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FROM SPECKLE MEASUREMENTS TO COMPUTATION OF THE BINARY SYSTEM ORBITS AT THE ASTRONOMICAL OBSERVATORY R. M. ALLER

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RESUMEN

La cámara speckle ICCD, propiedad del Observatorio Astronómico R. M. Aller, ya ha sido usada acoplada al telescopio español de 1.2-m del Observatorio Hispano-Alemán de Calar Alto (Almería, España) y se espera usar, próximamente, acoplándola al telescopio alemán de 3.5-m. Las observaciones de casi trescientas estrellas dobles y múltiples que ya se han obtenido con este instrumento están siendo analizadas en el Observatorio Astronómico R. M. Aller. La unión de estas mediciones con otras de épocas anteriores está permitiendo calcular orbitas o mejorar las ya existentes, haciendo uso del método de Docobo para el caso de sistemas binarios. Aquí presentamos una muestra de ello, incluyendo la estimación de masas para algunos sistemas interesantes.

ABSTRACT

The ICCD speckle camera of the Astronomical Observatory R. M. Aller has already been used with the Spanish 1.2-m telescope and it is pending to be attached to the German 3.5-m telescope at Calar Alto Observatory (Almería, Spain). In recent years, almost three hundred double and multiple stars have been observed with this instrumentation. All these data are analyzed at the Astronomical Observatory R. M. Aller and the angular separation and the position angle of each binary system is obtained with the corresponding uncertainty. Along with the whole set of previous measurements, we are able to calculate new orbits or improve the former one. These objectives are accomplished by using the Docobo's method to calculate the orbits of binary systems. As an outstanding result of these accurate orbits an the estimation of the mass for some systems with a special astrophysical interest are made.

Key Words: **BINARY SYSTEMS — STARS: MASS LOSS — TECHNIQUES: INTERFEROMETRIC**

1. STUDY OF BINARY SYSTEMS AT THE ASTRONOMICAL OBSERVATORY R. M. ALLER

The Galician Professor R. M. Aller was the one who introduced double stars research into Spain. He carried out micrometric measurements since early 30's. Moreover, he was the first Spanish ever, to determined an orbit of a binary system.

Later, Docobo (1985) published an original analytical method to calculate orbits of double stars (as for now, more than 200 orbits have been calculated). Since 1993 Docobo and Ling have been in charge of editing the Information Bulletin of IAU Commission 26 (double and multiple stars). In 2001 a *Catalog of Orbits and Ephemerides of Visual Double Stars* with 1,545 orbits of 1,208 systems (Docobo et al. 2001b) was published. At the present, several topics in binary star research are being pursued.

2. BINARY SYSTEMS AND SPECKLE INTERFEROMETRY

Astrometry and spectroscopy, two main techniques of observing binaries, complement each other. Astrometric and spectroscopic measurements of a double star allow to calculate its mass and, therefore, to set constraints on its evolution. Speckle interferometry technique, first introduced by Labeyrie in 1970, increases the overlap region where both techniques are applicable.

The resolution of an image is set not only by the diffraction limit of the telescope but also by the atmospheric seeing. Speckle interferometry allows to reach the diffraction limit. To achieve this aim, it is necessary to take many very short exposure images of a double star, so that for each of them we can consider the atmosphere to be frozen.

2.1. *Our instrumentation: an ICCD speckle camera*

With the aim to get more precise measurements of binary systems, a speckle camera was developed in cooperation with the Special Astrophysical Observatory (SAO) of the Russian Academy of Sciences in 1998. It is an ICCD speckle camera (for more details see Docobo et al. 2001a) that has been attached to the Spanish 1.2-m telescope and, in brief, it will be attached to the German 3.5-m telescope at Calar Alto Observatory (Almería, Spain).

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2.2. *Measurements of binary systems*

After a standard reduction procedure and a suitable calibration of data, we will be able to perform accurate measurements of angular separation and position angle. In Fig. 1, we can see the autocorrelation function of the very close binary STF1728 AB.

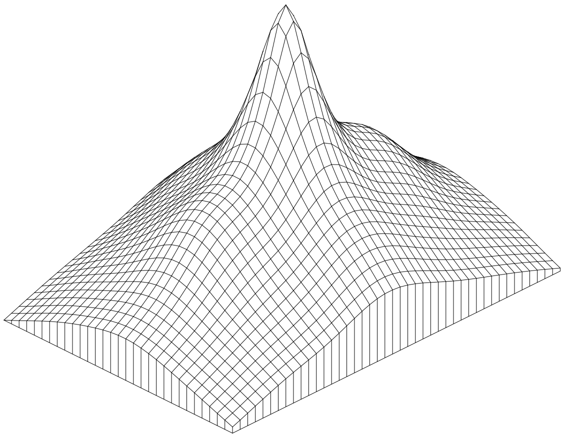

Fig. 1. Autocorrelation function of the very close binary STF1728 AB.

3. DOCOBO'S ANALYTICAL METHOD

As the main advantage of this orbits calculation method (Docobo 1985), it does not require knowledge of the areal constant. Simply, it is based on a mapping from the interval (0, 2π) into the family of Keplerian orbits whose apparent orbits pass through three base points (θ_i, ρ_i; t) (i = 1,2,3).

3.1. *Improved and new orbits*

With such method a large quantity of orbits have been improved. For example, we have calculated for *A* 347 a set of orbital elements (Docobo et al. 2004) that fits better the latter measurements.

On the other hand, we also compute new orbits. One of them is the *HU* 33 orbit (Andrade 2004) which is calculated from 4 visual and 13 speckle measurements.

3.2. *Measurements, orbits and mass determination*

Recently, we have focused our attention into the interesting system STF 3001 (see Fig. 2) in order to determine its mass with more precision than the previous solution (Docobo et al. 2003). We have fixed it in $3.65 \pm 0.60 M_\odot$, according to values obtained by means of other methods.

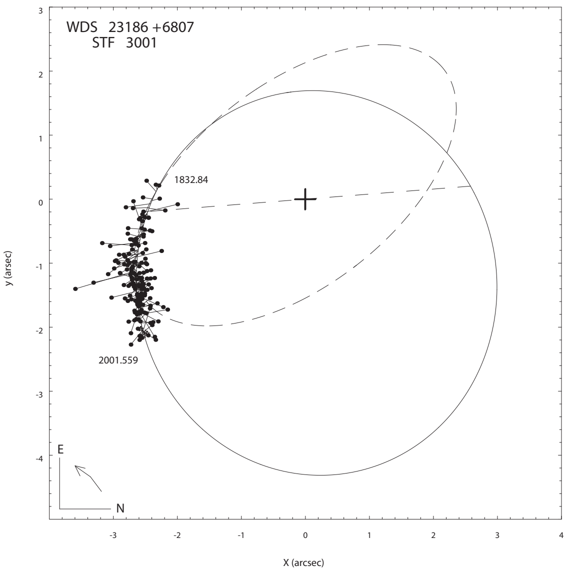

Fig. 2. STF 3001 orbit.

Also, we have a special interest in topics as dynamics of multiple stellar systems in mass-loss scenarios (Andrade & Docobo 2002, 2003, 2004; Docobo 2003).

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