Rotational Support of Giant Clumps in High-z Galaxies

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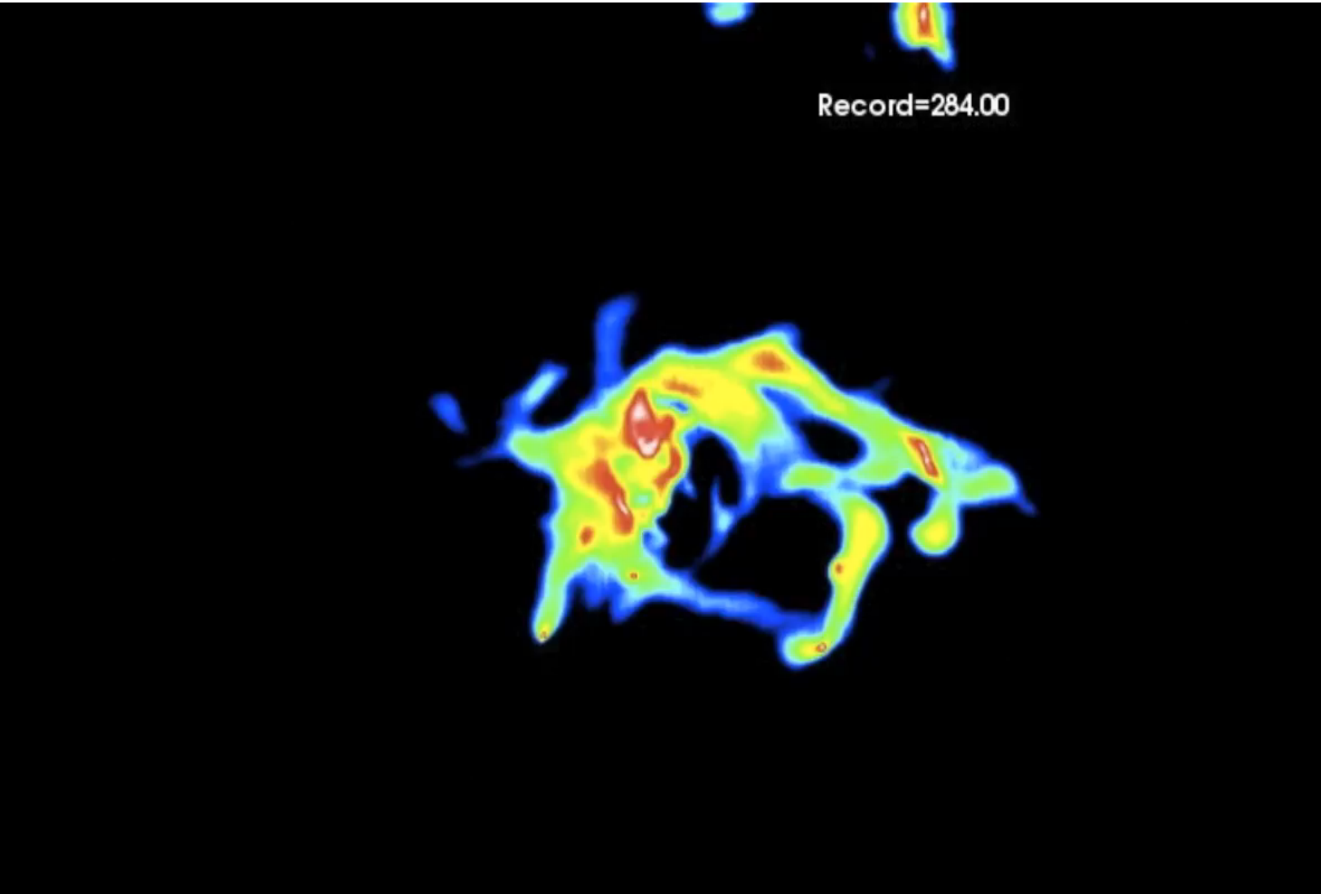
Galaxy formation simulations done with ART

- AMR code: HYDRO-ART (Kravtsov et al 1997, Kravtsov 2003)
- Gas Cooling, Star Formation, Stellar Feedback (Ceverino & Klypin 2009; Ceverino, Dekel and Bournaud 2010)
  - Cooling below 10^4 K (minimum temperature of 300 K).
  - Thermal feedback + runaway stars.
  - Things that we are NOT doing (although it is tempting): Shutdown cooling, shutdown of hydrodynamical forces.
- Sample of halos with a virial mass between 0.5-1 x 10^{12} $M_\odot$ at z=2
- Maximum resolution of 30-70 pc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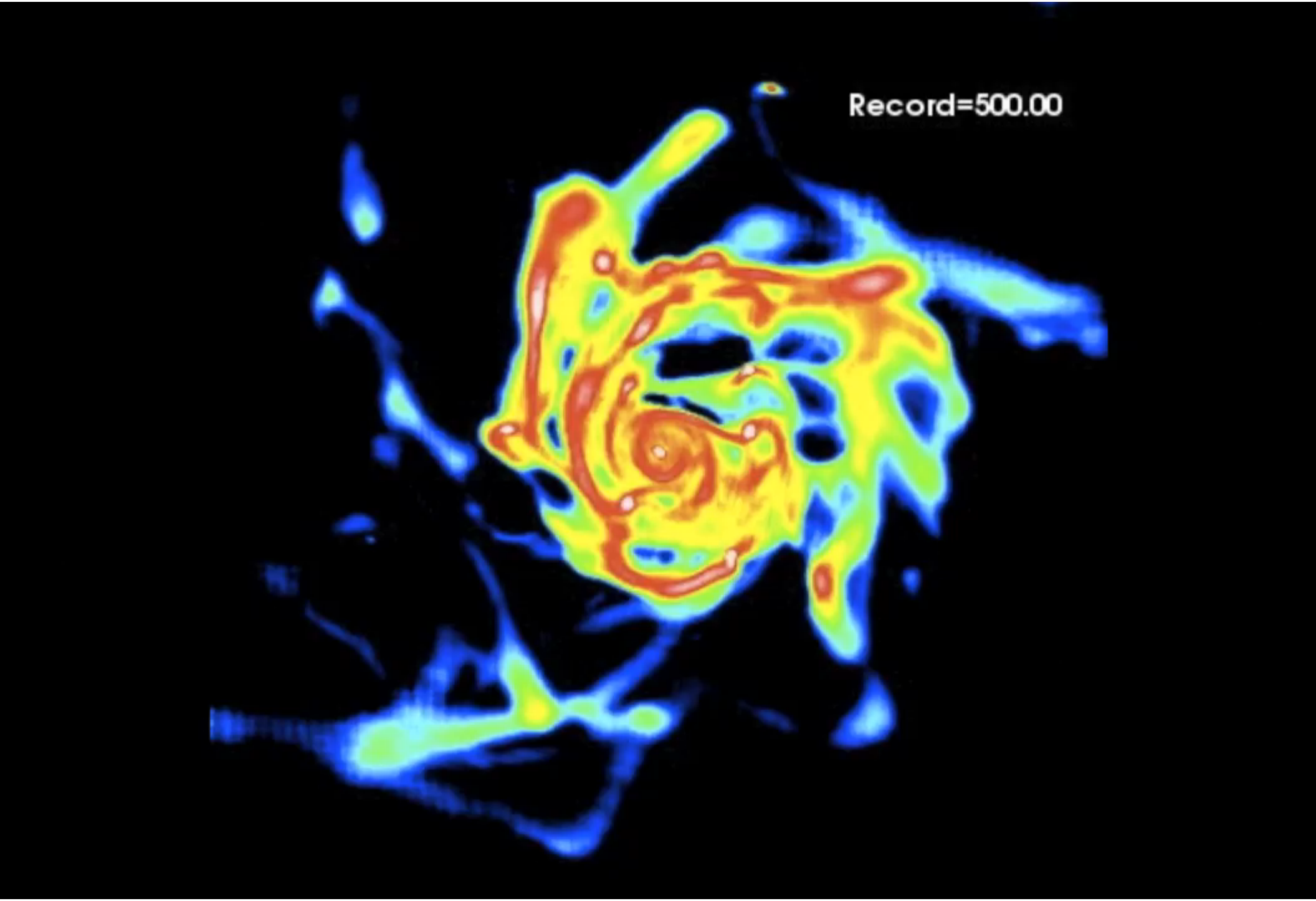
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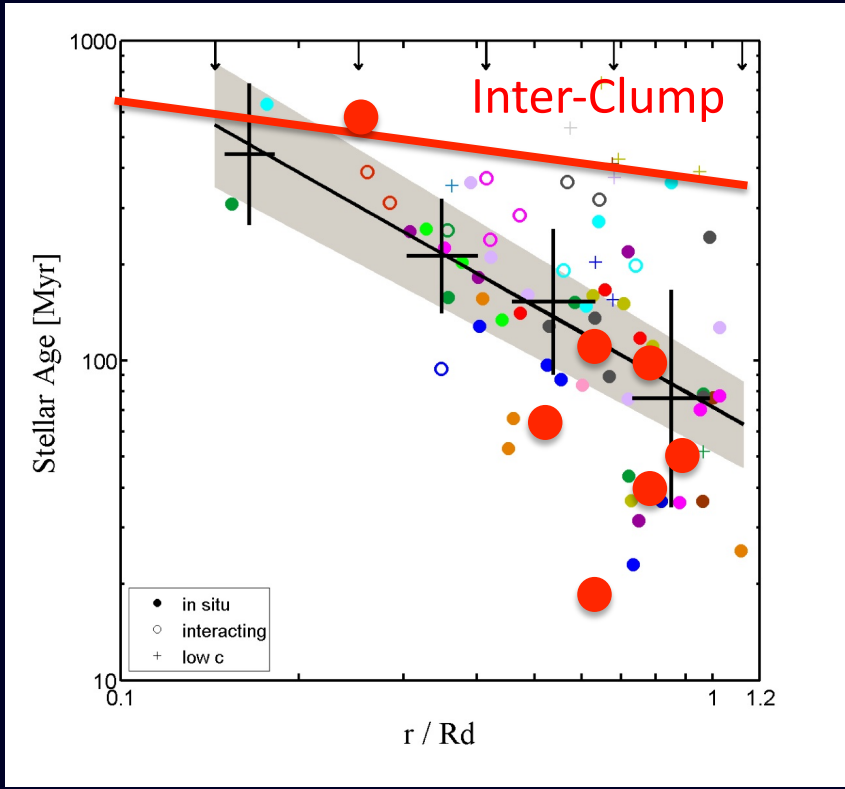
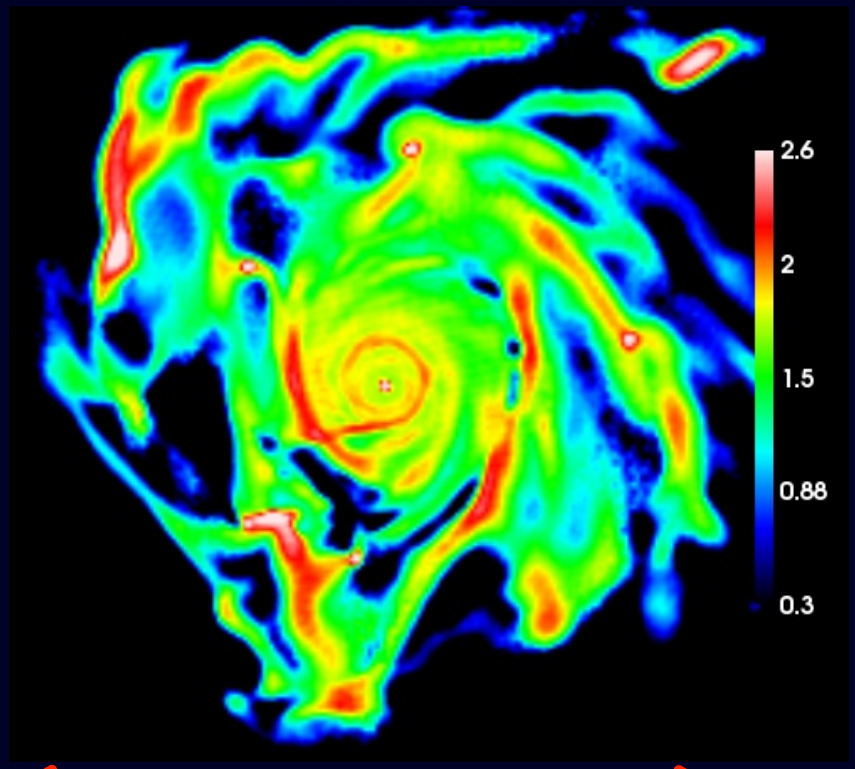
Clump's age gradient



- Prediction of the clump migration scenario
- 1/R age gradient
- Consistent with observations (Forster Schreiber et al. 2011)

Clumps support

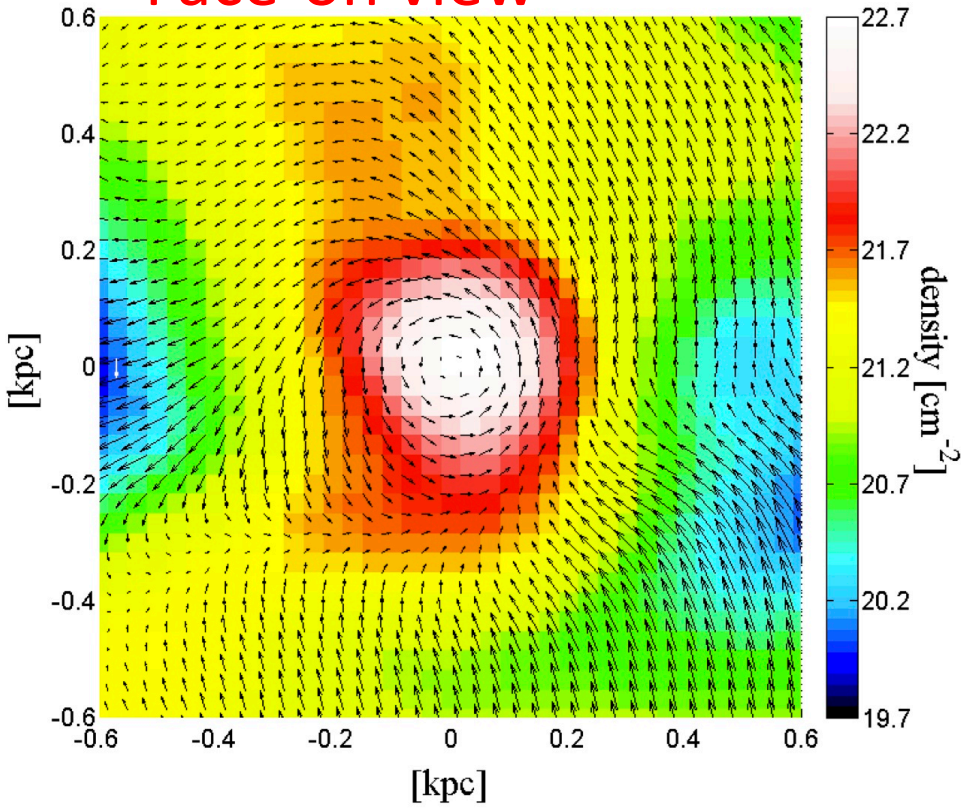
- Are the clumps supported by…
  - Rotation
  - Random motions/ pressure
  - Artifacts ?



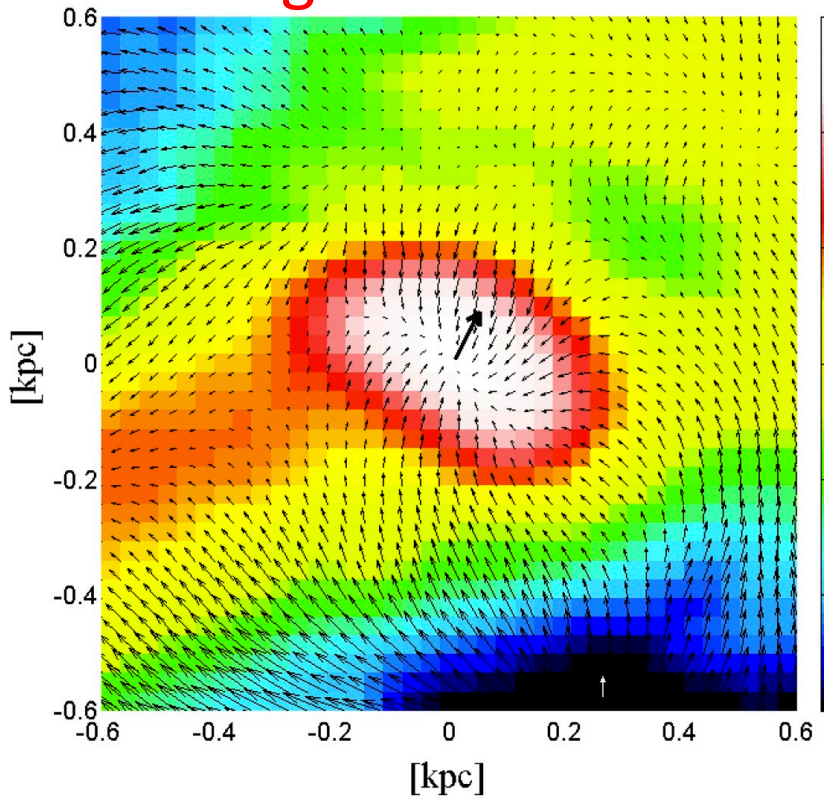
Clumps kinematics

Vc=70 km/s

Face-on view



Edge-on view

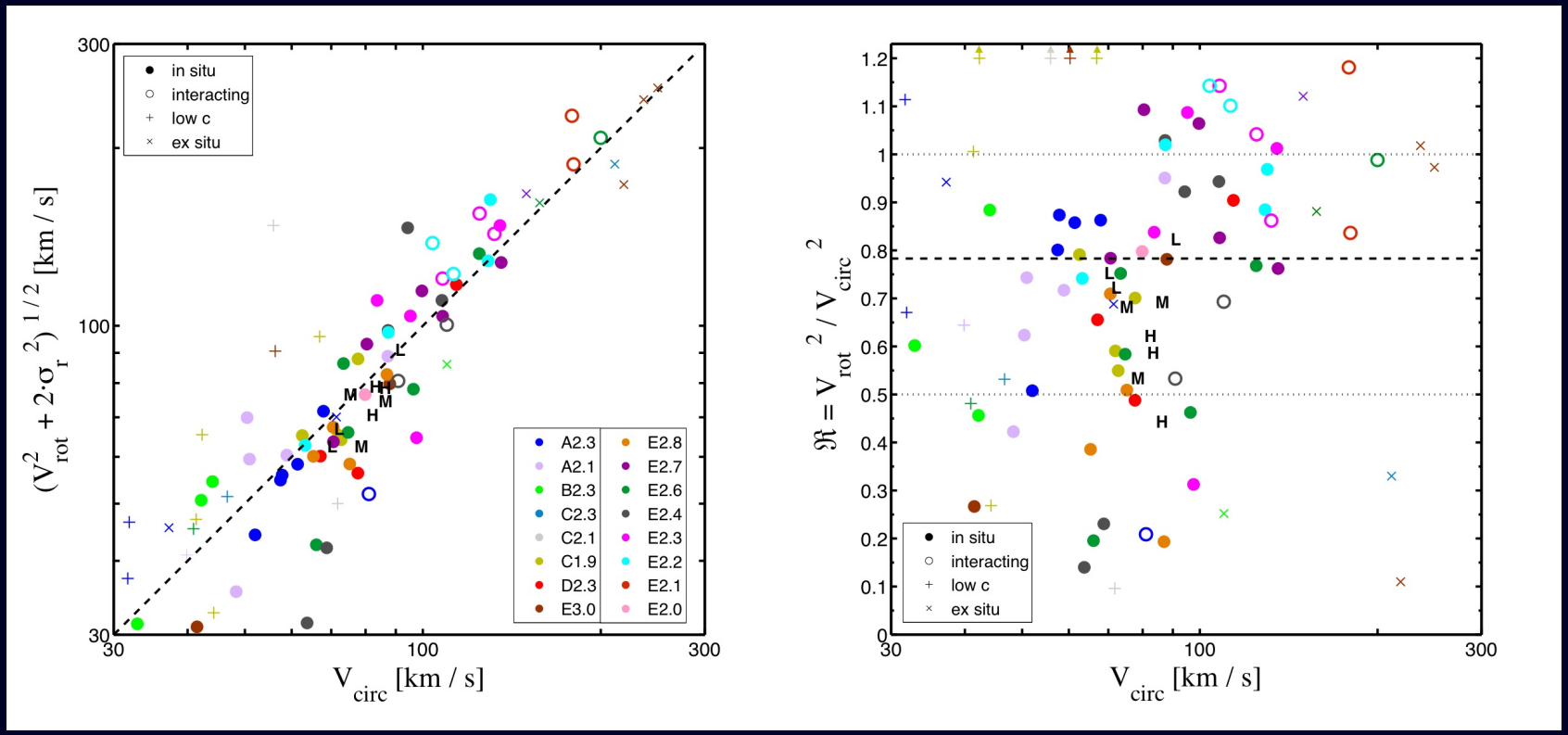


1.2 kpc

Clumps Statistics

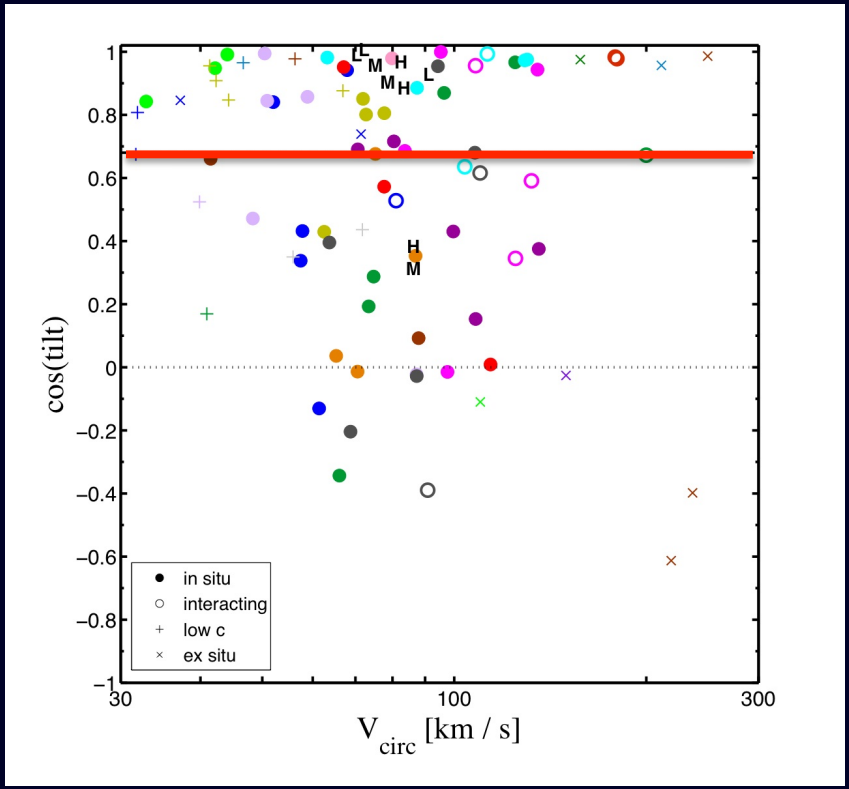
$V_{circ}^2 = V_c^2 + 2\sigma_r^2$

$\mathscr{R} = (V_c / V_{circ})^2$

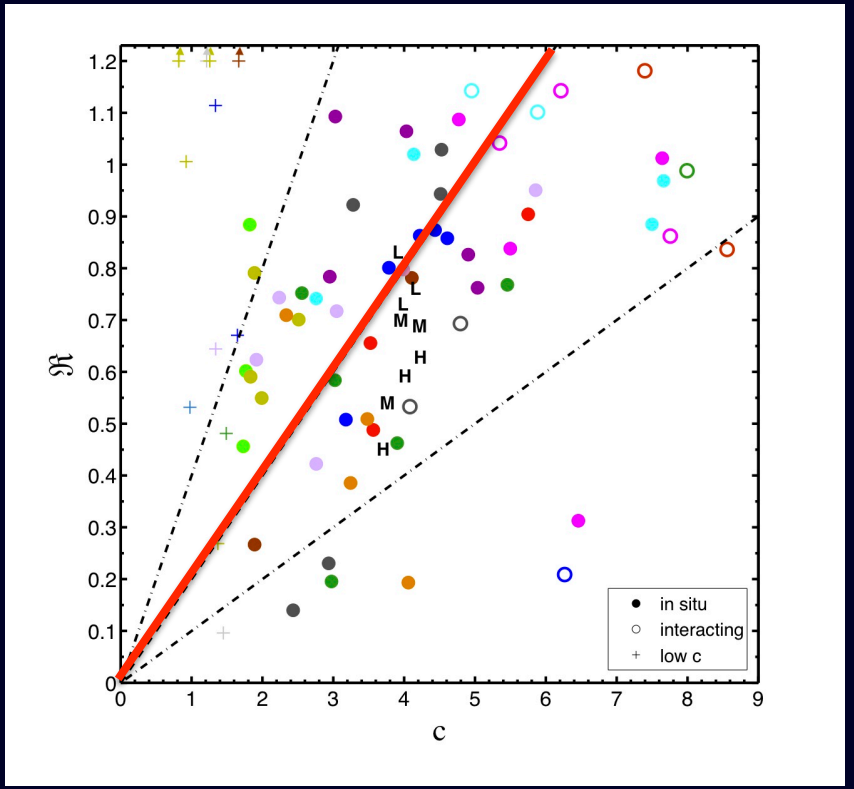


Clumps Statistics II

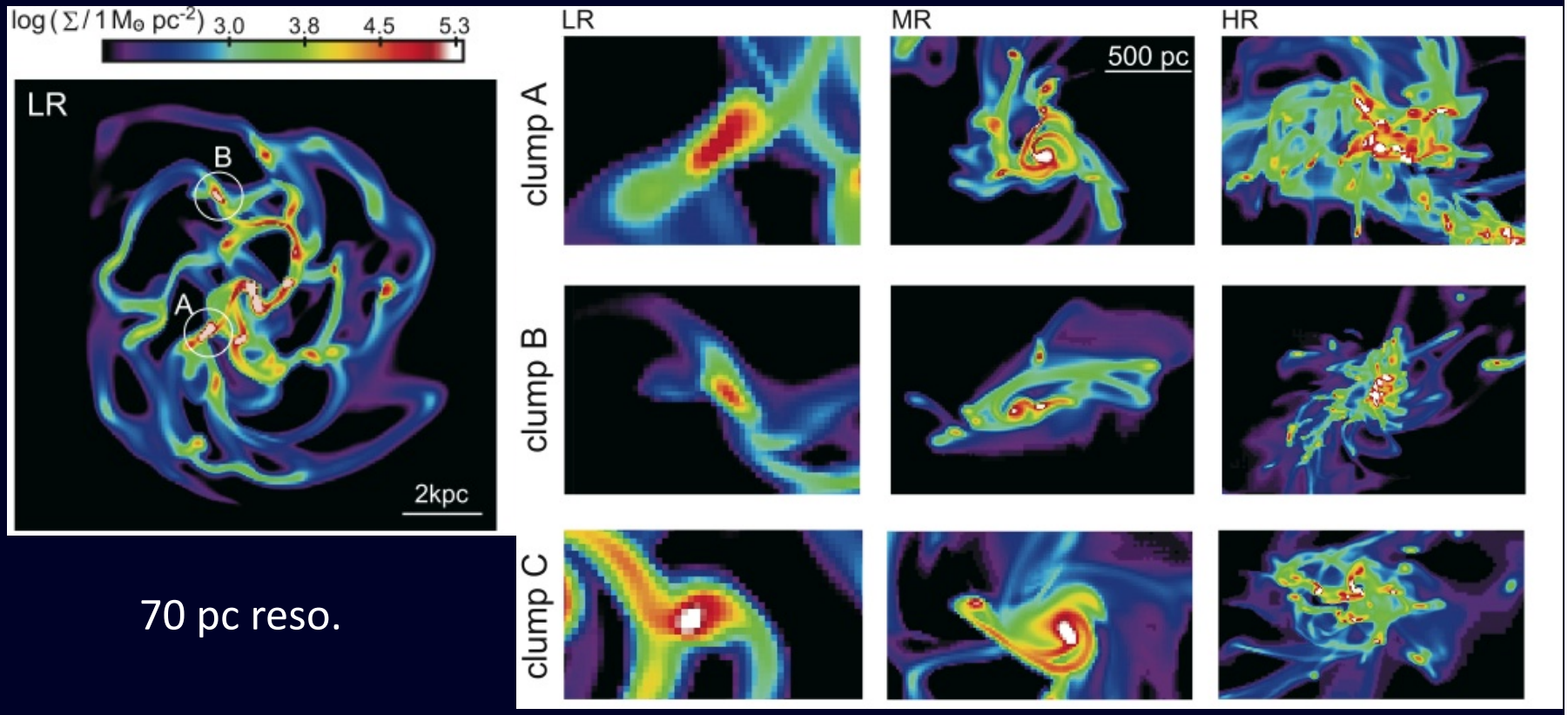
mean tilt of 45 degrees



$\mathscr{R}$ = 0.2 c



Isolated Disc Simulations

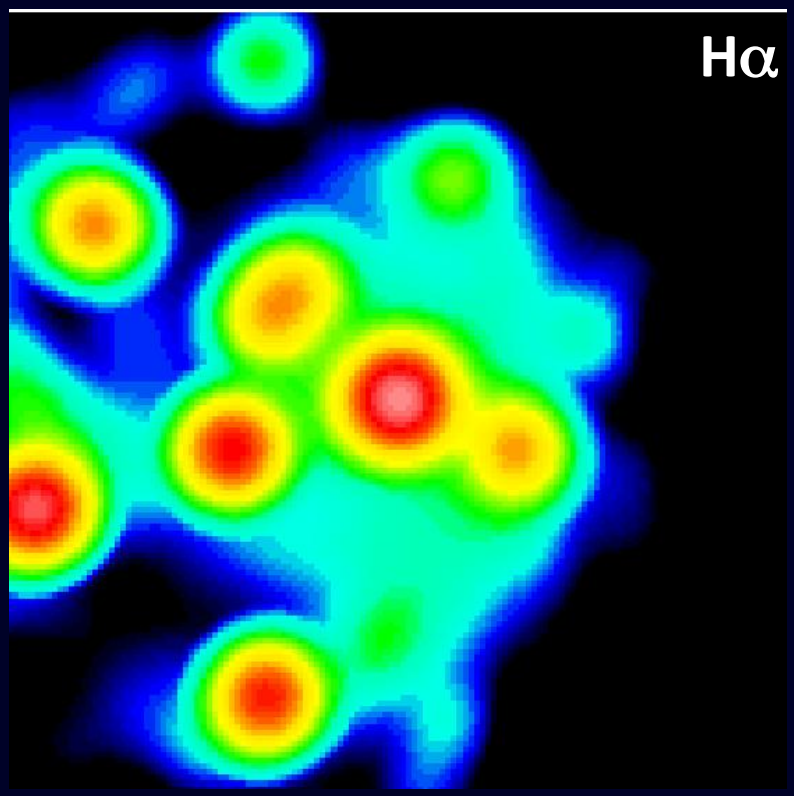


70 pc reso.

Higher resolution decreases rotation by 20% and increases dispersion by the same amount

Clumps support still dominated by rotation.

Mock Hα observation

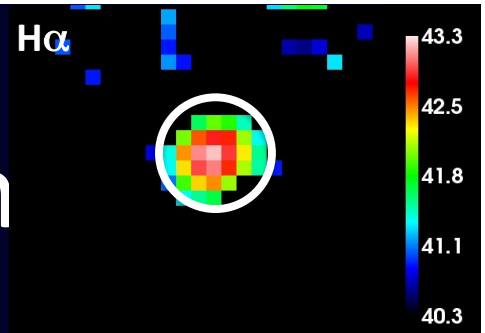


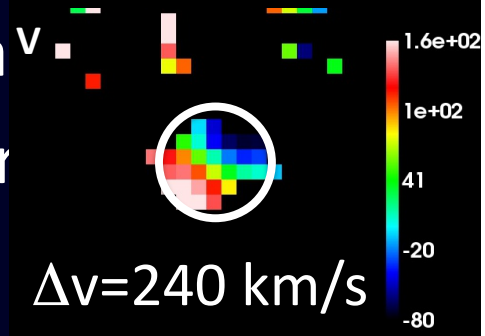
Beam smea

Clumps mar
resolved

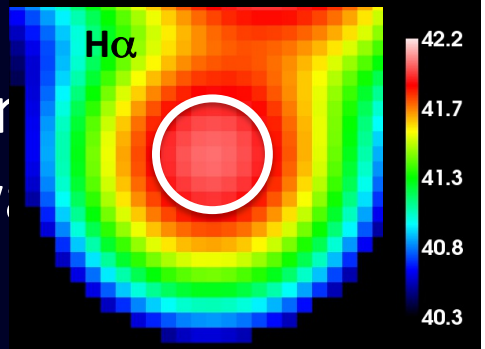
The rotatior
almost w

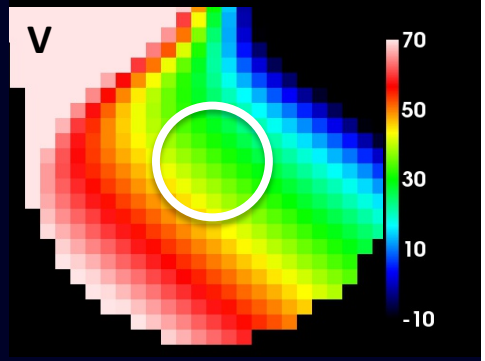
Δv=80 km/s





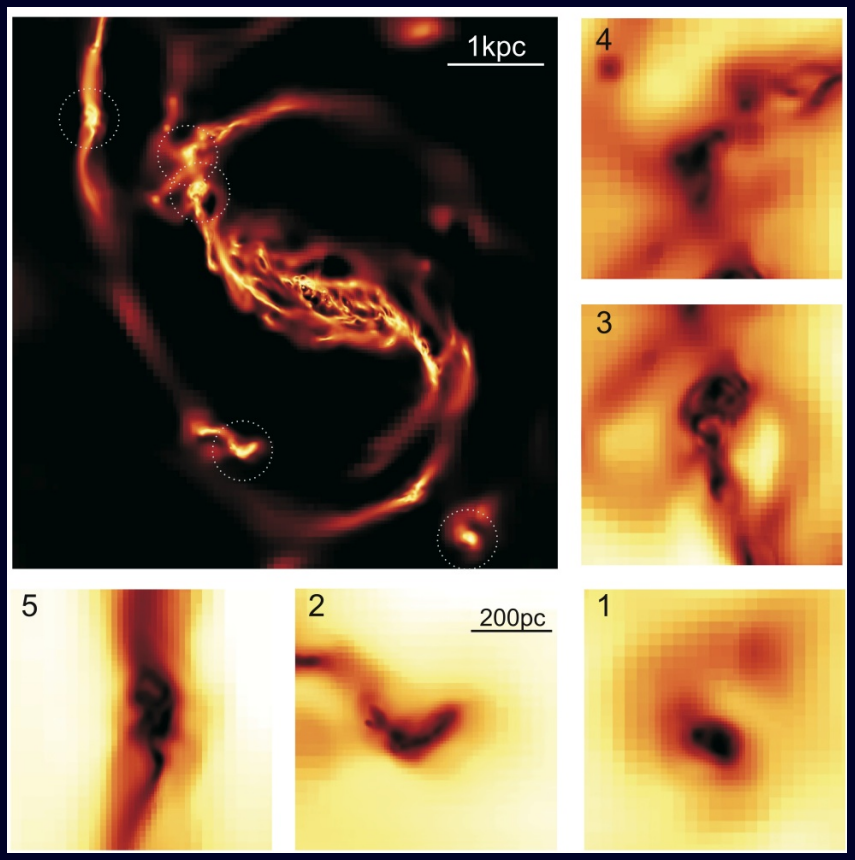
Δv=240 km/s



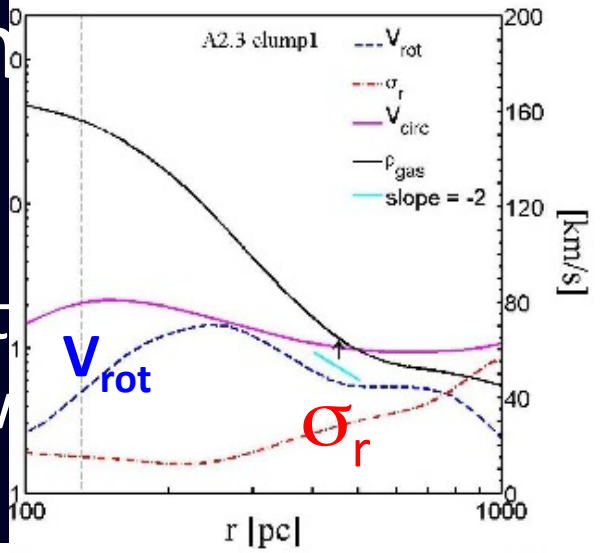


Giant Clumps are not h
analogs

Simulat
show



Rotating Giant Clump



Simu
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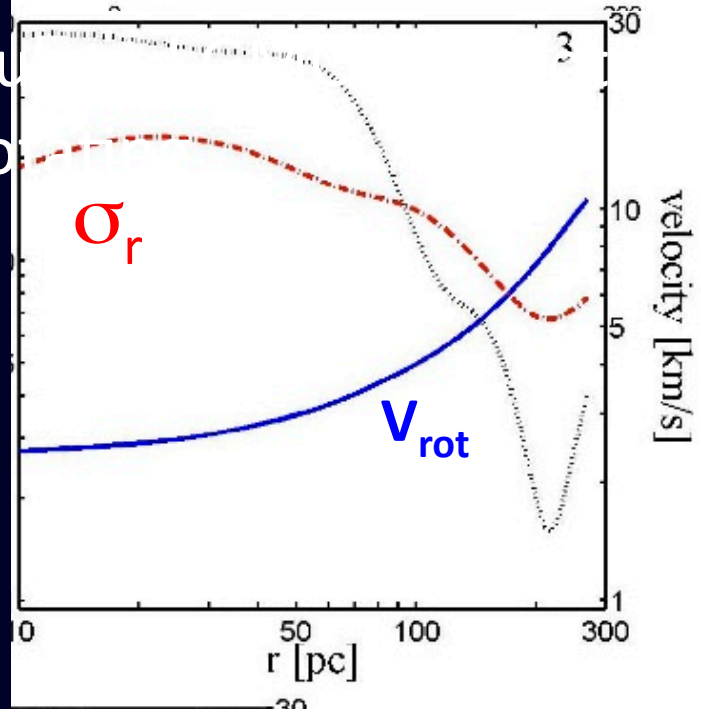

Non-Rotating Giant Molecular Cloud

Summary

- High-z, gravitationally-unstable discs break into Giant Clumps that migrate to the center.
- The gradients of Clump's age & gas fraction are testable predictions of this scenario.
- Giant Clumps are mainly supported by rotation.
- The observed clump rotation is weak due to beam smearing.
- Giant Clumps are not just massive analogs of local giant molecular clouds.

THE END

(FIN)