A METHOD TO ANALYSE VELOCITY STRUCTURE

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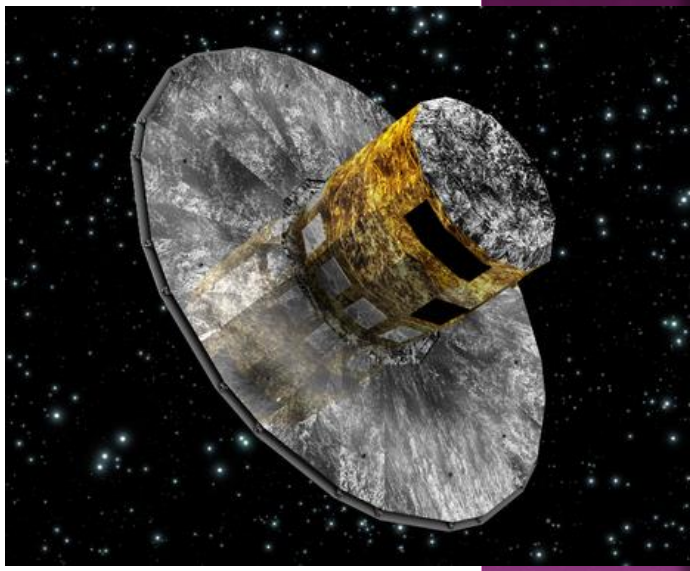
INTRODUCTION

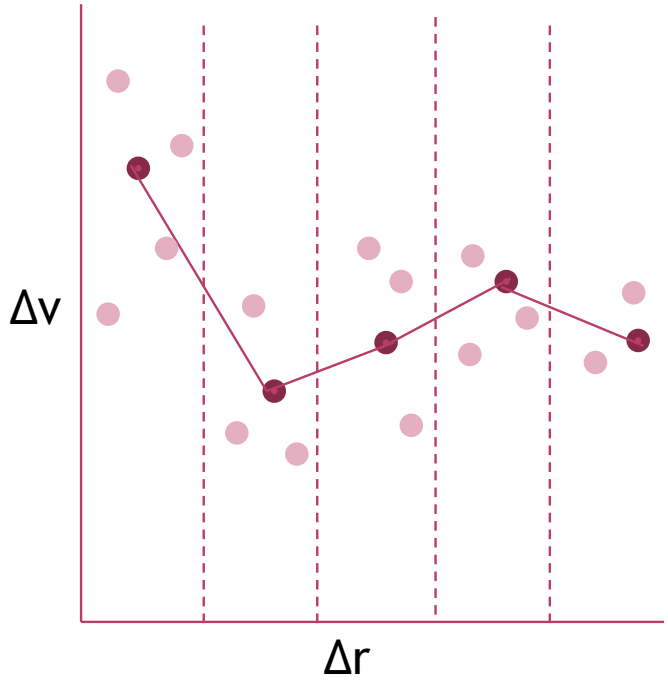


- There are methods looking at spatial structure of star clusters
  - Q, Λ, Σ … [1], [2], [3]
- Learn a lot from that
- What about velocity structure?
- Very relevant right now (Gaia + others)

[1] Cartwright & Whitworth (2004) MNRAS 348, 589-598
[2] Allison et al. (2009) MNRAS 395,1449–1454
[3] Maschberger & Clarke (2011) MNRAS 416, 541-546

THE METHOD IN BRIEF

- Calculate Δr and Δv for every pair
- Sort into Δr bins
- Average Δv in each bin
- Plot Δr against Δv
- Not going into errors



DEFINITIONS OF ΔV

- Magnitude definition Δv_M
  - $| \mathbf{v}_i - \mathbf{v}_j |$
  - Always positive
- Directional definition Δv_D
  - $\frac{d\Delta r}{dt}$
  - How fast moving towards/away

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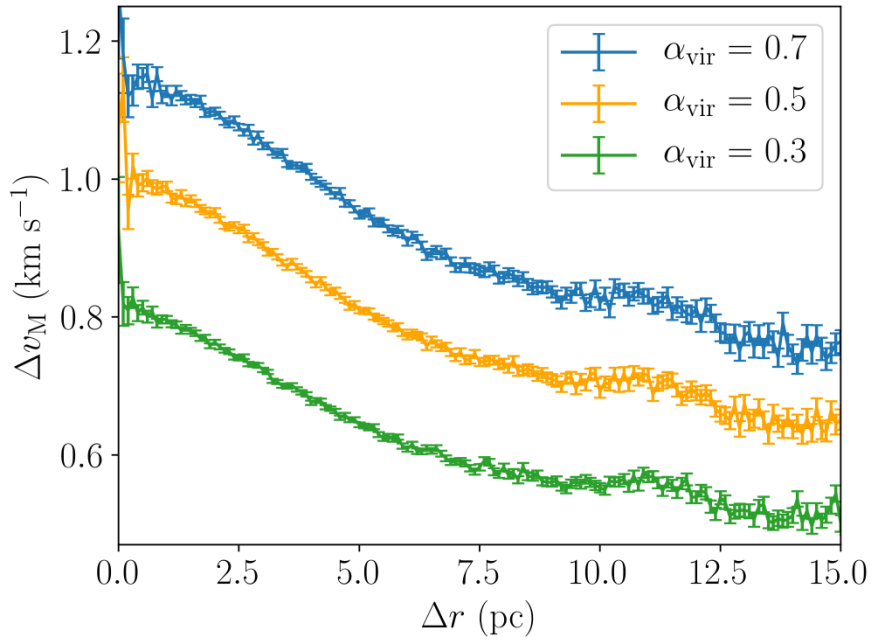
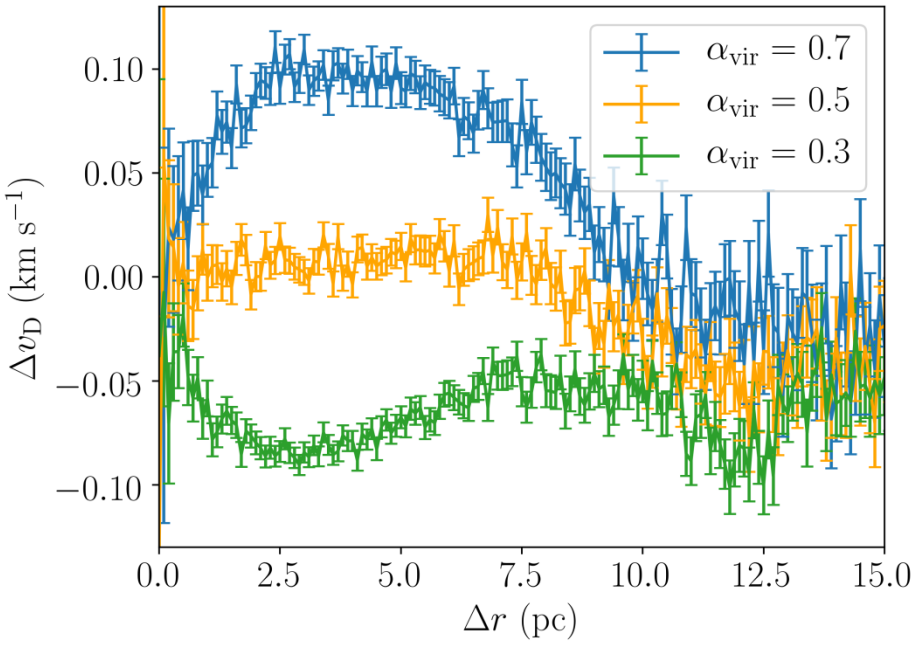
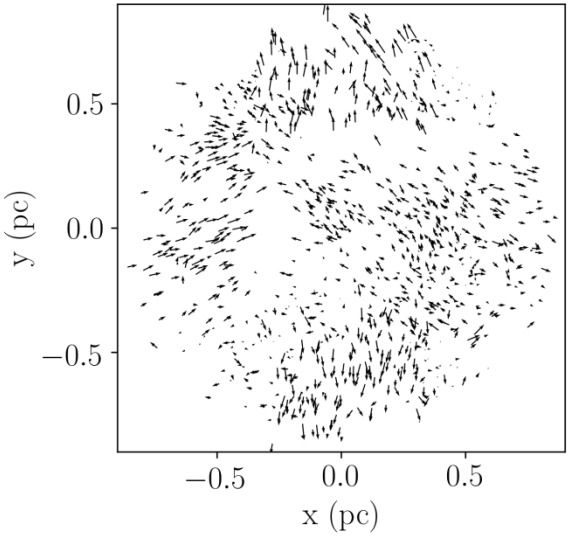
PLUMMER SPHERES

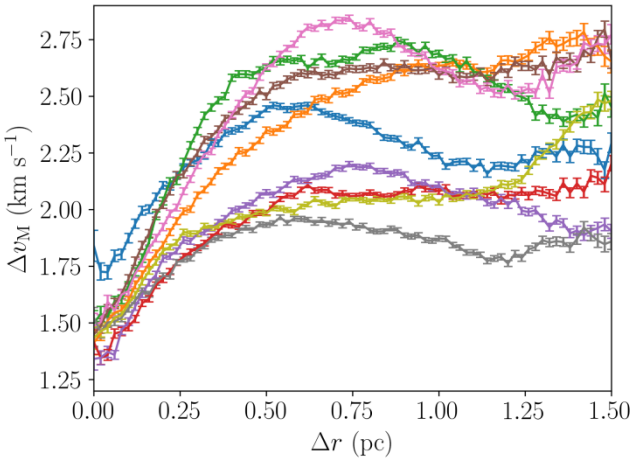
- Low Δr high Δv
- Stars in core move faster
- Clear difference
- Pulls out collapse / expansion

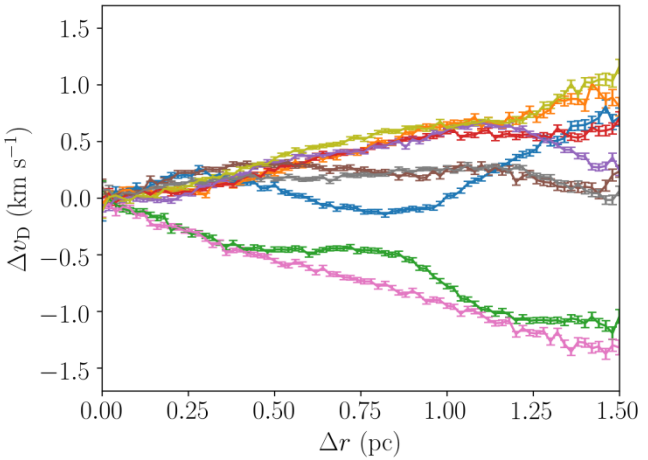


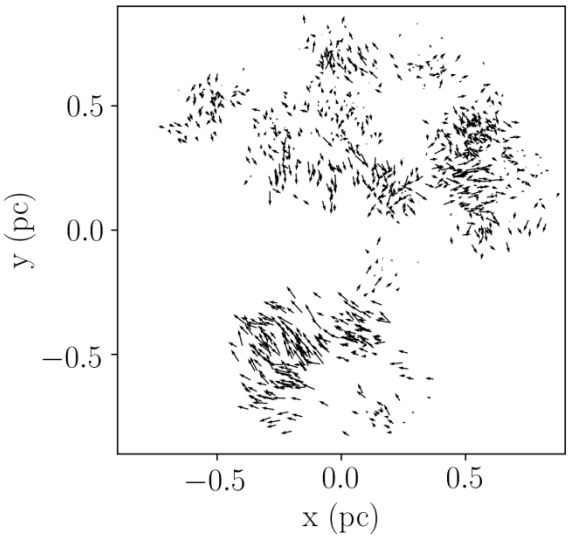


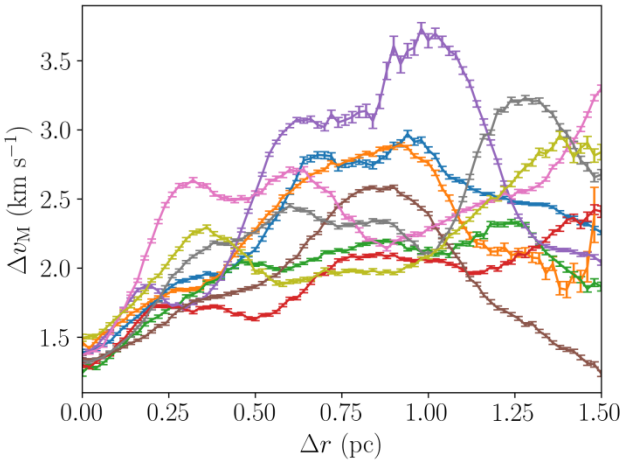
SUBSTRUCTURED DISTRIBUTIONS

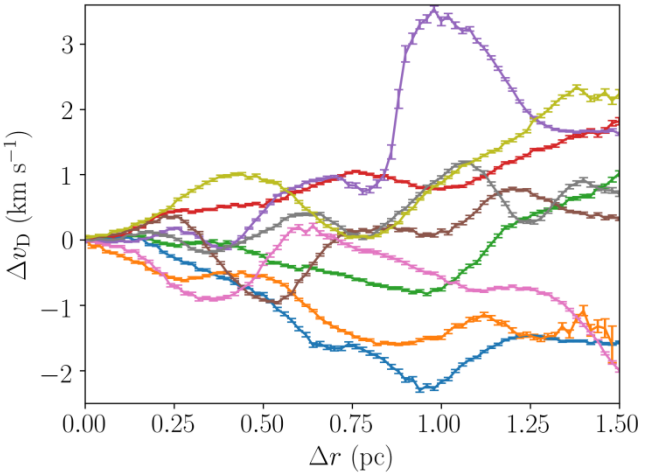












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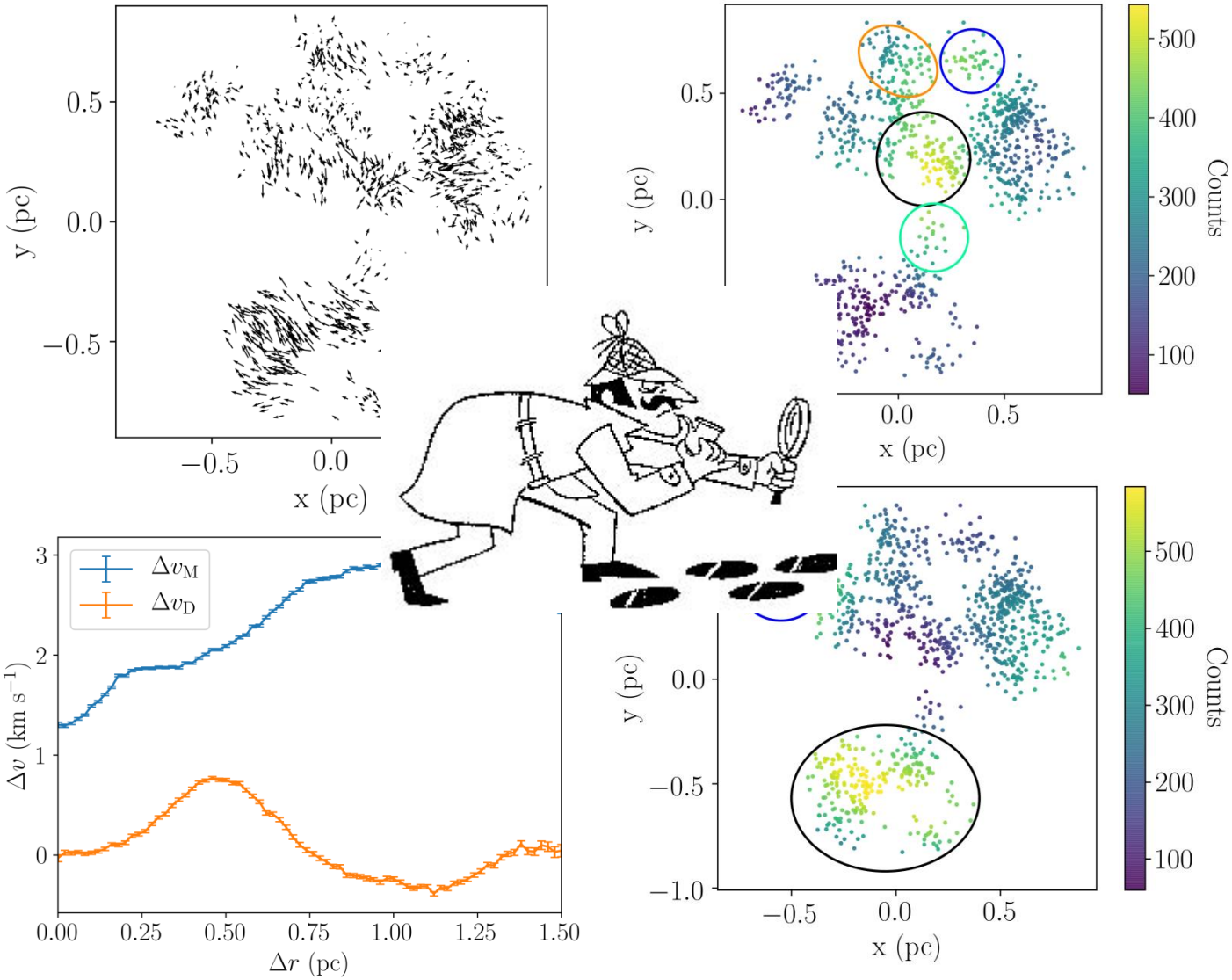
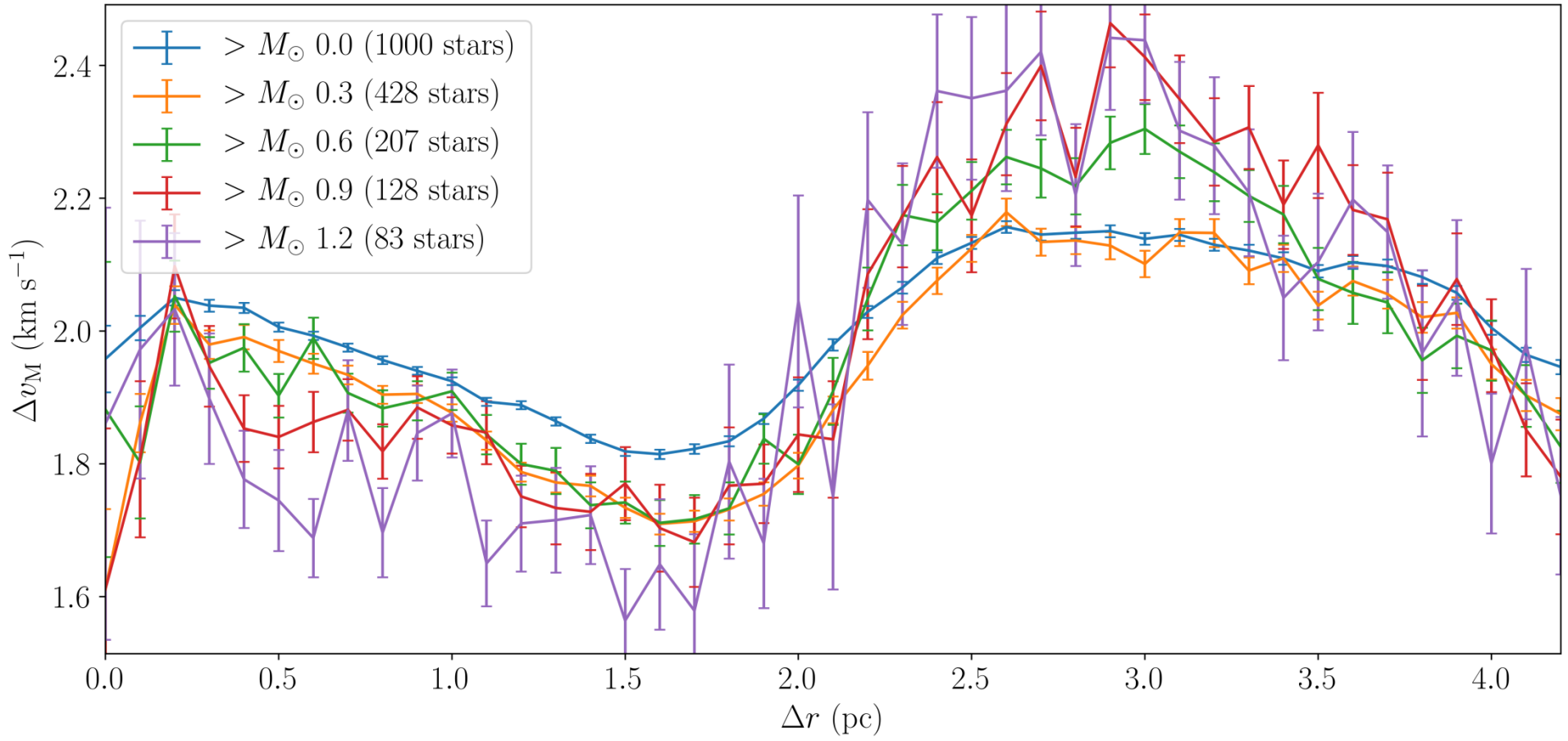


ERRORS (LOW MASS STARS)

- Magnitude definition



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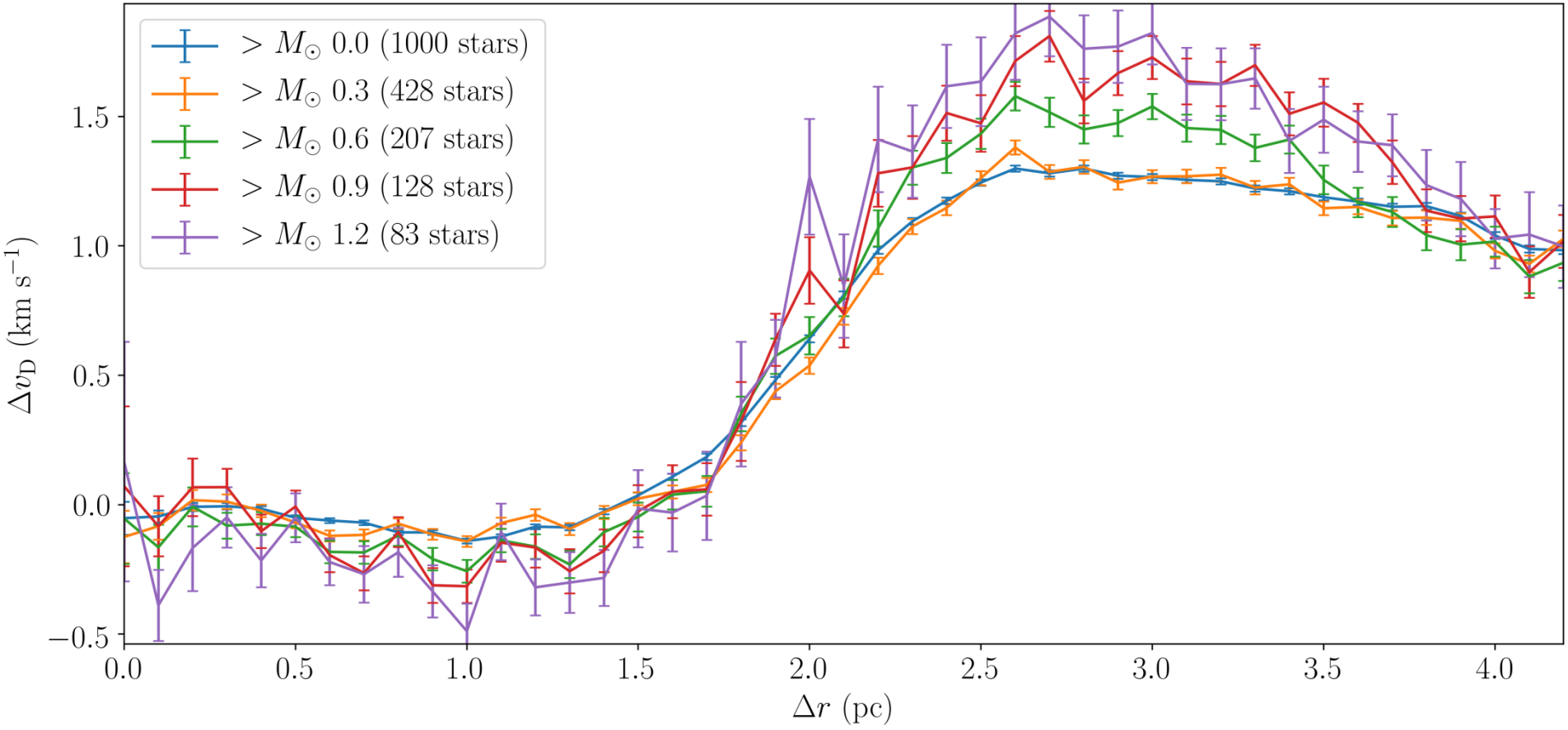

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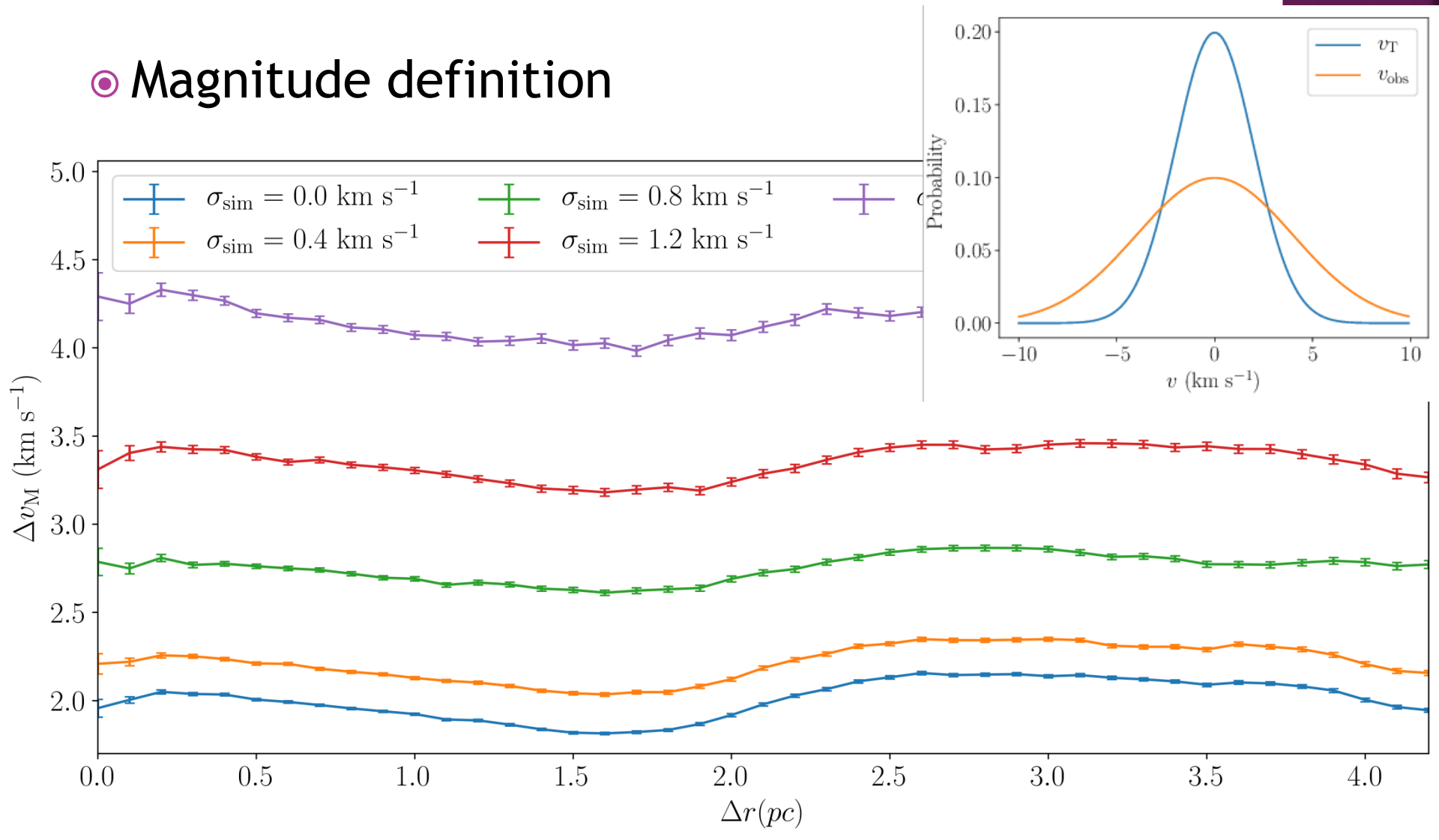

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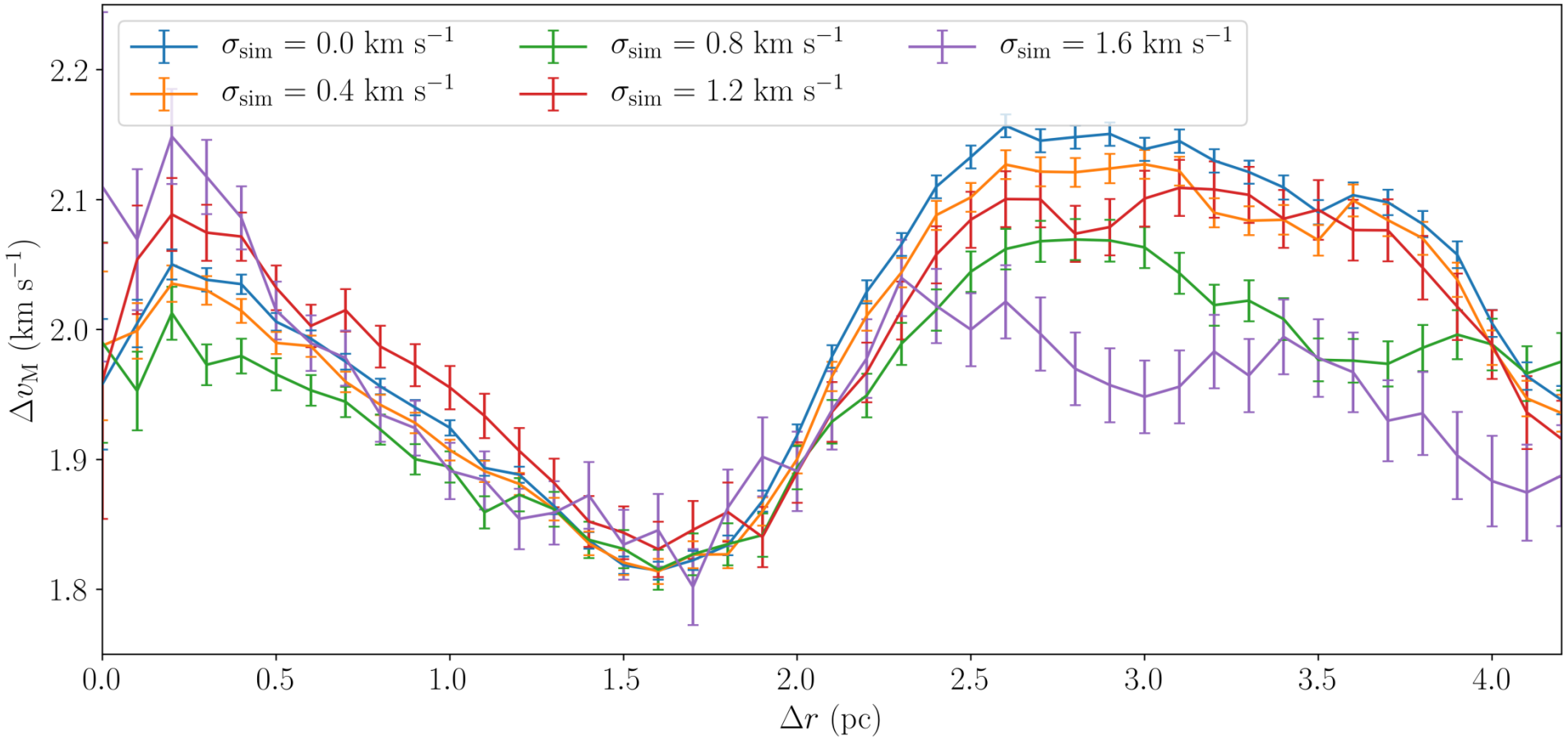

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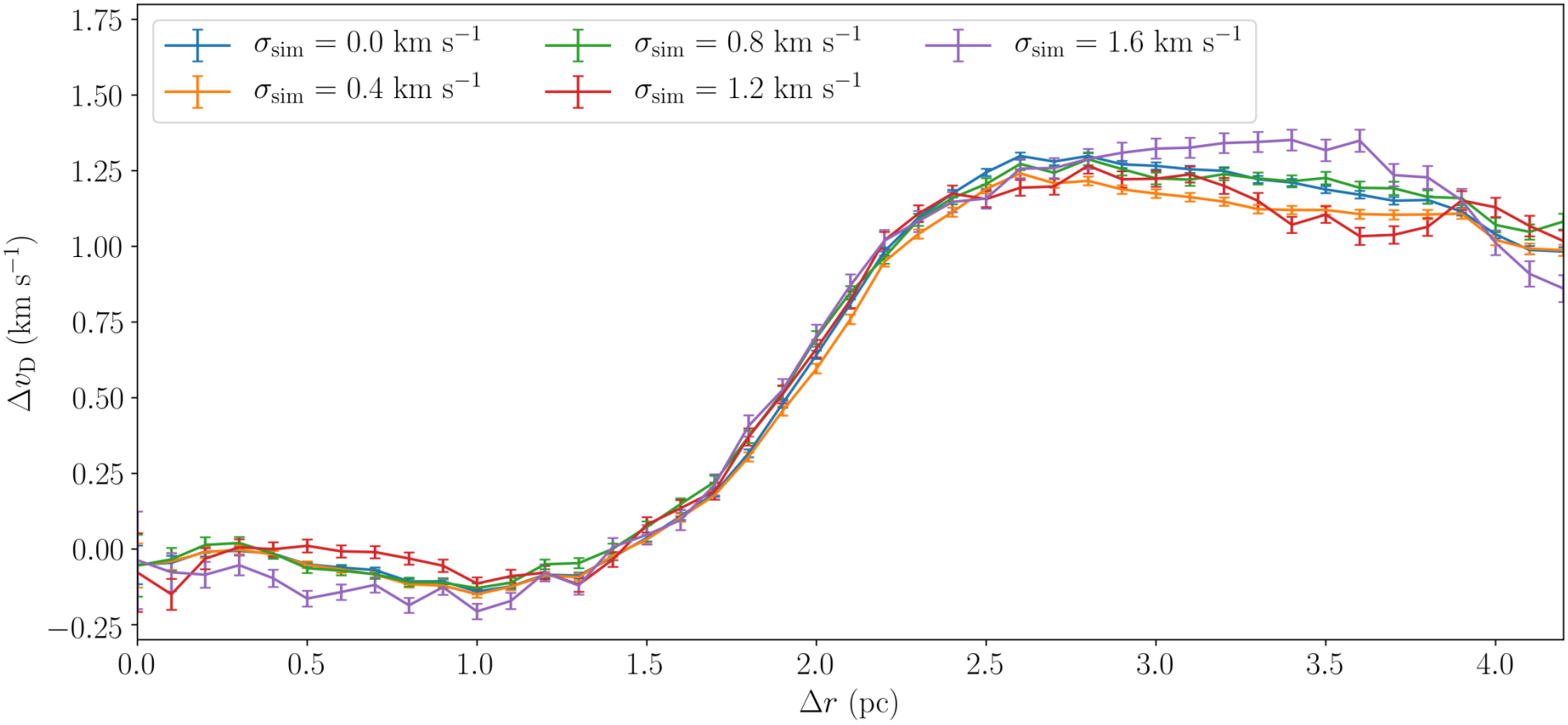

ADVANTAGES

- 1D, 2D, 3D
- Any frame of reference
- No assumptions about physical morphology
  - E.g no need to define cluster centre/radius
- Online - https://github.com/r-j-arnold/VSAT

CONCLUSIONS

- Developed a method for studying velocity structure
- Two definitions of Δv
- Robust
- Future work: apply to observational data