Can turbulence delay collapse?

LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

ORIGINS Excellence Cluster

Stefan Heigl   Andreas Burkert
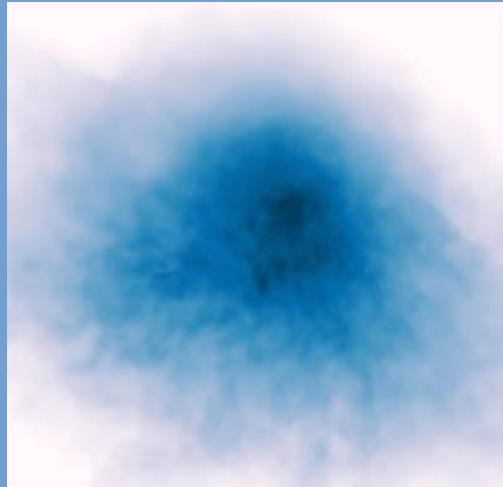
What happens during collapse?
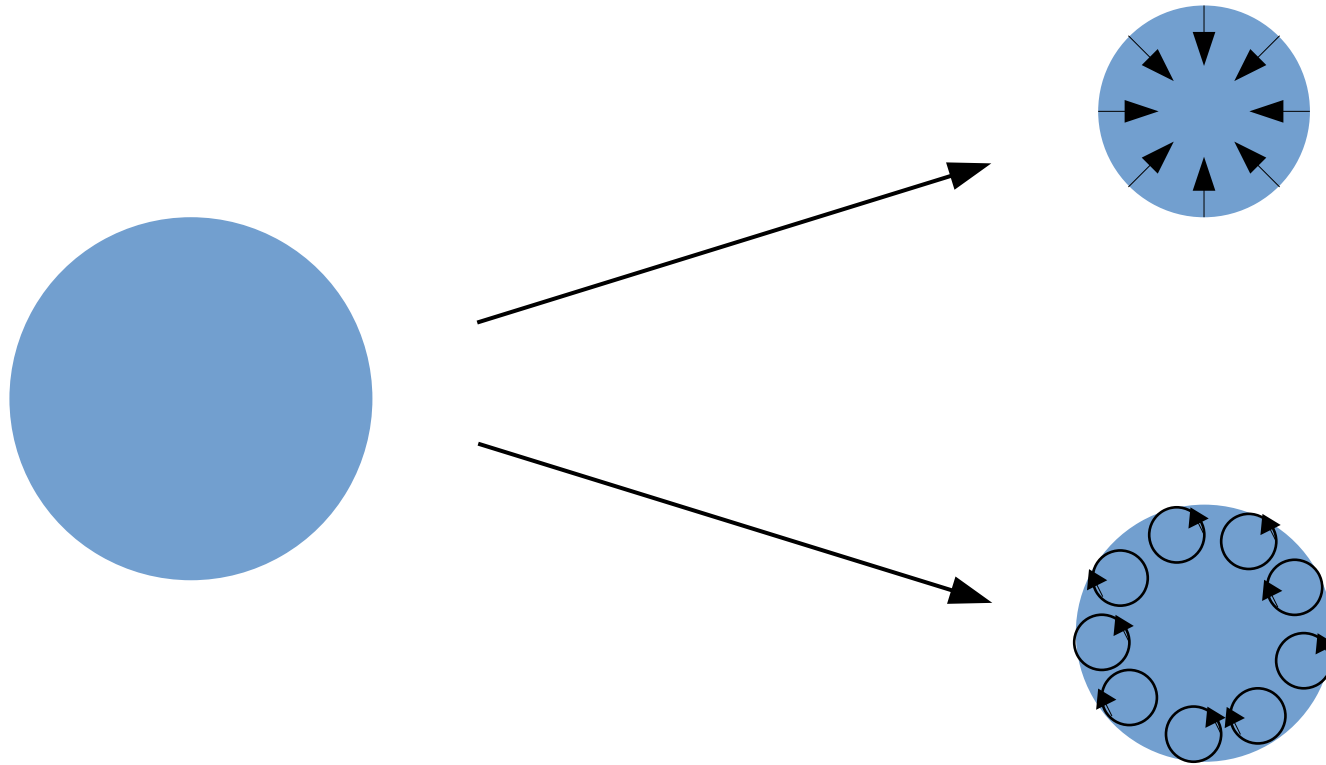
Collapse of BE-sphere on a free-fall time
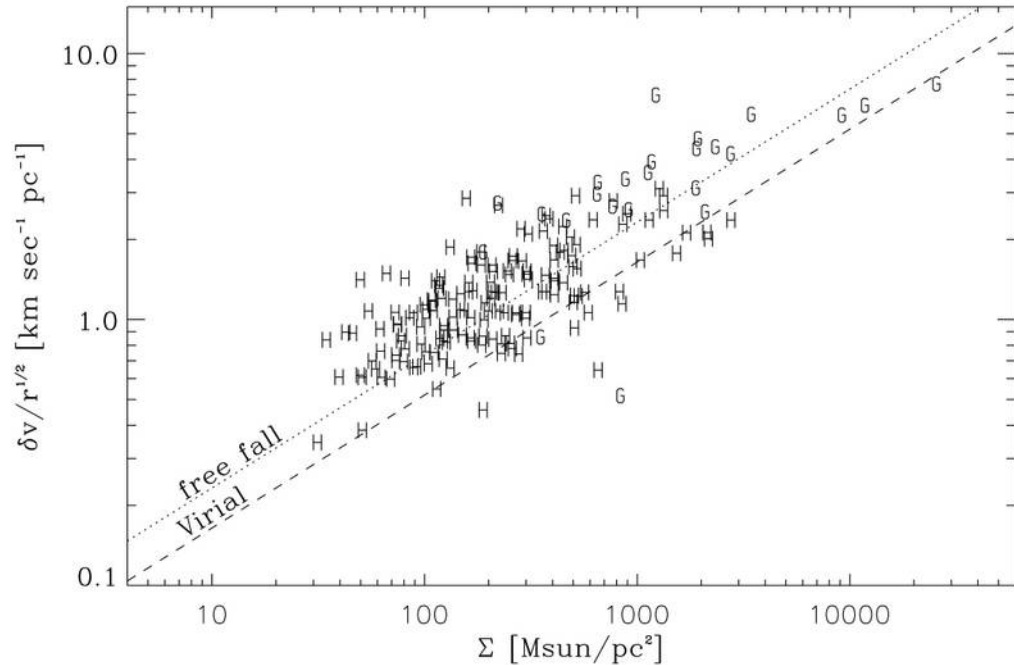

Foster & Chevalier 1993
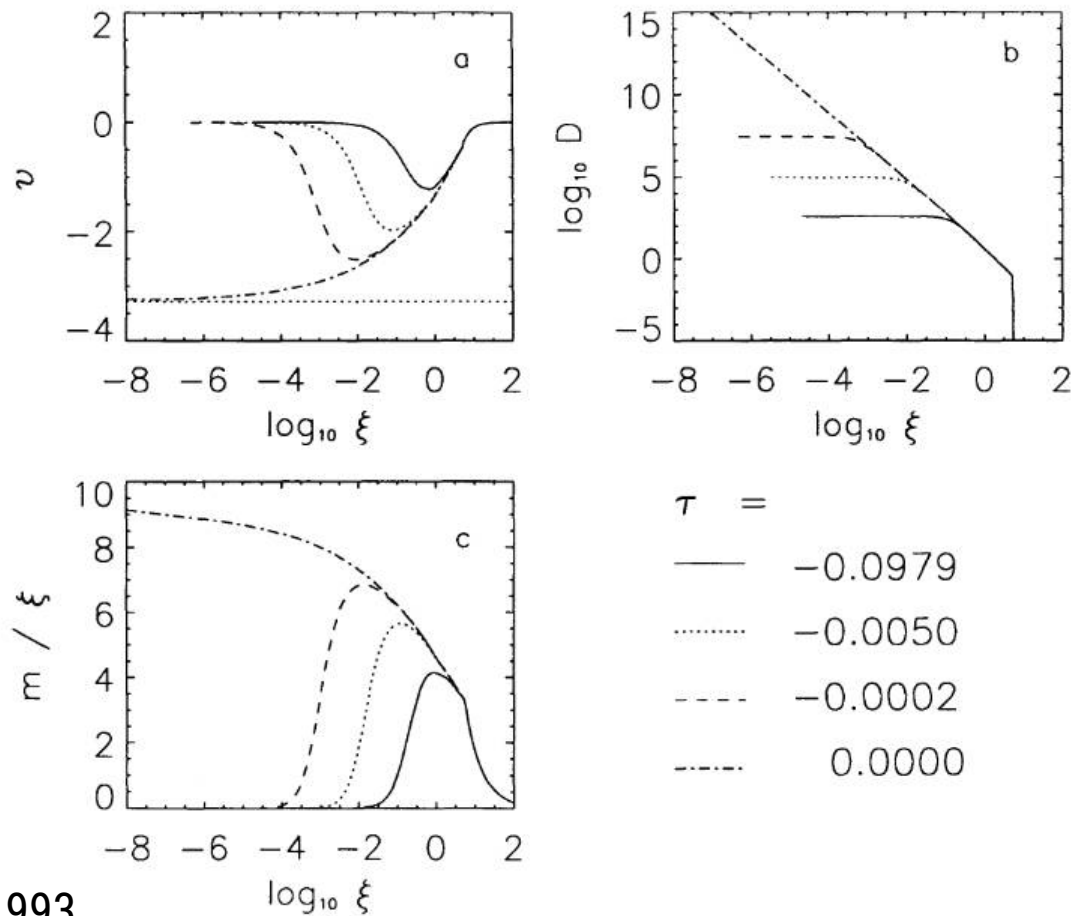
Fundamental questions

- Can gravitational collapse generate turbulence?
- Can turbulence slow down the collapse or even cause a quasi-equilibrium?

Gravity seems to be driving non-thermal motions

Vázquez-Semadeni et al. 2007, Ballesteros-Paredes et al. 2011, …:

Is everything in global collapse?

Ballesteros-Paredes et al. 2011 with points by Heyer et al. 2009 & Gibson et al. 2009

Is "adiabatic heating" by turbulence possible?

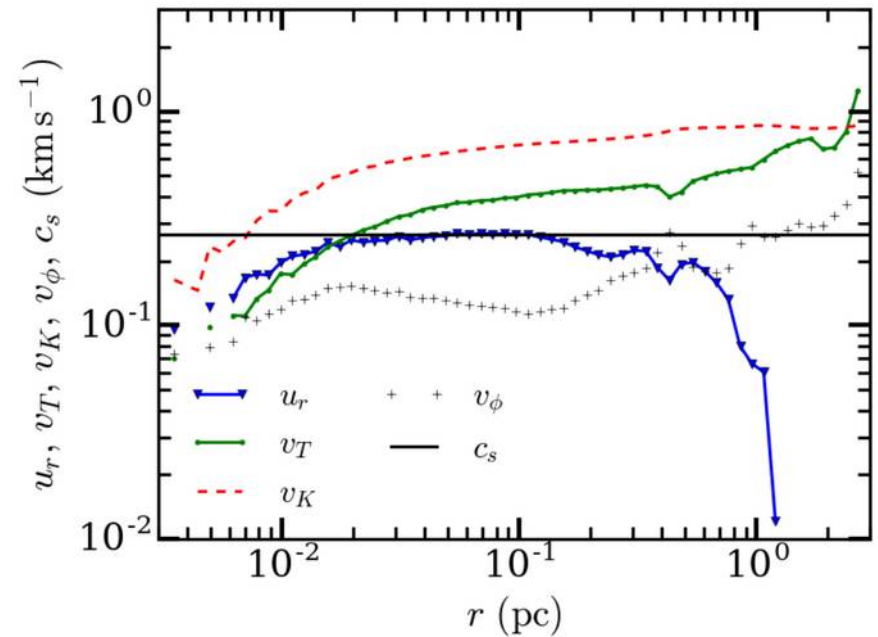## ADIABATIC HEATING OF CONTRACTING TURBULENT FLUIDS

BRANT ROBERTSON[1] AND PETER GOLDREICH[2]

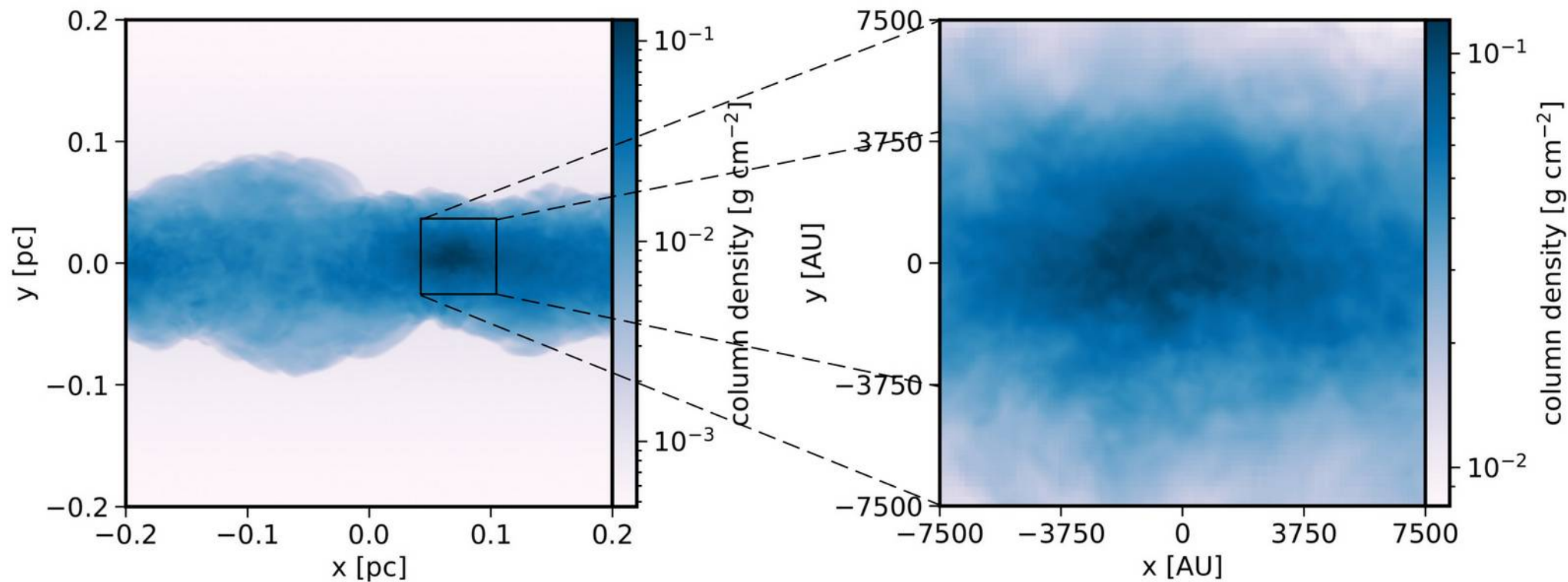[1] Steward Observatory, University of Arizona, 933 North Cherry Avenue, Tucson, AZ 85721, USA
[2] California Institute of Technology, 1200 East California Boulevard, Pasadena, CA 91125, USA
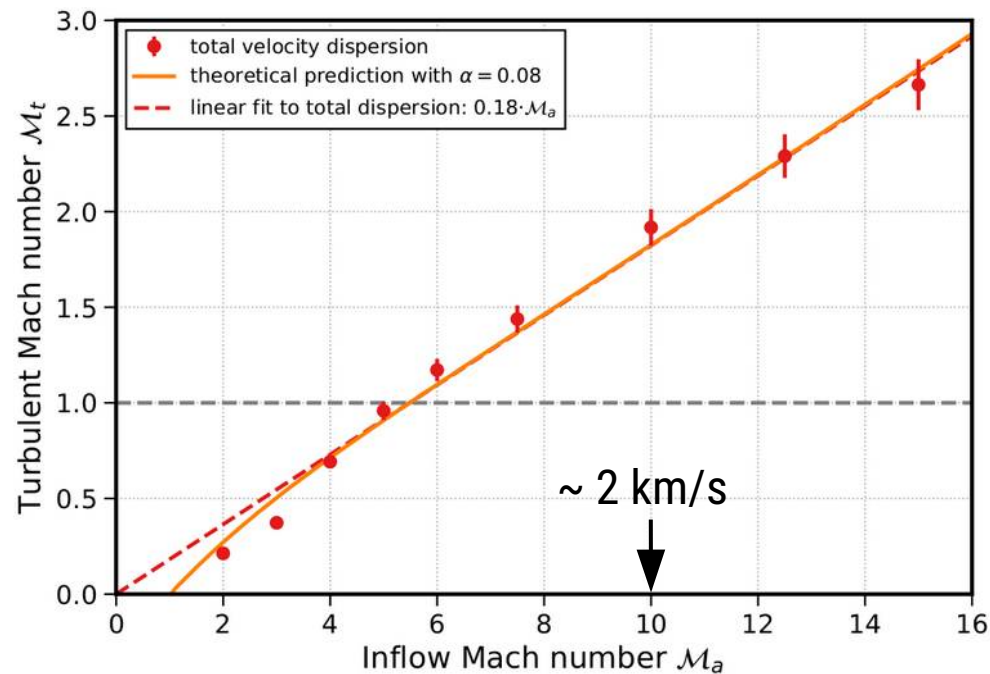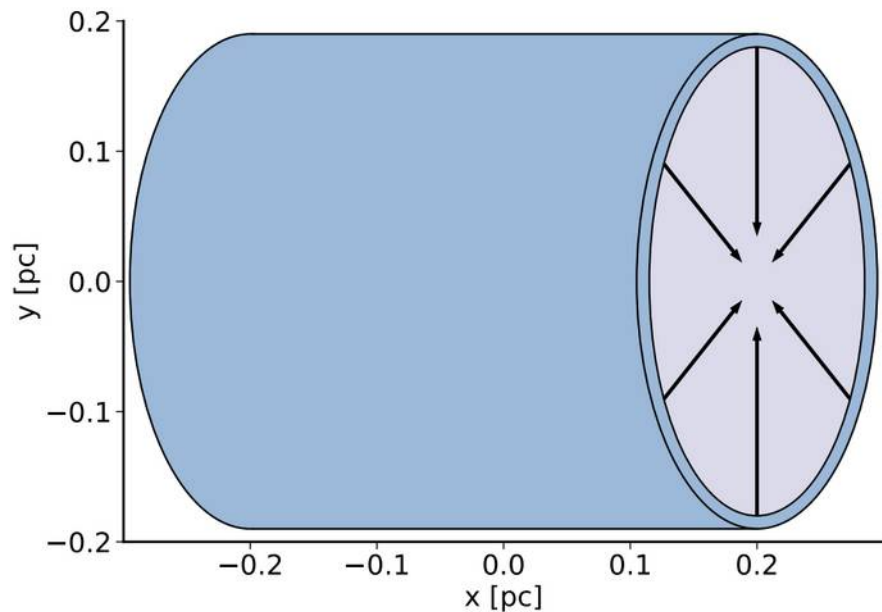
Robertson & Goldreich 2012,
Murray et al. 2017, Li 2018
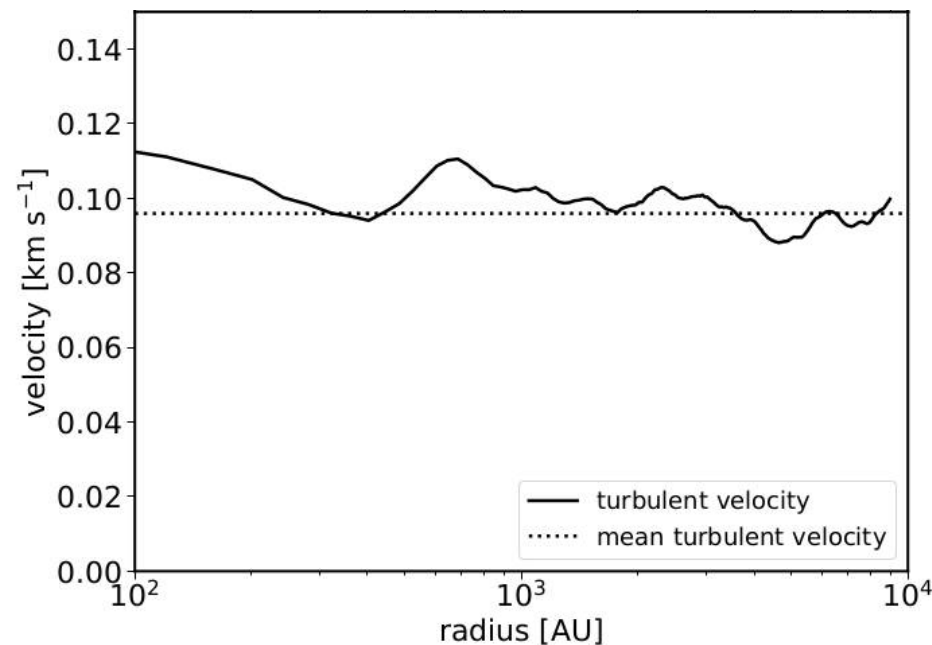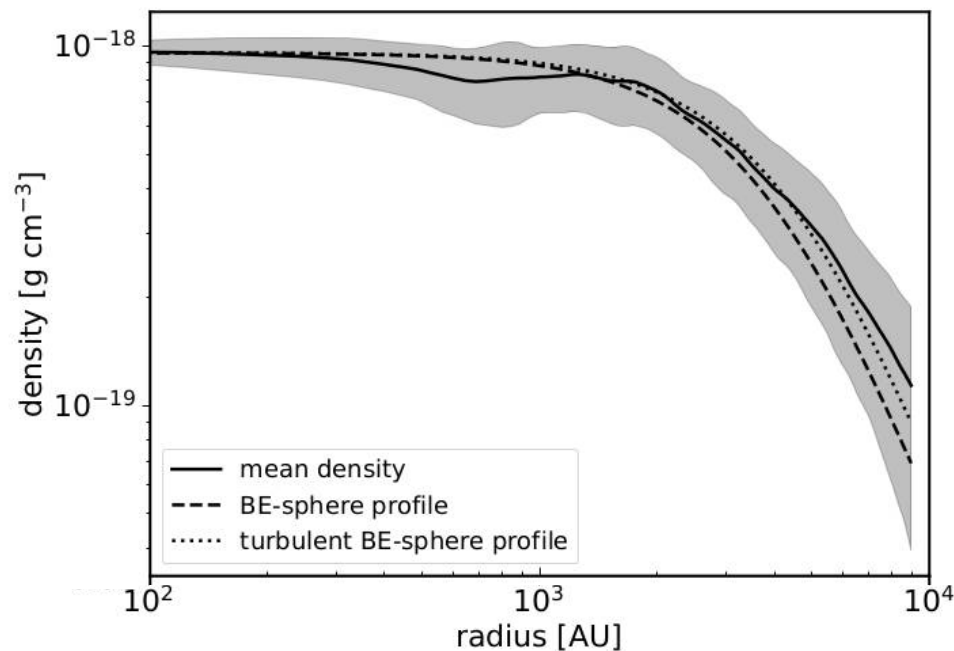
Turbulent filaments form turbulent cores
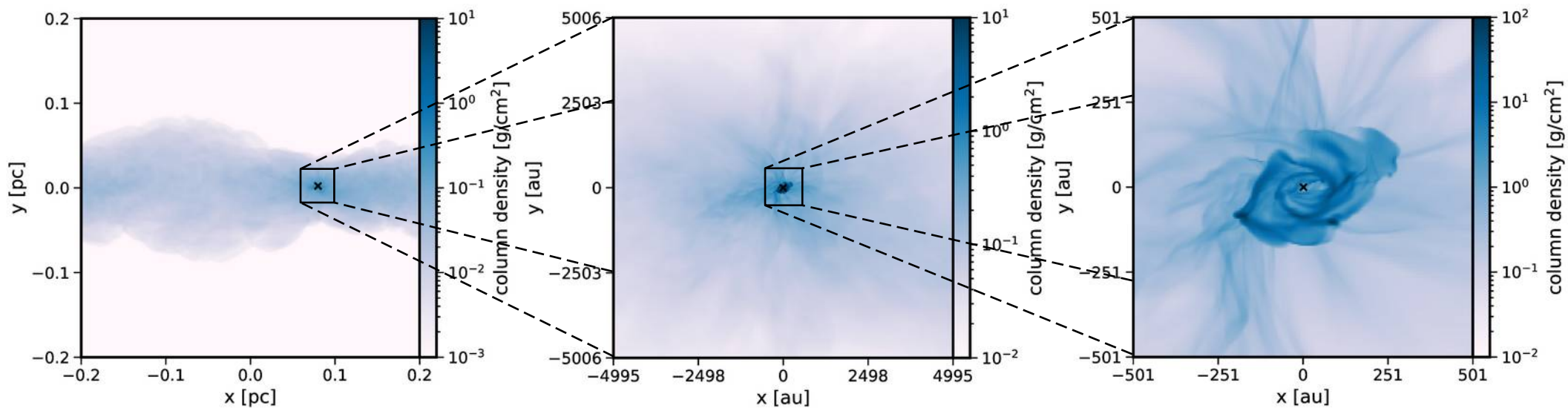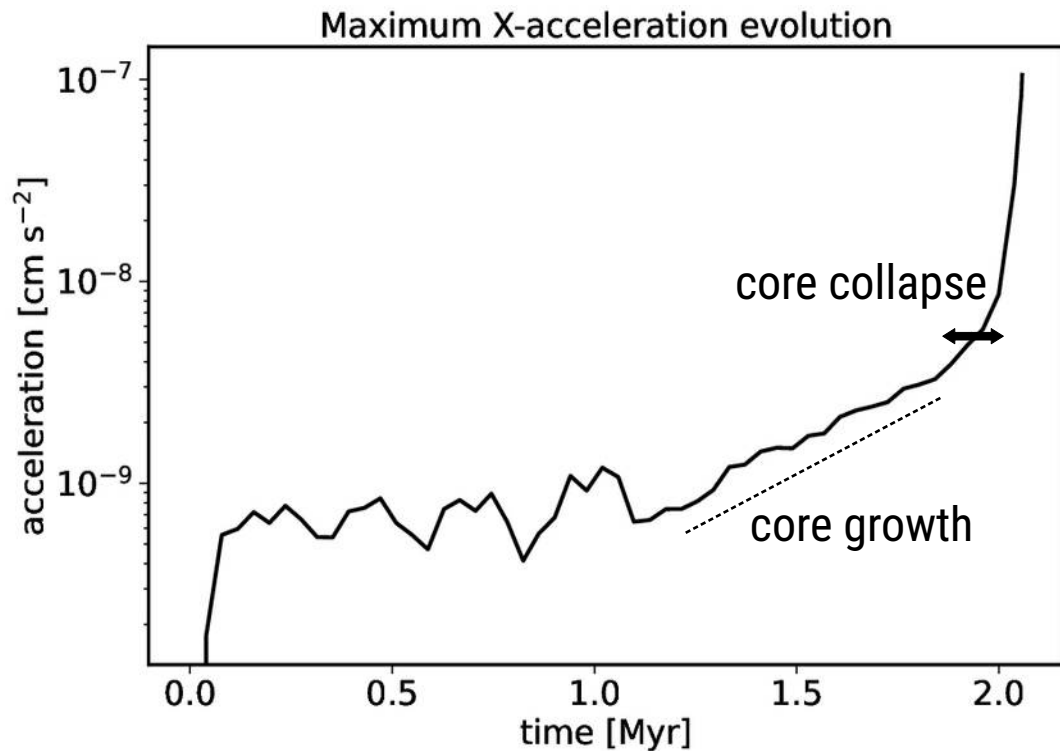
Turbulence scales with accretion velocity
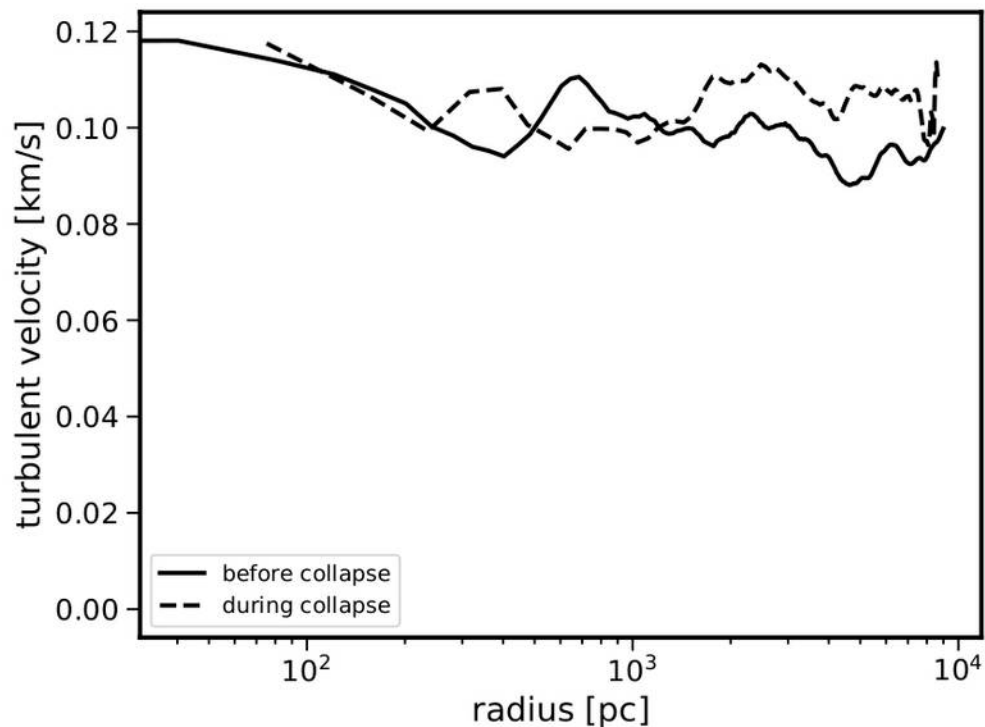

~ 2 km/s

Heigl et al. (2020)

Core seems to follow turbulent supported BE-sphere
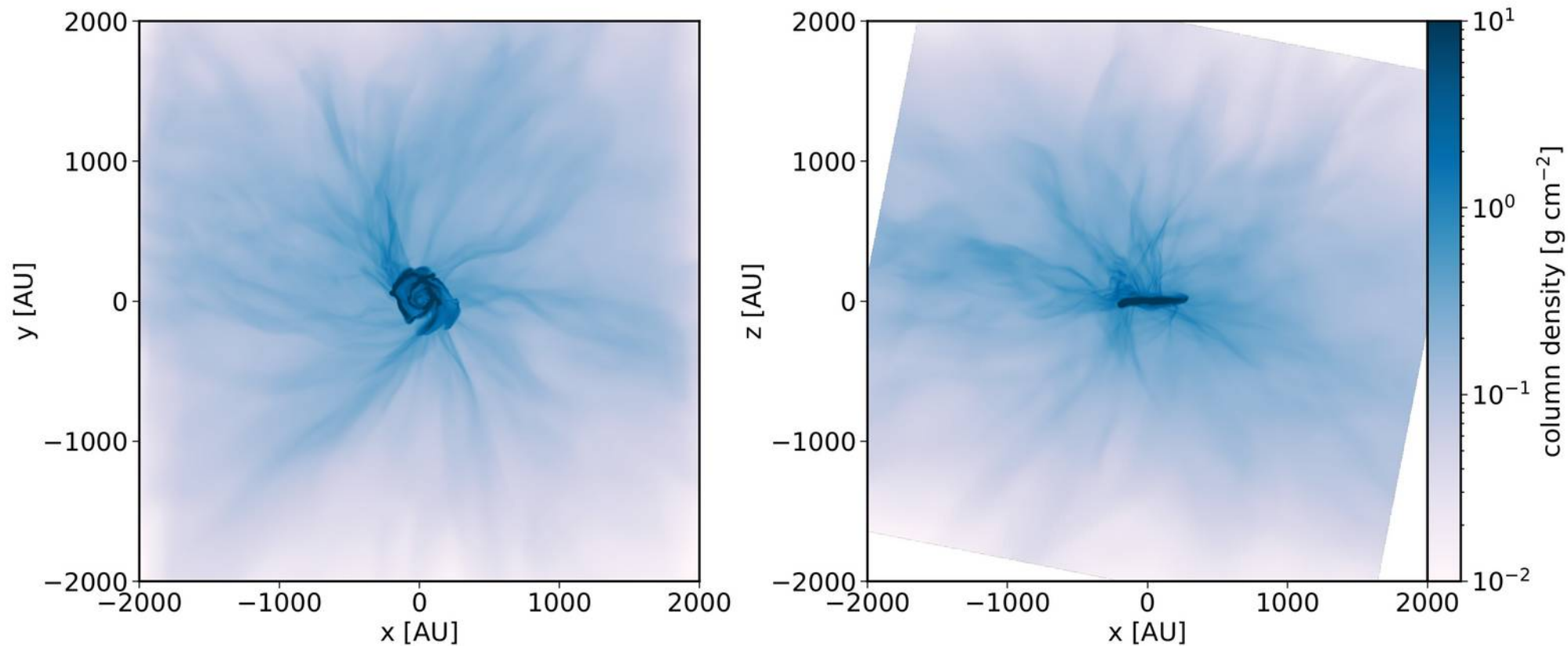

Heigl et al. 2024

Disk forms in the centre of the collapsing core

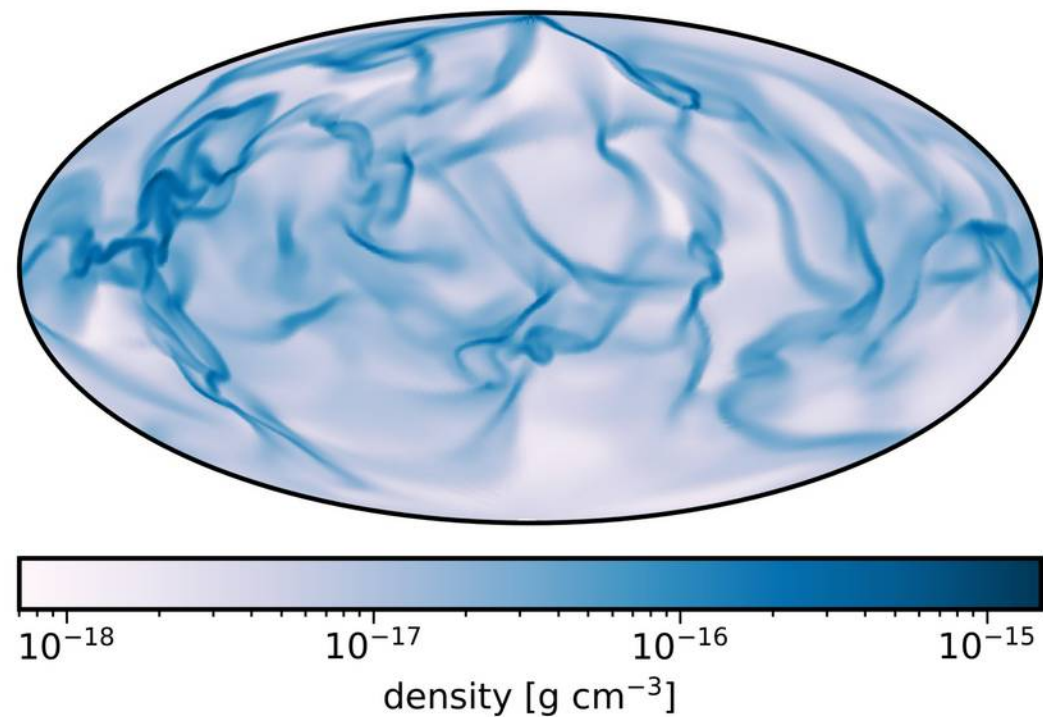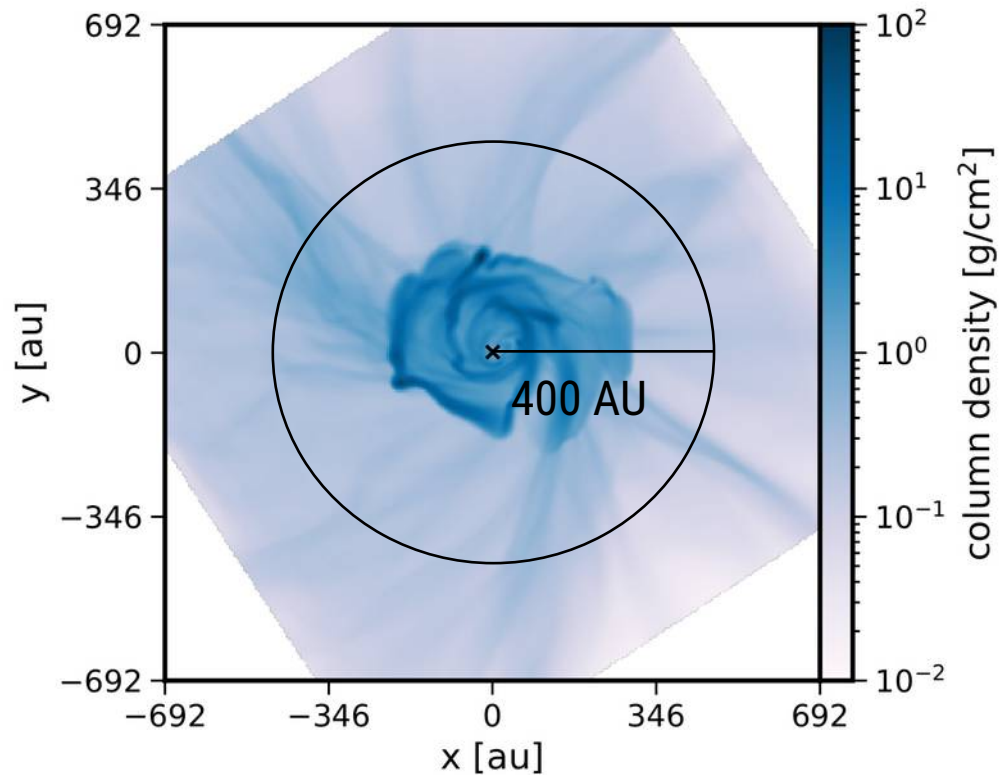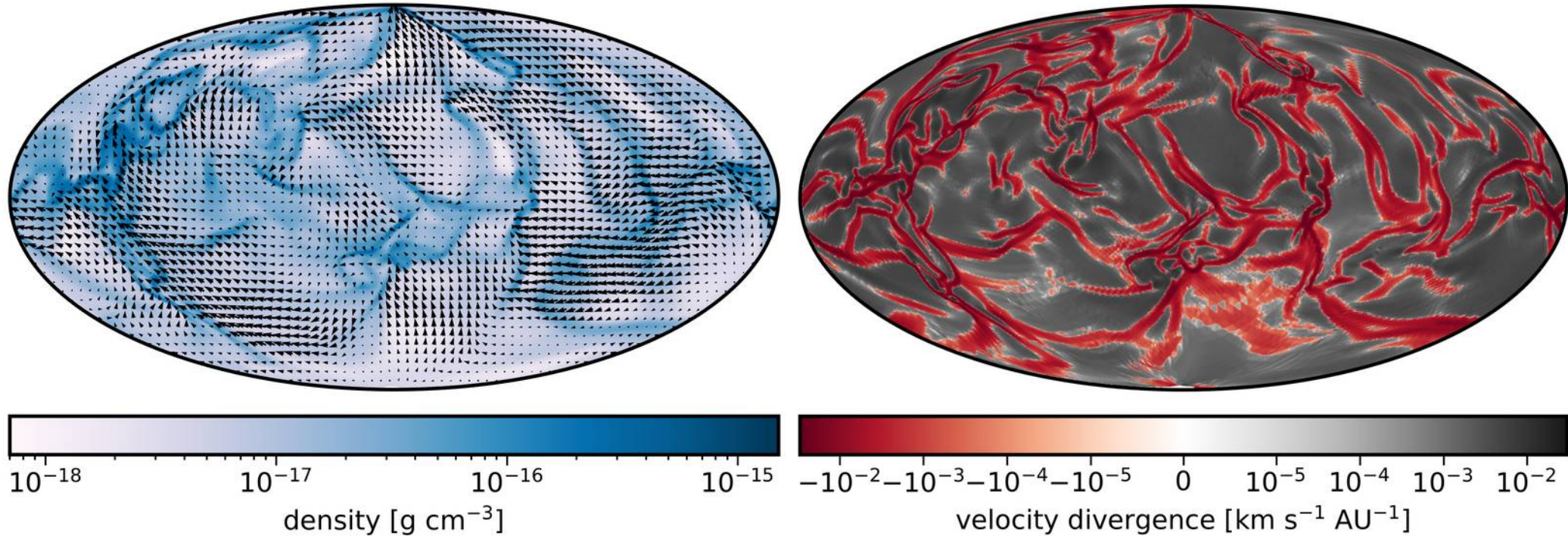# Collapse time does not seem affected by turbulence

Disks accretes mass along streamers
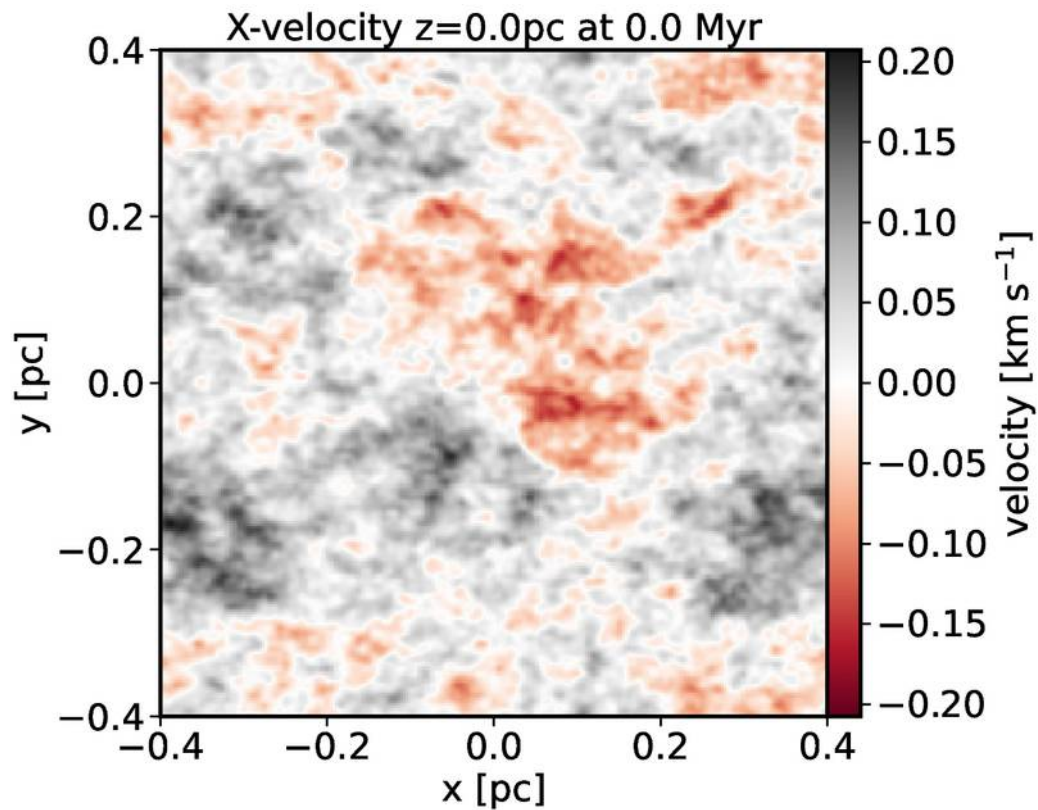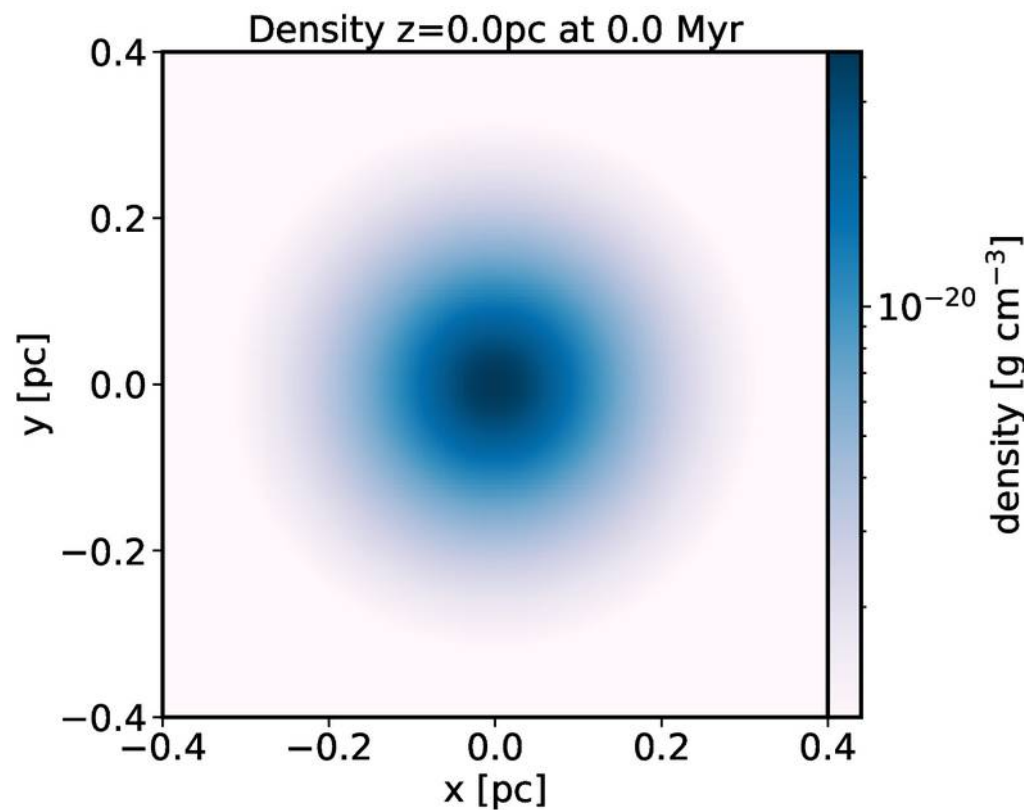

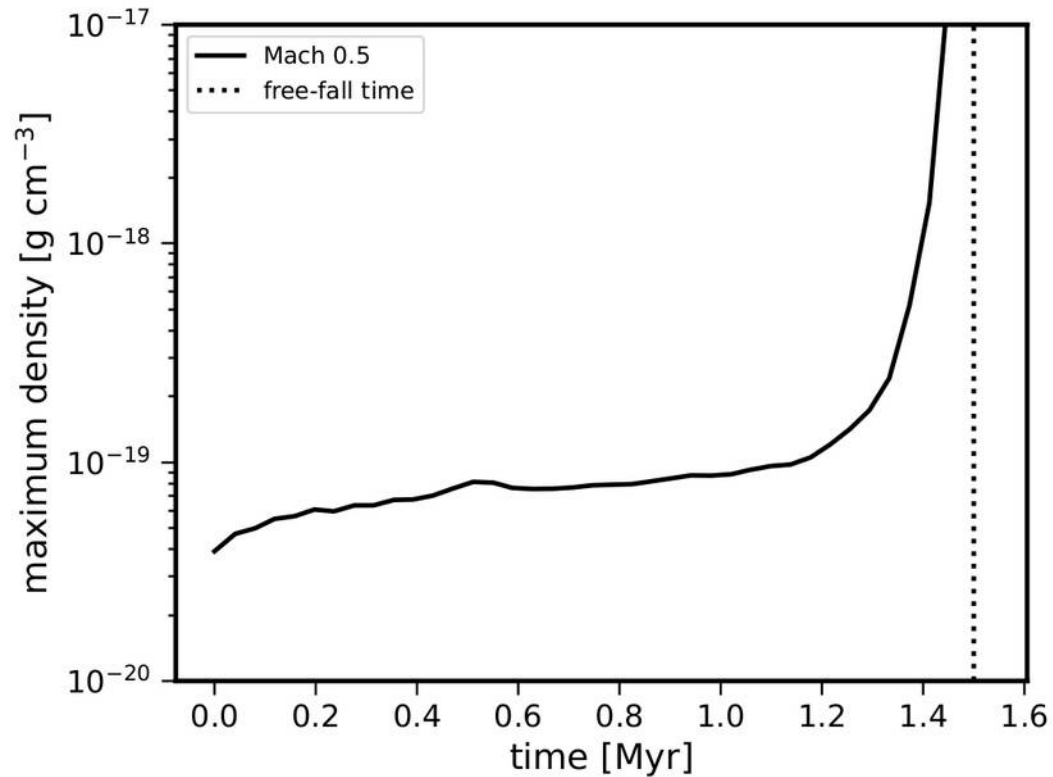
Heigl et al. 2024

Turbulence forms sheet-like streamers
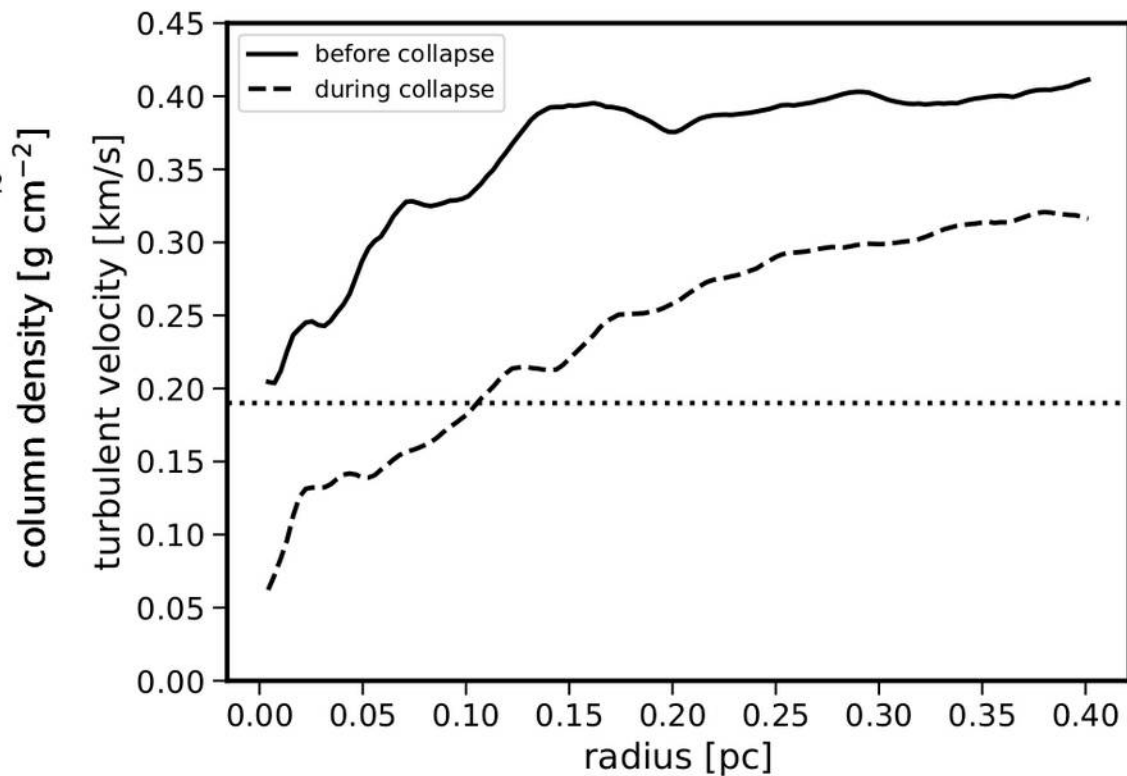
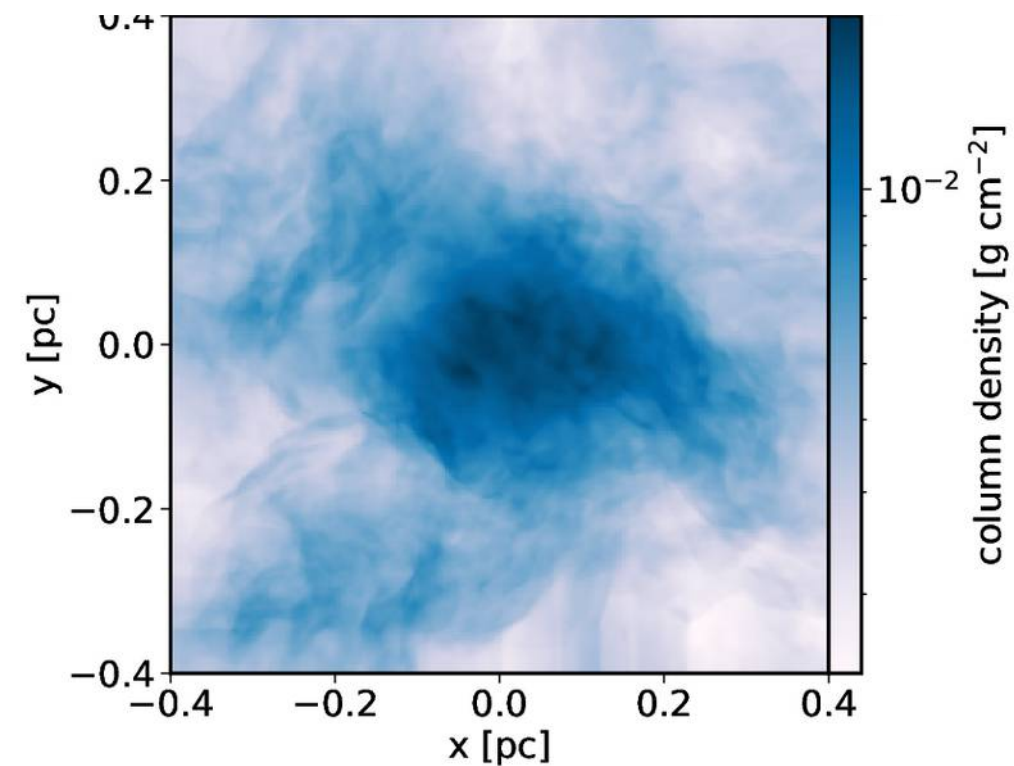# Overdensities are formed by residual motions

density [g cm^{-3}]

velocity divergence [km s^{-1} AU^{-1}]

Heigl et al. 2024
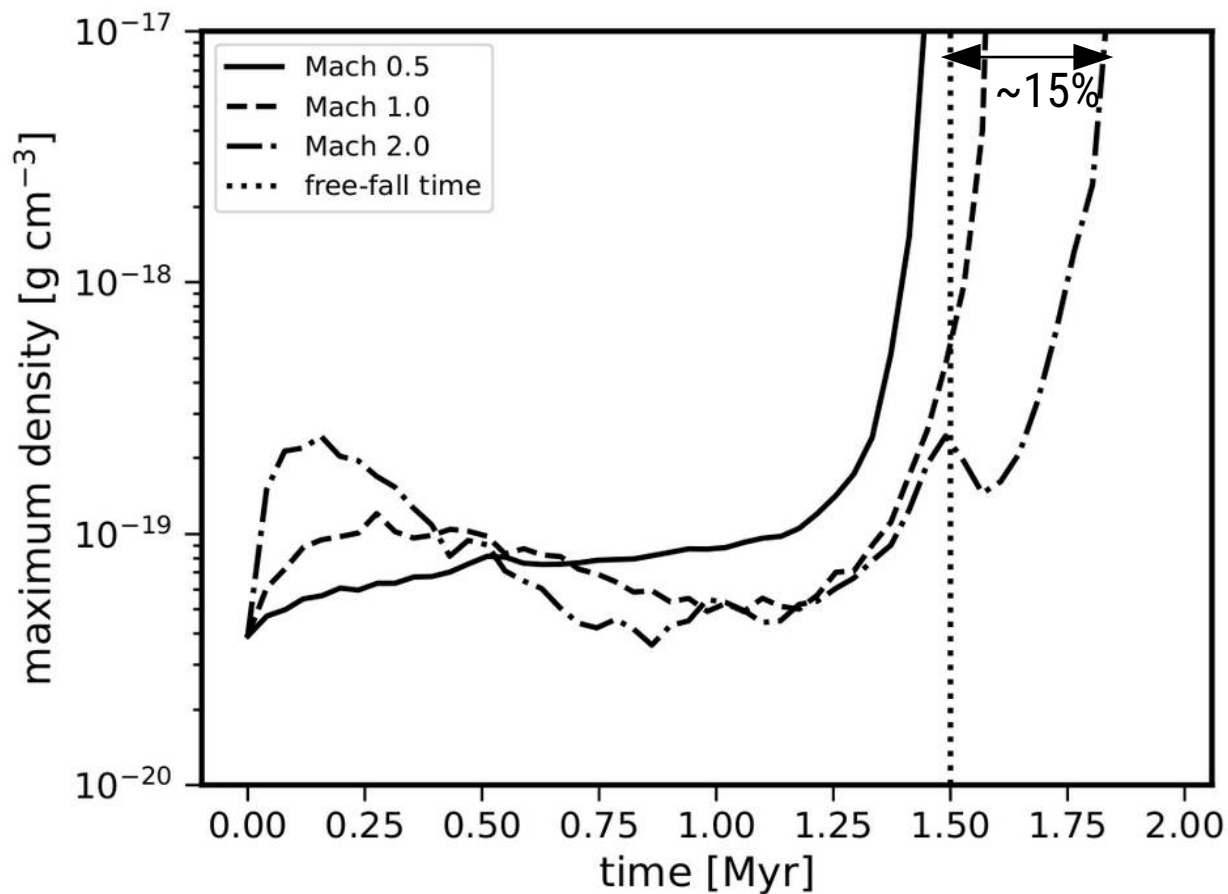
Simple test: turbulent collapse of BE-sphere

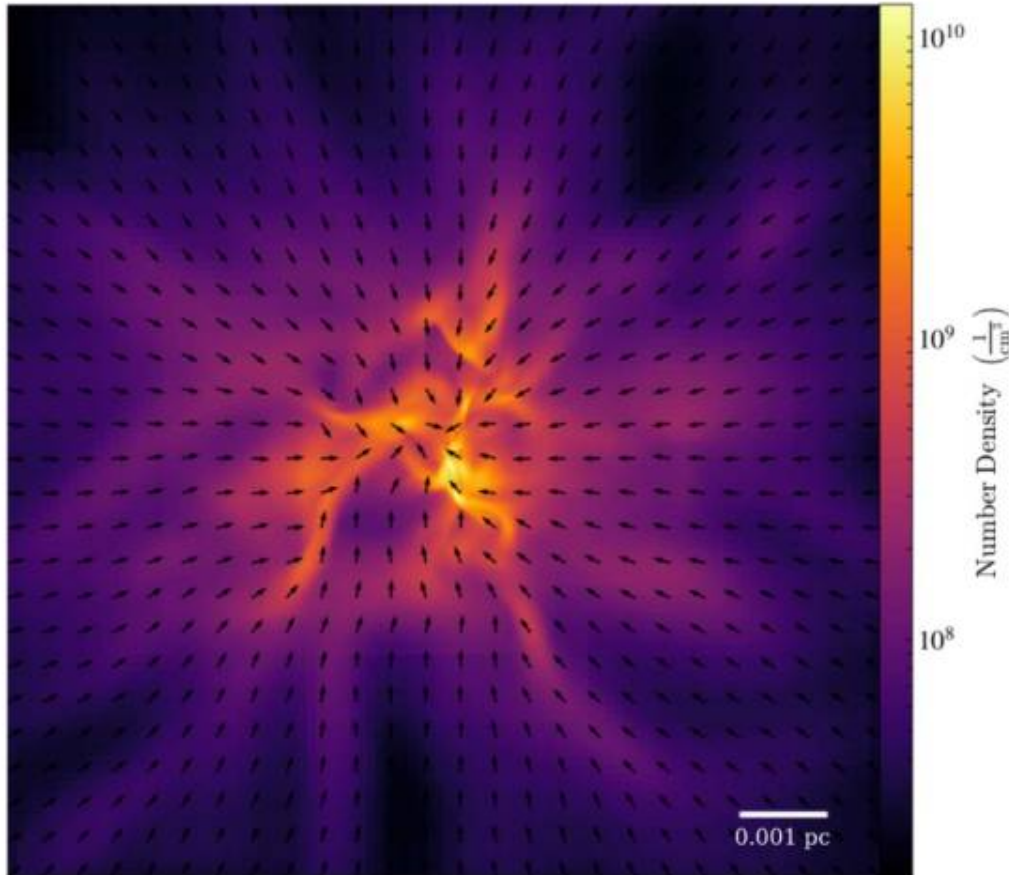# No difference to free-fall time
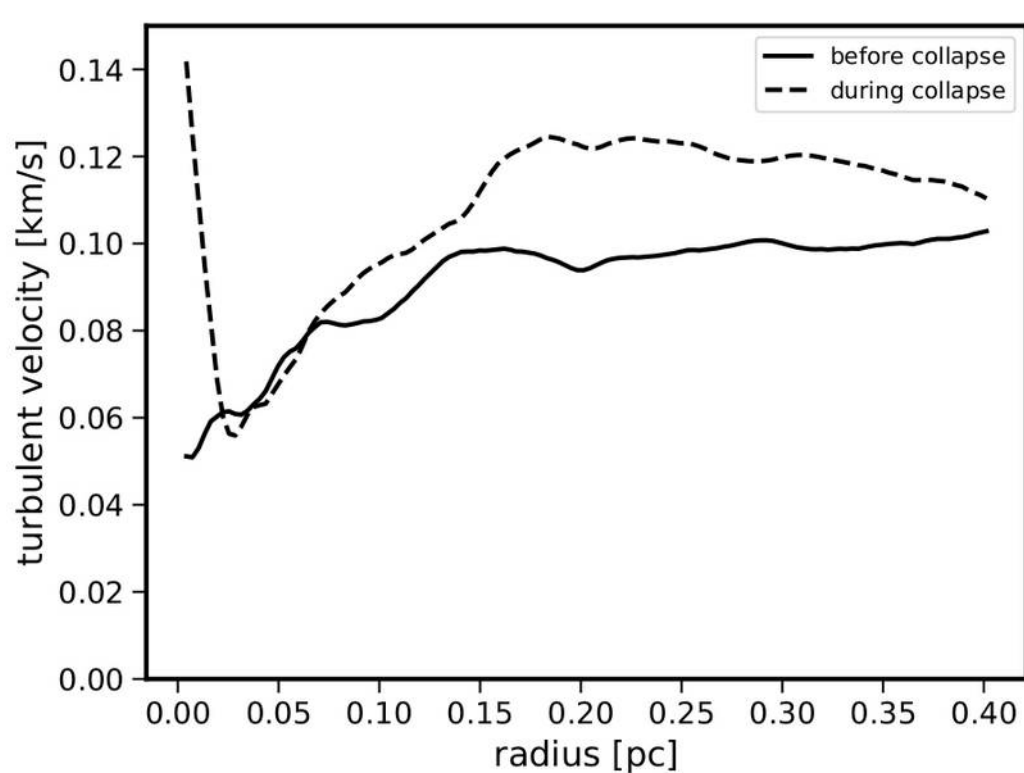
Lets try more turbulence

Larger Mach numbers show only small delay

Is turbulence created and instantly dissipated?

Guerrero & Vázquez-Semadeni 2020:

- collapse with different levels of initial turbulence
- no difference to free-fall time
- close to virialization
- turbulent dissipation seems to balance injection

Fundamental question

Should we be interested in turbulence of collapsing cores?

Core vs filament collapse