Mass Segregation in Young Stellar Groups

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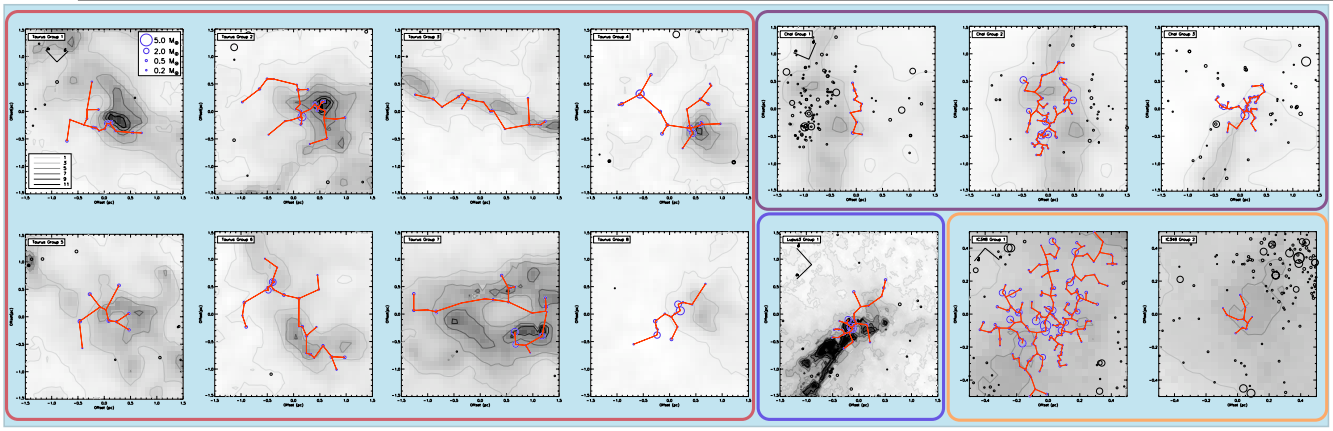
Does mass segregation extend to systems smaller than clusters? Yes!

Nearby star formation occurs in a more isolated mode than the dominant clustered formation mode. Do properties common to clustered formation extend to the more isolated case? This transition was probed by Testi et al (1999) who found cluster richness (total number and surface density of members) decreased from earlier to later Be-type stars (decreasing mass), with few clusters detected at lower-still masses. What about mass segregation in similar systems? We analyze nearby young stellar groups (Fig 1) which span a range of maximum mass members from late-B to late-K and are complete down to late-M. Most (12/14) of our stellar groups show evidence for a centrally-located most massive member, irrespective of the mass of that star (Fig 2), indicating the groups have (limited) mass segregation. These groups are no more than ~1 crossing time old, implying that the most massive group member formed in situ, and that some of the processes which operate to form large clusters still appear to be at play even in small groups.



Taurus groups: Froebrich et al (2007) extinction

Chal groups: Dobashi et al (2005) extinction

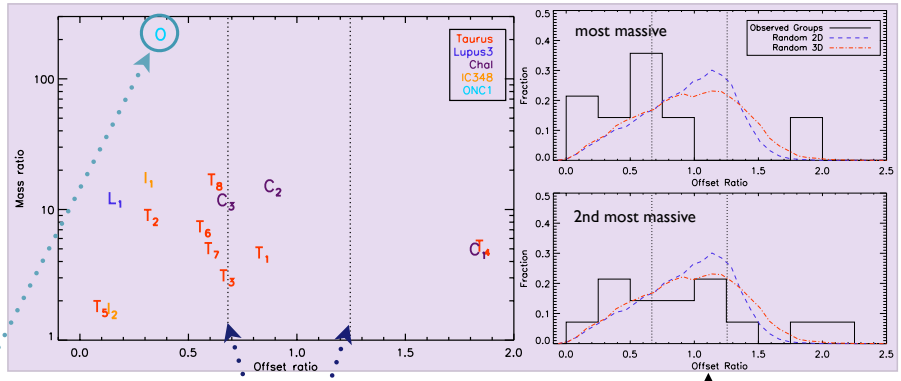
Lupus3 group: Teixeira et al (2005) + Rowles & Froebrich (2009) extinction

IC348 groups: Rowles & Froebrich (2009) extinction

Figure 1: Groups identified. YSOs are shown as blue circles with radius scales with mass. MST structures are shown in red, and the extinction is in greyscale.

Figure 2: Ratio of maximum mass in group to median mass versus ratio of offset from group centre (max. mass member to median value)

ONC1 data from Hillenbrand (1997): mass segregated larger clusters show similar offset ratio



25th and 75th quartile values for random distribution

offset ratios versus random 2D and 3D distributions

1. Mass Segregation

Fig 2 shows groups have much smaller offset ratios than expected from random sampling; the location of the second most massive member is ~consistent with random.

The groups are ~1 crossing time old, so the stellar locations are roughly primordial. The lack of crowding and excellent completeness in our catalogs allows us to measure mass segregation with high confidence.

2. Conclusion

Young nearby stellar groups show evidence of mass segregation, limited to ~the most massive group member.

More details for the experts:

3. Dataset

The YSO catalogs we analyze are primarily from Luhman et al (2010) & Rebull et al (2010) for Taurus, Luhman et al (2007) for Chal, Comeron (2008) for Lupus3, and Lada et al (2006) & Muench et al (2007) for IC348. Proper motion data was used where available in the catalogs to verify group members.

Masses were estimated for the YSOs following Luhman et al (2003) using Palla & Stahler (1999), Baraffe et al (1998), and Chabrier et al (2000) models with decreasing mass. The mass order is unaffected by the model adopted.

References

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4. Minimal Spanning Trees

We identify groups using MSTs, following Gutermuth et al (2009). YSOs are connected via their nearest neighbours (Fig 3, left). The distribution of nearest neighbour ('branch') lengths are then analyzed, and branches longer than the break point in the cumulative distribution are removed (right). YSOs which remain in groupings of > 10 members were considered to be groups.

Figure 3: Minimal Spanning Trees. *Left*: the complete MST structure in Chal; crosses indicate the YSO positions and red lines show the MST. *Right*: a magnified view of the final groups identified.