**Serb. Astron. J. № 162 (2000), 101 – 103**

**UDC 524.383**
Preliminary report

# KINEMATICS OF A SAMPLE OF VISUAL DOUBLE STARS

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(Received: November 6, 2000)

**SUMMARY: The Hipparcos-Input Catalogue also contains about 8000 already known visual double stars. In the framework of this-project campaign, in addition to other parameters, were also determined the parallaxes $\pi$, as well as the polar coordinates $\rho$ and $\theta$ for double stars. On the basis of a comparison of these data to those obtained earlier from the ground based measurements (WDS Catalogue) statistical examinations of a double-star sample ($1'' \leq \rho \leq 14''$) are performed.**

**It is shown that an exeptionally good agreement exists of the statistical distribution $\Delta\theta/\Delta t$ of the sample as function of $\rho(AU)$ and the curve $\dot{\theta} = \frac{C(\rho)}{\rho^2}$ representing the II Kepler law.**

## 1. INTRODUCTION

The separation in visual double stars is within the limits of a few fractions of an arcsecond to a few tens of arcseconds.

There are about thousand orbits of double stars calculated so far which proves their physical connection. As a rule these are very close pairs with separation largely about $1''$. Due to this their orbital motion is fast and they reveal their physical connexion within a short time.

The problem is with "wide" pairs because they are in general at large mutual distances not only apparently, but also physically and therefore during the last 200 years, since they have been observed, they have crossed a very short arc. In the case of such pairs it cannot be inferred whether the changes of the measured polar coordinates ($\rho''$ and $\theta^o$) are due to the proper motions or to the orbital ones.

The Hipparcos Campaign also included observations of the polar coordinates ($\rho''$ and $\theta^o$) and the parallaxes ($\pi''$) for about 8000 visual double stars from the WDS Catalogue (Worley, 1984).

From this list we separate a random sample of 1000 visual double stars with $1'' < \rho \leq 14''$. Knowing the values $\rho''$ for several observing epochs and their parallaxes we can estimate the rate of physical pairs in this sample.

## 2. BASIC ASSUMPTIONS

a) The variations in the polar coordinates are due to the orbital motion, hence they are connected through the following relation

$$\rho^2\dot{\theta} = C \ , \tag{1}$$

i.e. through the $2^{nd}$ Kepler's law, $C$ being the area constant.

b) The area constant is a linear function of separation $\rho_{AU}$ ($\rho_{AU} = \frac{\rho''}{\pi''}$).

$$C(\rho) = A + B \cdot \rho_{AU} \ . \qquad (2)$$

## 3. SAMPLE ANALYSIS

The variations in the position angles ($\theta^o$) within the time interval ($\Delta t$) are calculated following the equation

$$\frac{\Delta\theta}{\Delta t} = \frac{|\theta_{Hipp} - \theta_{WDS}|}{t_{Hipp} - t_{WDS}} \approx \dot{\theta}_s \qquad (3)$$

i.e. $\dot{\theta}_s = \varphi(\rho_{AU})$ averaged within intervals $\Delta\rho$= $50AU$. The subscripts $WDS$ and $Hipp$ indicate the data source: WDS Catalogue, i.e. Hipparcos.

The statistical distribution of the quantity $\dot{\theta}_s$ in $\rho_{AU}$ is presented in Fig. 1.

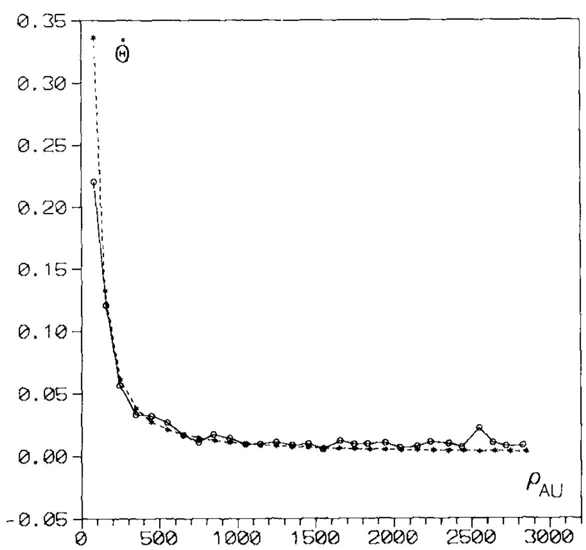


**Fig. 1.** *The distribution of $\dot{\theta}_s$ as function of $\rho_{AU}$ (solid line); distribution of $\dot{\theta}_{SA}$ as function of $\rho_{AU}$ (dashed line).*

Due to the small change of $\theta$ the area constant $C$ can be approximated with the following equation

$$C = \frac{\rho_{Hipp} \cdot \rho_{WDS} \cdot \sin(\theta_{Hipp} - \theta_{WDS})}{t_{Hipp} - t_{WDS}} \qquad (4)$$

From the averaged data concerning $C$ in the corresponding intervals of $\Delta\rho$ we calculate the linear correlation:

$$C(\rho) = A + B\ \rho = 2.6766 + 0.0135037\rho_{AU} \qquad (5)$$

illustrated in Fig. 2.

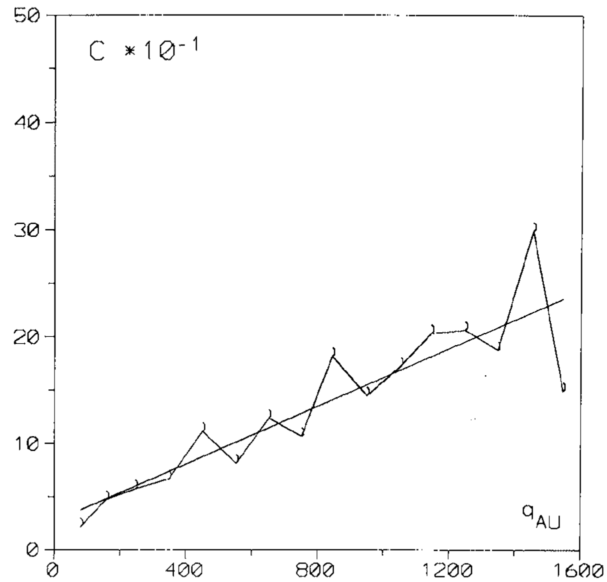


**Fig. 2.** *Dependence of area constant ($C$) on $\rho_{AU}$.*

In view of the assumptions a) and b) i.e. equations (1) and (2) one can calculate the semi-analytic $\dot{\theta}_{SA}$

$$\dot{\theta}_{SA} = \frac{C(\rho)}{\rho^2} \cdot 57.3^o \ . \qquad (6)$$

The distribution of $\dot{\theta}_{SA}$ calculated according to formula (6) is presented in Fig. 1 for the sake of an easier comparison with $\dot{\theta}_s$.

In these calculations about 20% of the analysed sample was rejected because the calculated values $\dot{\theta}_S$ and $C(\rho)$ had an unacceptable dispersion with respect to the main trend of the distribution.

## 4. CONCLUSION

After comparing the distributions as illustrated in Fig. 1. we found a good agreement.

Therefore, assumptions a) and b) are fulfilled in about 80% cases of the examined sample or, in other words, the components are gravitationally bound.

*Acknowledgements* – This work is a part of the project "Astrometrical, Astrodynamical and Astrophysical investigations", supported by Ministry of Science and Technology of Serbia.

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# КИНЕМАТИКА ЈЕДНОГ УЗОРКА ВИЗУЕЛНО ДВОЈНИХ ЗВЕЗДА

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УДК 524.383
*Претходно саопштење*

Из података WDS каталога и оних добијених у кампањи Hipparcos, на узорку од 1000 визуелно двојних звезда, анализирана је статистичка расподела промене позиционог угла по времену у функцији радијус вектора израженог у астрономским јединицама. Показано је да та расподела има изузетно добро слагање са кривом која представља Други Кеплеров закон код 80% парова узорка, те се може закључити да су ови парови у физичкој вези.