A Study of ADS 5983 (δ Geminorum)[1]

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ABSTRACT: Regular photographic observations of ADS 5983 (δ Gem) with the Pulkovo 26-in refractor have been made since 1972. The series of observations over the time interval 1972-1990 are considered. New orbital elements of the binary are obtained by the AMP–method. Some wave with a period about 5 years in the orbital motion of this star is found.

ADS 5983 (δ Gem) [R.A.=$7^h17^m.1$, Dec.=$+22° 05'$ (1950.0), $m_V(A)=3^m.5$, $m_V(B)=8^m.2$, Sp(A) = F2IV, Sp(B) = dK6] is an object of the Pulkovo program of visual double stars. Photographic observations of this star are carried out with 26-in refractor ($F = 10.4m, D = 65cm$). An objective grating is used which gives a magnitude difference of 5 magnitudes between the central image and the first order grating images. Plates of type ORWO, WO-1 are used.

A set of observations which consists of 80 plates with 1200 individual relative positions has been treated. The yearly values of relative distances ρ and positional angles θ, their mean errors δ_ρ and δ_θ, and the number of plates N are given in Table 1.

The mean value of δ_ρ for all 17 yearly places is equal to $\pm 0''.018$. This value is equal to $\pm 0''.014$ for 16 places without the observation of 1981.083 which has been used in the study with corresponding small weight for ρ. The mean value of δ_θ is $\pm 0°.10$.

According to Batten (1967), the bright component of the pair ADS 5983 is the spectroscopic binary HD 56986 with an unseen companion whose period of revolution is P=$6^y.13$. Taking into account the great value of the mass function f(m)=$3.8\mathcal{M}_\odot$, the hypothesis of the relativistic nature of this satellite has been proposed (Trimble & Thorne 1969). The mass of this satellite was estimated from 6 to $9\mathcal{M}_\odot$. But the astrometric study (Blinnicov & Ptitsyn 1971) did not confirm the existence of the unseen component with such a great mass. Then the presence of the satellite with $m=0.8\mathcal{M}_\odot$ and with P about 1 year was revealed by the next spectroscopic observations (Akhundova & Guseynov 1972).

The astrometric study of the Pulkovo observational series over the interval 1972-1984 (Shakht, 1988) showed the possibility of the presence of satellite with P=6 ± 1 year but with a small mass (about $0.2\mathcal{M}_\odot$). We have assumed in this case that the amplitude of the observational deviations from the orbital motion estimated as $0''.02\pm0''.01$ corresponds to the semi-major axis of the main star which is moving under the gravitational attraction of the invisible satellite.

At present some noticeable wave in the residuals in ρ coordinate has been found. The distribution of the residuals $\delta\rho$ following a five-year cycle shows the amplitude equal to $0''.020\pm0''.007$ m.e. We are planning to make a more detailed analysis of the residuals, but now we suppose that there is a possible influence

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[1]The authors of this paper were unable to attend the Colloquium — *eds.*

TABLE 1.   Observations of ADS 5983

Epoch	ρ	$\delta\rho$	$\theta_{2000.0}$	$\delta\theta$	N
1972.189	6$''$.208	0$''$.008	219°.63	0°.12	3
1973.118	6.211	0.029	219.84	0.11	6
1974.188	6.197	0.012	219.94	0.13	7
1975.218	6.155	0.009	220.54	0.17	4
1976.161	6.143	0.029	220.27	0.15	2
1977.178	6.163	0.004	220.68	0.08	4
1978.173	6.156	0.007	220.62	0.06	8
1979.008	6.148	0.020	221.07	0.06	4
1981.083	6.054	0.092	221.40	0.18	2
1982.137	6.075	0.022	221.46	0.04	6
1983.173	6.069	0.010	221.68	0.05	5
1984.153	6.038	0.008	221.84	0.10	8
1986.119	6.039	0.012	221.99	0.09	4
1987.244	5.961	0.019	222.42	0.15	7
1988.263	6.004	0.010	222.24	0.05	4
1989.142	6.003	0.012	222.54	0.10	3
1990.215	5.975	0.014	222.76	0.09	3

of one or two unseen satellites with small masses.

We have also tried to determine the elements of the orbit of ADS 5983 assuming that this orbit is an elliptical one. To determine them by the apparent motion parameters method (AMP–method), (Kisselev, this Colloquium) used to determine the orbit of a visual binary on the basis of short–arc observations, we adopted the values of $\pi_{tr} = 0''.061$ and relative velocity $\Delta V_r = -0.4 \mathrm{km\ s^{-1}}$ according to Woolley's catalogue (1970).

It was found that a value of the mass sum of the components equal to $2.5\mathcal{M}_\odot$, in accordance with the "mass–luminosity" relation, is the most satisfactory one for this orbit.

The orbital elements which were deduced on the basis of Pulkovo observations and the elements of Hopmann's (1959) orbit are given in Table 2.

TABLE 2.   Orbital elements for ADS 5983

	a	P	e	ω	i	Ω	T_n	M_{AB}
AMP	6$''$.03	622.0	0.75	63°.7	62°.3	353°.9	1644.8	$2.5\mathcal{M}_\odot$
Hopmann	6$''$.90	1200.0	0.11	57°.2	63°.3	18°.4	1437.0	$1.0\mathcal{M}_\odot$

The comparison with previous observations 1829–1923 shows that both our orbit and Hopmann's one are acceptable. However we had some difficulties in determining this orbit because of the wave in visual relative motion of this star, so we assume that our orbital elements are preliminary. We intend also to improve this orbit.

We would like to note that Pulkovo Observatory has accumulated some long–term observational series of stars with suspected unseen companions, which was done on the initiative of the Chief of Photographic Astrometry Department, A.N. Deutsch.

These object are the followings: 61 Cygni, ADS 7251, Lalande 21185, ADS 11632, ADS 48, AC +48° 1595/1589, and some others.

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