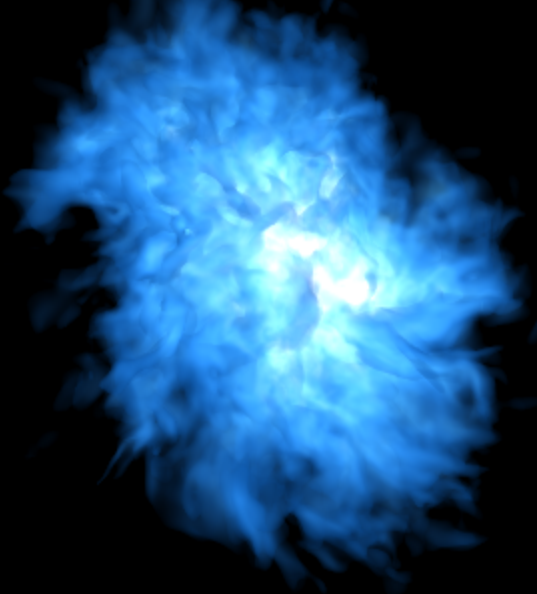


# **The Role of Magnetic Fields in Population III Star Formation**



**Matthew Turk**

**Jeffrey Oishi**

**Tom Abel**

**Greg Bryan**

**"What about magnetic fields?"**

**Increasingly well-explored space ...**

**Xu, et al (2008)**

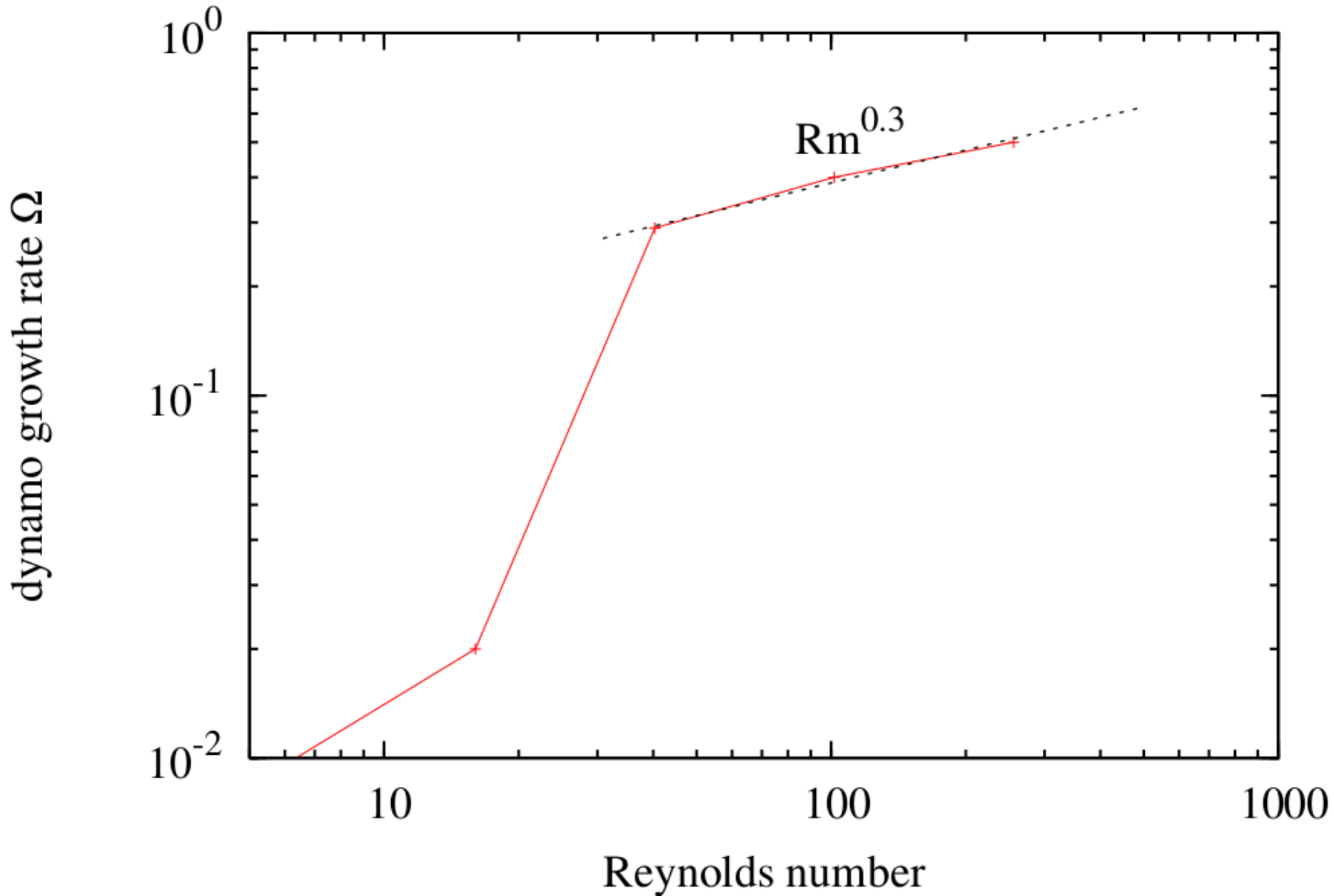
**Biermann battery: not  
sufficient for dynamical  
importance!**

**(astro-ph/0807.2647)**

**Federrath, et al (2011)**

**Small-scale dynamo action on  
scales less than Jeans Length**

**(astro-ph/1102.0266)**

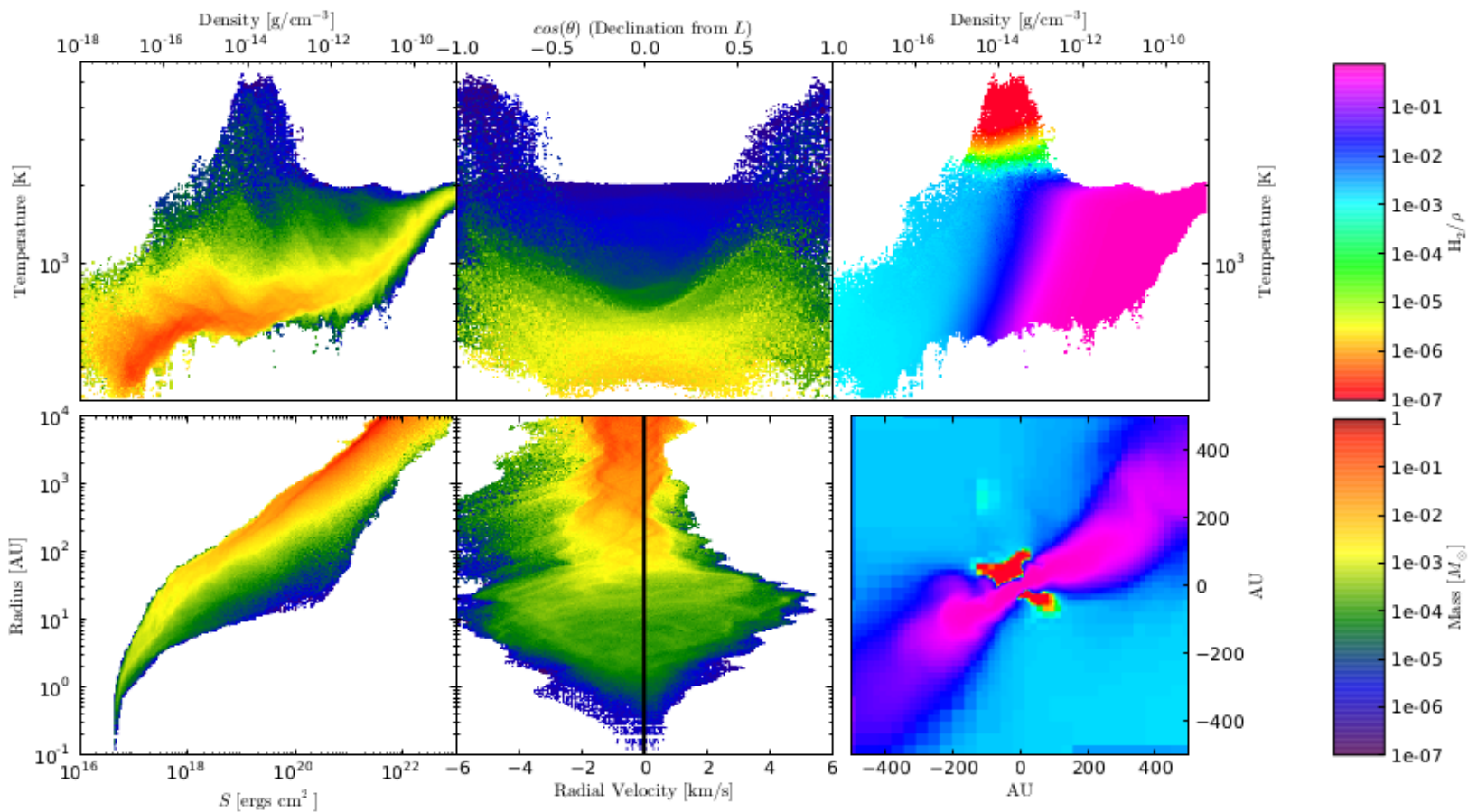


Federrath et al 2011 (astro-ph/1102.0266)

**Schober, et al (2012)**

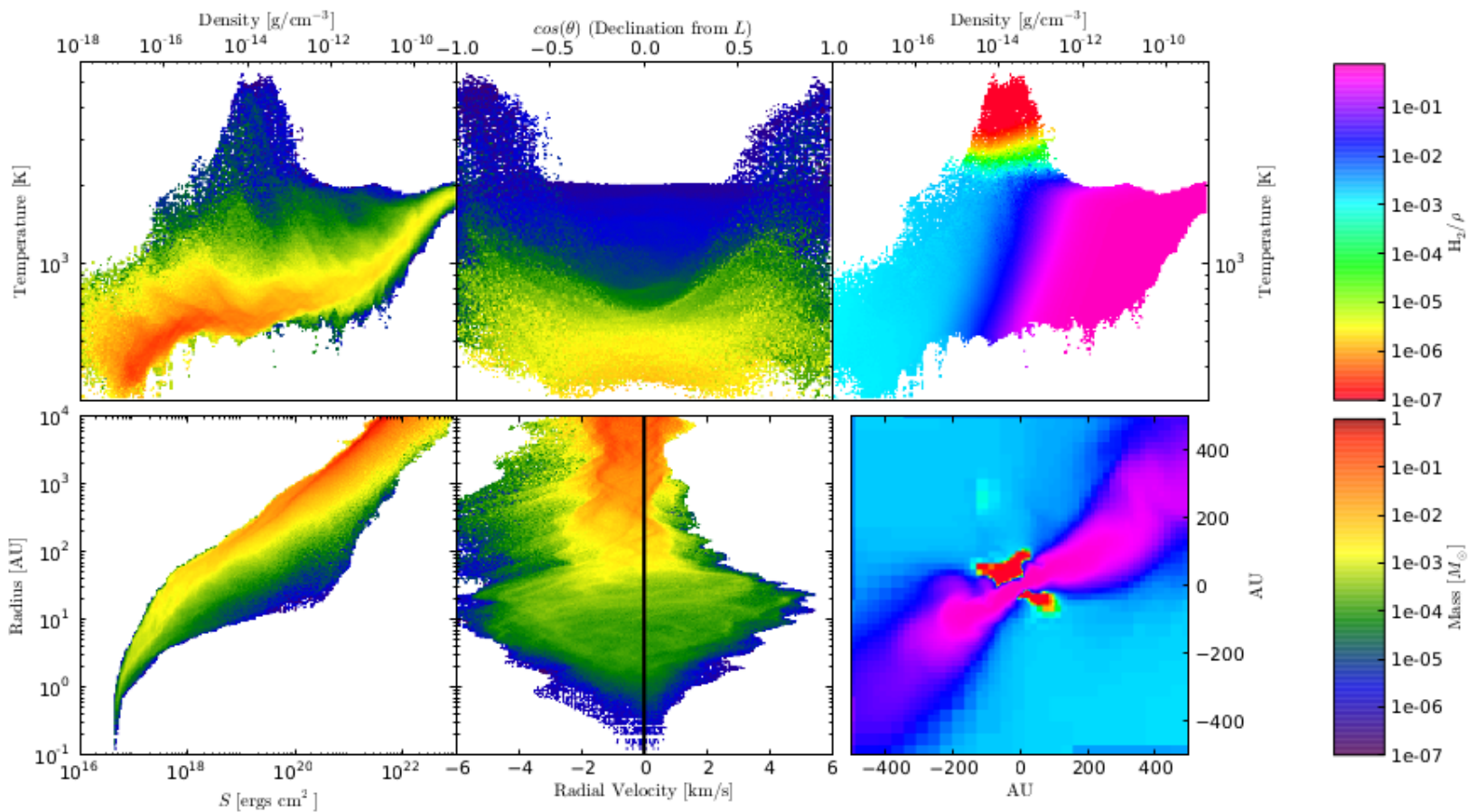
**Saturation of magnetic field  
energy from small-scale dynamo**

**(astro-ph/1204.0658)**



**Do magnetic fields alter disk structure?**



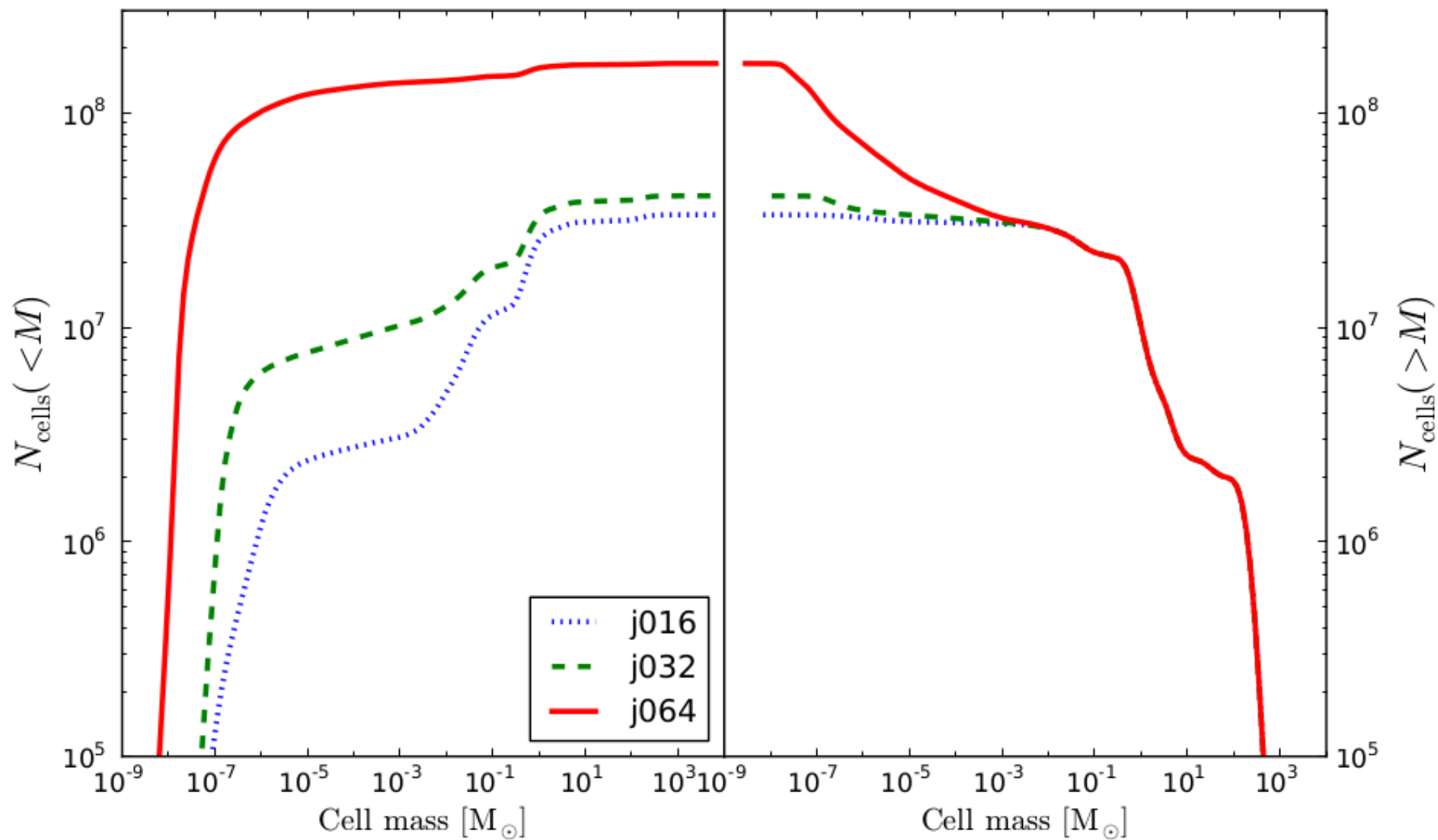


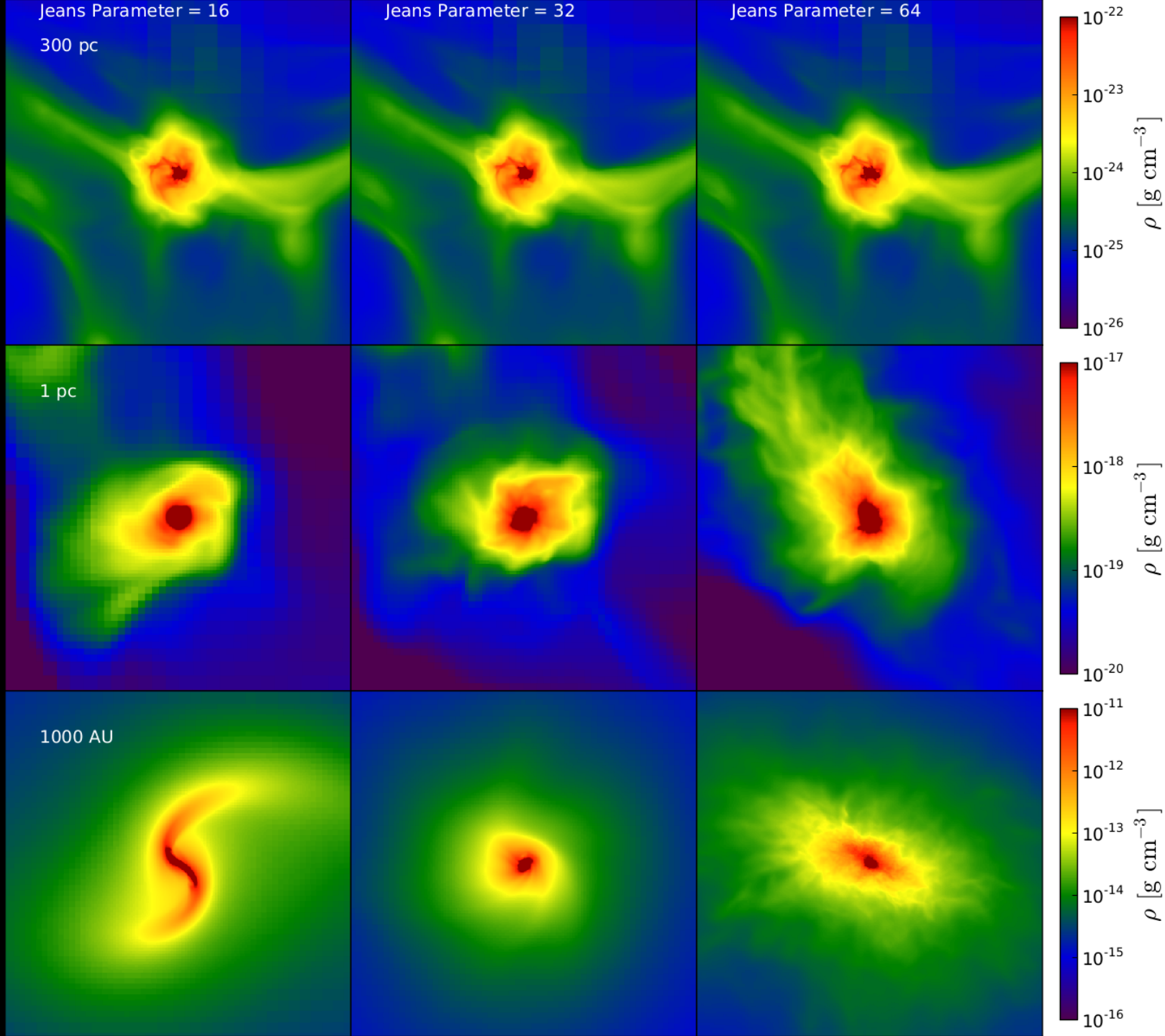
**Do we see amplification in cosmology?**

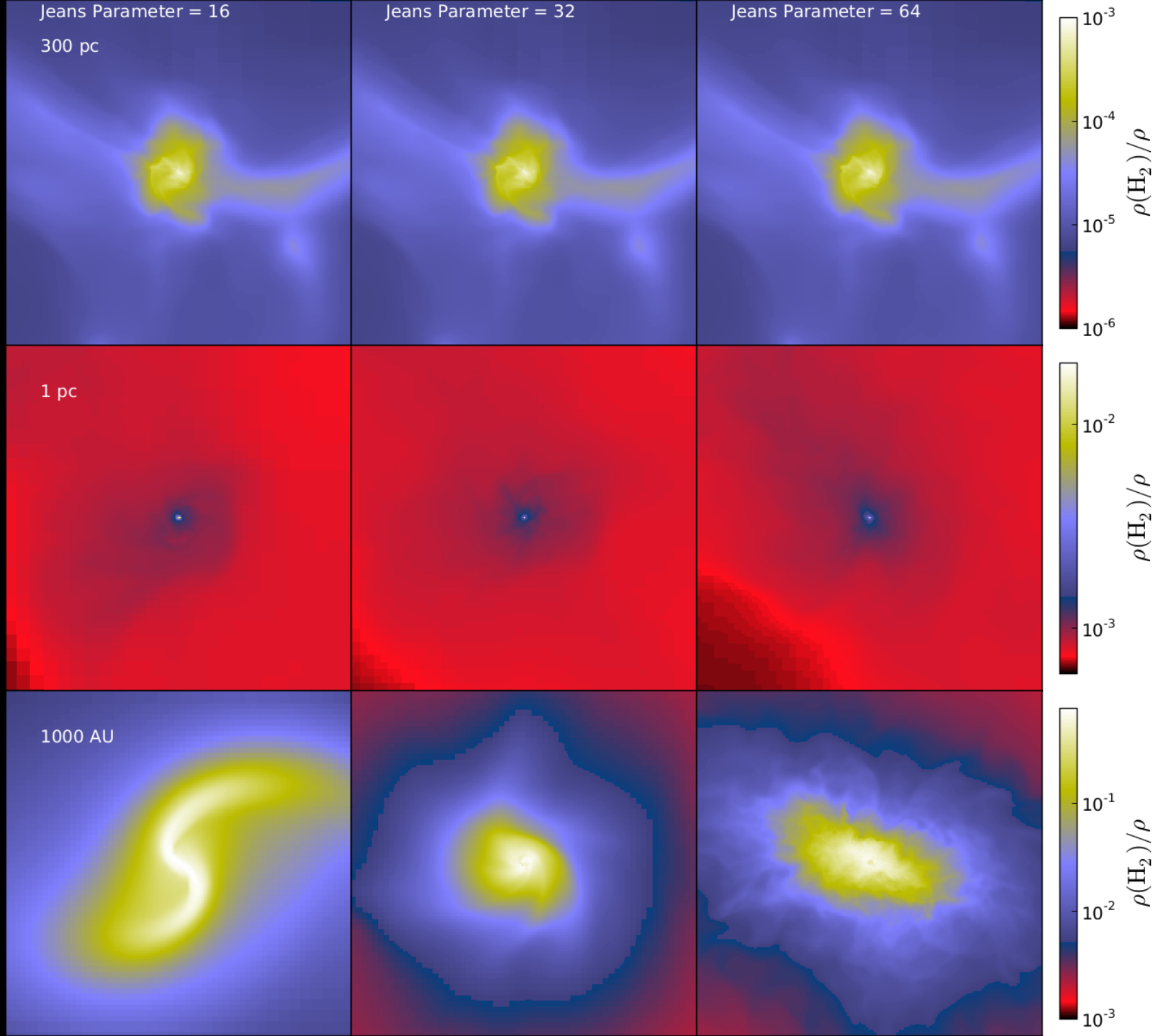
**Seed field of  $10^{-14}$  G at  $z = 99$ .**

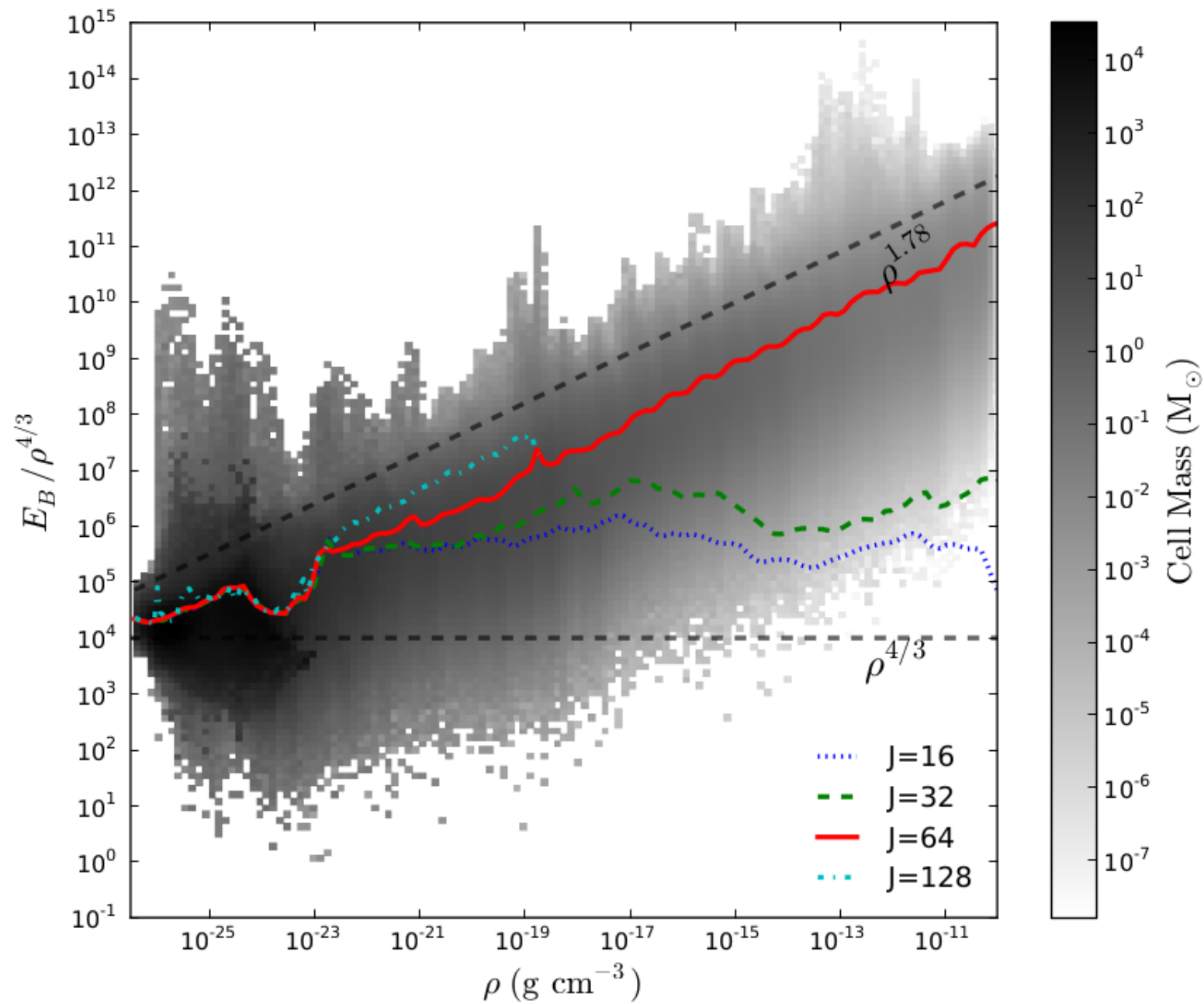
**Resolve the 200 K Jeans  
Length by 16, 32, 64 cells.**

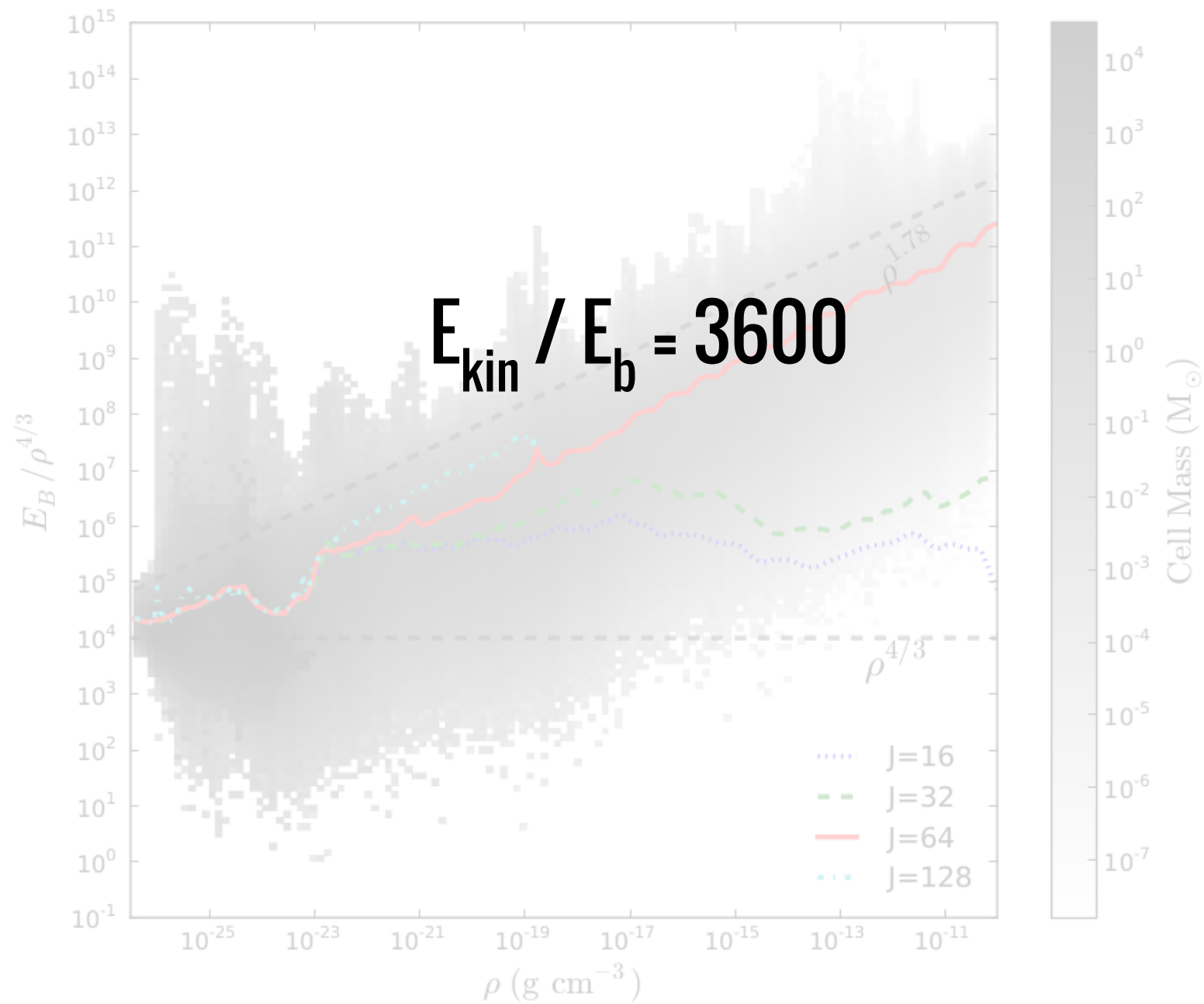
**(astro-ph/1112.4479)**









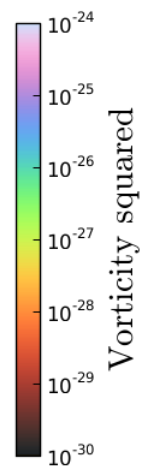
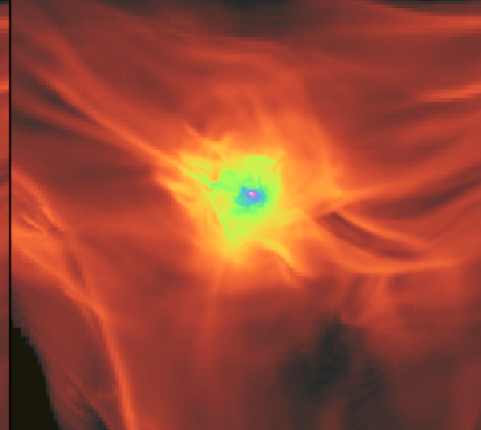
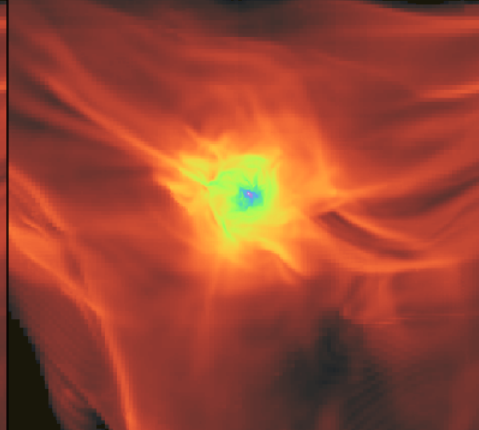
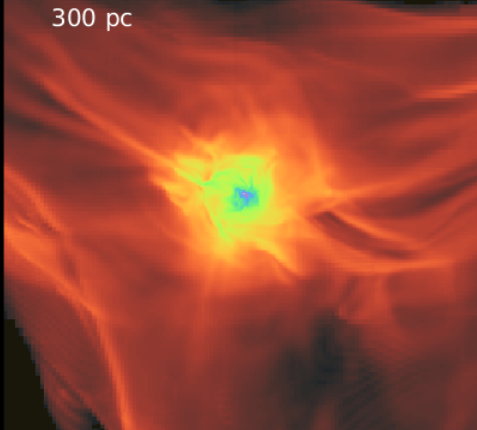


Jeans Parameter = 16

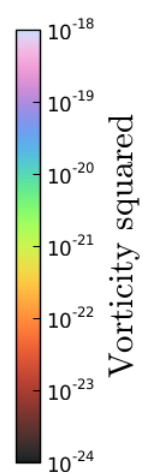
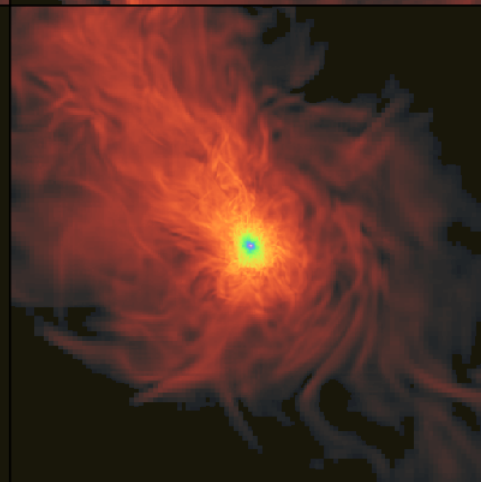
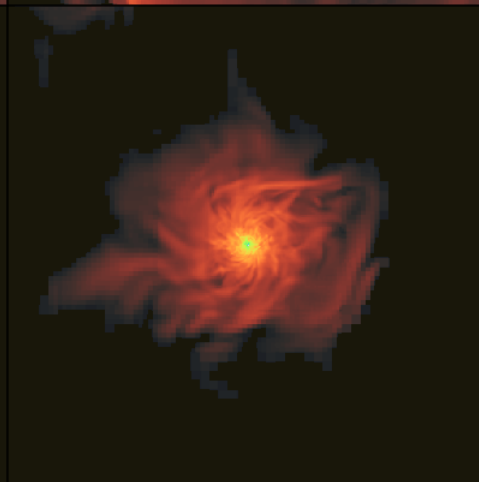
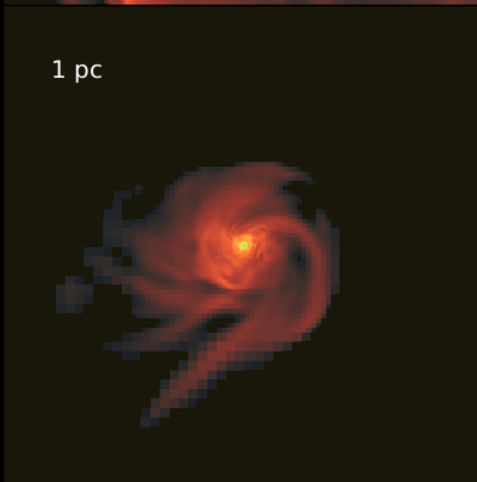
Jeans Parameter = 32

Jeans Parameter = 64

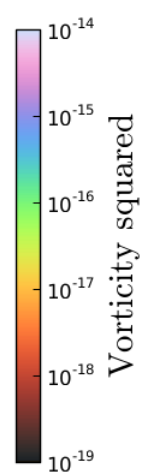
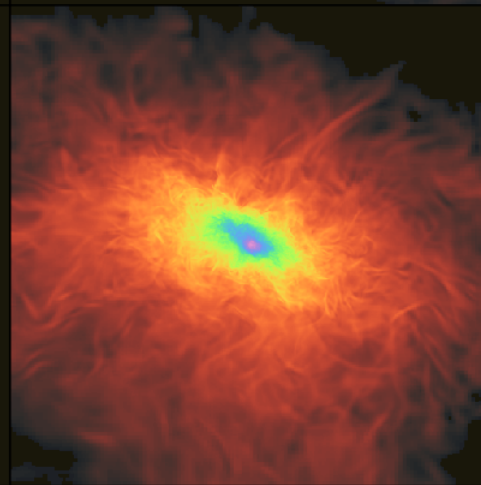
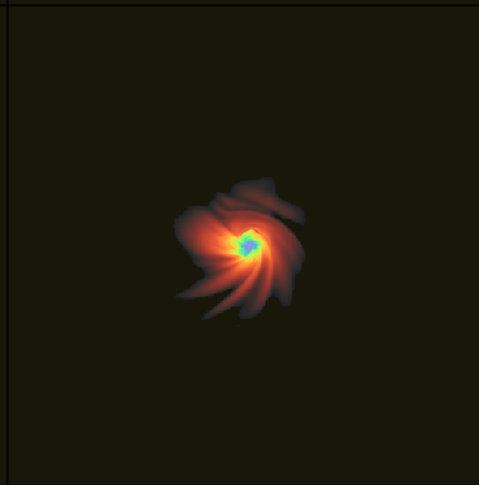
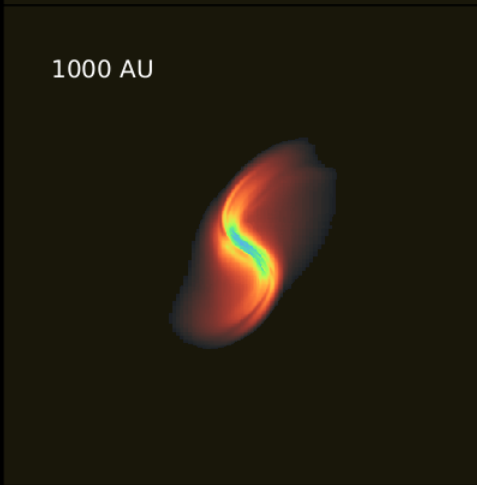
300 pc



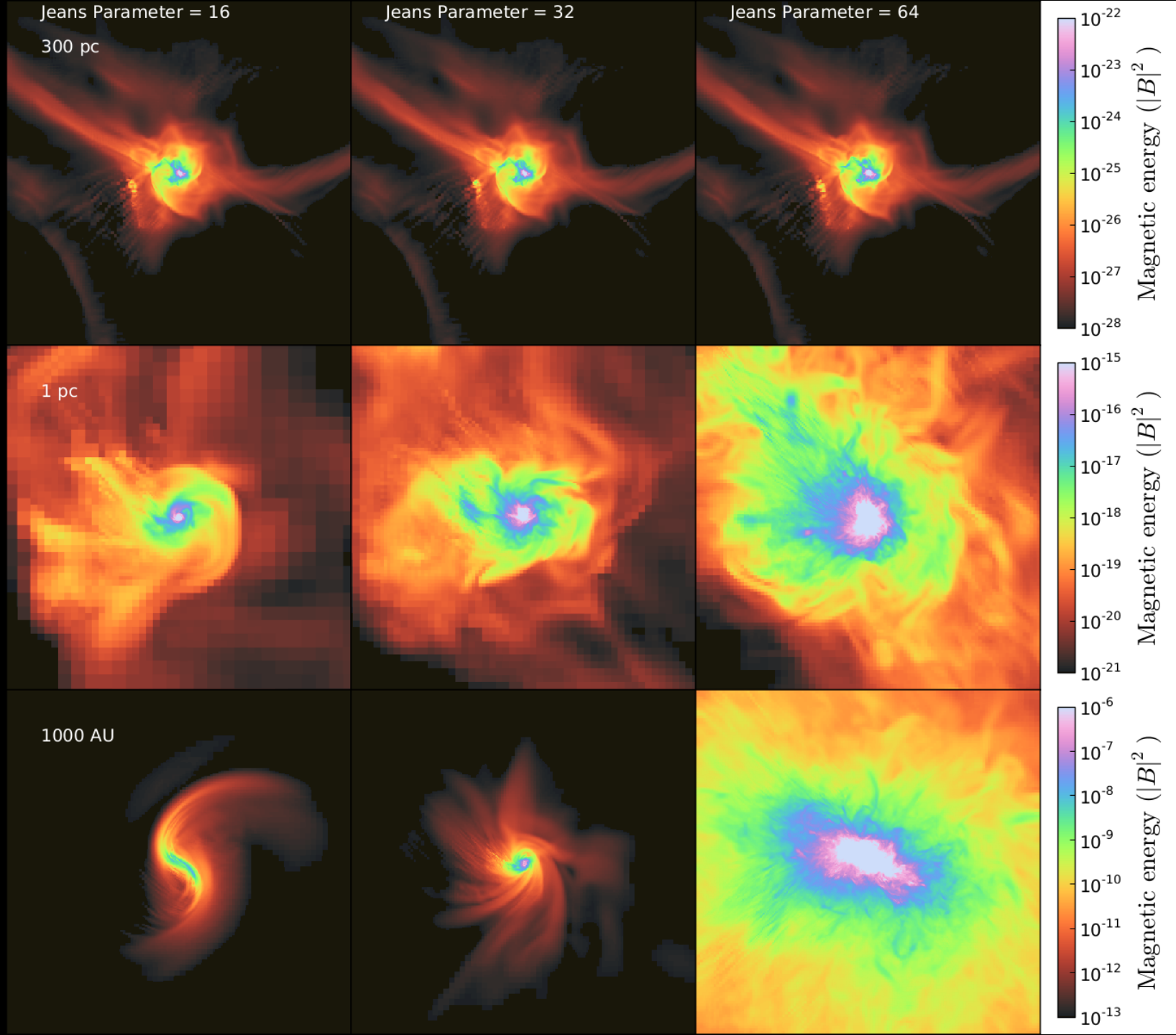
1 pc



1000 AU





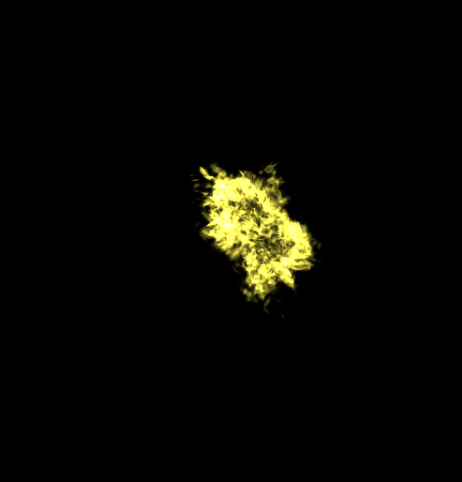
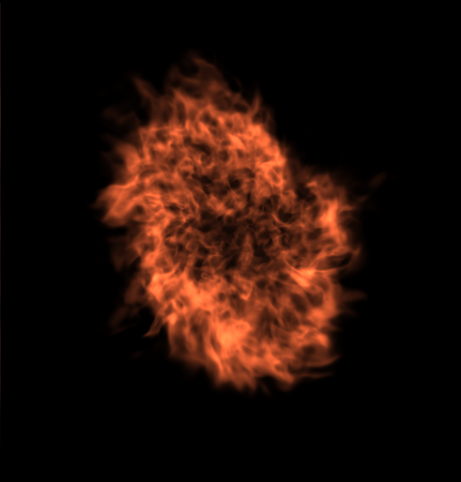
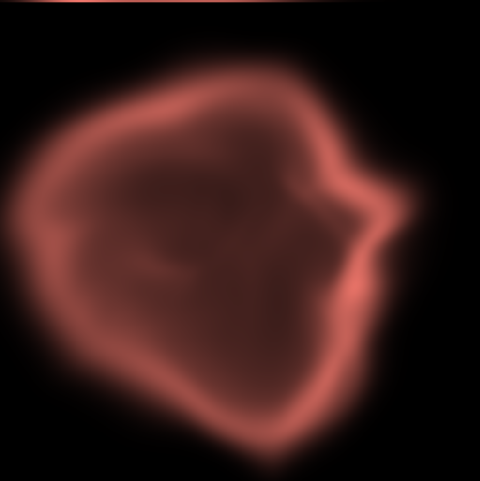
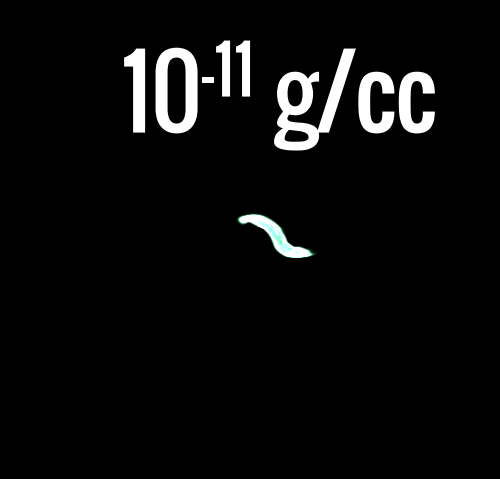
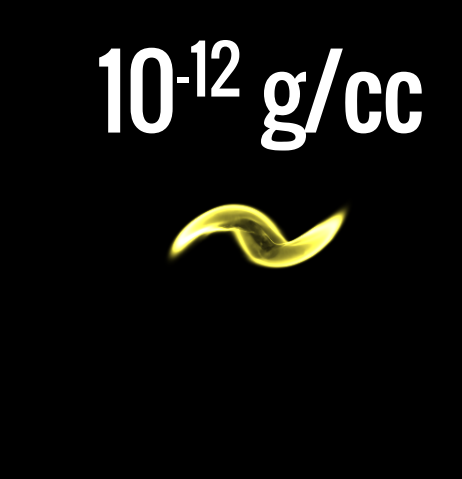
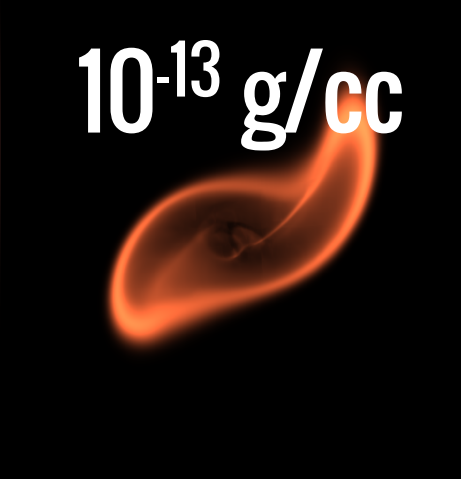
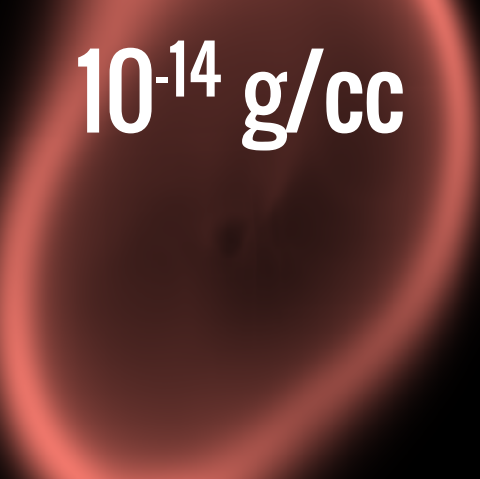


$10^{-14}$  g/cc

$10^{-13}$  g/cc

$10^{-12}$  g/cc

$10^{-11}$  g/cc

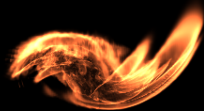


1000 AU

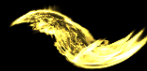
$10^{-12} |B^2|$



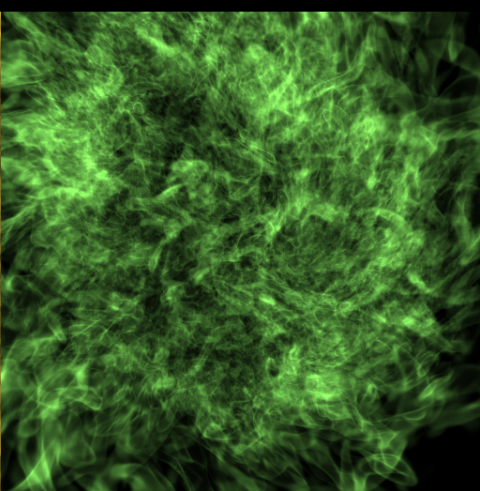
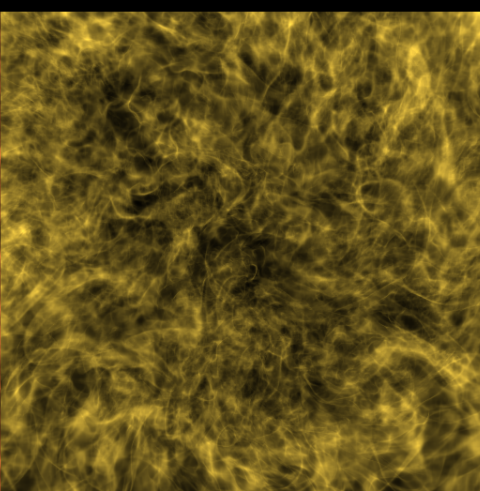
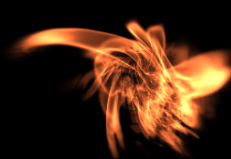
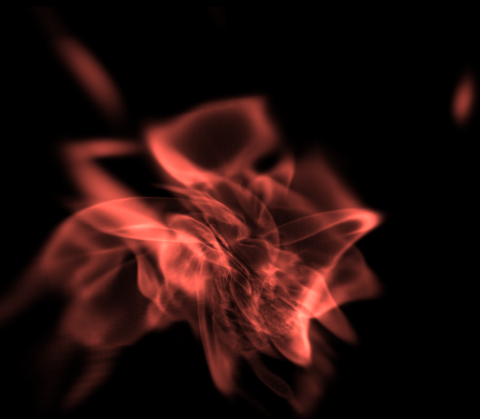
$10^{-11} |B^2|$



$10^{-10} |B^2|$

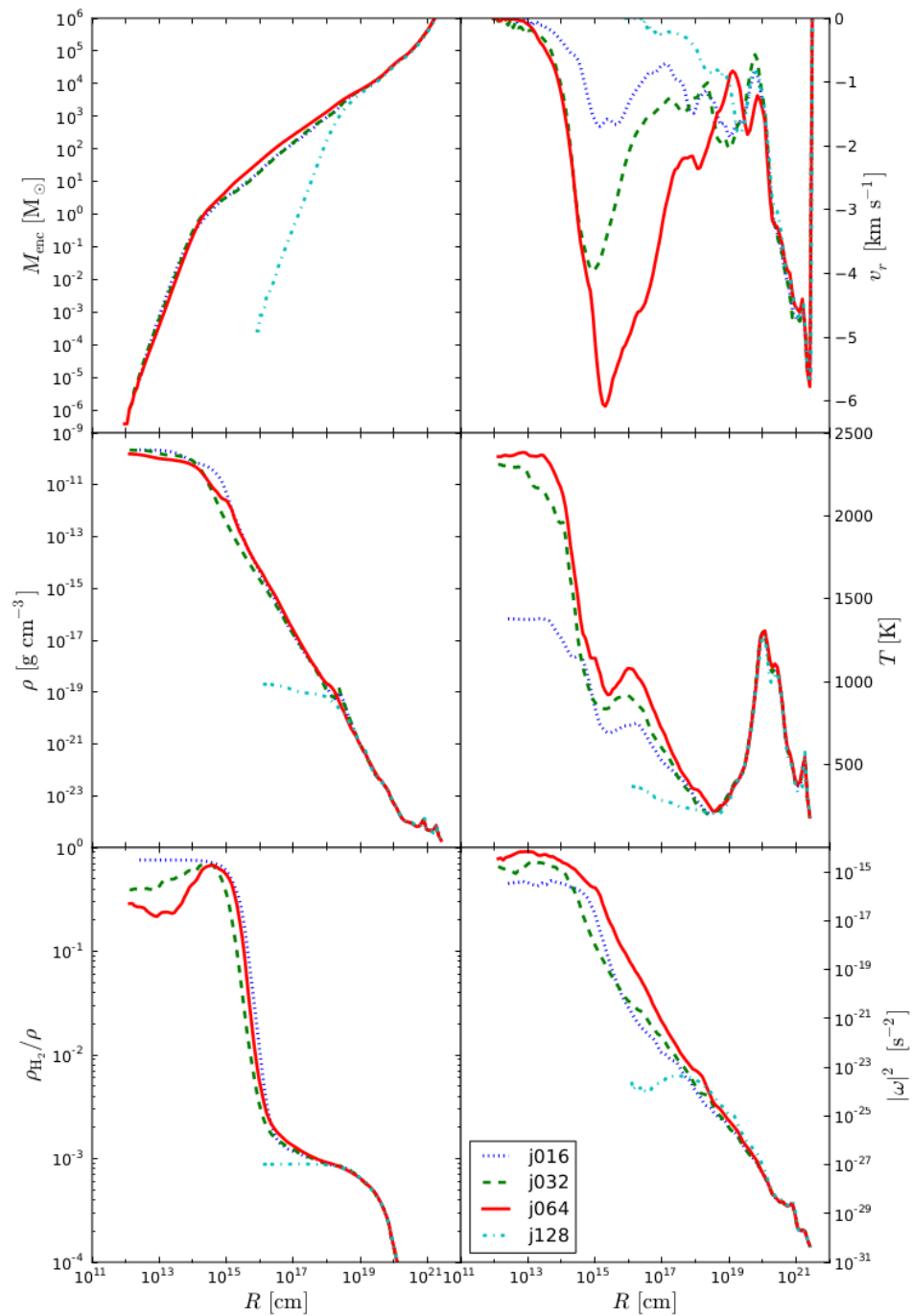


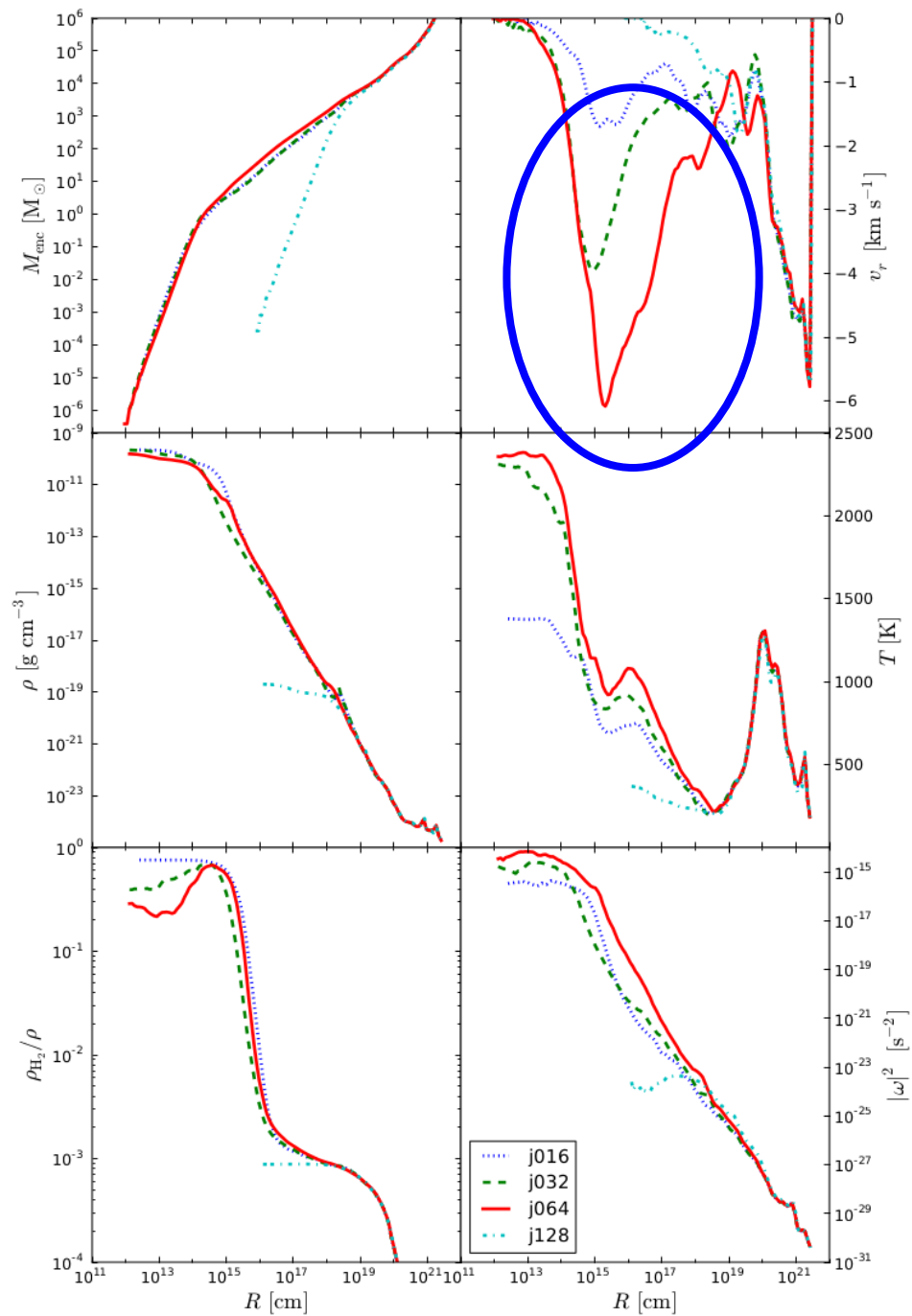
$10^{-9} |B^2|$



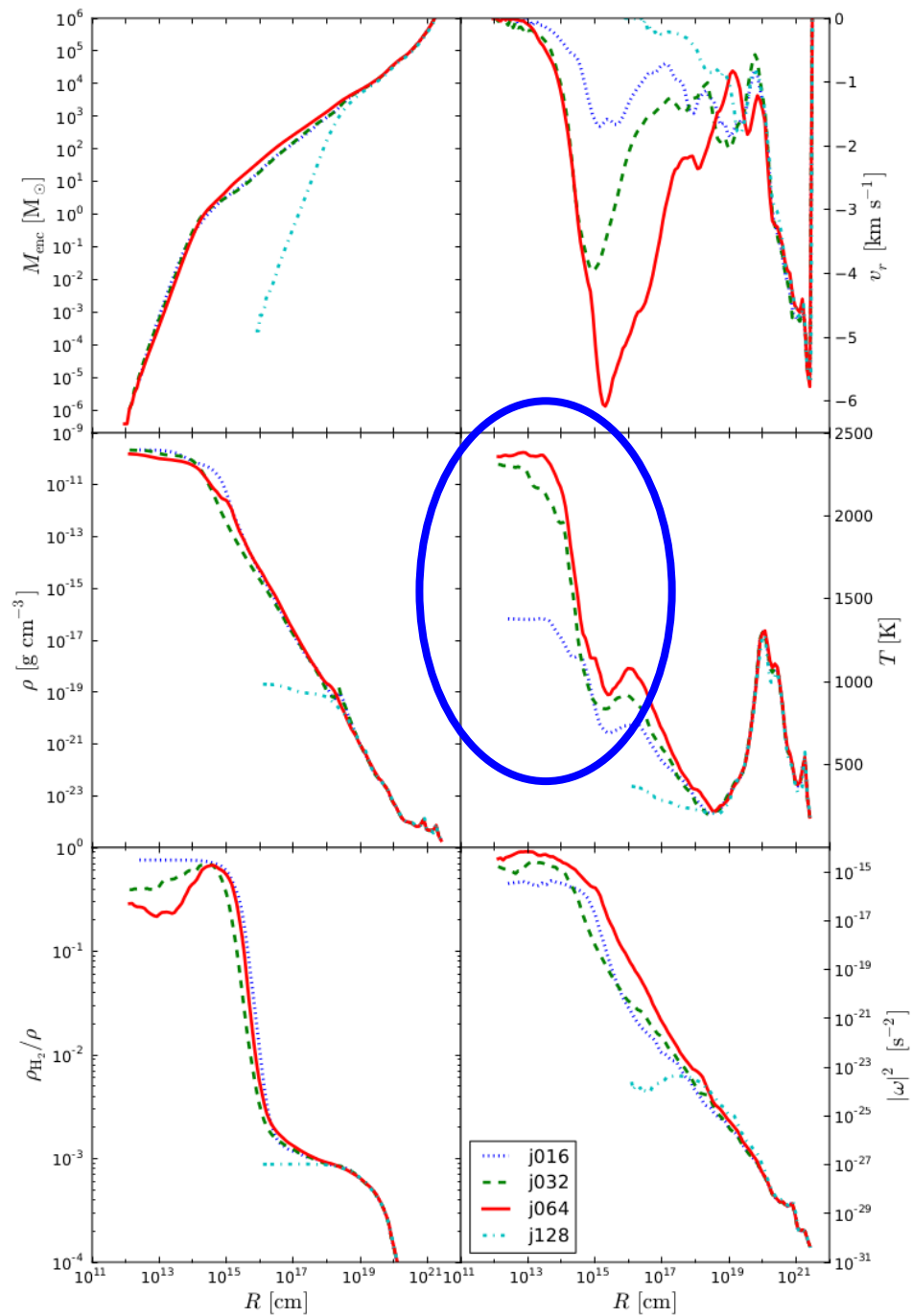
1000 AU

# Three primary





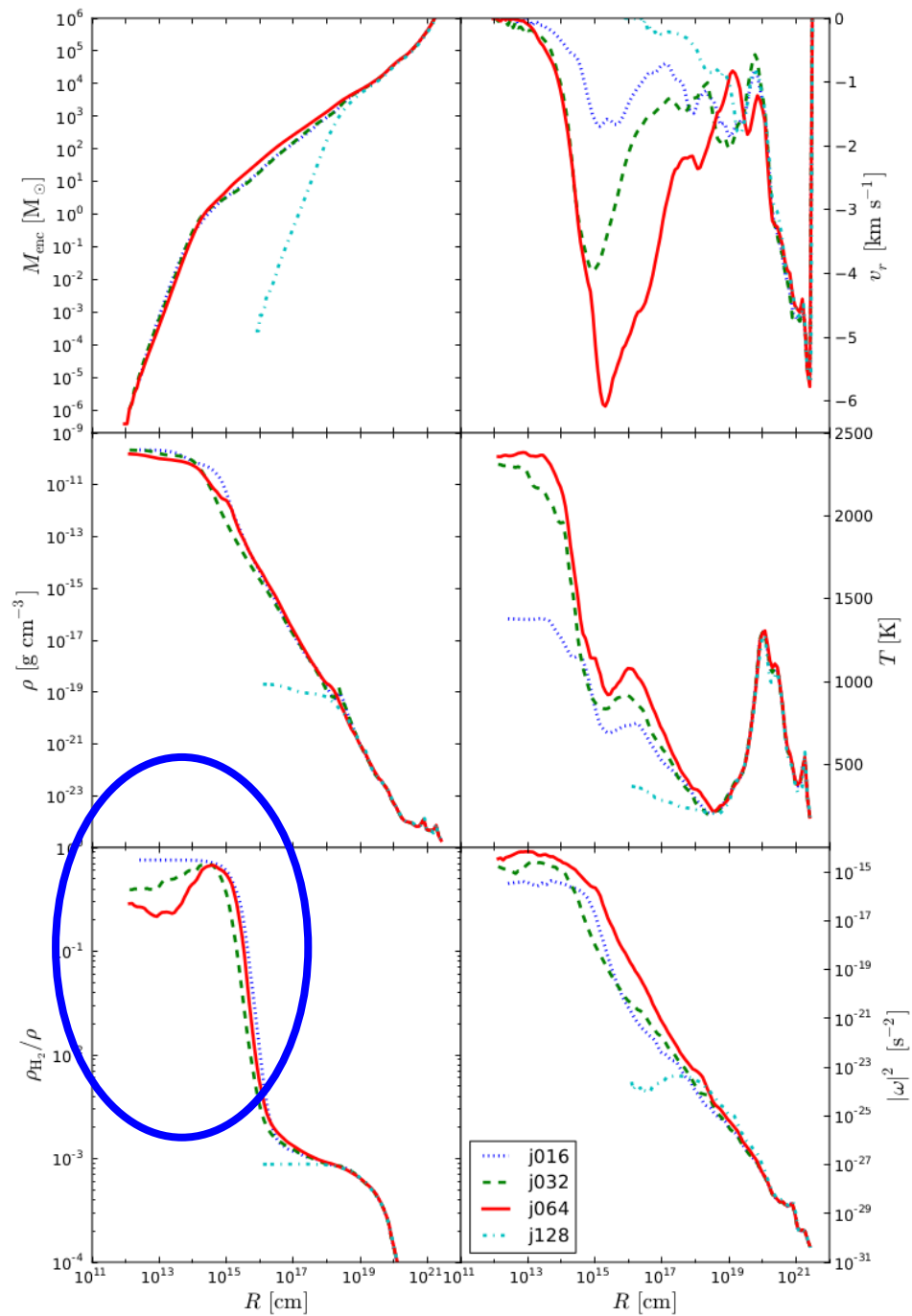
Increased inward velocity



Increased inward velocity

Increased core temperature



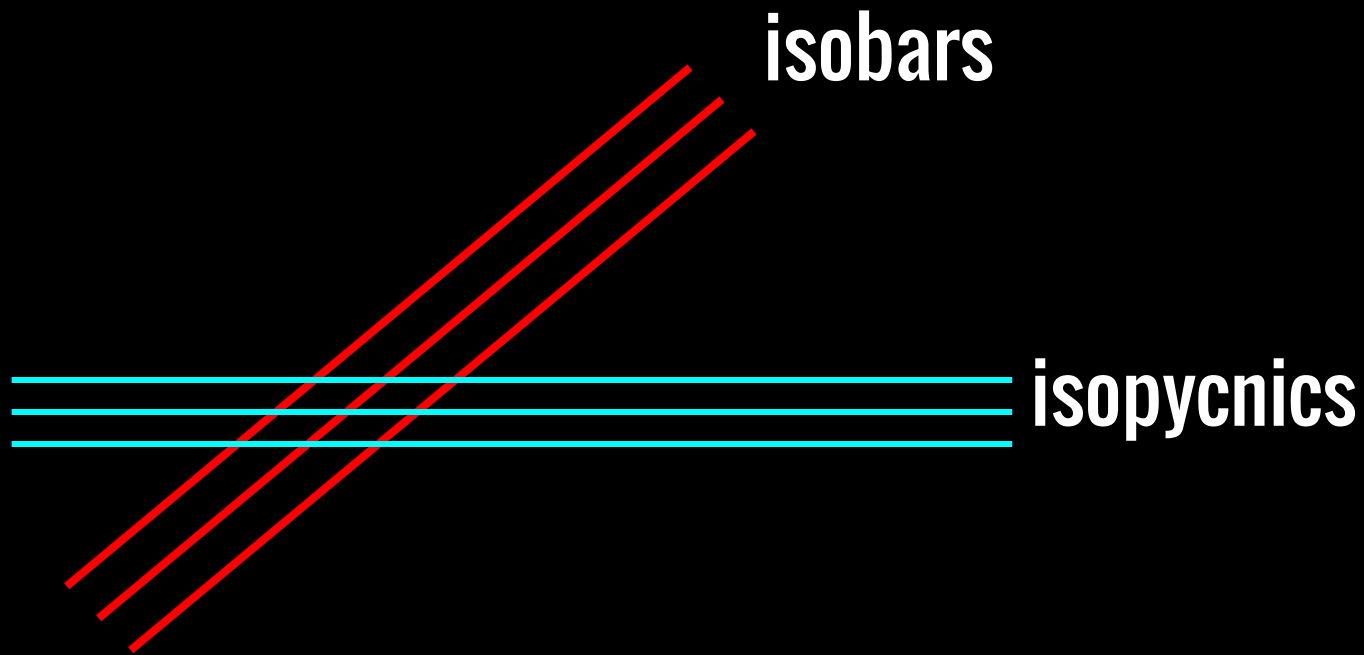


**Increased inward velocity**

**Increased core temperature**

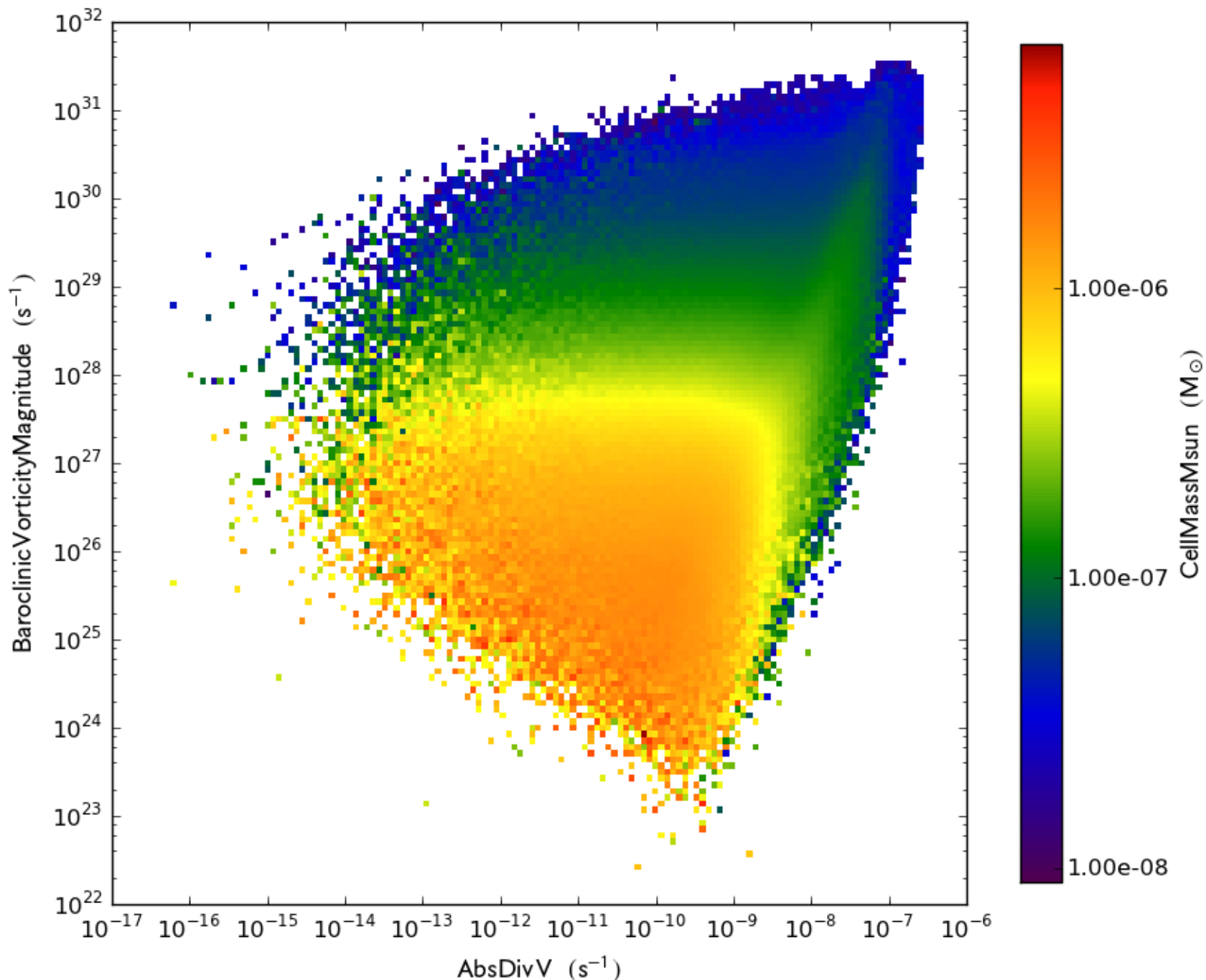
**Decreased  $\text{H}_2$  fraction**

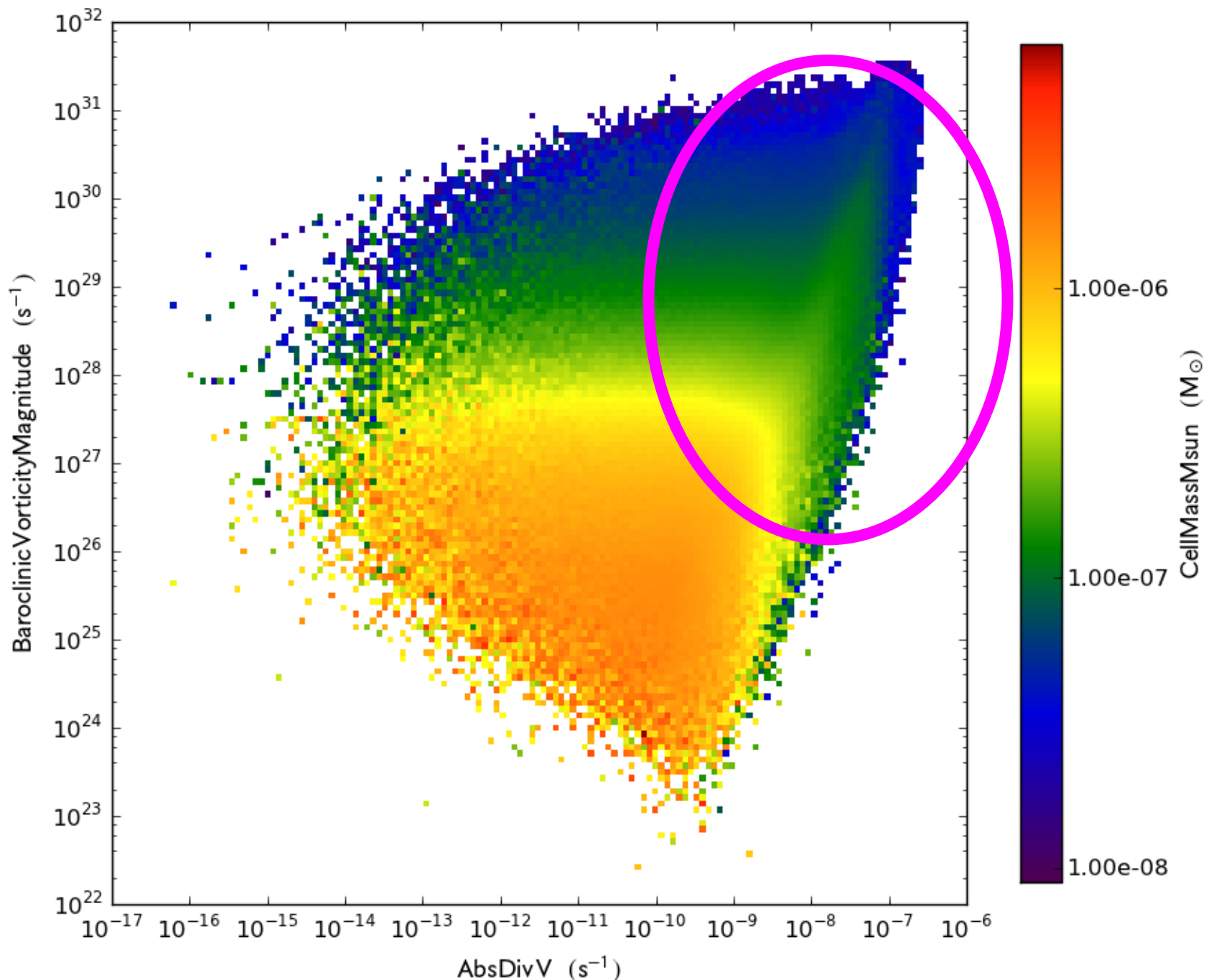
# Baroclinic vorticity production

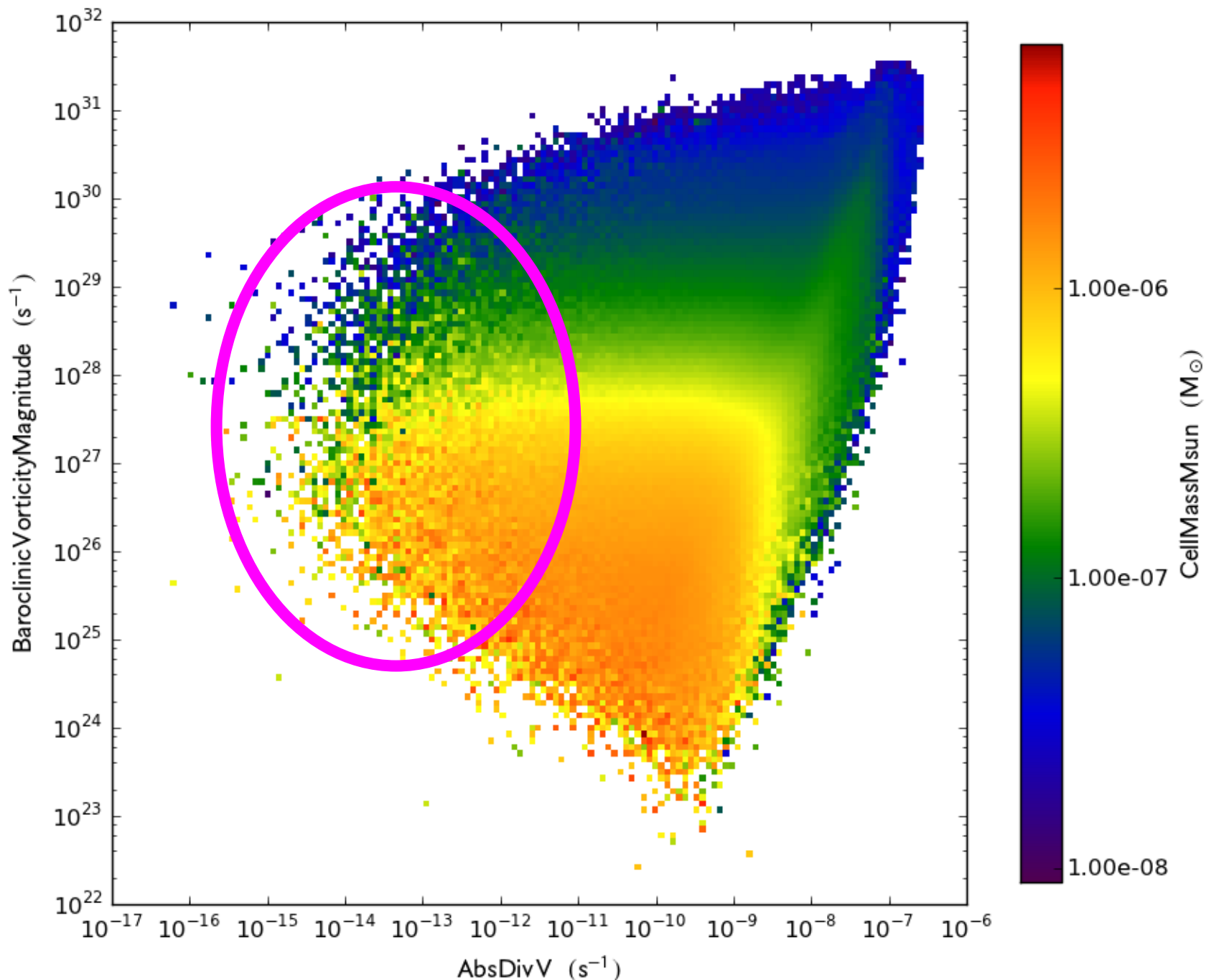


**Shocks, chemothermal gradients, and convection.**









**Disk structure is changed, but  
perhaps not by the magnetic field**

**Dynamo action operates in  
cosmological initial conditions**

# Thank you.

---

**Collaborators:**

**Jeffrey Oishi**

**Tom Abel**

**Greg Bryan**

[enzo-project.org](http://enzo-project.org)

[yt-project.org](http://yt-project.org)