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The third body in the system UX Her

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Abstract. The paper presents new photoelectric observations of the eclipsing binary system UX Her. The data were used to derive 21 times of minima. The shape of the (O-C) curve indicates the presence of the third body in the system. In the case that the orbital period of the eclipsing pair is constant the following elements were obtained: $P_3 = 69\pm5$ years, $e_3 = 0.46$ and $f(m_3) = 0.0034$ M$_\odot$. The minimum mass of the third body was estimated as 0.3 M$_\odot$.

Key words: binaries – photometry – orbital period – multiple systems

1. Introduction

UX Her (BD +16°3311, HD 163175, HIP 87643, $V_{max} = 8.97$, sp. type A0V, Hipparcos parallax $\pi = 4.78\pm1.15$ mas) was discovered by Miss Cannon in 1908 (Pickering, 1909). She found its binary nature and supposed the Algol type with a period of 13.9 days. Later on Zinner (1914) confirmed the classification and estimated the length of the period of 1.54882 days. The light elements were improved by several authors: Kordylewski (1934), Ashbrook (1952), Kaho (1952) and Tsesevitch (1954). Gordon & Kron (1965) published the light-curve solution based on their own photoelectric observations. It was not, however, possible to find one set of elements to satisfy both minima and colors. They found that the secondary component does not fill its Roche lobe and it is an "undersized" subgiant according to Kopal's classification. Further solutions were found by Horák (1966) and by Cester et al. (1979).

The revised elements were published by Mardirossian et al. (1980). They described the secondary component as oversized and overluminous for its mass and temperature which favours an early K spectral type, in contrary to Gordon & Kron (1965) who gave spectral type G0. Mardirossian et al. (1980) confirmed that the secondary star (component) does not fill its inner critical surface associated with the derived photometric mass ratio.

Hall (1974) ascertained that there is no evidence that the subgroup of post-main-sequence mass-exchange remnants exists and in which the subgiants are smaller than their Roche-lobe. The binaries which are mass-exchange remnants are not detached. They only appear detached. The solutions of the radial velocity curve are based on its distorted shape. Thus the absolute dimensions are sensitive to uncertainties in the relative radius of the subgiant. UX Her falls into this group. It is possible that some, or all, subgiants do not fill their Roche-lobes exactly at least in some time-intervals. According to Giuricin & Mardirossian (1981) the system UX Her can be treated as a nonconservative case of the binary star evolution. Its initial orbital period was determined to be 1.7218 days (Chaubey, 1980).

Lázaro et al. (1997) obtained and analysed infrared photometry of the system. They found a semidetached configuration of UX Her: the secondary star being smaller than its Roche lobe mean radius by about 9 - 14%. Taking into account the physical parameters they found that the secondary star is located above the main sequence H-R diagram and it is overluminous for its mass and effective temperature, as it should be expected for a subgiant. The authors concluded that the secondary is an evolved low mass late-type star. They estimated the mass of the primary within the limits of 2.09 $M_\odot$ and 2.28 $M_\odot$ according to its spectral type.

Unfortunately, no modern solution, based on the Roche geometry, has been published.

The spectroscopic observations of UX Her undertaken by Sanford (1937) yielded the elements of the primary component: $K_1 = 50.5$ km.s^{-1}, $e = 0.08$. Later Lucy & Sweeney (1971) recomputed the spectroscopic orbit with a method suitable for low eccentricities. They determined $K_1 = 46.8$ km.s^{-1} and found much lower value of the eccentricity, $e = 0.03$. However, they believed, as in many cases, that this is a spurious eccentricity and it is a product of the observational errors. Spectral type of the primary component was estimated as A0V - A3V by Hill et al. (1975).

2. Observations

We incorporated UX Her into the observational program for the following reasons: the change of the period has not been studied since 1982, the interpretation of the (O-C) curve is not unambiguous and there is no consensus on the classification of the system - "d" or "sd" type. The finding of the answer of this question could lead to a better understanding of the processes responsible for the period changes.

The photoelectric observations of UX Her have been obtained at the Skalnaté Pleso (SP) Observatory of the Astronomical Institute of the Slovak Academy of Sciences and Mt. Suhora Observatory (MS) of Cracow Pedagogical University. SAO 103188 (= BD+16°3308) served as a principal comparison star at both observatories. The stability of the comparison star was checked in part of the nights with respect to SAO 103168 (BD+16°3300) and SAO 103211 (BD+17°3377).

The observations were carried out from 1995 to 2003. As a result 21 minima were obtained. They are included in Table 1.

Due to quite a long orbital period of the system we still have not covered the whole orbital cycle by observations. Multicolour $UBVRI$ CCD observations with a new 0.5m telescope at Stará Lesná Observatory (see Pribulla & Chochol, 2003) are planned in spring 2004. Such observations are necessary for a reliable light-curve solution.

3. Period changes

Gordon & Kron (1965) mentioned the instability of the orbital period first time. Further, the changes of the period were studied by Kreiner (1971), Mallama (1980) and Rafert (1982). The last author proposed the approximation by a downward parabola or periodic representation.

In the last two decades the number of photoelectric and CCD minima grew up and was possible to make a new more accurate study of the period changes. Table 1 contains all individual minima found in the literature till 2003. The successive columns contain the time of minimum, type of observations and literature. The type of observation is denoted as follows: v - visual, p - mid-exposure of a patrol plate on which the variable appeared faint, pg - photographic minima obtained from a series of observations, cc - CCD, e - photoelectric without filter or with a filter not given - eU,eB,eV,eR - photoelectric observation in U, B, V and R filter, respectively. The character "s" in column 1 denotes the secondary minimum. Normal ("n") and uncertain minima (":") are denoted in the column "Type".

The (O-C) curve of UX Her according to the elements:

$$\text{Min I} = 2\,439\,672.3760 + 1.5488530 \times E \tag{1}$$

is shown in Fig. 1.

For further investigation we excluded secondary minima, visual minima with a very large deviation from the (O-C) curve, and "p" minima derived from sky patrol plates. The total number of minima not taken into account was 30. Due to large scatter of the visual minima we computed normal minima for each observational season. If available we used published visual normal minima. For some seasons only one minimum was available.

The minima used in the computation are collected in Table 2. The successive columns contain:

- time of minimum
- type of the observation: v - visual, pv - photovisual, pg - photographic, e - photoelectric (weighted average if minimum in several filters available)
- weight of the minimum

Table 1. List of all available minima times of UX Her

JD_{hel} 2400000+	Type	Ref.	JD_{hel} 2400000+	Type	Ref.	JD_{hel} 2400000+	Type	Ref.
19875.665s	pgn	1	28023.464	v	10	37880.364	v	27
19876.466	v	2	28023.4668	vn	10	37883.491	v	23
22882.800	v	3	28026.556	v	10	37956.272	p	21
23553.457	v	4	28037.412	v	10	38230.411	v	23
23553.469	v	3	28054.446	v	10	38532.445	v	23
23635.551	v	3	28068.383	v	11	38535.518	v	23
23666.523	v	3	28373.516	v	11	38642.394	v	23
23934.461	v	3	28376.608	v	11	38975.404	v	23
24072.3197	v	3	28387.461	v	11	38978.509	v	23
24117.237	v	3	28446.3119	vn	11	38989.349	v	23
24151.314	v	3	28446.313	v	11	39325.458	v	28
24357.320	vn	5	28477.289	v	11	39356.419	v	25
24374.356	v:	4	28689.485	v	11	39591.844	v	29
24481.212	v	3	28703.418	v	12	39650.673	v	30
24600.487	v	6	28720.4571	v	6	39667.716	v	30
24617.536	v	3	28751.429	v	11	39701.807	v	31
24724.397	v	3	28779.312	v	11	39983.707	v	31
25362.534	v	3	28782.4141	vn	11	40022.4201	e	32
25373.365	v	3	28782.420	v	11	40039.4564	e:	32
25376.458	v	3	28827.331	v	11	40039.459	v	33
25483.347	v	4	28838.170	v	11	40039.460	v	34
25497.281	v	3	28858.300	v	11	40053.3974	e	32
25500.378	v	3	29987.418	pgn	13	40107.606	v	31
25774.530	vn	3	30904.348	vn	5	40344.575	v	34
25808.583	v	3	30904.348	v	2	40344.577	v	34
25833.381	vn	3	32473.321	v	4	40358.519	v	34
25878.305	v	3	33128.488	v	4	40403.431	v	34
25881.382	v	3	33430.507	v	14	40403.4372	e	32
25904.626	v	3	33433.605	v	14	40417.378	v	34
26152.450	v	4	33483.175	pg	15	40431.3161	e:	32
26485.454	v:	4	33856.451	v	16	40465.368	v	34
26945.462	vn	7	34209.614	v	17	40482.420	v	34
27261.431	pv	8	34531.747	e	18	40541.277	v	34
27580.496	v	9	34884.888	pg	12	40725.591	v	34
27608.369	v	9	35290.6844	e	19	40753.472	v	34
27611.469	v	9	35332.510	v	20	40781.3576	e	35
27625.404	v	9	36074.419	p	21	40798.389	v	34
27628.5077	vn	9	37073.425	v	22	40798.404	v	34
27628.508	v	9	37135.379	v	22	40801.497	v	34
27628.510	v	4	37169.458	v	23	40835.565	v	34
27639.363	v	9	37172.554	v	23	41041.562	v	34
27642.438	v	9	37197.327	v	24	41055.507	v	34
27656.389	v	9	37197.331	v	25	41097.321	e:	36
27659.483	v	9	37197.332	v	22	41106.618	v	34
27933.635	v	10	37211.274	v	22	41148.430	v	34
27944.482	v	10	37378.546	v	26	41148.439	v	34
27961.508	v	10	37488.510	v	23	41154.629	v	34
27989.398	v	10	37547.378	v	24	41165.460	v	34
28003.325	v	10	37818.427	v:	26	41165.466	v	34

Table 1. (continued)

JD_{hel} 2400000+	Type	Ref.	JD_{hel} 2400000+	Type	Ref.	JD_{hel} 2400000+	Type	Ref.
41168.575	v	34	43747.401	v	43	48107.4213	eB	34
41543.3884	e	37	43764.440	v	34	48107.424	v	52
41543.397	vn	38	43792.325	v	34	48161.634	v	42
41560.425	v	34	43806.259	v	34	48409.454	v	53
41574.369	v	34	44001.398	v	34	48426.480	v	44
41803.593	v	34	44010.696	v	42	48426.4832	ccn	54
41814.435	v	34	44083.519	v	44	48443.518	v	44
41814.442	v	39	44125.321	v	34	48452.808	v	42
41831.479	pg	40	44156.292	v	34	48796.663	v	42
41845.416	v	34	44295.686	v	34	48813.700	v	42
41907.367	v	34	44461.404	v	34	48852.419	v	34
41938.343	v	34	44470.713	v	42	49202.458	cc	34
41938.348	v	34	44492.3899	e	45	49216.398	v	44
41938.350	v	34	44732.460	v	44	49487.431	v	44
41983.246	v	34	44746.4010	e	46	49504.4901	eB	34
42212.487	v	34	44786.668	v	42	49535.458	v	44
42257.394	v	34	44803.700	v	42	49535.472	v	55
42288.383	v	34	45085.604	v	34	49566.426	v	44
42291.479	v	34	45122.768	v	42	49569.519	v	44
42302.319	v	34	45141.358	v	34	49569.538	v	44
42455.662	v	34	45141.359	v	34	49843.695	v	42
42528.462	v	34	45158.397	v	34	49899.4439	v	44
42576.465	v	34	45449.582	v	34	49899.4464	eV	56
42596.580	v	34	45539.413	v	47	49899.4474	v	44
42607.445	v	34	45556.454	v	44	49899.4475	cc	63
42621.383	v	34	45881.716	v	42	49899.4481	v	44
42621.391	v	34	45889.456	v	34	49899.4509	v	44
42638.423	v	34	45889.460	v	48	49930.4221	v	44
42652.3636	e	41	45898.751	v	42	49930.4228	v	44
42669.418	v	34	45906.503	v	49	49930.4235	v	44
42833.575	v	34	45934.369	v	34	49930.4270	v	44
42878.486	v	34	45934.378	v	44	49930.4284	v	44
42923.409	v	34	45943.664	v	42	49930.4298	v	44
42926.510	v	34	46253.436	v	44	49930.4312	v	44
42935.798	v	42	46270.470	v	44	49930.4332	v	44
42949.743	v	42	46324.681	v	42	49930.4395	v	44
42971.421	v	34	46360.302	v	49	50006.3178	eV	56
42971.425	v	34	46679.375	v	44	50249.4876	eU	56
42983.807	v	42	46679.396	v	44	50249.4876	eV	56
42983.810	v	42	46964.365	v	50	50249.4877	eB	56
42983.824	v	42	46981.403	v	34	50311.4429	v	44
43016.346	v	34	46998.439	v	44	50579.3805	v	44
43047.313	v	34	46998.443	v	50	50627.4058	eB	57
43061.252	v	34	47029.418	v	44	50644.4471	v	44
43109.272	v	34	47365.519	vn	34	50675.4203	eB	57
43330.746	v	42	47712.452	v	44	50675.4227	eV	57
43330.755	v	42	47729.496	v	51	50720.3377	e	64
43397.362	v	34	47757.384	v	34	50720.3396	eV	56
43702.494	v	34	48093.479	v	44	50720.3398	eB	56

Table 1. (continued)

JD_{hel} 2400000+	Type	Ref.	JD_{hel} 2400000+	Type	Ref.	JD_{hel} 2400000+	Type	Ref.
50720.3404	eU	56	51015.4005s	eV	56	51798.332	v	61
50943.3752	eR	58	51053.344	v	59	52055.454	v	61
50943.3755	eV	58	51375.4887	v	44	52055.4545	eV	56
50970.4870s	eR	58	51375.5088	v	44	52402.395	v	62
50970.4881s	eV	58	51674.4346	e	60	52481.3929	e	56
51015.3930s	eV	56	51753.4256	eV	56			

References: 1 - Prager (1936), 2 - Tsesevitch (1954), 3 - Kordylewski (1934), 4 - Kreiner (2001), 5 - Tsesevitch (1944), 6 - Gadomski (1937), 7 - Warmbier (1933), 8 - Himpel (1937), 9 - Lause (1935), 10 - Lause (1936), 11 - Lause (1938), 12 - Koch & Koch (1962), 13 - Gaposchkin (1953), 14 - Pohl (1950), 15 - Kaho (1952), 16 - Busch (1956), 17 - Ashbrook (1952), 18 - Fitch (1964), 19 - Gordon & Kron (1965), 20 - Rudolph (1959), 21 - Huth (1963), 22 - Todoran (1963), 23 - Obůrka (1967), 24 - Flin & Slowik (1967), 25 - Czerlunczakiewicz & Flin (1968), 26 - Dueball & Lehmann (1964), 27 - Pohl & Kizilirmak (1964), 28 - Kizilirmak & Pohl (1969), 29 - Robinson (1967), 30 - Robinson & Ashbrook (1968), 31 - Baldwin (1974), 32 - Pohl & Kizilirmak (1970), 33 - Blasberg (1969), 34 - BBSAG Bull. 5–46, 35 - Kizilirmak & Pohl (1971), 36 - Pohl & Kizilirmak (1972), 37 - Baldinelli et al. - (1973), 38 - Flin (1972), 39 - Braune et al. - (1977), 40 - Ahnert (1973), 41 - Brancewicz & Kreiner (1976), 42 - Baldwin & Samolyk (1996), 43 - Braune et al - (1981), 44 - Brno observers 45 - BBSAG Bull. 50, 46 - BBSAG Bull. 55, 47 - BAV Mitt. 38, 48 - BAV Mitt. 39, 49 - BAV Mitt. 43, 50 - Isles (1990), 51 - BAV Mitt. 56, 52 - BAV Mitt. 59, 53 - BAV Mitt. 60, 54 - Hipparcos (present paper), 55 - BAV Mitt. 79, 56 - This paper, 57 - Ogloza (1997), 58 - Zola (1998), 59 - BAV Mitt. 122, 60 - Marchev (2002), 61 - BAV Mitt. 143, 62 - BAV Mitt. 154, 63 - Agerer & Hübscher (1996), 64 - Agerer & Hübscher (1999)

– (O-C) values according to the ephemeris (1)

– reference

In our computations we assigned the weights arbitrarily: $w = 20$ for pe minima, (the lower accuracy minima (:) have weights 10), w=10 for CCD minima. The normal visual minima obtained weights 1 - 5 according to the number of individual minima taken into the computation. Some individual visual minima have weight "1". Normal ("n") and uncertain minima (":") are denoted in the column "Type".

Since the (O-C) diagram seems to exhibit a periodical behaviour we assume that the period changes are apparent due to a gravitational influence of a third body in the system. In order to obtain the orbital parameters we used the same method as described in the paper of Chochol et al. (1998). The (O-C) values are expressed by the formula:

$$\begin{aligned} \text{Min I } &= JD_0 + PE + QE^2 \\ &+ \tfrac{a_{12}.\sin i}{c}\left[\tfrac{1-e^2}{1+e\cos\nu}\sin(\nu+\omega) + e\sin\omega\right], \end{aligned} \tag{2}$$

Table 2. Final minima list used for the calculation of the LITE orbit.

JD_{hel} 2400000+	Type	w	(O-C)	Ref.	JD_{hel} 2400000+	Type	w	(O-C)	Ref.
19876.466	v	1	-.0198	1	41870.1971	vn	4	-.0013	3
22882.800	v	1	-.0095	2	42269.7929	vn	3	-.0096	3
23601.4756	vn	3	-.0017	3	42578.0190	vn	4	-.0052	3
24069.2203	vn	3	-.0106	3	42652.3636	e	20	-.0056	21
24403.7794	vn	2	-.0037	3	42971.4230	vn	5	-.0099	3
24646.9571	vn	2	.0041	3	43352.4379	vn	2	-.0128	3
25432.2273	vn	3	.0058	3	43772.1840	vn	2	-.0059	3
25847.3234	vn	3	.0093	3	44117.5686	vn	3	-.0155	3
26152.450	v	1	.0118	3	44492.3899	e	20	-.0166	22
26485.454	v:	1	.0124	3	44662.7638	vn	2	-.0166	3
26945.462	vn	2	.0111	4	44746.4010	e	20	-.0174	23
27261.431	pv	1	.0141	5	45130.5167	vn	3	-.0173	3
27628.5077	vn	3	.0126	6	45514.6333	vn	2	-.0162	3
28023.4668	vn	3	.0142	7	45909.5935	vn	4	-.0135	3
28446.3119	vn	3	.0224	8	46377.3432	vn	3	-.0174	3
28720.4571	v	1	.0207	9	47055.7481	vn	3	-.0102	3
28782.4141	vn	3	.0235	8	47927.7525	vn	3	-.0100	3
29987.418	pgn	1	.0198	10	48107.4213	e	20	-.0081	24
30904.348	vn	0	.0288	11	48426.4832	ccn	10	-.0100	3*
32473.321	v	1	.0137	3	48432.6777	vn	3	-.0109	3
33128.488	v	1	.0159	3	48920.5693	vn	3	-.0080	3
33856.451	v	1	.0180	12	49202.458	cc	10	-.0105	25
34531.747	e	20	.0141	13	49504.4901	e	10	-.0047	26
34884.888	pg	1	.0166	14	49845.2389	vn	5	-.0036	3
35290.6844	e	20	.0135	15	49899.4464	e	20	-.0060	3
38230.411	v	1	.0171	16	49899.4475	cc	10	-.0049	27
38981.6038	vn	2	.0162	3	50006.3178	e	20	-.0054	3
39494.2693	vn	3	.0114	3	50249.4876	e	20	-.0055	3
40022.4201	e	20	.0033	17	50478.7194	vn	2	-.0040	3
40039.4564	e:	10	.0022	17	50627.4058	e	20	-.0075	28
40042.5581	vn	3	.0062	3	50675.4215	e	20	-.0062	28
40053.3974	e	20	.0036	17	50720.3377	e	20	-.0067	29
40403.4372	e	20	.0026	17	50720.3399	e	20	-.0045	3
40412.7256	vn	4	-.0021	3	50943.3754	e	20	-.0039	30
40431.3161	e:	10	.0021	17	51214.4264	vn	2	-.0022	3
40781.3576	e	20	.0029	18	51674.4346	e	20	-.0033	31
40786.0026	vn	3	.0013	3	51753.4256	e	20	-.0038	3
41097.321	e:	10	.0002	19	52055.454	v	1	-.0017	32
41128.2983	vn	4	.0005	3	52055.4545	e	20	-.0012	3
41543.3884	e	20	-.0020	20	52402.395	v	1	-.0038	33
41558.8808	vn	2	.0018	3	52481.3929	e	20	.0026	3

References: 1 - Tsesevich (1954), 2 - Kordylewski (1934), 3 - this paper, Warmbier (1933), 5 - Himpel (1937), 6 - Lause (1935), 7 - Lause (1936), 8 - Lause (1938), 9 - Gadomski J. (1937), 10 - Gaposchkin (1953), 11 - Tsesevitch (1944), 12 - Busch (1956), 13 - Fitch (1964), 14 - Koch & Koch (1962), 15 - Gordon & Kron (1965), 16 - Obůrka (1967), 17 - Pohl & Kizilirmak (1970), 18 - Kizilirmak & Pohl (1971), 19 - Pohl & Kizilirmak (1972), 20 - Baldinelli et al. (1973), 21 - Brancewicz & Kreiner (1976), 22 - BBSAG Bull. 50, 23 - BBSAG Bull. 55, 24 - BBSAG Bull. 96, 25 - BBSAG Bull. 105, 26 - BBSAG Bull. 107, 27 - Agerer & Hübscher (1996), 28 - Ogloza (2003), 29 - Agerer & Hübscher (1999), 30 - Zola (2003), 31 - Marchev (2003), 32 - BAV Mitt. 143, 33 - BAV Mitt. 154

where $a_{12}\sin\ i$, e, ω are orbital elements, ν is the true anomaly of the binary orbit around the centre of the mass of the triple system, $JD_0+PE+QE^2$ is the quadratic ephemeris of the minima in an eclipsing binary and c is the velocity of light. In the computation we assumed two cases (i) orbital period of the eclipsing pair is constant ($Q=0$ in the last relation) (ii) there is a continuous change of the period.

To obtain the optimal fit and corresponding elements of the light-time orbit including errors, we have used the damped differential corrections method. In case that the orbital period of the eclipsing pair is constant we got $a_{12}\sin i =$ 2.43±0.05 AU and optimal linear ephemeris:

$$\begin{array}{rll} \text{Min I} = 2\,439\,672.3755 & + \; 1.5488524 & \times \; E \\ \pm 9 & \qquad \pm 3 & \end{array} \tag{3}$$

The results of computation for both cases are given in Table 3. The corresponding fit is shown in Fig. 2. Although the fit explains the (O-C) data quite well, the last two minima deviate much (Fig. 2). The assumption of the continuous period change explains the early data much better.

Since the assignment of the weights of different types of minima is rather arbitrary we tried to estimate the weights more reliably. Number of the photographic, plate and CCD minima is rather low so their weights could not be estimated independently. Fitting the (O-C) diagram by ordinary polynomials (with respect to ephemeris (1)) the following standard deviations of photoelectric and visual minima were determined σ_{pe} = 0.0008 - 0.0018 (depending on the degree and time interval of the data), σ_v = 0.008. This corresponds to the relative weight of the individual observation $(\sigma_{pe}/\sigma_v)^2$ = 19.75 - 100. The lower estimate is very close to the original weight estimate (w_{pe} = 20). The higher estimate (determined from the first part of the pe dataset) gives a much higher weight to the photoelectric minima. For w_{pe} = 100 (for all pe minima) we tried to fit all minima in Tab. 2. This resulted in somewhat different parameters: in case that $Q = 0$ (linear ephemeris of the eclipsing pair assumed) P_3 = 23750±1770 days, e_3 = 0.60(7), a_{12} = 2.26(13), $f(m_3)$ = 0.0027(6); in case where Q was not fixed the differential corrections did not converge (probably due to a lack of pe minima in the first part of the (O-C) diagram). Since the more properly estimated weights did not change the character of the fit and parameters substantially, we regard the original solution as more appropriate. Moreover, assigning too high weights to the pe minima leads to omission of the old visual and photographic minima which makes the estimate of the orbital period quite unsure.

4. Discussion and conclusion

As the primary component seems to be a normal A5V star, and the secondary an evolved low-mass late-type star, both below their Roche lobes, the existence

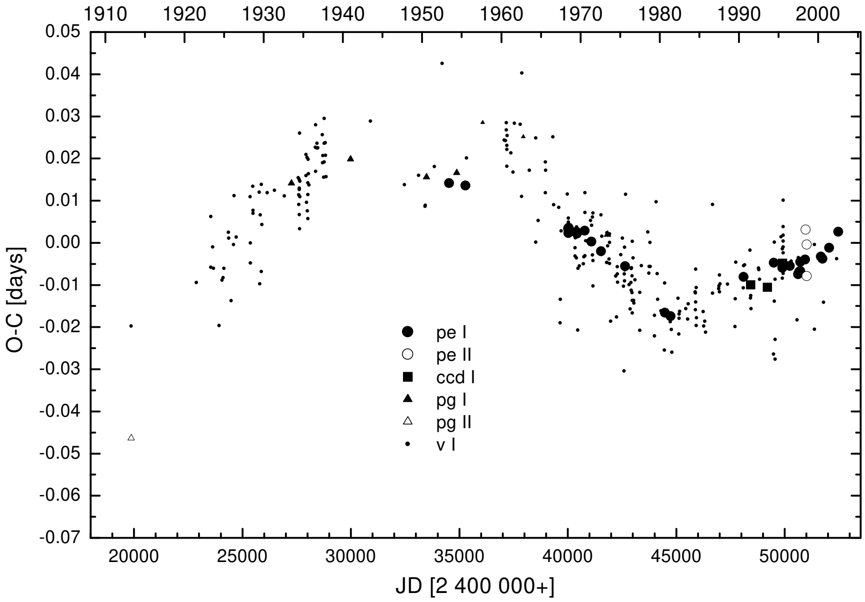

Figure 1. (O-C) diagram for all available minima times of UX Her according to ephemeris (1)

of the Roche lobe overflow is improbable at least at present time (Lázaro et al., 1997). Therefore we were looking for another mechanism of the (O-C) curve modulation.

Assuming that the orbit of the third component is coplanar and accepting masses $m_1 + m_2 = 2.83$ M$_\odot$ (Lázaro et al., 1997), the mass of the third body is $m_3 = 0.315\ M_\odot$ (for the case of a constant orbital period of the eclipsing pair). If the third component is a main-sequence star it should be of M3-4 spectral type. According to Lang (1992) the third component is nearly 9 magnitudes fainter in the visual passband. Hence, its spectroscopic and/or photometric detection would be very difficult. Assuming the Hipparcos parallax $\pi = 4.78$ mas, the maximum angular separation should be about $\approx$0.15". The semi-amplitude of the radial-velocity changes is about 1.2 km.s^{-1}. There is only one set of spectroscopic observations of the system (Sanford, 1937). Therefore, it is impossible to ascertain the existence of a possible third body from the variations of the systemic velocity.

Although the third body has not been directly detected yet, one can see a fairly good agreement between the theoretical and observational (O-C) curve. The presence of the third body in the system of UX Her seems to be a main reason for period changes.

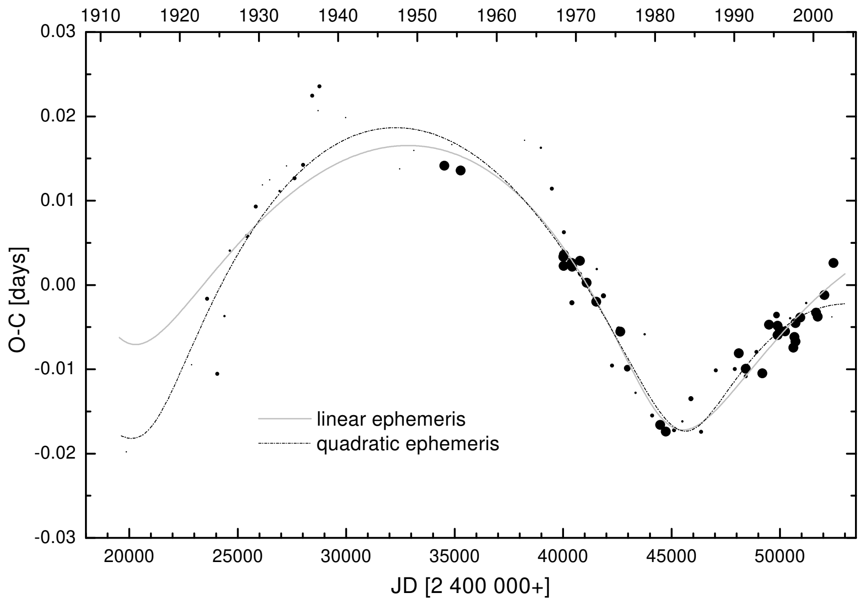

Figure 2. Theoretical 3rd-body fits to the mean minima times (Table 2) assuming linear (solid line) and quadratic (dashed line) ephemeris of the eclipsing pair. The size of the symbols is scaled proportionally to the weights

Table 3. The light-time effect solution and corresponding ephemeris of the binary system

Element		Linear eph.	Quadratic eph.
P_3	[days]	25200(1700)	24900(1000)
e_3		0.46(7)	0.50(7)
ω_3	[rad]	4.4(2)	4.9(2)
T_0	[JD]	2 419 500(2 100)	2 420 900(1 300)
a_{12}sin i	[AU]	2.52(19)	2.56(14)
$f(m_3)$	[$M_\odot$]	0.0034(9)	0.0036(7)
JD_0	[JD]	2 439 672.3755(9)	2 439 672.3782(11)
P_{binary}	[days]	1.5488524(3)	1.54885211(16)
Q	[days]	0.0	-1.08(27) 10^{-10}
$\sum$(O-C)^2	[days^2]	0.003269	0.002648

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