Milky Way's young substellar population

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YOUNG BROWN DWARFS

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Introduction

The existence of brown dwarfs (BDs), the objects with masses below the H-burning limit at ~80 MJup, challenges our understanding of star and planet formation. An overarching issue in most brown dwarf studies is the question of their formation. One of the predictions from several BD formation theories is that **the ocurrence rate of these objects should be a function of the star-forming environment**. The factors that may facilitate BD formation are the following:

- **high gas densities** (Bonnell et al. 2008; Hennebelle & Chabrier 2009; Jones & Bate 2018)
- **high stellar densities** which favour BD formation through ejections (Bonnell et al. 2008)
- **the presence of massive stars**, where BDs can form through photoevaporation (Whitworth & Zinnecker 2004), or by disk fragmentation (Stamatellos et al. 2011; Vorobyov et al. 2013)

Brown dwarfs in nearby SFRs

SONYC (Substellar Objects in Nearby Young Clusters) survey provided a census of the sub-stellar population in several nearby star forming regions (d<300 pc). We find that:

- **Star-to-BD ratio = 2 - 5** (BDs 0.03 - 0.08 $M_\odot$, stars < 1$M_\odot$)
- The **Initial Mass Function (IMF)** below 1$M_\odot$ can be described as a single power law in form $dN/dM \propto M^{-\alpha}$, with the exponent **α = 0.6-1**
- **Planetary-mass objects** with masses below deuterium-burning limit do exist, but **are rare** (20-50 times less common than stars), at least down to ~5 MJup
- Please visit browndwarfs.org/sonyc

Brown dwarfs in massive clusters

We extend our study to two massive young clusters:

- **RCW 38**: d~1.7 kpc; contains a rich population of OB stars; its stellar density is an order of magnitude higher than that of the Orion Nebula Cluster (ONC)
- **NGC 2244**: d~1.6 kpc; characterized by a substantial population of OB stars, but with a stellar density compared to the nearby SFRs, like Cha-I or Lupus 3.

The power-law exponent α is found to be in agreement with those in nearby SFRs (Fig 1.), as well as the number ratio of stars to BDs (Fig. 2). Our results reveal **no clear evidence for variations** in the formation efficiency of BDs and very low-mass stars **due to the presence of OB stars, or a change in stellar densities.** Our findings rule out photoevaporation and fragmentation of infalling filaments as substantial pathways for BD formation.

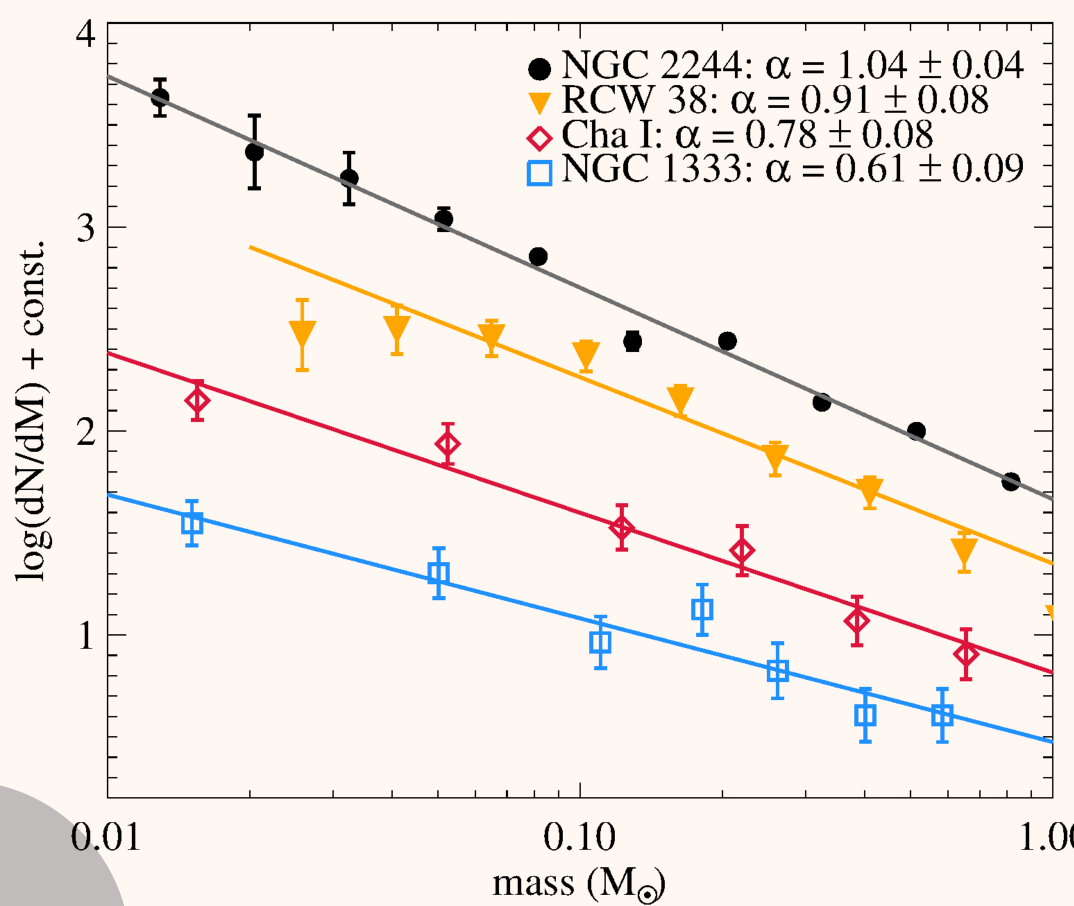

Fig 1. The low-mass IMF in two nearby SFR (NGC 1333 and Cha I), compared to the IMF in massive young clusters rich in massive OB stars (NGC 2244 and RCW 38), and high stellar densities (RCW 38). Data from Scholz et al. (2012), Muzic et al. (2015, 2017, 2019).

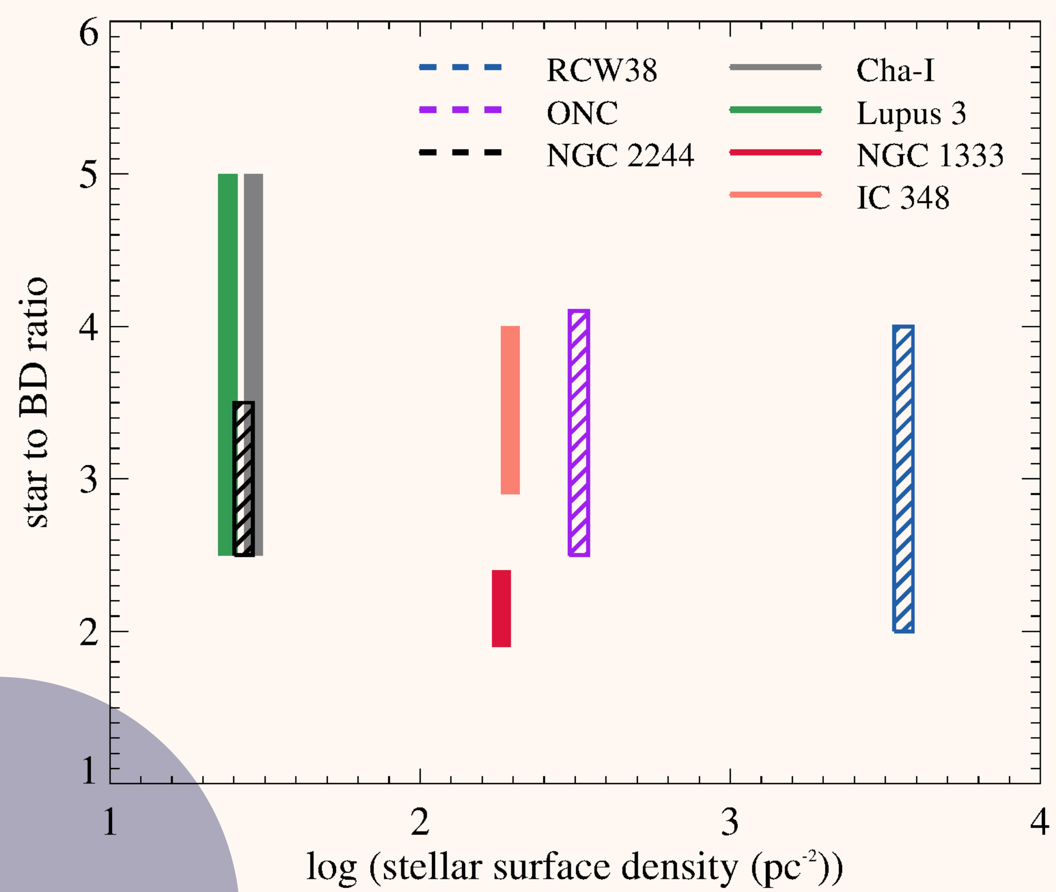

Fig 2. Dependence of the star-to-BD dwarf number ratio on cluster surface density. The filled polygons represent the regions with few or no massive stars, while the dashed ones mark the regions with substantial OB star population. Figure from Muzic et al. (2019).

References: Bonnell et al., 2008, MNRAS, 389, 1556; Hennebelle & Chabrier 2009, ApJ, 702, 1428; Jones & Bate 2018, MNRAS, 478, 2650; Muzic et al. 2015, ApJ, 810, 159; Muzic et al. 2017, MNRAS, 471, 3699; Muzic et al. 2019, ApJ, 881, 79; Scholz et al. 2012, ApJ, 756, 24; Stamatellos et al. 2011, MNRAS, 413, 1787; Vorobyov et al. 2013, MNRAS, 433, 3256; Whitworth & Zinnecker 2004, A&A, 427, 299.

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