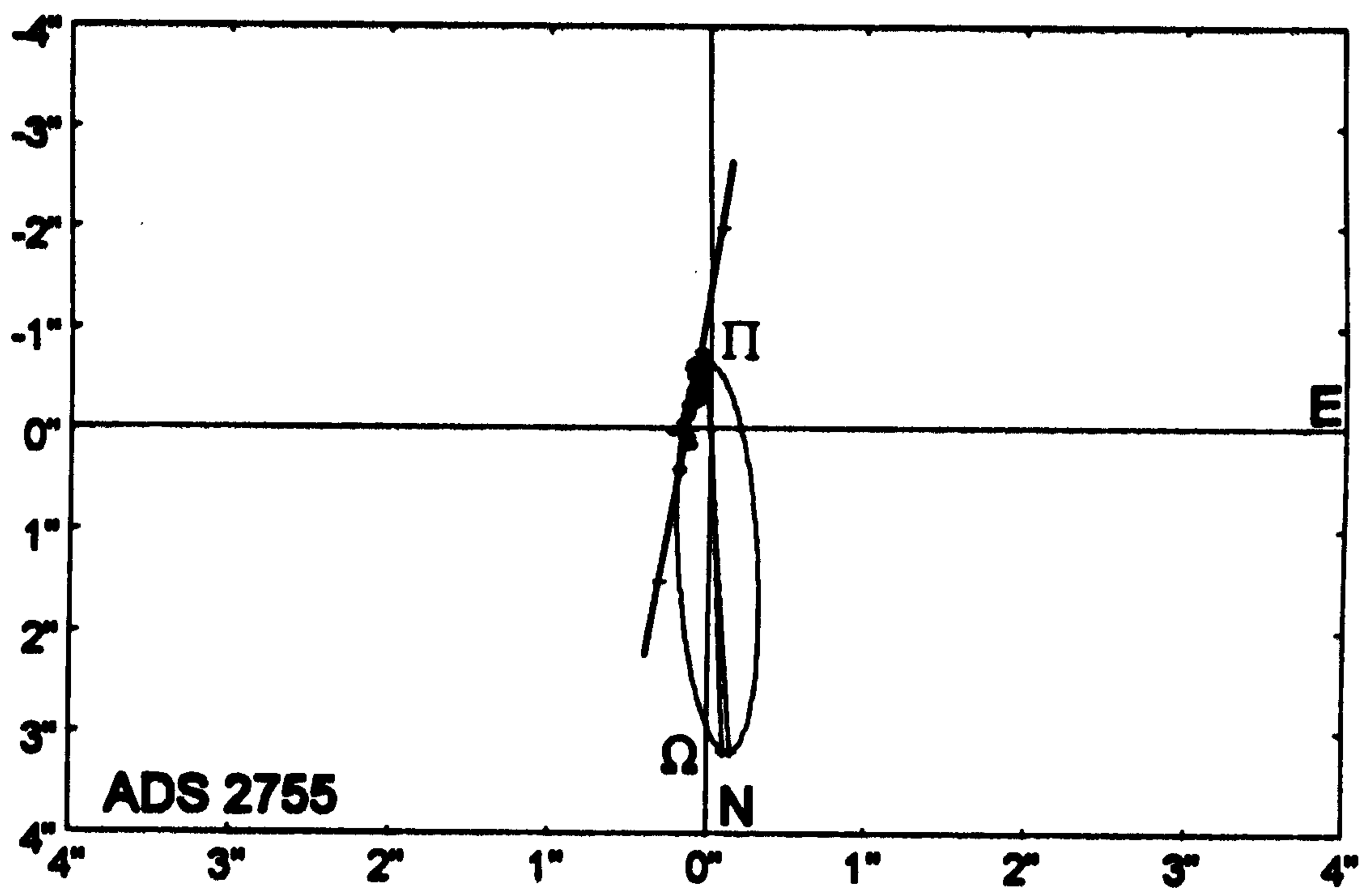

Fig. 2.

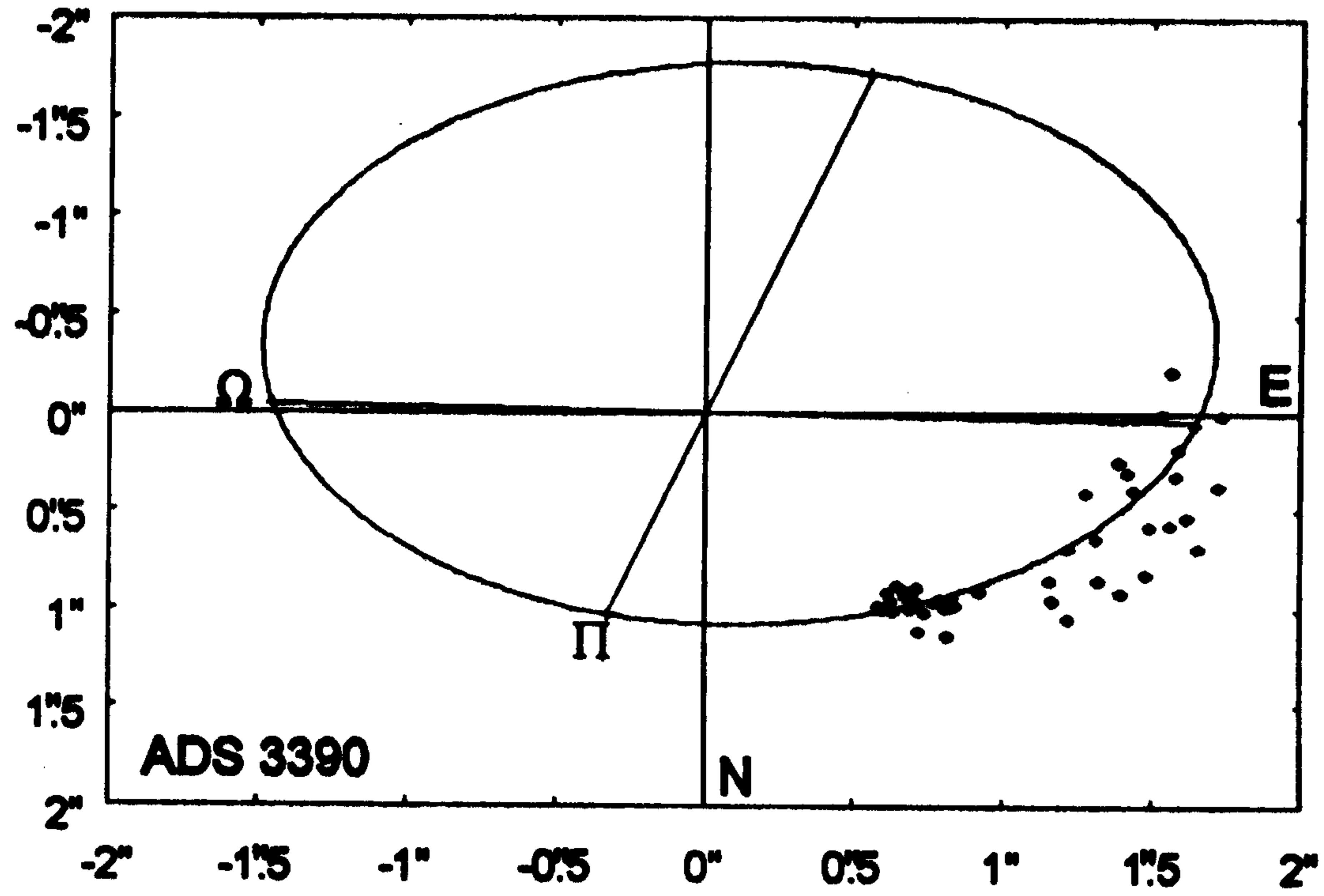

Fig. 3.

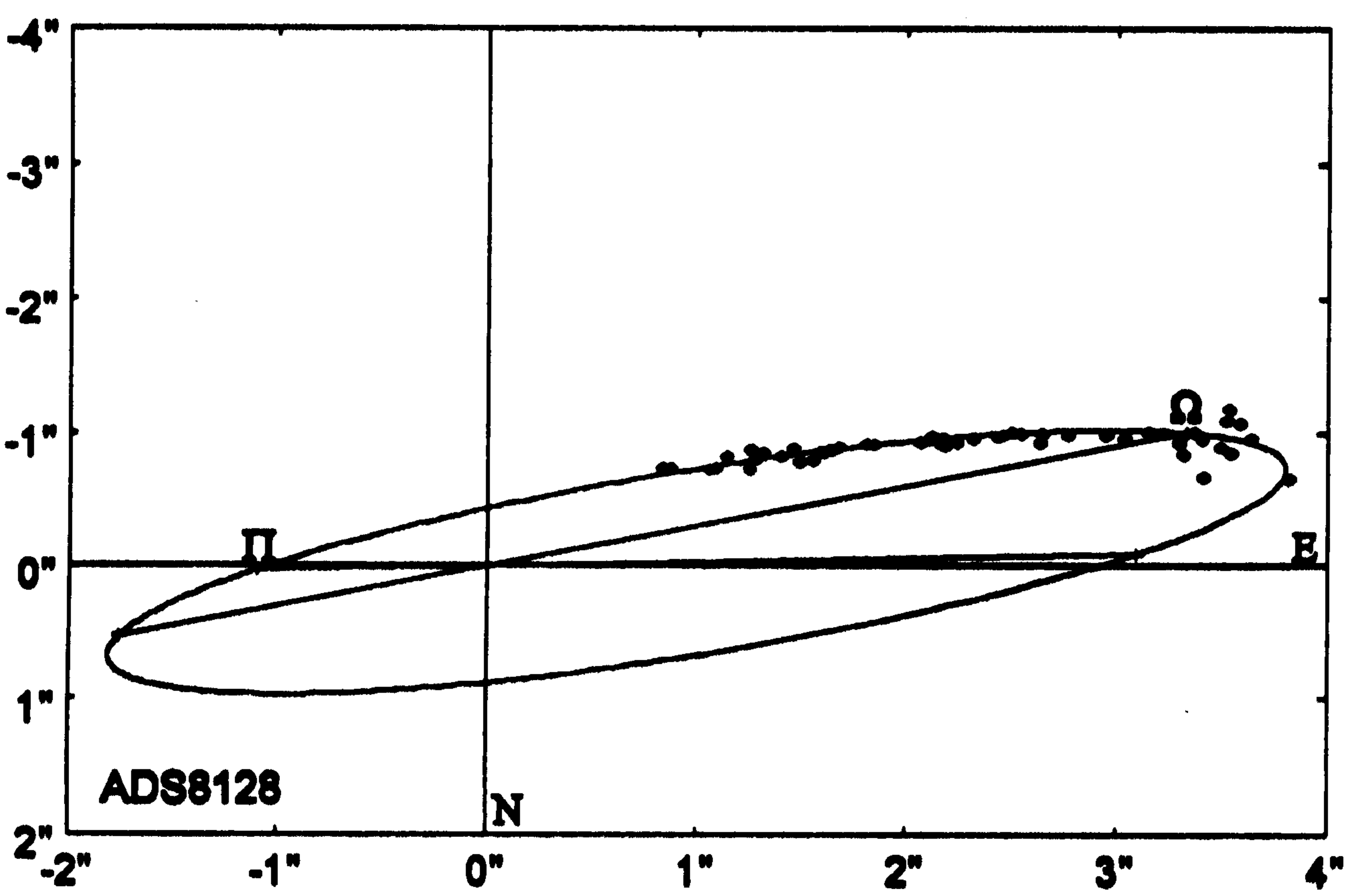
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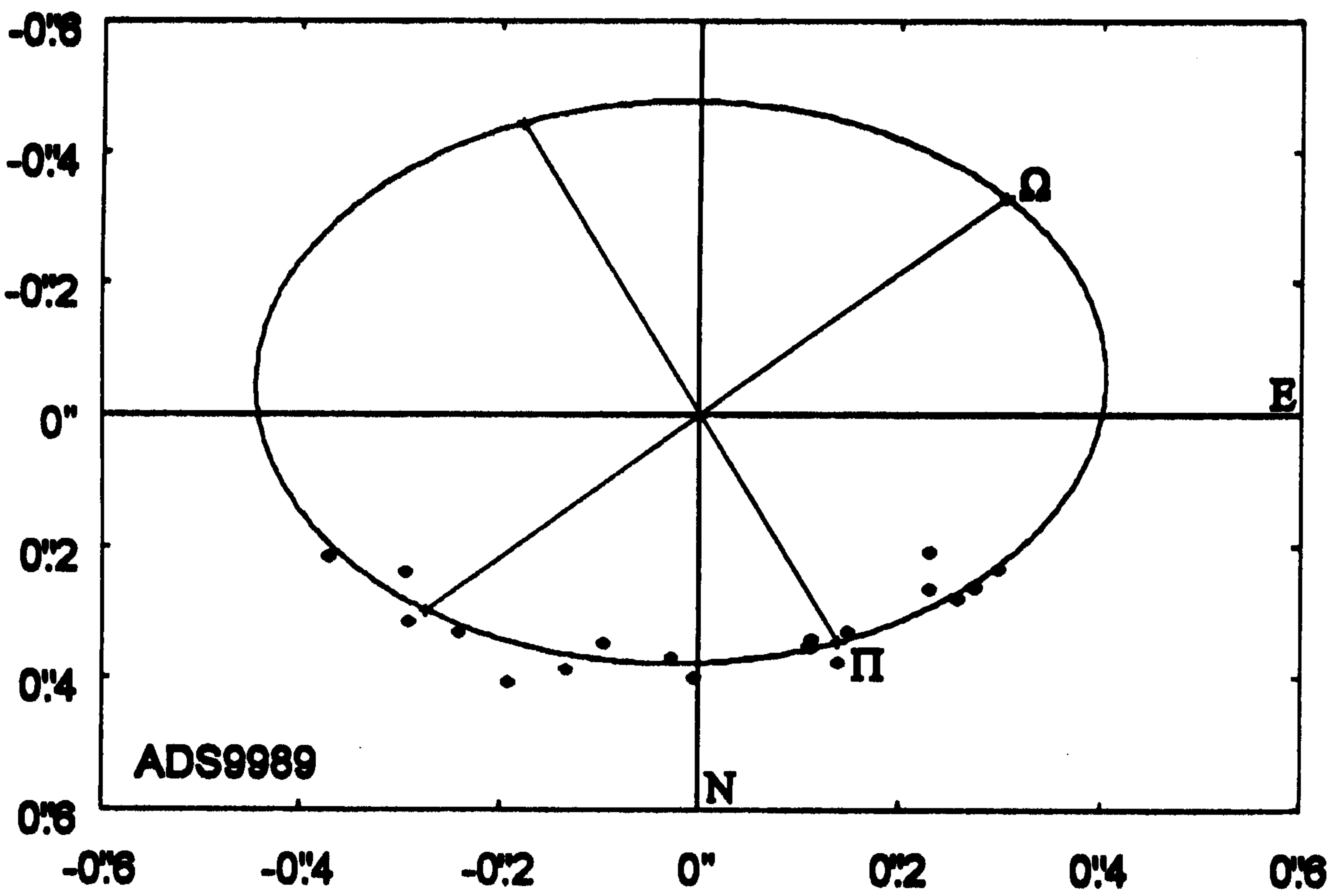
Fig. 4.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Ω
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-0."2
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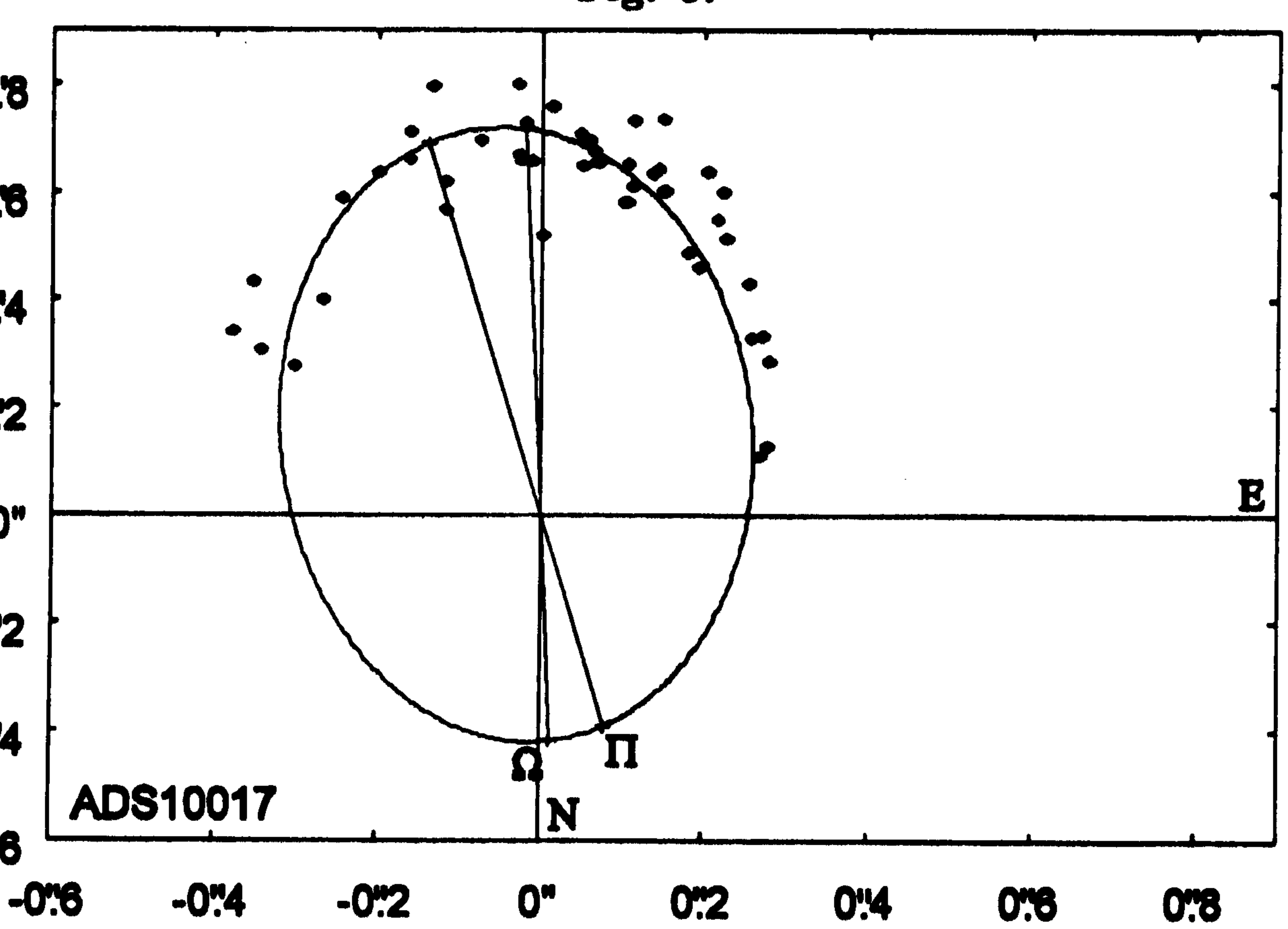
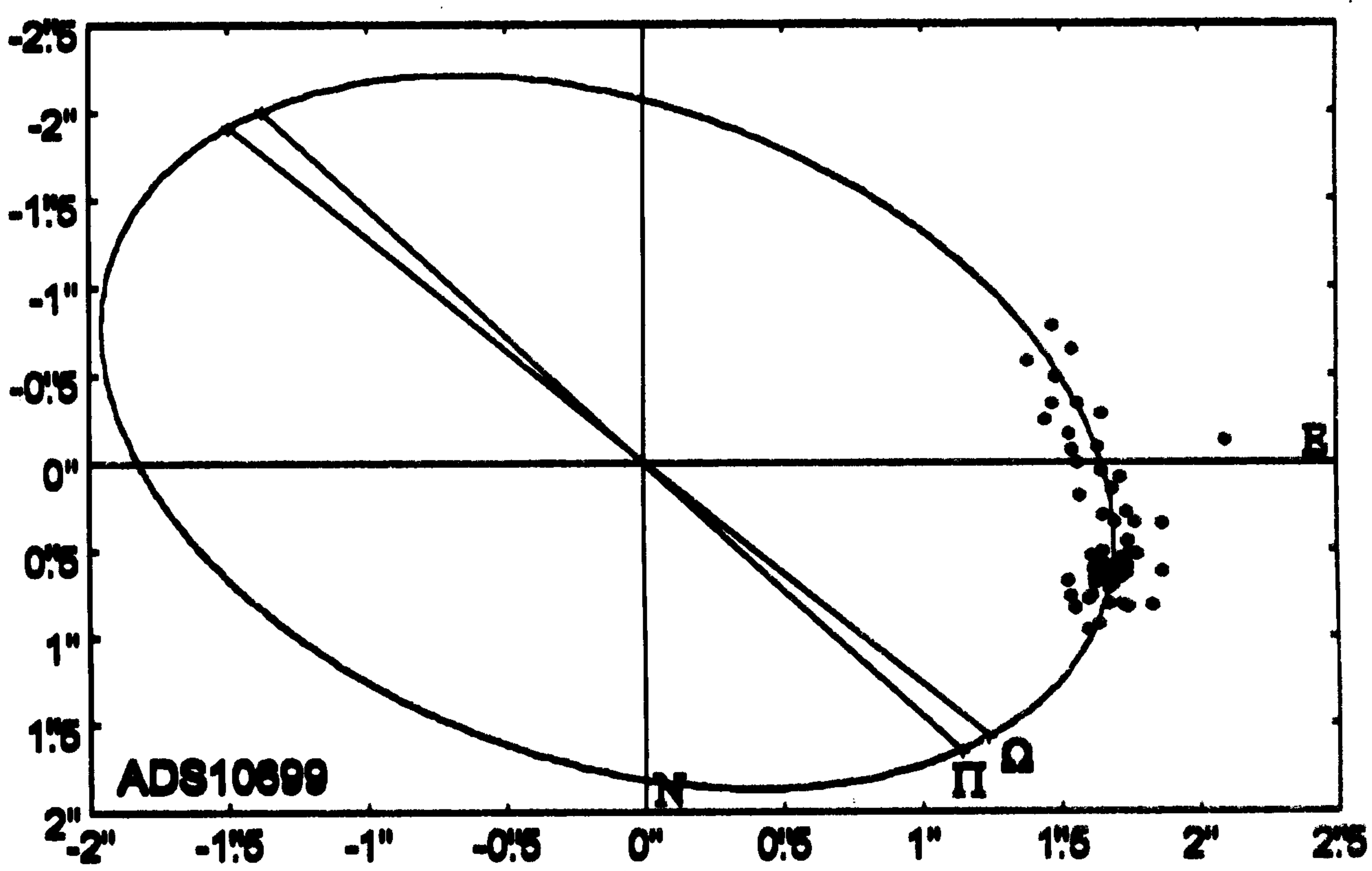
0."6

Fig. 5.


-0."8
-0."6
-0."4
-0."2
0"
0."2
0."4
0."6
E
Ω
Π
ADS10017
N
-0."6
-0."4
-0."2
0"
0."2
0."4
0."6
0."8


ADS10699
E
N
Ω
Π
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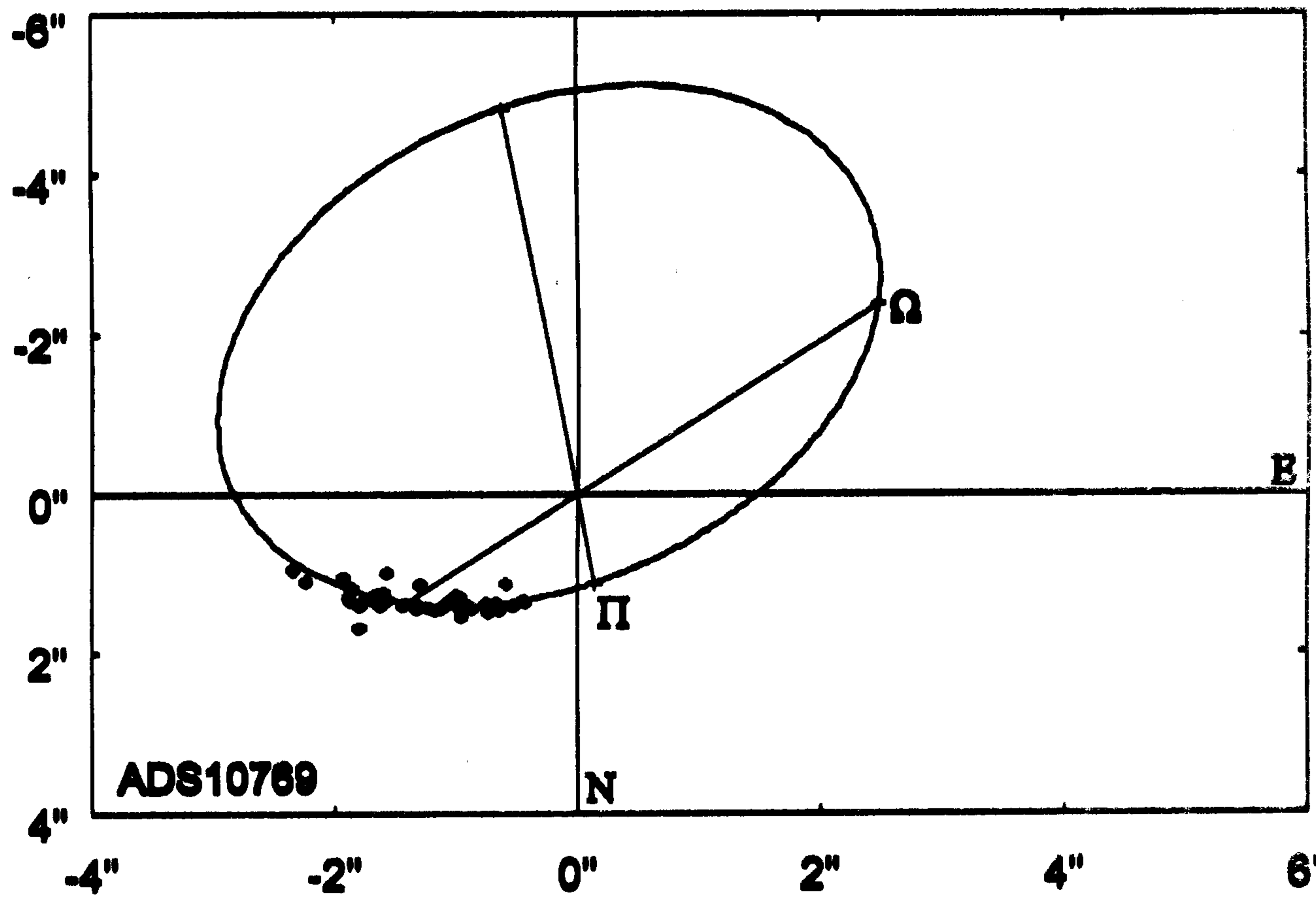
-1"
-1"
0"
0"
1"
1"
2"
2"

Fig. 7.


ADS10769
E
N
Ω
Π
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-2"
0"
2"
4"
-4"
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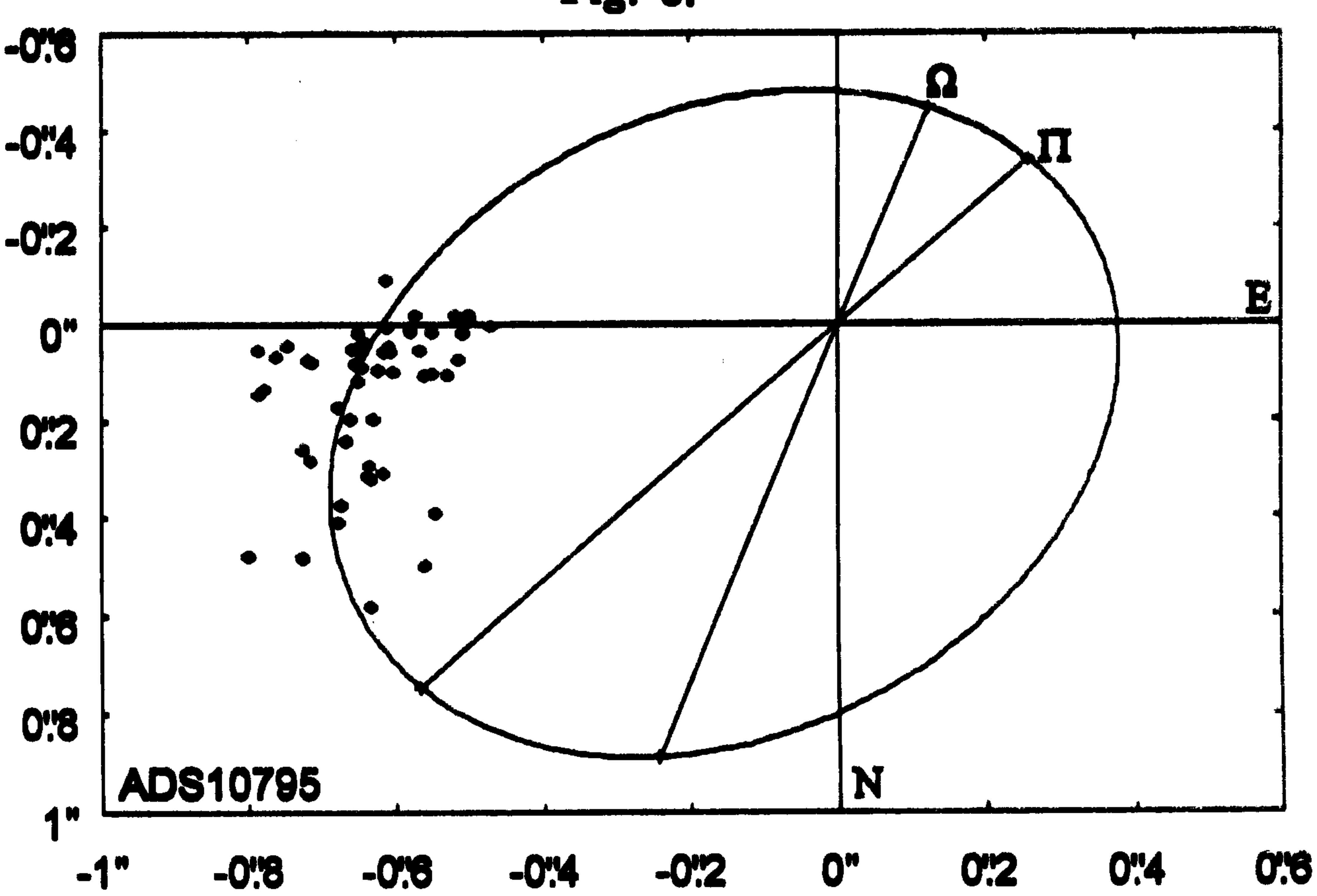
0"
2"
4"
6"

Fig. 8.


ADS10795
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N
Ω
Π
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0"

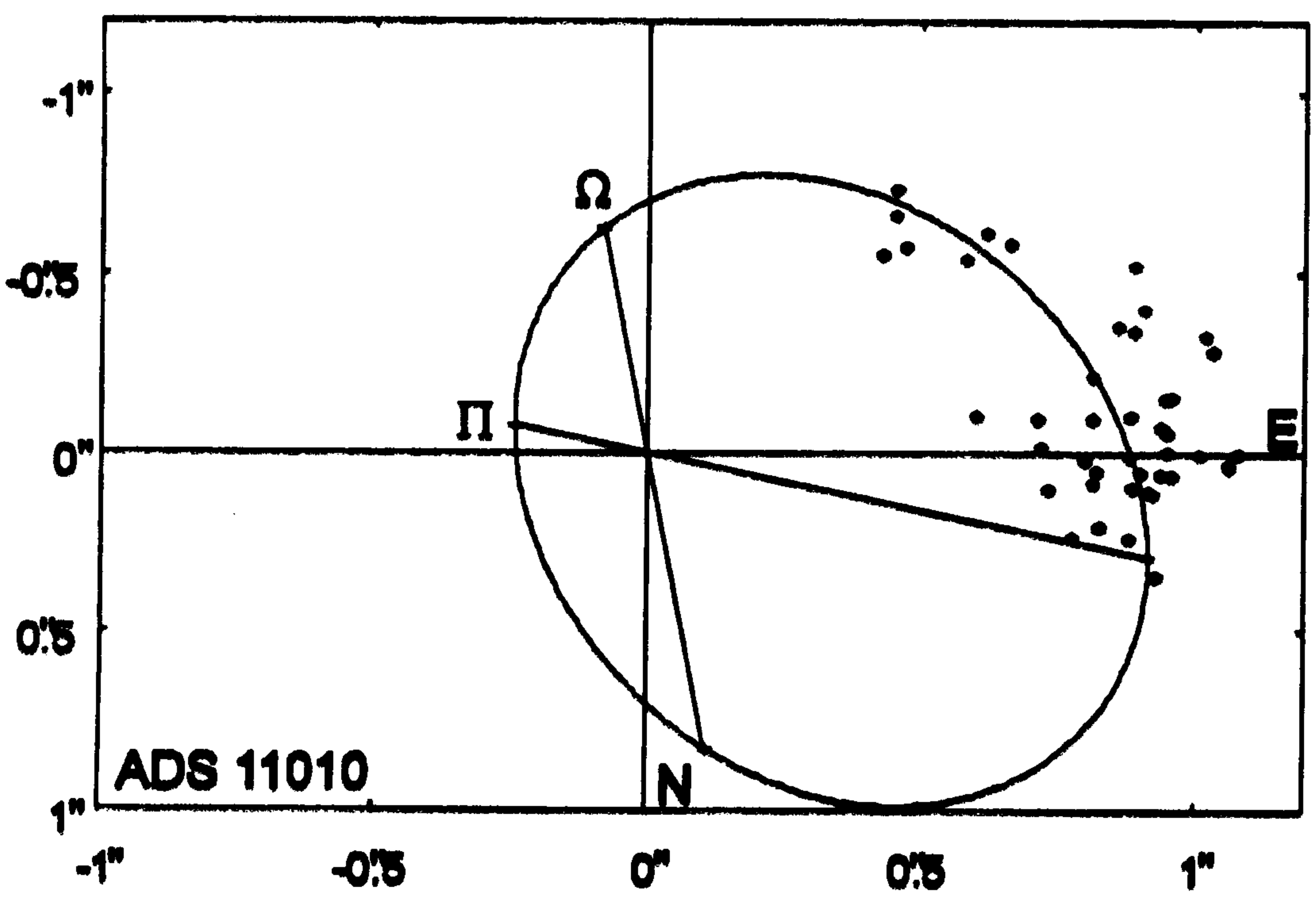

Fig. 10.

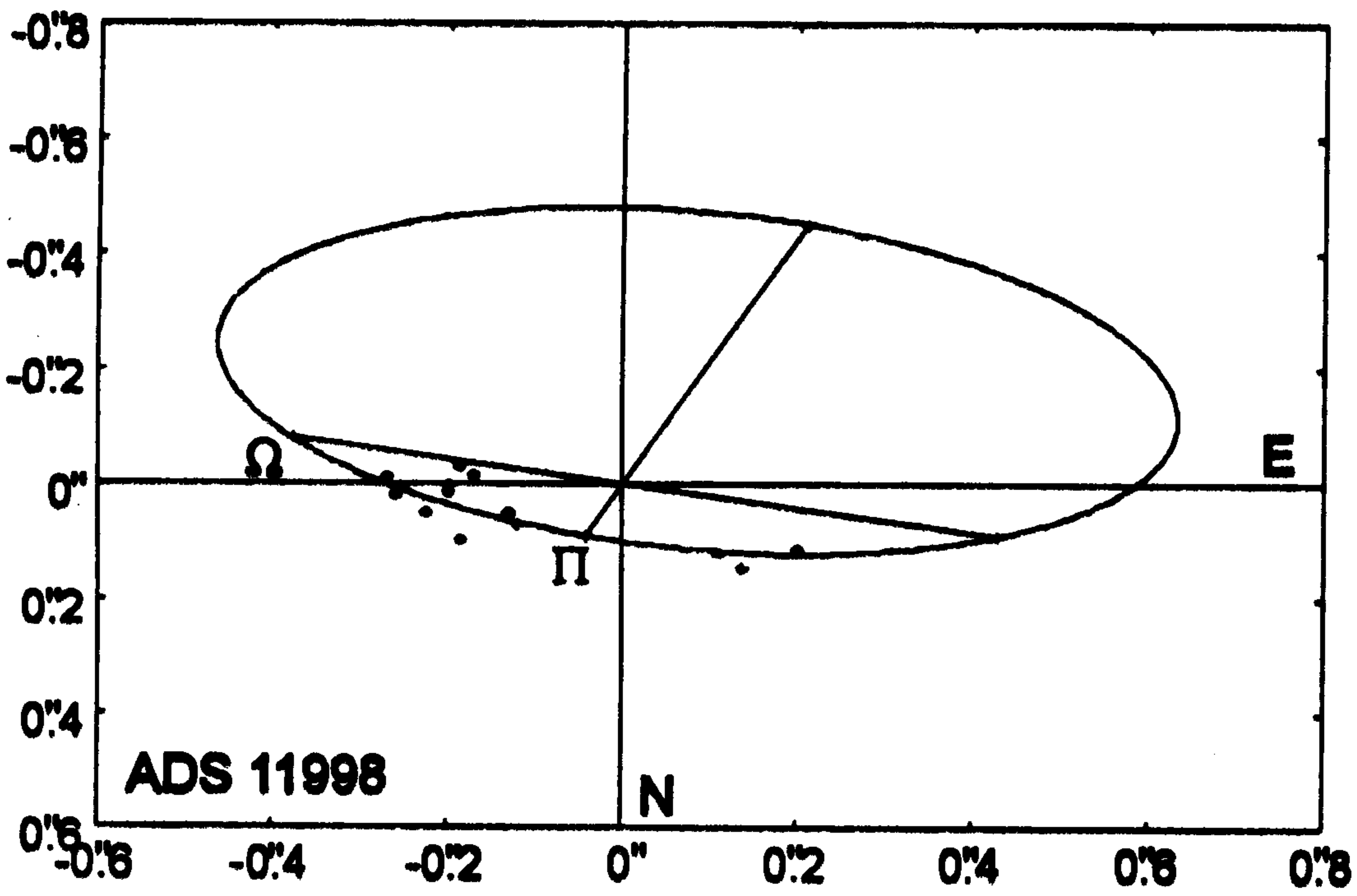

Fig. 11.

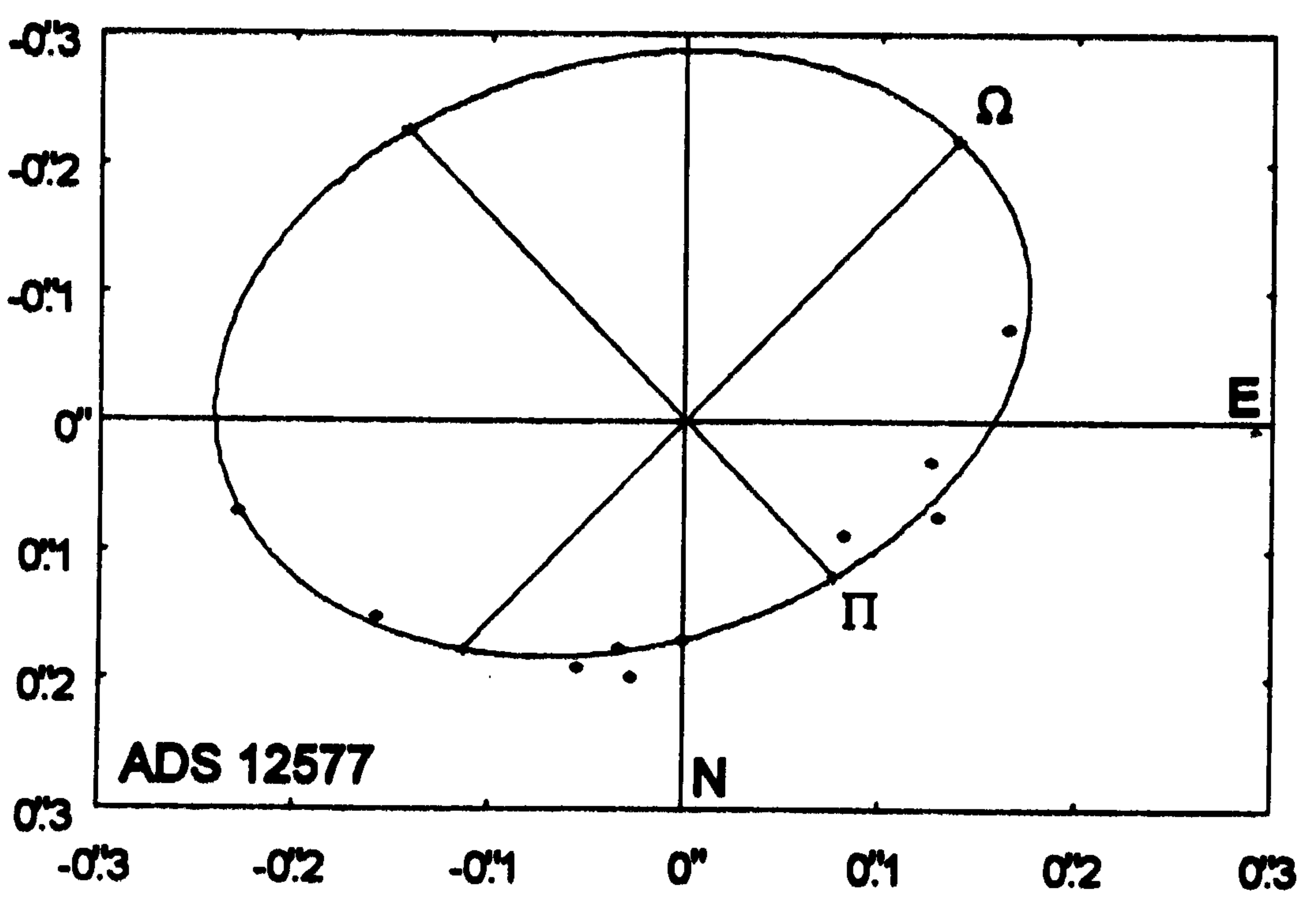

Fig. 12.

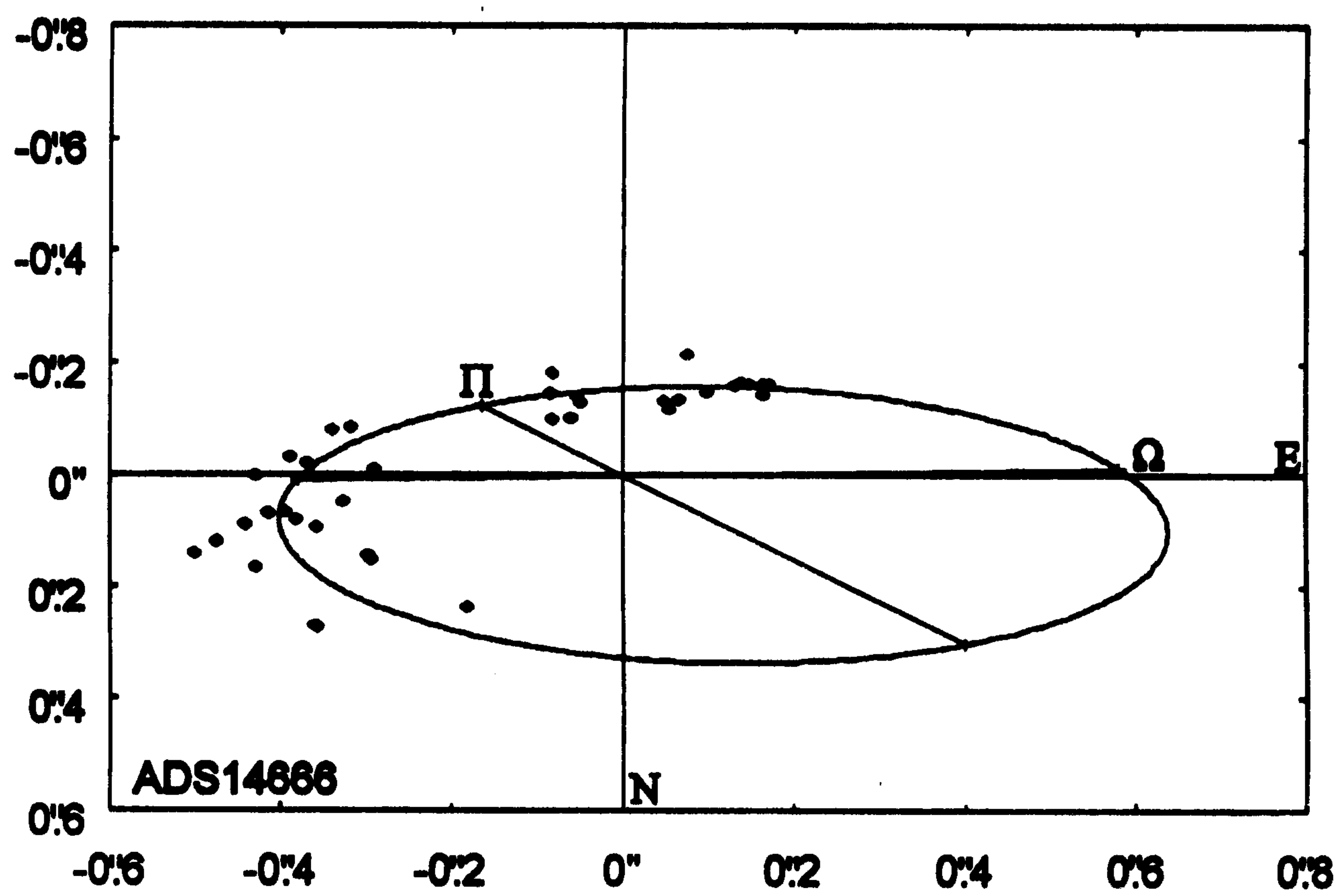

Fig. 13.

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ПУТАЊСКИ ЕЛЕМЕНТИ ТРИНАЕСТ ДВОЈНИХ СИСТЕМА

Г. М. Поповић и Р. Павловић

Астрономска опсерваторија, Волгина 7, 11050 Београд, Југославија

УДК 521.328
Претходно саопштење

Саопштавају се путањски елементи и одговарајуће астрофизичке величине следећих двојних система: ADS 1359 = β 870, ADS 2755AB = β 536, ADS 3390 = Σ 577, ADS 8128 = Σ 1527, ADS 9989 = A 2181, ADS 10017 = Hu 481, ADS 10699 = Σ 2199, ADS 10769 = Σ 2205, ADS 10795 = Σ 2215, ADS 11010 = β 1127, ADS 11998 = A 2992, ADS 12577 = Hu 951 и ADS 14666 = OΣ 527.