Unravelling the Story of Massive Star Formation: Clues from the YSOs of NGC2264

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Structure of Talk

- NGC2264
- What’s special about it?
- INDICATE
- What did we find?
- Conclusions
NGC2264

- Embedded cluster in Mon OB1
- Distance ~720pc
- Age spread of ~4-5 Myr (e.g. Mayne & Naylor 2008, Venuti et al. 2017)
- 1 O-type star (binary), SMon
- North older
- Star formation active
[Catalogues: Rapson et al.(2014) + Kuhn et al.(2014)]

Buckner et al. (A&A, in prep)
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• Distinguishes clustered point from random

• Quantifies the DEGREE of clustering of each point

• Assigns an index to each point
The Index

• An evenly spaced control field of the same size & parameter space as dataset is created
• Calculate average distance to point’s 5th nearest neighbour in control field
• Count how many neighbours are within that radius for each point in the dataset
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\[ I = \frac{3}{5} = 0.6 \]

\[ I = \frac{20}{5} = 4 \]

Buckner et al. (2019)
The higher the index $\rightarrow$ more spatially clustered the star is
WAIT! WAIT! WAIT! WAIT!

HOLD ON A SECOND!
I want to know more about this!
In detail here:

✓ Buckner et al. (2019)
Bibcode: 2019A&A...622A.184B

✓ Demonstration on Thursday
Location: The Hospitium

Free Stuff!
(1) As the YSOs evolve they become more spatially dispersed
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(2) The degree of clustering also decreases as they evolve.
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![Bar chart showing typical index values of clustered sources for Class 0/I, Class II, Class TD, and Class III. The values decrease from Class 0/I to Class III.]
(3) Less objects are spatially clustered in (older) North
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- North: 6.9% clustered, 93.1% dispersed
- South: 29.0% clustered, 71.0% dispersed
(4) Clustered objects in North are less tightly so than in South.
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Stars are forming in a tightly clustered environment, then dynamically evolving to form part of NGC2264’s dispersed population.
Class II
1.132 mas/yr

Class III
2.047 mas/yr

Buckner et al. (A&A, in prep)
Internal PMs for within 0.05° of SMon

- Green = Class II
- Purple = Class III
Summary

• Characterised the spatial & kinematic behaviour of YSOs in NGC2264

• Distinct difference in clustering behaviour by evolutionary stage

• More evolved objects → More dispersed

• Typical PM’s of Class III objects are ~2x larger than Class II

• Argue dynamical evolution rather a primordial signature of SF

• Effect of stellar feedback from SMon is significant within 0.05°