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DIFFRACTO-ASTROMETRY MEASUREMENTS: KINEMATICS OF THE ORION TRAPEZIUM

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RESUMEN

A partir de datos de la compilación histórica del Washington Double Star Catalog (WDS), y los obtenidos al aplicar la técnica de Difracto Astrometría (DiAs) a imágenes públicas de la Wide Field Planetary Camera 2 (WFPC2) del *Hubble Space Telescope* (HST) se realizó el estudio de la cinemática relativa de las componentes del Trapecio de Orión (OT) con una precisión del orden de $\sim$1 km s^{-1}.

ABSTRACT

Using the historical database of the Washington Double Star Catalog (WDS) and astrometric data obtained by applying the Diffracto-Astrometry (DiAs) technique to *Hubble Space Telescope* Wide Field Planetary Camera 2 (HST/WFPC2) public images, the relative kinematics of the Orion Trapezium (OT) stellar components is obtained with a precision of $\sim$1 km s^{-1}.

Key Words: astrometry — open clusters and associations: general — stars: kinematics and dynamics

1. INTRODUCTION

Following Allen et al. (1974, 2004), we apply the novel DiAs technique (Sánchez et al. 2008, 2011, 2013), to the analysis of the kinematics of the Orion Trapezium (OT) brighter components (A to F). Using images of the HST-WFPC2 and data from the historic compilation of the WDS (Mason et al. 2001), we obtain precise kinematical measurements which are in agreement with the model proposed by Allen & Poveda (1974).

2. DATA

The WDS contains the relative astrometry (separation and position angle) of the OT pairs of components back to 1780. However, the measurements have no uncertainties associated. We select the data following the Allen et al. (2004) criteria.

The DiAs technique was applied to 47 images of the OT taken with the HST/WFPC2 in 16 different filters, and spanning over a period of 12 years (1995–2007). These HST public images must include the entire OT (A to F components) in one CCD detector. The relative astrometry attained by DiAs has a precision of $\sim$10 milliarcseconds (Ruelas et al. 2011, 2013).

Joining the astrometry obtained with DiAs to that of WDS, we end up with a high precision astrometric compilation spanning over two hundred years.

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TABLE 1

POSITION ANGLE, SEPARATION AND VELOCITY

Vector	P.A. Slope arcsec yr^{-1}	Separation Slope mas yr^{-1}	$\lvert v_t \rvert$ km s^{-1}
AB	12.17 ± 5.90	1.91 ± 0.15	3.91 ± 0.30
AC	9.83 ± 2.84	-1.16 ± 0.23	2.59 ± 0.41
AD	13.46 ± 1.30	0.84 ± 0.15	3.23 ± 0.17
AE	-39.20 ± 8.10	2.87 ± 0.25	5.91 ± 0.49
AF	-31.25 ± 8.21	6.30 ± 1.19	13.45 ± 2.20
BC	-1.04 ± 4.43	0.57 ± 0.18	1.15 ± 0.37
BD	18.43 ± 2.20	1.24 ± 0.13	4.21 ± 0.16
BE	27.76 ± 5.36	-0.93 ± 0.19	2.46 ± 0.31
BF	-7.49 ± 2.84	3.83 ± 0.17	7.69 ± 0.34
CD	31.68 ± 3.64	0.47 ± 0.19	4.16 ± 0.12
CE	-0.65 ± 5.80	2.03 ± 0.74	4.00 ± 1.46
CF	-61.49 ± 20.48	5.69 ± 0.39	11.53 ± 0.79
DE	28.94 ± 2.16	1.99 ± 0.25	7.52 ± 0.28
DF	-20.99 ± 9.68	-1.18 ± 0.26	3.31 ± 0.43
EF	-29.41 ± 8.57	6.26 ± 0.90	13.69 ± 1.64

3. RESULTS

For every pair of components of the OT, separation and position angle were fitted as linear functions of time by means of the least-squared method (Olivares et al. 2011). The slopes of the trends are shown in Table 1; measurements are given by pairs of components and identified by two letters. The first one corresponds to the component respect to

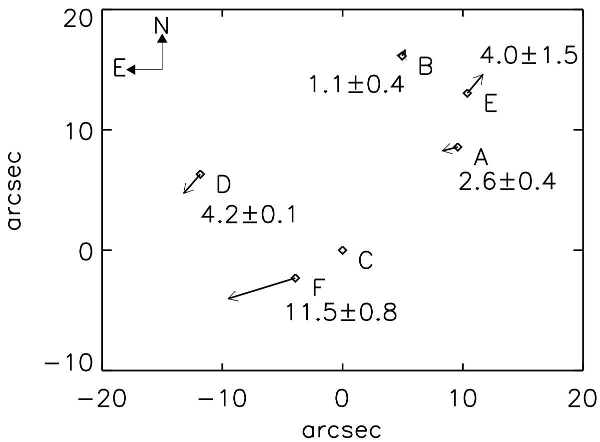

Fig. 1. OT components' position in the year 2007.84, and transversal velocities relative to component C. Values are in km s^{-1}.

which the second one is measured. Columns 2 and 3 illustrate the slopes of the fits for position angle and separation, both in angular units per year. The last column shows the transversal velocity modulus calculated taking the distance to the Orion Nebula as 414 ± 7 pc (Menten et al. 2007).

In Figure 1 a diagram of the OT kinematics relative to component C (the most massive component of the system: 44 ± 7 $M_{\odot}$, Kraus et al. 2009) is presented. The centre of mass should be near this component, thus the escape velocity from the OT can be reliably estimated using this reference frame.

4. DISCUSSION AND CONCLUSIONS

Applying the DiAs technique to the study of the OT, and joining its results to those of the historic compilation of the WDS, allowed us to obtain the kinematics of the system with a precision of the order of 1 km s^{-1}. The kinematical results are the following:

- Component E, though it has a smaller velocity than that reported by Allen et al. (2004) and Sánchez et al. (2008), shows a total velocity of 10.2 km s^{-1} with respect to component A. This value is the vectorial addition of 5.9 ± 0.5 km s^{-1} of transversal velocity, plus 8.3 km s^{-1}of radial velocity as determined by Costero et al. (2008).
- Component F seems to be escaping from the system with a total velocity at least equal to the tranversal velocity $v_t = 11.5 \pm 0.8$ km s^{-1}, but it is probably a foreground star.
- The rest of the OT components have velocities consistent with a bound and virialised system.

The fact that one of the OT components appear to be escaping from the system endorses the dynamical model proposed by Allen et al. (1974). In this model the authors find that in a million years, thirteen out of thirty trapezia systems eject one or two components.

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