

GAIA and Population II Visual Binaries

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Abstract. The results of a kinematical population classification of 497 Hipparcos orbital binaries are discussed. Less than 10% of the stars from the sample belong to the thick disk. Only seven stars have halo kinematics. There are no direct dynamical mass determinations for extreme halo stars. Some suggestions, concerning Population II visual binaries for which ground-based astrometric observations in combination with GAIA data will be useful in the future for the better determination of orbits for long period Population II binaries, are offered.

1. Introduction

The ESA's GAIA mission will radically change our knowledge about visual binary stars and precise stellar masses. It is expected that over 60 million visual binaries will be detected, 10 million orbital elements calculated, and over 10 000 star masses with uncertainties up to 1% determined (ESA, 2000).

This contribution is aimed to show the unsatisfactory situation in the domain of the investigation of Population II orbital binaries. It is well-known that ground-based astrometric, radial velocity and photometric observations in combination with Hipparcos data are very useful for the considerable improvement of orbital, astrometric and photometric parameters of the known binaries and the detection of new ones. Similarly, new ground based astrometric and other observations of the Population II long period visual binaries in combination with GAIA data will be useful in the future for determining accurate orbits of these stars and their masses. Several binaries are proposed for observations.

2. High Velocity Hipparcos Orbital Visual Binaries

Bartkevičius and Gudas (2001a) obtained kinematical parameters for a sample consisting of 497 orbital visual binaries: stars from Hipparcos Catalogue Double Star Annex DMSA/O (ESA, 1997) and binaries



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with orbital elements obtained from reprocessed Hipparcos data and ground-based observations (Soderhjelm, 1999; Pourbaix, 2000; Pourbaix and Jorissen, 2000; Martin and Mignard, 1998; Martin et al., 1998; Gontcharov et al., 2000). Kinematically, most (89%) of the selected binaries belong to the thin disk, less than 10% to the thick disk. Only seven binaries are halo stars. Five of them kinematically belong to the intermediate halo. Two sdF7 subdwarfs HD 219617 and HD 132475 have extreme halo kinematics. Unfortunately, these very interesting stars have rather poorly determined orbital elements. HD 219617's orbit inclination is $i = 90^\circ$ (Hartkopf et al., 2000), Heintz (1991) presented two alternative orbits, $P = 260$ yr, $a = 0.800''$, and $P = 100$ yr, $a = 0.402''$. For the second subdwarf with extreme halo kinematics HD 132475, even its orbit is not confirmed by subsequent observations (Worley and Heintz, 1983). The search through the catalogues of metal-deficient stars (Bartkevičius, 1980, 1984), Population II Star Catalog (Bartkevičius and Bartkevičienė, 1984), unpublished Population II Binary Catalog (Bartkevičius, 1993) and the papers published after compilation of this catalog do not reveal any more extreme Population II visual binaries with determined orbits. Therefore, we completely lack direct dynamical mass determination for these astrophysically very important stars.

As mentioned above, the orbital elements of binaries analysed by Bartkevičius and Gudas (2001a) have been determined from Hipparcos measurements or combining them with the ground-based orbits. These binaries form only one third of the orbits published in a new Fifth Catalogue of Orbits of Visual Binary Stars (Hartkopf et al., 2000). In spite of the fact that remaining two-thirds of the orbits have been obtained only from the ground-based measurements and in most cases are less precise than the orbits of stars analysed by Bartkevičius and Gudas (2001a), kinematical classification of those stars will be performed (Bartkevičius and Gudas, 2001b) with the hope to supplement the sample of the thick disk orbital binaries.

3. Metal-deficient Visual Binaries, Possible Candidates for Ground-based Observations

GAIA measurements will allow us to obtain reliable orbits for visual binaries with orbital periods shorter than 50 years. Just as in the Hipparcos case, the ground-based astrometric measurements in combination with GAIA measurements will significantly improve the precision of orbital elements, especially for long period binaries. These measurements are very important for the rare Population II binaries.

Eleven metal-deficient visual binaries candidates for the ground-based measurements have been selected from the unpublished Population II Binary Catalogue (Bartkevičius, 1993). The criteria of the selection of stars were as follows: physical binary, $[\text{Fe}/\text{H}] < -0.6$, no orbit determinations, number of existing position measurements > 5 . Relative astrometric measurements (position angle and angular separations of the components) have been obtained from the Washington Double Star Data Center. The mean angular separation $\langle D \rangle$ (in arcsec) and the rate of change of the position angle dPA/dt (deg/yr) have been calculated. A rough estimate of the orbital period has been made from the rate of change of the position angle dPA/dt and from the third Kepler's law, assuming the mean projected separation $\langle D \rangle$ as a major semi-axis of the orbit, mass sum that equals to 1 solar mass, and using trigonometric parallax from Hipparcos. Calculated elements with the spectral type, metallicity $[\text{Fe}/\text{H}]$, number of angular separation ND and position angle NPA measurements are presented in Table 1.

Table I. Metal-deficient visual binary stars – candidates for the ground-based observations.

	Name	Sp	$[\text{Fe}/\text{H}]$	$\langle D \rangle$ arcsec	ND	dPA/dt deg/yr	NPA	P yr
HD	23439AB	sdK1+sdK3	-1.12	7.94	95	0.06	95	3000
HD	111971AB	MDE	-0.82	1.38	16	-0.03	16	1000
HD	111980AB	sdF7	-1.25	1.95	7	-0.20:	7	1900
HD	128636AB	F-WMM	-0.86	0.29	6		6	100
HD	130166AB	G2WF5		0.49	5		5	200
HD	156384AB-C	M2		31.01	9	0.08	10	3500
HD	156384AC	M2	-0.5	31.16	47	0.09	47	3500
HD	156384BC			31.3	15	0.14	14	3000
HD	163810AB	sdG5	-1.47	0.44	12	-1.14	12	300
HD	211998AB	sdG2	-1.50	0.12	11	-72::	5	5
HD	224927AB	sdA8	-1.08	0.15	6	-3.:	4	200
G	19-20/21	wdA+sdM6		12.92	7		7	10000
G	122-2AB	(sdK1)		3.76	32	0.13	32	2000

The most promising stars candidates with estimated period less than 1000 years are HD 128636, HD 130166, HD 163810 and HD 224927. Very interesting candidate system is sdG5 subdwarf HD 163810. Its estimated period is about 300 years. An exceptional system is ν Ind (HD 211998) having a short period of about 5 years.

4. Conclusions

1. Less than 10% of Hipparcos orbital visual binaries kinematically belong to the thick disk. Only 7 of 497 Hipparcos orbital visual binaries have halo kinematics. Direct dynamical mass determinations for extreme halo stars still do not exist.

2. In order to take a full advantage of GAIA measurements and enlarge the number of reliably derived long period halo binary orbits, relative ground-based astrometric measurements should be made. Eleven candidate systems are proposed in Table 1.

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