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Photometric determination of the system IMF of the 25 Orionis stellar group

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Abstract. We present advances towards the construction of the photometric system IMF of the 25 Orionis stellar group using optical and near-IR photometry from DECam and CIDA Deep Survey of Orion, as well as the public *Hipparcos*, UCAC4, VISTA and 2MASS catalogs. We selected about 1300 photometric member candidates on the basis of their positions in an optical-near-IR diagram, with an estimated efficiency of $\sim$ 80% for the low mass stars. The IMF presented here covers a mass range from 9 M_{Jup} up to 12.9 $M_{\odot}$ and has a shape consistent, in general, with previous studies, but improvements for removing the extragalactic contaminants in the least massive bins are still in progress.

1. Introduction

The Initial Mass Function (IMF) is one of the fundamental gauges in modern astrophysics as well as an essential input to many astrophysical studies. There are numerous IMF studies of several stellar associations (Bastian et al. 2010), however, only a few of them cover the whole stellar mass range in spatially complete surveys (Peña Ramírez et al. 2012).

We have an ongoing project to construct the system IMF of the 25 Orionis stellar group (25 Ori), first with photometric candidates and then with a statistically complete sample of spectroscopically confirmed members in the full estimated mass range of the group (Suárez et al. 2017a). This study is observationally feasible due to the physical properties of 25 Ori (330-360 pc away, $7-10$ Myr old, $\bar{A}_V \approx 0.28$ mag and radius of $\approx 1.0°$; (Briceño et al. 2005, 2007). Part of such spectroscopic follow up is reported in Suárez et al. (2017b). In this contribution we present advances on the photometric version of the 25 Ori IMF down to the planetary mass domain and including the massive members of the group for the first time, extending the previous work by Downes et al. (2014).

We worked with optical and near-IR photometric data from several private and public catalogs in a field of view of 2°.2 diameter around the 25 Ori overdensity (Downes et al. 2014). In Table 1 we summarize the photometric sensitivities and spatial coverages of these catalogs.

We selected as photometric candidates to 25 Ori members the sources lying inside the pre-main sequence (PMS) locus in the Ic vs $Ic-J$ diagram defined by the previously confirmed 25 Ori members. The contamination in this sample of candidates was estimated from a control field observed at the 25 Ori Galactic latitude and from the Galactic population simulated by the Besançon model (Robin et al. 2003). In Figure 1 we show the selection of the 25 Ori member candidates and in Table 2 we summarize the number of sources.

Table 1. Spatial coverage and photometric sensitivity of the photometric data used in this study.

Survey	Phot. Band	Area [%]	Satur. (mag)	Comp. (mag)	Satur. ($M_\odot$)	Comp. ($M_\odot$)	Ref.
DECam	i	≈ 75	16.0	24.0	0.16	0.011	1
CDSO	Ic	100	13.0	20.0	0.85	0.019	2
UCAC4	i	100	6.0	15.0	8.90	0.290	3
Hipparcos	Ic	100	<5.0	—	12.6	—	4
VISTA	J	100	12.0	20.5	0.84	0.010	5
2MASS	J	100	4.0	16.0	17.6	0.035	6

References: (1) PI. G. Suárez; (2) Downes et al. (2014); (3) Zacharias et al. (2013); (4) Perryman et al. (1997); (5) Petr-Gotzens et al. (2011); (6) Skrutskie et al. (2006)

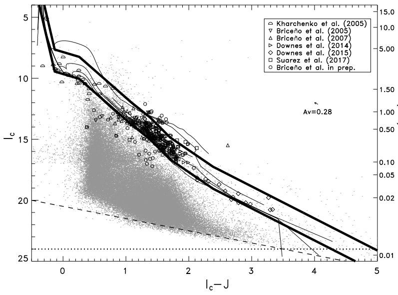

Fig. 1. Color-magnitude diagram used to select the photometric candidates to 25 Ori members. The thick solid lines show the PMS locus defined by the 25 Ori confirmed members (open symbols). The dots indicate the observations toward 25 Ori. The dotted and dashed lines represent the completeness limits of the DECam and VISTA catalogs, respectively. The 1, 5, 8 and 10 Myr isochrones from Baraffe et al. (2015) and Marigo et al. (2017) are indicated by the solid curves.

Table 2. Number of sources inside the PMS locus defined in the Ic vs $Ic - J$ diagram.

Origin	Sources	Ic range
25 Ori FOV	1295	[5.08, 24.85]
Control Field FOV	656	[8.16, 23.3]
Besançon Model	428	[8.07, 18.0]

To estimate the masses of the sources lying inside the PMS locus we worked with the models of Baraffe et al. (2015) for the PMS stars and the models of Marigo et al. (2017) for the stars in the main sequence, assuming a distance of 336 pc (Suárez et al. 2017b) and an age of ~8 Myr (Briceño et al. 2007).

The total mass range covered by our photometric candidates goes from 9 M_{jup} to 12.9 $M_\odot$. In Figure 2 we show the preliminary mass distribution of the 25 Ori photometric candidates before and after removing the contaminants. The peak of the resultant IMF is close to 0.3 $M_\odot$, which is consistent with the study of Downes et al. (2014). For mass values above the IMF peak, the change of the slope occurs at ~ 1 $M_\odot$, as predicted by Kroupa et al. (1993).

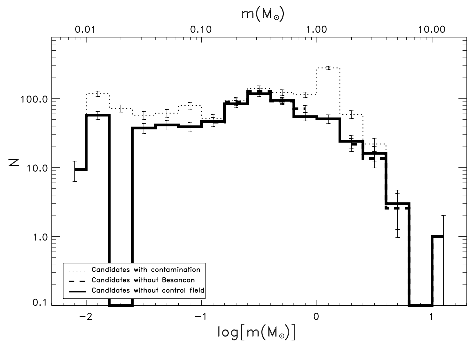

Fig. 2. Preliminary mass distributions of the 25 Ori photometric member candidates.

The shape of the system IMF in the planetary mass domain ($m < 20M_{jup}$) is still affected to some level by the contamination from extragalactic sources. Its correction in this unprecedentedly deep observations of this low extinction region is still an ongoing work. A complete analysis of this study will be presented in Suárez et al. (2017, in prep.).

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