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A UKIDSS-based search for low-mass stars and small stellar clumps in off-cloud parts of young star-forming regions*,**

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Abstract. The form and universality of the mass function of young and nearby star-forming regions is still under debate. Its relation to the stellar density, its mass peak and the dependency on most recent models shows significant differencies for the various regions and remains unclear up to date. We aim to get a more complete census of two of such regions. We investigate yet unexplored areas of Orion and Taurus-Auriga, observed by the UKIDSS survey. In the latter, we search for low-mass stars via photometric and proper motion criteria and signs for variability. In Orion, we search for small stellar clumps via nearest-neighbor methods. Highlights in Taurus would be the finding of the missing low-mass stars and the detection of a young cluster T dwarf. In Orion, we discovered small stellar associations of its OB1b and OB1c populations. Combined with what is known in literature, we will provide by this investigations a general picture of the results of the star-forming processes in large areas of Taurus and Orion and probe the most recent models.

1. INTRODUCTION

The origin of the lowest-mass objects, like brown dwarfs (BDs), produced in star-forming (SF) regions is still an unsolved question in modern astrophysics. The mass function (MF) is the most common observational constraint and, up to date, its form in this mass range, its peaking mass, and weather it is universal or not remains unclear [10]. Additionally, the access of the relation between BD-to-star ratios and stellar densities and better approximations of the disk and binary fractions could help to investigate this interesting question. Some of the recent SF models include the proposition, that these lowest-mass objects could have been ejected during their birth and should therefore be located further away from the main clouds [1]. But, up to date, no or only few searches were conducted in such areas. In this work, we use the Data Release 5 (DR5) of the deep (J<20.2 mag) wide-field near-infrared (NIR) UKIDSS Galactic Cluster Survey (GCS) conducted with WFCAM on the UKIRT Telescope, Hawaii [7]. It delivers photometry in $ZYJHK$ filters in, amongst others, yet unexplored regions away from the main clouds of the very young and nearby SF regions Taurus-Auriga and Orion down to 30 and 45 M_{Jup} for cluster members, respectively. Therefore, we can contribute to the interesting questions for the BD formation by extending the investigated SF regions and thereby get a more complete census of

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them. Additionally, we used the 2MASS survey [5] to calculate proper motions for the brighter objects (J<16.8 mag) which allows us to assign cloud membership and to better select member candidates.

2. SEARCH FOR LOW-MASS STARS AND SMALL STELLAR CLUMPS

For both of our investigated areas, we calculated high-resolution (1.5′ for Taurus and 2.1′ for Orion) NIR extinction maps using the NICER method [9] with $J-H$ and $H-K$ colors.

The 1 Myr old Taurus-Auriga SF region is of rather lower stellar density (250 $M_\odot$ in 300 sq.deg.), located around 140 pc away, and its MF shows a peak at around 0.8 $M_\odot$ [10], possibly related to a dearth of low-mass stars in the already explored parts of the region. Instead, the 30 sq.deg. covered by the UKIDSS GCS are located in the not yet investigated north of its main cloud. There, we searched for low-mass cloud members (<0.5 $M_\odot$) of M-, L- and T type, whereas the finding of the cool and faint BDs (<0.08 $M_\odot$) formed the main goal. Their spectra are dominated by large absorption bands (TiO, VO, CH_4), which allow to search for them via various color and magnitude combinations (using both observed- and dereddened photometry) and signs for youth such as disks, which indicators are amongst others photometric variability and H_α emission. Using another method, we searched for transition disks in a small overlap with Spitzer/IRAC observations by selecting possible members, showing infrared excess in their spectral energy distributions, with the Spanish Virtual Observatory (VOSA, [2]) tool. As well, we found candidates for long-term variability at a 99.5% confidence level, possibly related to binarity or accretion disks, by comparing 2MASS and UKIDSS GCS data.

Furthermore, we analysed the 20 sq.deg. UKIDSS GCS covered area in the 1–5 Myr old Orion region. This area is located around 350 to 460 pc away, shows a much larger stellar density (1000 $M_\odot$ in 300 sq.deg.), and a peak of the MF at around 0.1–0.2 $M_\odot$ [6] , similar to other young SF regions. The region investigated here is located inbetween Orions A- and B-cloud and includes the σOrionis- (already investigated, [8]) and parts of the Trapezium cluster. There, the OB1b and OB1c associations, and a more dispersed population [3] should be overlaid. We searched for small stellar clumps via nearest-neighbor distances (NN2, NN6, [6]) and stellar number counts of candidates previously selected by observed and dereddened photometric- and proper motion membership criteria. The encountered clumps, including amongst others NGC 1981, were then analysed via the minimal spanning tree technique [4]. Additionally, we investigated the MF and density distribution of those small areas and compared it to the well known clusters in that region.

3. FUTURE AND ONGOING WORK

Our ‘hunting grounds’ have remained unexplored until now. In Taurus we hope therefore to encounter many new low-mass stars, and might discover the first cluster T dwarf in that region. We will contribute to the interesting questions for the BD formation and the form of the MF. The various candidates will be observed to assign spectral type, confirm membership, estimate surface gravity and to derive new number frequencies. We will be able to estimate masses and ages of all the sources and can therefore investigate the form of the low-mass luminosity and mass function and compare them to other SF regions. But, above all, we are interested in probing recent SF models and investigating the proposition of the member embryo ejection. We plan to pursue this program to extend in coverage and in depth previous studies in those benchmark SF regions from low-mass stars down to planetary-mass objects.

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