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THE TECHNIQUES OF DIFFRACTO-ASTROMETRY APPLIED TO HUBBLE SPACE TELESCOPE AND ADAPTIVE OPTICS IMAGES

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Following the lead established by Allen et al. (1974, 2004) in the study of internal motions in Trapezium-type systems, we decided to investigate the possibility of performing precision astrometry on saturated Hubble Space Telescope (HST) images.

A region widely observed by the HST is that of the Orion Trapezium (OT). The HST archive contains public domain observations obtained with the WFPC2 during a 12 year time interval (1995–2007). For saturated stellar images of the bright OT components –which is the most common case for HST Orion Nebula images– we investigated the possibility of obtaining the position of the photocentre by means of centring techniques which utilise the characteristics of the diffraction pattern: i.e. the “spider” (the image of the secondary mirror support) as well as the concentric diffraction rings. These techniques appear to be very promising for exploiting not only the important HST public image data base but also images obtained at telescopes using adaptive optics techniques (Sánchez et al. 2008).

In what follows we present the improved methodology and analysis techniques used to measure the relative position between components of the OT.

We select HST/WFPC2 images from the Multimission Archive (MAST) at STScI of the OT following criteria dictated by date, filter, exposure time and CCD (PC or WF). See example-image on Figure 1.

We find the stellar photocentre position of all components by following these steps:

(1) Select four points on the spikes and adjust a couple of lines at whose intersection lies an approximate photocentre.

(2) Use this pixel to make perpendicular cuts to the spikes at different positions.

(3) Adjust Gaussians to the intensities of those cuts by the Levenberg-Marquardt method.

(4) Correct the geometric distortion of the coordinates of the Gaussian centres, using the Kozhurina-Platais method.

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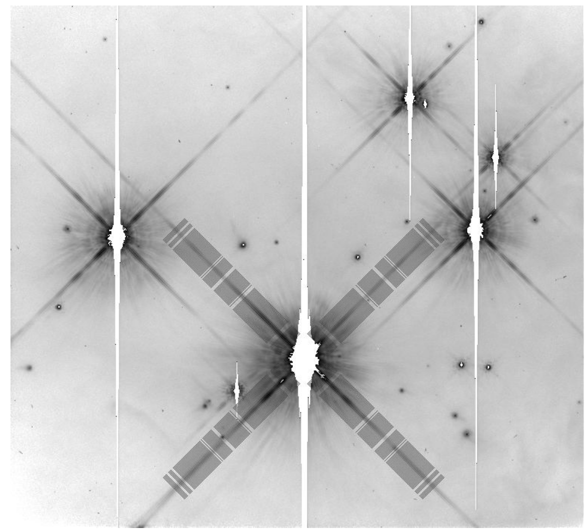

Fig. 1. HST/WFPC2 saturated image of the Orion Trapezium components (12-07-1998, F791W filter, 60 sec exp., PC CCD). Superimposed photocentre analysis cuts of the spikes on C component.

(5) With the centres and uncertainties corrected, trace a couple of lines at whose intersection lies the photocentre.

(6) Do the same for the eight neighbours of the initial pixel.

(7) The final photocentre is the weighted mean of those nine photocentres and their uncertainties.

Finally we measure all component vectors, both separation and position angle (and their variation in time for different image epochs) with its associated uncertainty. Some results are presented in Olivares et al. (2011).

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