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ON THE COMPONENT MASSES OF VISUAL BINARIES

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SUMMARY: In the Sixth Catalog of Orbits of Visual Binary Stars we found those belonging to the Main Sequence to form a sample containing 432 visual binaries. Their total masses were obtained dynamically, i.e. they were calculated using the orbital elements and the new Hipparcos parallaxes. For the same pairs the total mass was also found astrophysically - by applying the mass-luminosity relation. The apparent magnitudes of the components were found in two different ways: by deriving them from total magnitudes and magnitude differences, and by taking their values directly from a catalogue. The results for these two approaches show no essential discrepancy. The values of total masses obtained dynamically have a large dispersion involving even completely unrealistic values. This is a clear indication that the input data are not sufficiently reliable. Nevertheless, in a large number of cases the agreement between total masses obtained by us in two different ways is quite satisfactory indicating that i) for many visual binaries, as a rule not too distant and with high-quality orbital elements, the dynamical total masses can be reliable; ii) the mass-luminosity relation yields quite satisfactory estimates for the component masses when they belong to the Main Sequence and iii) a correlation between the relative parallax error and orbit grade exists.

Key words. binaries: visual – Stars: fundamental parameters

1. INTRODUCTION

As a result of publishing the Hipparcos Catalogue (ESA 1997) trigonometric parallaxes became available for a large number (about 100 000) of stars, including visual binaries. In their case, of course if we have orbital elements, accurate trigonometric parallaxes are important because one can then calculate the total masses via Kepler's third law (e. g. Martin and Mignard 1998, Martin et al. 1998, Söderhjelm 1999, Balega et al. 2002, 2004, 2005).

The database for the orbital elements is the Sixth Catalog of Orbits of Visual Binary Stars (Hartkopf and Mason 2009) where the data concerning 2024 orbits of 1888 double or multiple stars are given. All orbits are graded on a 1-5 scale (1 =definitive, 2 = good, 3 = reliable, 4 = preliminary and 5 = indeterminate). The best grade (1) characterizes a very low fraction (about 3% only). Many orbits were determined from low-precision measurements or from those covering a short orbital arc. Consequently, such orbits have worse grades and their improvement is necessary.

Besides, in the case of many binaries a large body of photometric and spectroscopic data, updated regularly, is also available: apparent magnitudes of components m_A and m_B, as well as spectral types (Sp), can be found in the Washington Double Star Catalog, WDS, (Mason et al. 2009). There are alternative sources of the photometric data: total apparent magnitudes (Johnson magnitude m_t) can be found in Hipparcos; they should be combined with magnitude differences Δm, contained most completely in the Second Photometric Magnitude Difference Catalog, SPMDC, which was till recently available in the Washington database. This catalogue is now superseded by the new Third Photometric Magnitude Difference Catalog, TPMDC[1]. For many stars (about one third) of our sample in TPMDC the magnitude difference is not available. For this reason our source of the magnitude difference was SPMDC. It is very well known that apparent magnitudes combined with distances enable us to estimate the individual masses of binary components. Therefore, it is also important that the photometric data are accurate enough.

Among the input data, the distances certainly occupy an important place since with accurate distances one directly calculates the absolute magnitudes and true semimajor axes rather than estimating them on the basis of the luminosity class, spectral type (if available), and masses expected on this basis. More accurate orbital elements followed by more accurate parallaxes (which will be available after GAIA astrometric mission) will contribute to calculate the total masses with an error much smaller than the current ones.

The intention of the present authors is to examine the data mentioned above within a sample of binaries more closely. The aim of this examination is to reach a better insight into the quality and reliability of these data. This may be useful in identifying those binaries for which some of the given data require a substantial improvement.

It is then of interest to compare the masses determined in such a way (*astrophysically*) to the masses of binaries determined via Kepler's third law (*dynamically*).

A preliminary version of this study was presented during IAU Symposium 240 in Prague within the framework of the IAU General Assembly in August 2006 (Ninković and Cvetković 2007).

Unlike the preliminary version where we used the old Hipparcos parallaxes (ESA 1997), here we use the new Hipparcos parallaxes (van Leeuwen 2007) obtained in the framework of a new reduction of the Hipparcos astrometric data (van Leeuwen and Fantino 2005), and new orbital elements announced in the meantime. It should be expected that improved parallaxes will contribute, on the one hand, to obtaining more reliable masses of binaries from the orbital elements and, on the other hand, to estimating the reliability of the orbital elements themselves.

2. PROCEDURE

In the Sixth Catalog of Orbits of Visual Binary Stars we find 432 pairs which, according to the data given in WDS, belong to the Main Sequence (MS): for 67 of them the spectral types for both components followed by the designation V (MS) are given, whereas in the case of the remaining 365 pairs only one spectral type, followed by the same designation, is given. This may be the spectral type of one component, or the integrated one. Therefore, the whole sample is divided into two subsamples: one containing 67 binaries with both Sp given and the other containing 365 binaries where this is not the case. The two subsamples will be examined separately.

Having the orbital elements at our disposal, in particular the period P and the semimajor axis a, and the new trigonometric parallax (van Leeuwen 2007), we calculate the dynamical total masses applying Kepler's third law for the whole sample of 432 visual binaries. The input data used in this calculation are presented in Table 1; the two subsamples are separated by a double line. When identifying the stars from our sample in addition to the HIP number we also use the number from WDS, the discoverer's name, and component designation.

Since Table 1 is very large, only a part of it is given herewith; the full table can be found at the journal's site.[2]

Table 1. Input data on binaries: first three columns contain WDS number, star name and components and HIP number, m_t is the total magnitude of a pair, Δm is the magnitude difference, m_A and m_B are the magnitudes of components from WDS, π is the new parallax (van Leeuwen 2007), P, a and G are period, semimajor axis and grade of orbit from Sixth Catalog of Orbits of Visual Binary Stars.

WDS	Name	HIP	m_t	Δm	m_A	m_B	π [mas]	P [year]	a [sec]	G
00022+2705	BU 733AB	171	5.80	2.794	5.80	8.90	82.17	26.28	0.830	2
00184+4401	GRB 34AB	1475	8.09	2.613	8.07	11.04	278.76	2600.00	41.150	5
00315−6257	I 260CD	2487	4.53	1.290	4.60	6.54	19.36	44.66	0.404	3
00318+5431	STT 12	2505	4.74	0.217	5.33	5.62	8.64	536.47	1.165	4
00491+5749	STF 60AB	3821	3.46	3.820	3.52	7.36	167.98	480.00	11.994	3
01084−5515	RST1205AB	5348	3.94	2.388	4.02	6.80	10.92	210.37	0.804	5
01398−5612	DUN 5AB	7751	5.76	0.138	5.78	5.90	127.84	483.66	7.817	5
02039+4220	STT 38BC	9640			5.10	6.30	8.30	63.67	0.302	2
02140+4729	STF 228	10403	6.05	0.593	6.56	7.21	25.26	144.00	0.896	2

[1]http://www.usno.navy.mil/USNO/astrome- try/optical-IR-prod/wds/dm3

[2]http://saj.matf.bg.ac.rs/180/pdf/Table1.pdf

For the purpose of calculating astrophysical total masses we need the photometric data. In WDS we do not find the apparent magnitude for the secondary for two binaries only. In the case of 21 binaries ($\approx 5\%$) in SPMDC the magnitude difference is not given, whereas the total magnitudes cannot be found in Hipparcos for two systems (HIP 9640 and HIP 70327). In both these cases the total magnitude is given for the pairs AB, but we consider the BC pairs since we have their orbital elements. For those in SPMDC pairs where more than one magnitude-difference value is given, we use the mean value.

We apply two approaches. In the first one - herein referred to as Approach I - the input data are m_t and $\Delta m = m_B - m_A$, whereas the individual magnitudes are calculated by using the well-known formula (Heintz 1978, p.28):

$$m_A - m_t = \frac{5}{2}\log(1 + 10^{-0.4\Delta m}) \quad . \qquad (1)$$

In the second one - referred to as Approach II - the individual WDS magnitudes m_A and m_B are applied directly. The reason why we do so is firstly, to examine the reliability of the photometry and secondly, because the photometric data, we need, are not available for a small fraction of our sample. Thus we have two sets of individual apparent magnitudes between which some small differences are found. Their influence on the results will be commented below. The two sets of individual apparent magnitudes are converted into the corresponding sets of individual absolute magnitudes. As earlier, the new trigonometric parallaxes are applied. In both cases the interstellar extinction is neglected since we deal with stars close to the Sun.

The next step is to calculate the masses of the components via the mass-luminosity relation. The particular form of this relation adopted here is that proposed by Angelov (1993) which uses the absolute bolometric magnitudes. It has been applied successfully previously in estimating star masses based on their luminosity (Olević et al. 2003, Olević and Cvetković 2004, 2005a, 2005b, Cvetković and Novaković 2006, Cvetković 2008, Cvetković et al. 2008). We assume the bolometric correction (BC) values according to Kulikovskij (1985, p.246). In the case of the subsample of 67 binaries, BC is applied for each component according to the given Sp, whereas in the case of the subsample of 365 binaries, we assume BC according to the estimated Sp. By applying the mentioned mass-luminosity relation and adding the obtained individual masses we obtain the astrophysical total masses.

3. RESULTS

The first question concerns the uncertainty of the apparent magnitudes. For this purpose the apparent magnitudes from Approach II are plotted against those from Approach I, for each subsample separately. It is seen that for both subsamples (Fig. 1) this dependence follows a straight line very closely. There are only a few secondaries where the apparent magnitudes obtained from the two sources show a substantial difference. For instance, the largest difference in the apparent magnitude for a secondary Δm_B: calculated (Approach I) and taken from WDS (Approach II) is equal to $\Delta m_B = m_B(I)$-$m_B(II)$=5.84 for HIP 47080. In SPMDC for this pair only one Δm is given and its value is much smaller than the value of the difference of the individual apparent magnitudes available in WDS (see Table 1). We find another significant difference in the apparent magnitudes of the secondary. It concerns HIP 16649 where Δm_B attains 3.10. The catalogue apparent magnitude indicates for this star a lower brightness

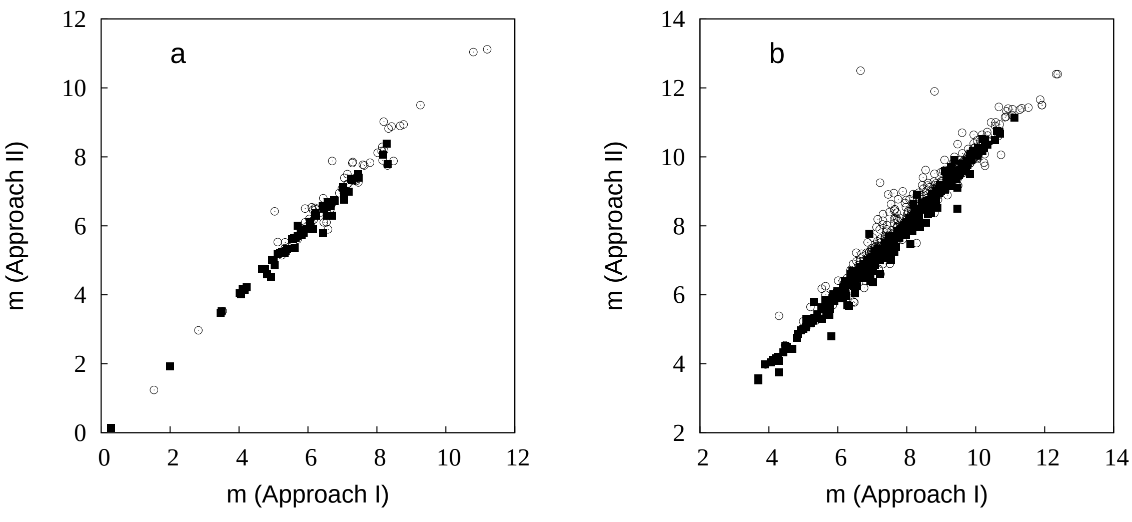

Fig. 1. *Apparent magnitudes from Approach II versus apparent magnitudes from Approach I: a) for the subsample of 67 binaries; b) for the subsample of 365 binaries; filled squares - primary components, open circles - secondary components.*

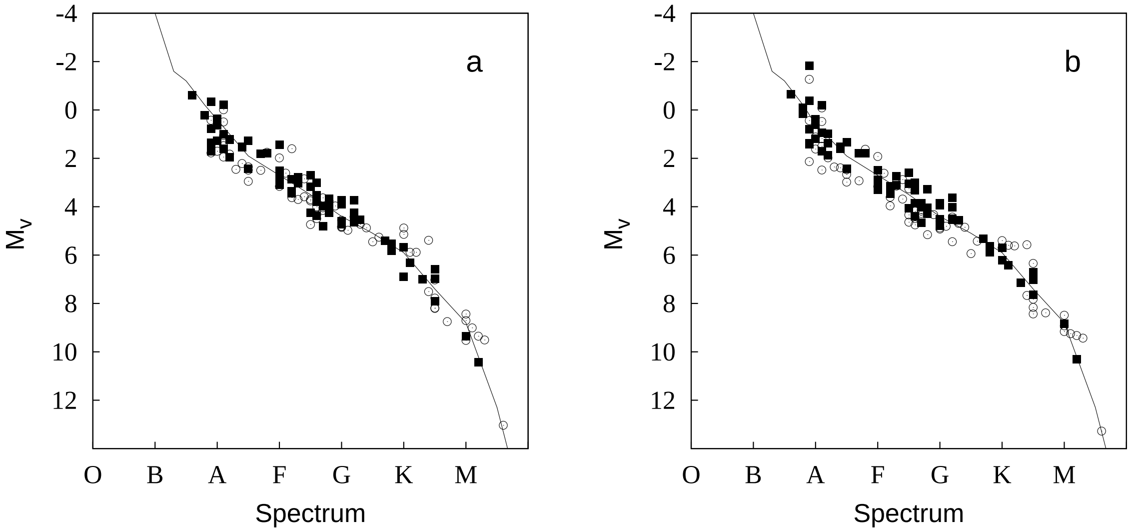

Fig. 2. *Absolute visual magnitudes versus spectral types for the subsample of 67 binaries: a) for Approach I; b) for Approach II; filled squares - primary components, open circles - secondary components; the curve follows the dependence given in Binney and Merrifield (1998).*

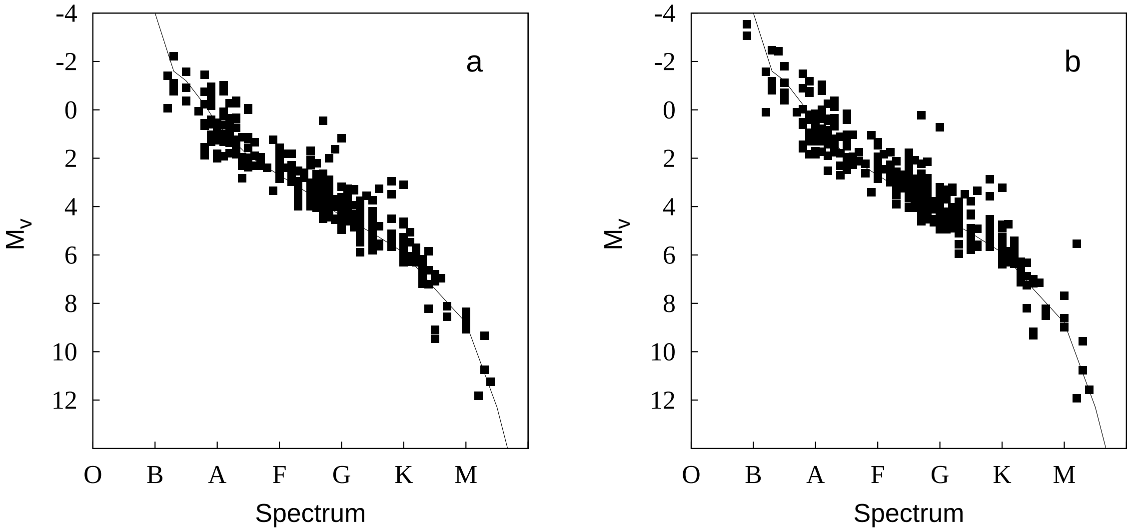

Fig. 3. *Absolute visual magnitudes versus spectral types for the subsample of 365 binaries: a) for Approach I; b) for Approach II; filled squares - primary components; the curve follows the dependence given in Binney and Merrifield (1998).*

than that obtained by applying (1). This pair is of B9.5V spectral type, thus a rather hot star, so that an error in the estimate of the individual apparent magnitudes is quite possible. Finally, the root mean square (rms) of the residuals between the magnitudes resulting from the two approaches is for both subsamples lower for the primaries (0.08 - smaller subsample and 0.03 - bigger subsample) than for the secondaries (0.13 - smaller subsample and 0.07 - bigger subsample).

The application of the mass-luminosity relation requires the stars to belong to MS. Therefore, using the absolute visual magnitudes and spectral types we construct the corresponding HR diagram. In the case of the subsample of 67 binaries, since the spectral types are available for both components, each of the two versions of HR contains both the primaries and the secondaries (Fig. 2). The two versions correspond to the two approaches: a) Approach I, b) Approach II. The curves passing through the points are obtained by means of the dependence between the absolute visual magnitude and spectral type according to a table from Binney and Merrifield (1998). The points are concentrated around the curves

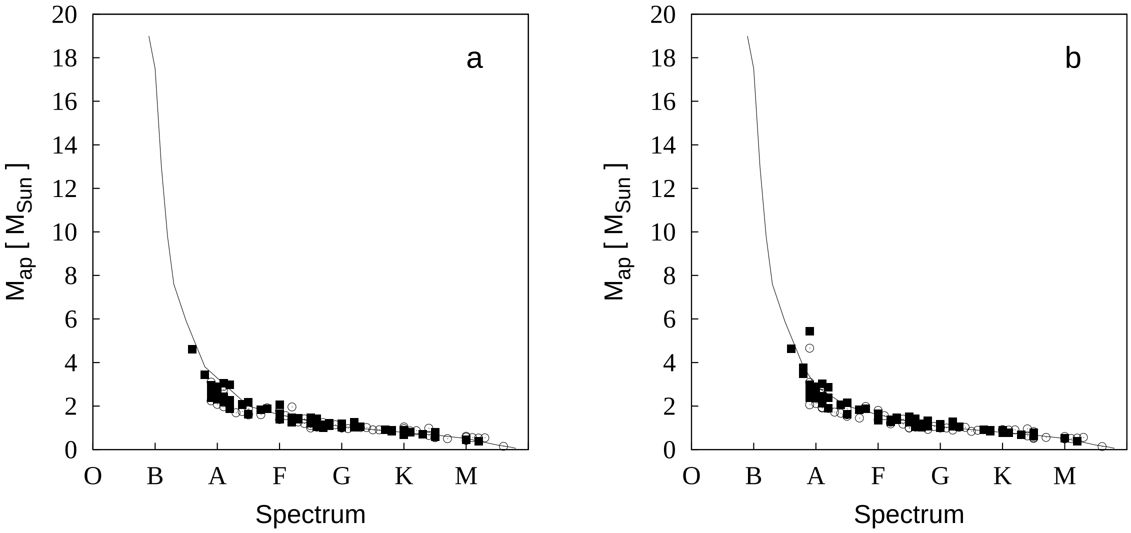

Fig. 4. *Astrophysical mass versus spectral types for the subsample of 67 binaries: a) for Approach I; b) for Approach II; filled squares - primary components, open circles - secondary components; the curve follows the dependence given in Binney and Merrifield (1998).*

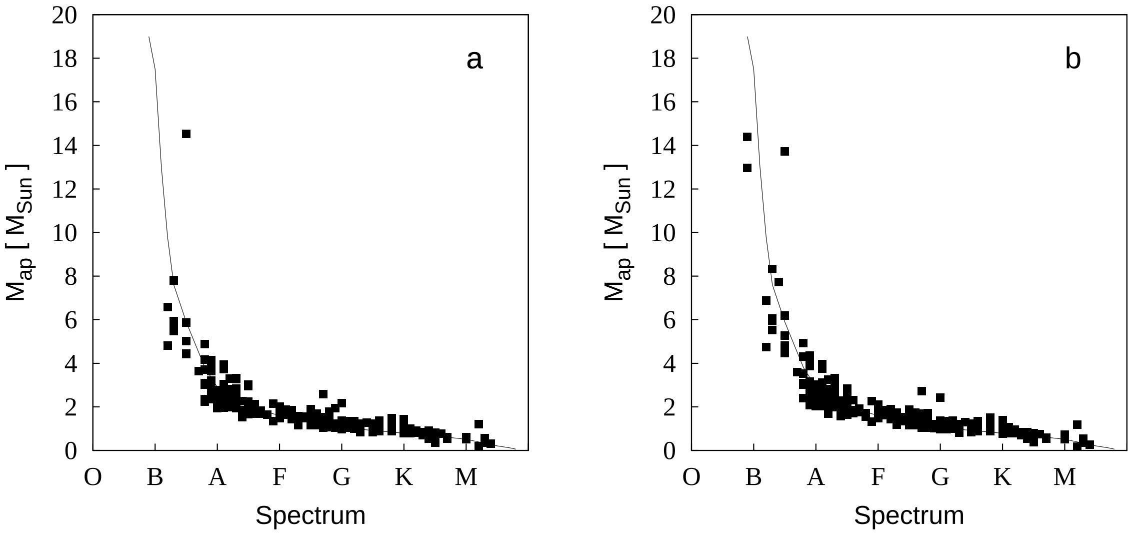

Fig. 5. *Astrophysical mass versus spectral types for the subsample of 365 binaries: a) for Approach I; b) for Approach II; filled squares - primary components; the curve follows the dependence given in Binney and Merrifield (1998).*

sufficiently closely. As can be seen from the figure, the difference between the two approaches is very small. The scatter is affected, among others, by the errors in the trigonometric parallax. Its influence does not differ between the two approaches because the same parallaxes are used. The rms of the residuals between the absolute magnitudes (theoretical-ours) resulting from the two approaches are: 0.29 (primaries, Approach I), 0.37 (secondaries, Approach I), 0.26 (primaries, Approach II) and 0.39 (secondaries, Approach II).

The same is also presented in the case of the subsample of 365 binaries (Fig. 3) containing the primaries only. In this figure we see a very similar situation as in Fig. 2. The rms of the residuals between the absolute magnitudes (theoretical-ours) resulting from the two approaches are: 0.18 (Approach I) and 0.17 (Approach II). In this case, with regard that only one spectral type is given, we cannot be sure whether it concerns the primary indeed, or, perhaps, this is the integrated spectral type. This, combined with the parallax, contributes additionally to the scatter seen in Fig 3.

The spectral type of the components can be also estimated on the basis of their visual absolute magnitudes. For about 40% of the binaries from the

Table 2. Determined magnitudes and spectral types for binary stars from subsample of 365 ones: first column - HIP number, m_A^I and m_B^I are the apparent magnitudes of components according to Approach I, M_A^I and M_B^I are the corresponding absolute magnitudes, m_A^{II} and m_B^{II} are the apparent magnitudes of components according to Approach II, M_A^{II} and M_B^{II} are the corresponding absolute magnitudes, Sp_A and Sp_B are the spectral types found by us, $Sp(WDS)$ is the spectral type published in WDS.

HIP	m_A^I	m_B^I	M_A^I	M_B^I	m_A^{II}	m_B^{II}	M_A^{II}	M_B^{II}	Sp_A	Sp_B	Sp(WDS)
518	6.37	7.27	4.71	5.61	6.42	7.32	4.76	5.66	G3	G9	G3
768	8.17	9.74	4.00	5.57	8.29	9.98	4.12	5.81	F8	G9	G3
794	9.18	10.27	5.46	6.55	9.56	9.74	5.85	6.03	G9	K2	K1
1005	8.88	8.91	2.67	2.69	8.98	8.98	2.77	2.77	F0	F0	F0
1296	6.96	7.26	0.54	0.84	7.03	7.12	0.61	0.70	A1	A1	B8nn
1700	7.64	8.48	1.55	2.38	7.54	8.77	1.45	2.68	A3	A9	B8.5
2237	7.16	7.22	4.62	4.68	7.23	7.40	4.69	4.86	G2	G2	G0
2533	9.28	9.31	5.96	5.99	9.70	9.70	6.38	6.38	K0	K0	K0
2548	5.86	7.81	1.31	3.27	5.84	7.99	1.30	3.45	A2	F4	B9.5
2762	5.62	6.44	3.98	4.81	5.61	6.90	3.97	5.26	F8	G4	F8

subsample containing 365 ones the difference of the individual visual apparent magnitudes (both taken directly or calculated) m_A and m_B is significant; in particular $\Delta m > 0.7$, being also the difference between the corresponding absolute magnitudes. The spectral types of the components are found on the basis of the dependence visual absolute magnitude versus spectral type as earlier Binney and Merrifield (1998). The results are given in Table 2. For a majority among the 365 pairs the spectral type of the primary found by us and that given in WDS are very close to each other.

Since Table 2 is very large, only a part of it is given herewith; the full table can be found at the journal's site.[3]

In order to examine the values of the astrophysical masses we plot them versus the spectral type. In the case of the subsample containing 67 binaries, the mass of each component is given for both approaches (Fig. 4). In that of the subsample containing 365 binaries only the masses of the primaries are presented (Fig. 5) for both approaches. It is seen that in all these cases the dependence of the mass on the spectral type also follows closely the trend presented by the curve drawn on the basis of the corresponding dependence given by Binney and Merrifield (1998). The rms of the residuals are in the case of the smaller subsample, 0.13 for the primaries in both approaches, and 0.19 (Approach I), 0.21 (Approach II) for the secondaries. In the case of the bigger subsample, the corresponding values are 0.11 (Approach I) and 0.10 (Approach II), respectively. The unit is the solar mass.

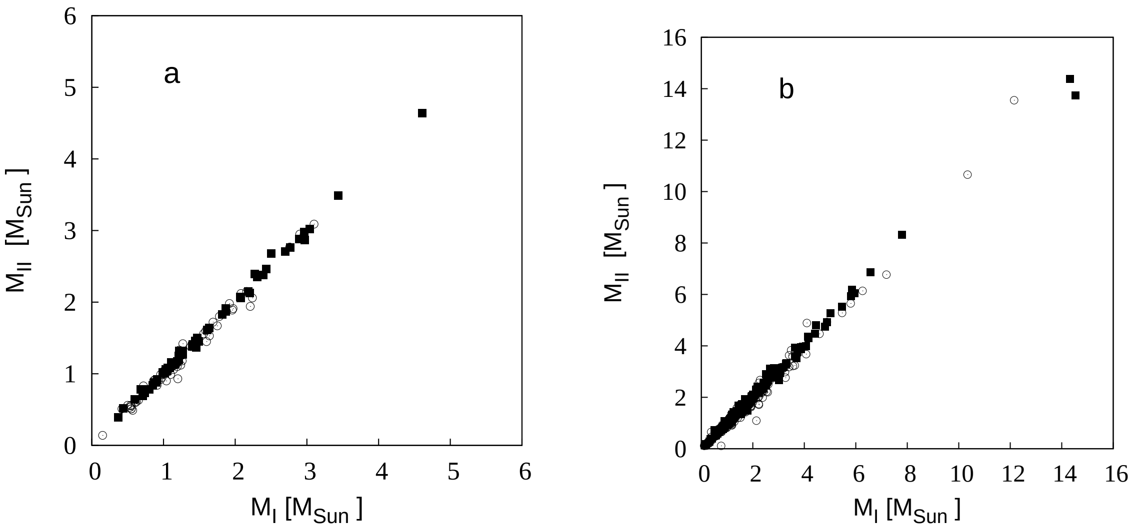

Fig. 6. *Component masses from Approach II versus component masses from Approach I: a) for the subsample of 67 binaries; b) for the subsample of 365 binaries; filled squares - primary components, open circles - secondary components.*

[3]http://saj.matf.bg.ac.rs/180/pdf/Table2.pdf

Table 3. Calculated masses for binary stars of the whole sample: the first column contains HIP number, G is the orbit grade, π is the parallax, σ_π its error, Sp(WDS) spectral type from WDS, $\mathcal{M}_1^I$ is mass of primary according to Approach I, $\mathcal{M}_2^I$ mass of secondary according to Approach I, $\Sigma\mathcal{M}^I$ is sum of masses from two preceding columns, $\mathcal{M}_1^{II}$ is mass of primary according to Approach II, $\mathcal{M}_2^{II}$ is mass of secondary according to Approach II, $\Sigma\mathcal{M}^{II}$ is sum of two preceding masses and $\mathcal{M}_{dyn}$ is the dynamical mass of the pair; asterisk means large discrepancy between astrophysical and dynamical total masses and m - multiple star.

HIP	G	π [mas]	σ_π [mas]	Sp(WDS)	$\mathcal{M}_1^I$ [$\mathcal{M}_\odot$]	$\mathcal{M}_2^I$ [$\mathcal{M}_\odot$]	$\Sigma\mathcal{M}^I$ [$\mathcal{M}_\odot$]	$\mathcal{M}_1^{II}$ [$\mathcal{M}_\odot$]	$\mathcal{M}_2^{II}$ [$\mathcal{M}_\odot$]	$\Sigma\mathcal{M}^{II}$ [$\mathcal{M}_\odot$]	$\mathcal{M}_{dyn}$ [$\mathcal{M}_\odot$]	
171	2	82.17	2.23	G7 K5	0.91	0.55	1.45	0.92	0.51	1.43	1.49	
1475	5	278.76	0.77	M2 M6	0.37	0.15	0.52	0.39	0.14	0.52	0.48	
2487	3	19.36	2.97	A2 A7	2.27	1.60	3.87	2.39	1.45	3.85	4.56	
2505	4	8.64	0.43	B8 B9	3.44	3.10	6.55	3.49	3.09	6.59	8.52	
3821	3	167.98	0.48	G0 dM0	1.04	0.61	1.65	1.03	0.60	1.63	1.58	
5348	5	10.92	0.39	B6 B9	4.61	2.24	6.86	4.64	2.06	6.70	9.02	
7751	5	127.84	2.19	K0 K5	0.68	0.72	1.40	0.78	0.83	1.61	0.98	
9640	2	8.30	1.04	B8 A0				3.76	2.54	6.30	11.88	*m
10403	2	25.26	0.66	F2 F7	1.27	1.13	2.39	1.27	1.11	2.38	2.15	

The agreement between the component masses obtained by using the two approaches for the subsample of 67 binaries can be seen in Fig. 6a, i.e. in Fig. 6b for the subsample of 365 binaries. An immediate consequence is a good agreement between the total masses obtained by using the two approaches. This can be seen in Table 3. The rms of the residuals are in the case of the smaller subsample 0.03 for the primaries and 0.04 for the secondaries. In the case of the bigger subsample, the corresponding values are 0.01 and 0.02, respectively. The unit is the solar mass.

Since Table 3 is very large, only a part of it is given herewith; the full table can be found at the journal's site.[4]

The comparison of the total masses obtained astrophysically and dynamically is seen in Fig. 7 and Fig. 8 and the data are given in Table 3. The cases where the difference between the two masses of a pair is significant, are indicated by an asterisk. There are a few cases in which the dynamical mass exceeds 100 solar masses; then no value is given, instead there is the sign >. Table 3 is composed of three parts separated by a double line; the first part concerns the subsample of 67 binaries, the second one concerns the subsample of 365 binaries for which no significant differences between the two masses are found, and the last one concerns the same subsample, but those binaries where these differences are significant (indicated by asterisk).

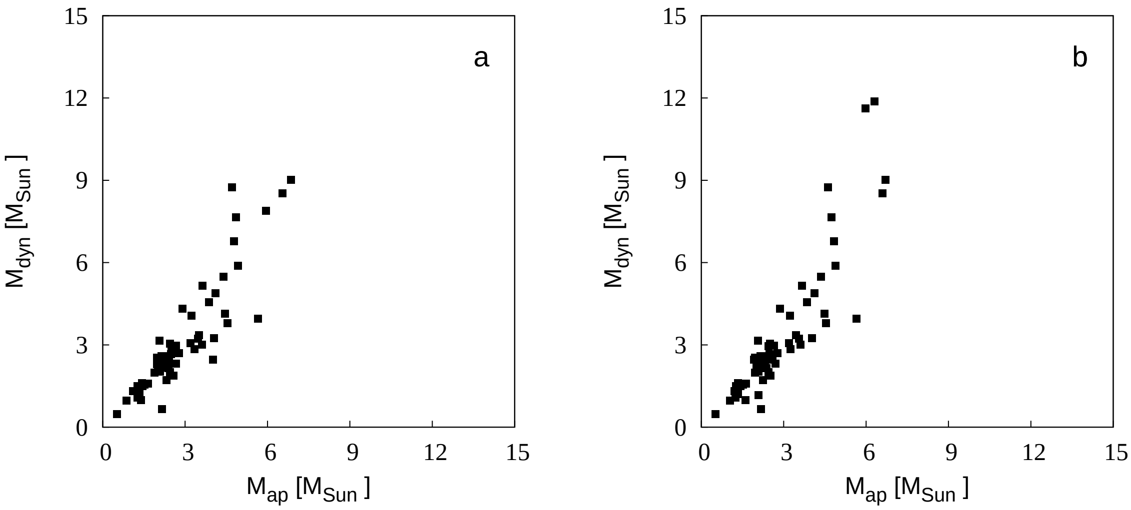

Fig. 7. *Dynamical mass versus astrophysical mass for the subsample of 67 binaries: a) from Approach I; b) from Approach II.*

[4]http://saj.matf.bg.ac.rs/180/pdf/Table3.pdf

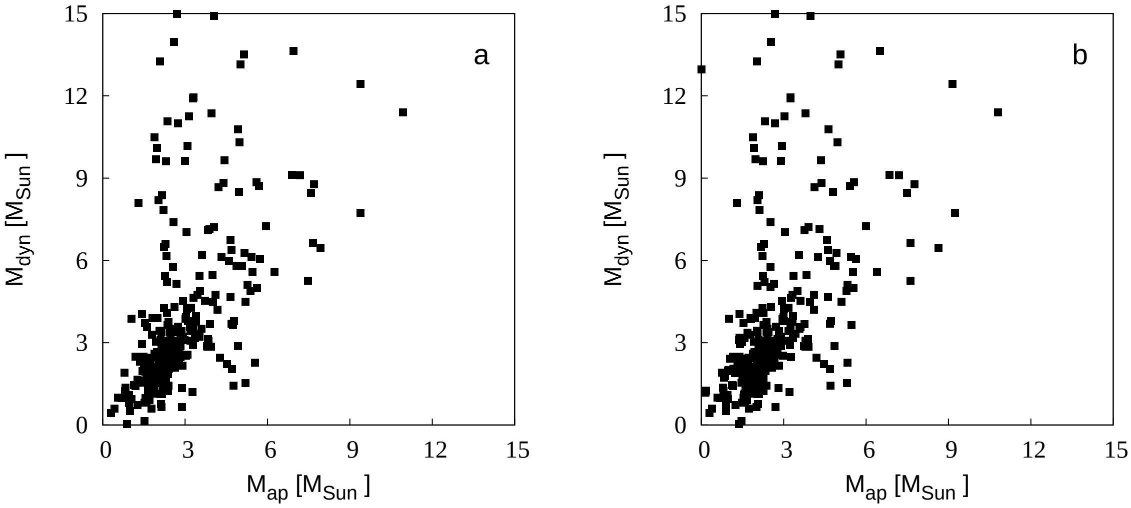

Fig. 8. *Dynamical mass versus astrophysical mass for the subsample of 365 binaries: a) from Approach I; b) from Approach II.*

In the case of the subsample of 67 binaries - Fig. 7a (astrophysical mass from Approach I) and Fig. 7b (astrophysical mass from Approach II) - we have almost a straight line with very few outliers. One binary is not represented in these two plots because its dynamical mass is beyond the limits of the plots (first part of Table 3). In the case of the subsample of 365 binaries - Fig. 8a (astrophysical mass from Approach I) and Fig. 8b (astrophysical mass from Approach II) - the scatter is apparently larger which is more contributed by dynamical masses. Here we also find binaries not represented in the plots because of their too large dynamical masses (third part of Table 3). As we have seen from the comparison, the results for the total astrophysical masses in both subsamples show that it is almost unimportant which approach is applied. Therefore, the plots presented in Figs. 7a and 7b, i.e. 8a and 8b, do not differ very much. The rms of the residuals are in the case of the smaller subsample 0.49 (Approach I) and 0.82 (Approach II). In the case of the bigger subsample the corresponding values are 2.63 and 2.56, respectively. The unit is the solar mass.

The large deviations of the dynamical total masses from the astrophysical ones (indicated by asterisk) appear in cases when such a binary belongs to a multiple star (in Table 3 indicated by m), has a low parallax (generally unreliable), or its orbit is of a low quality (grade $G = 3$, 4, 5). In addition, these influences can be combined. (Table 3).

A correlation between the orbit grade and relative error of the parallax is found. This correlation is shown in Fig. 9. It is clearly seen that, on the average, for orbits of low quality the relative parallax error is high. Now, the scatter of dynamical masses in Fig. 8 can be more easily understood. It is largely a consequence of low quality of both orbits and parallaxes. In the third part of Table 3, orbit grades 4 and 5 prevail and parallaxes less than 10 mas are very frequent.

In the cases where we have orbits of high quality (grade 1, 2) and reliable parallaxes, the agreement between the astrophysical and dynamical total mass of a pair is generally very good (see Table 3). Therefore, the mass-luminosity relation assumed here appears sufficiently correct.

4. DISCUSSION AND CONCLUSIONS

The comparison of the two approaches shows no essential difference as to whether the individual magnitudes are taken directly from a catalogue or they are calculated from the total magnitude and magnitude difference. Therefore, it is of no influence on the results which approach we use. This fact is important because there are, in general, many binaries for which the magnitude difference is not available or, on the other hand, there are cases where the apparent magnitude of the secondary is not given.

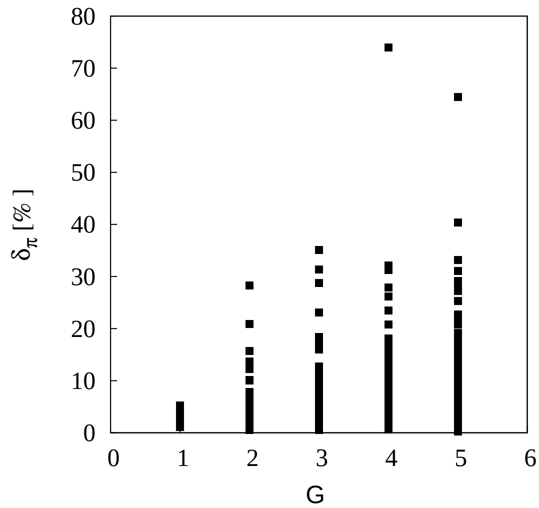

Fig. 9. *Relative parallax error versus orbit grade.*

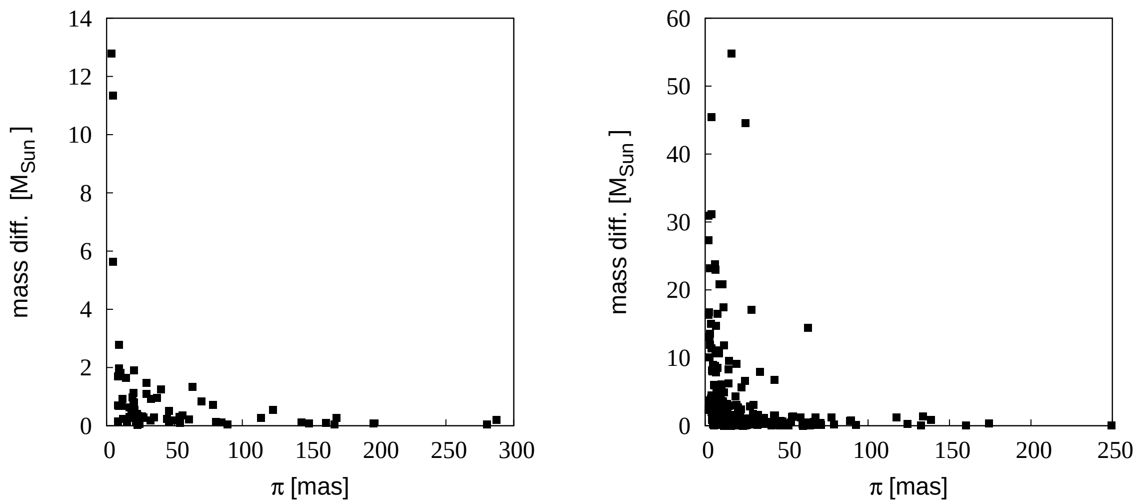

Fig. 10. *Mass difference versus parallax a) for subsample of 67 binaries b) for subsample of 365 binaries.*

The dynamical total masses found here for the whole sample, show a very high dispersion attaining in some, though rare, cases either extremely high or extremely low values. The reason is, evidently, in observational errors. Almost in all these cases the orbital elements are classified with bad grades, and the trigonometric parallaxes are very small, near the observational accuracy limit. A correlation is found between the orbit grade and relative parallax error. Taking also into account the well-known fact that the determination of the total mass via Kepler's third law is very sensitive to the inaccuracy of the parallax, as well as to that of the orbital elements, it becomes quite clear why the mass interval, covered by the dynamical total masses, is so wide to include sometimes unrealistic values. The parallax influence on the mass determination is examined also by plotting the modulus of the mass difference (dynamical and astrophysical) versus parallax (Fig. 10). As seen from Fig. 10, very high mass differences are typical for low parallaxes.

One may infer that the trigonometric parallaxes are generally sufficiently reliable inside of about 100 pc from the Sun. This inference concerns the new Hipparcos parallaxes as well. The spectral types estimated by us for the 365 pairs belonging to the larger sample are more or less close to the spectral type given in WDS.

A general conclusion is that the astrophysical data (photometry and spectroscopy) are subject to a significant noise, especially in the case of the secondaries where both apparent magnitudes and spectral types, as a rule, are much less certain than in the case of the primaries.

Besides, such comparisons of the total masses, as done here, may help in distinguishing the visual binaries with sufficiently reliable parallaxes, and orbital elements of sufficiently high quality. They can then be used in further statistical analyses.

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О МАСАМА КОМПОНЕНТИ ВИЗУЕЛНО ДВОЈНИХ ЗВЕЗДА

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Оригинални научни рад

У Шестом каталогу орбита визуелно двојних звезда нашли смо оне које припадају главном низу и на тај начин образовали узорак који садржи 432 визуело двојне звезде. Њихове укупне масе добили смо динамички, тј. израчунали смо их коришћењем орбиталних елемената и нове Хипаркосове паралаксе. За исте парове нашли смо такође и астрофизичке масе применом релације маса-сјај. Апсолутне магнитуде компоненти нашли смо на два начина: рачунањем из укупних магнитуда и разлике магнитуда или смо их узели директно из каталога. Резултати за ова два прилаза не показују битно разилажење. Вредности укупних маса добијене динамички имају велику дисперзију па чак има и потпуно нереалних вредности. Ово је јасна индикација да улазни подаци нису довољно поуздани. Поред тога, у великом броју случајева слагање између укупне масе коју смо добили на два различита начина је сасвим задовољавајуће што указује да: 1) за многе визуелно двојне, које по правилу нису сувише далеко и са квалитетним орбиталним елементима, динамичке укупне масе могу бити поуздане; 2) релација маса-сјај даје сасвим задовољавајуће оцене маса компоненти када оне припадају главном низу, и 3) постоји корелација између релативне грешке паралаксе и оцене орбите.