

# Turbulence, Compressibility, Self Gravity, and Magnetic Fields.

David C. Collins  
Metropolis Postdoctoral Fellow  
Los Alamos National Lab  
University of Michigan  
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with A. Kritsuk,  
H. Li,  
P. Padoan,  
M. Norman,  
H. Xu

# Purpose

- Turbulence
- Magnetic Fields
- Supersonic
- Gravity

# Simulations




- Idealize!
- Isothermal (...)
- Supersonic (perhaps a bit *too* supersonic...)
- Ideal MHD
- Self Gravitating
- Driven Turbulence
- Magic Paddles
- Periodic

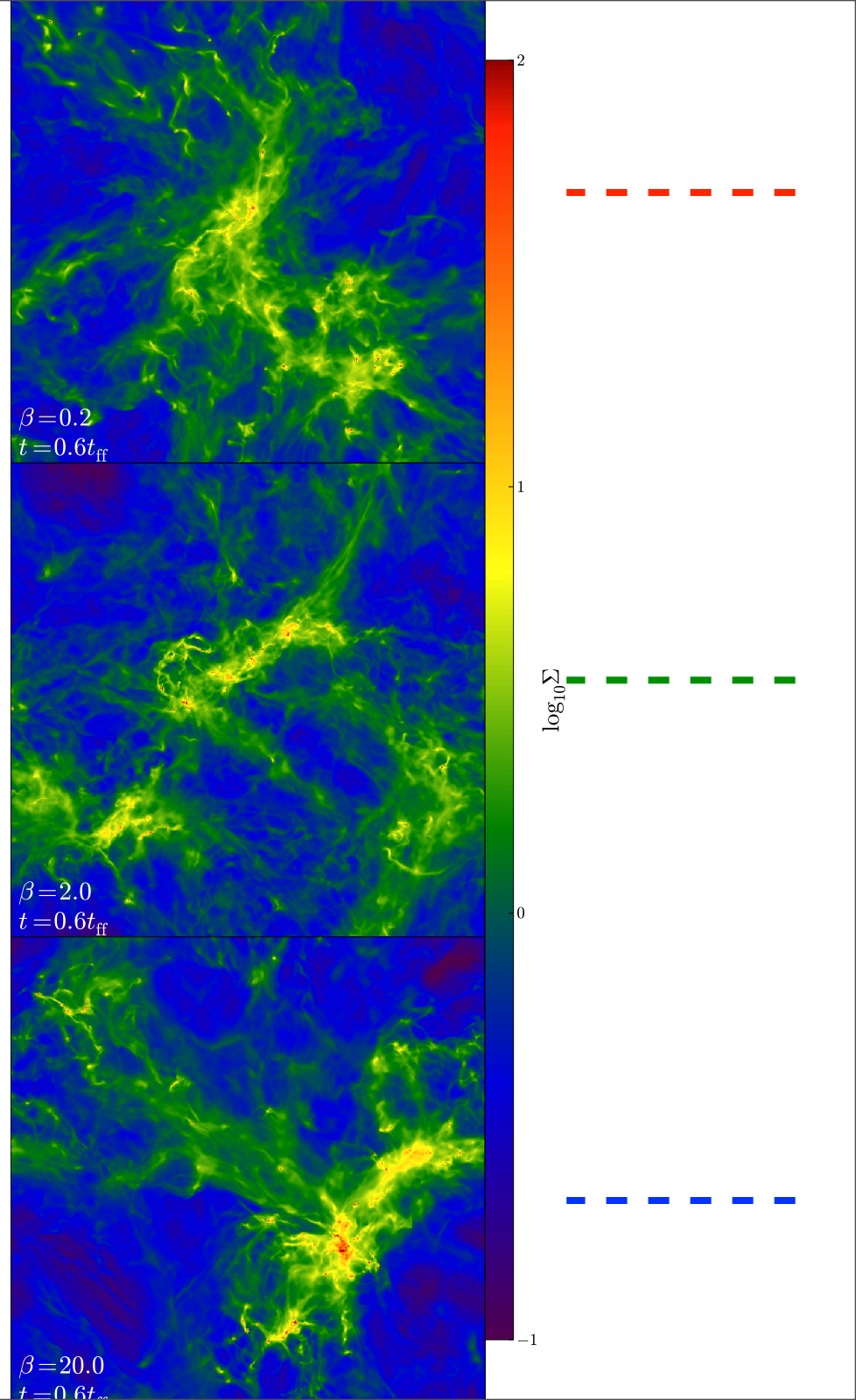
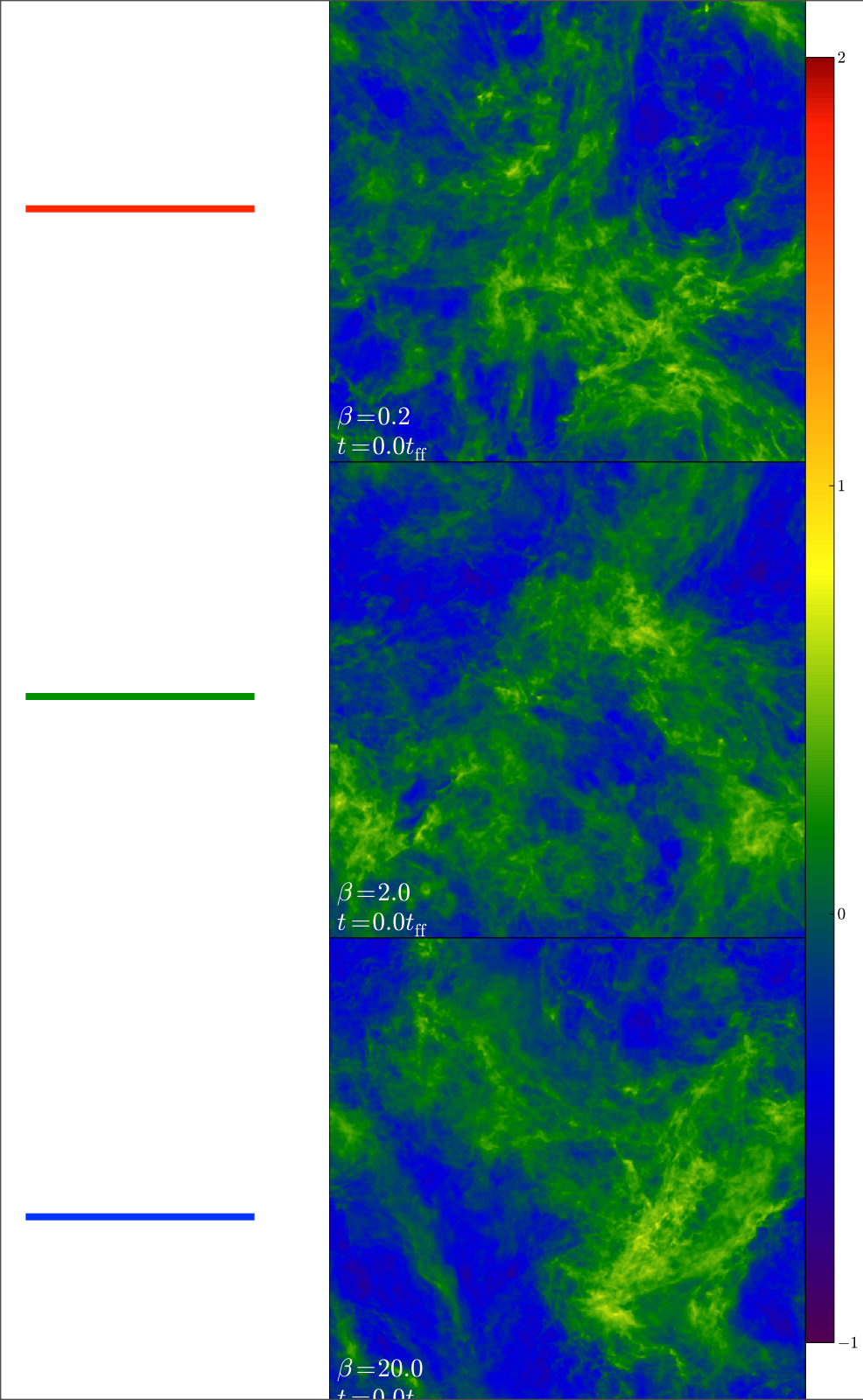
# Simulations

- Drive!
  - Uniform initial field, density
  - solenoidal velocity, large scale
  - steady state, saturated
- Collapse ( $t:=0$ )
  - 0.6 free fall times
  - Analyze  $t=0$ ,  $t=0.6$

# Three Simulations

- Mach 10
- Isothermal Ideal MHD
- Gravity
- AMR+MHD (512+4 levels)
- Enzo:(Collins+2010)  
[enzo-project.org](http://enzo-project.org)
- Results (Collins+2011, Collins+2012)
- yt ([yt-project.org](http://yt-project.org))
- Kraken

	$\beta = 0.2$
	$\beta = 2.0$
	$\beta = 20$



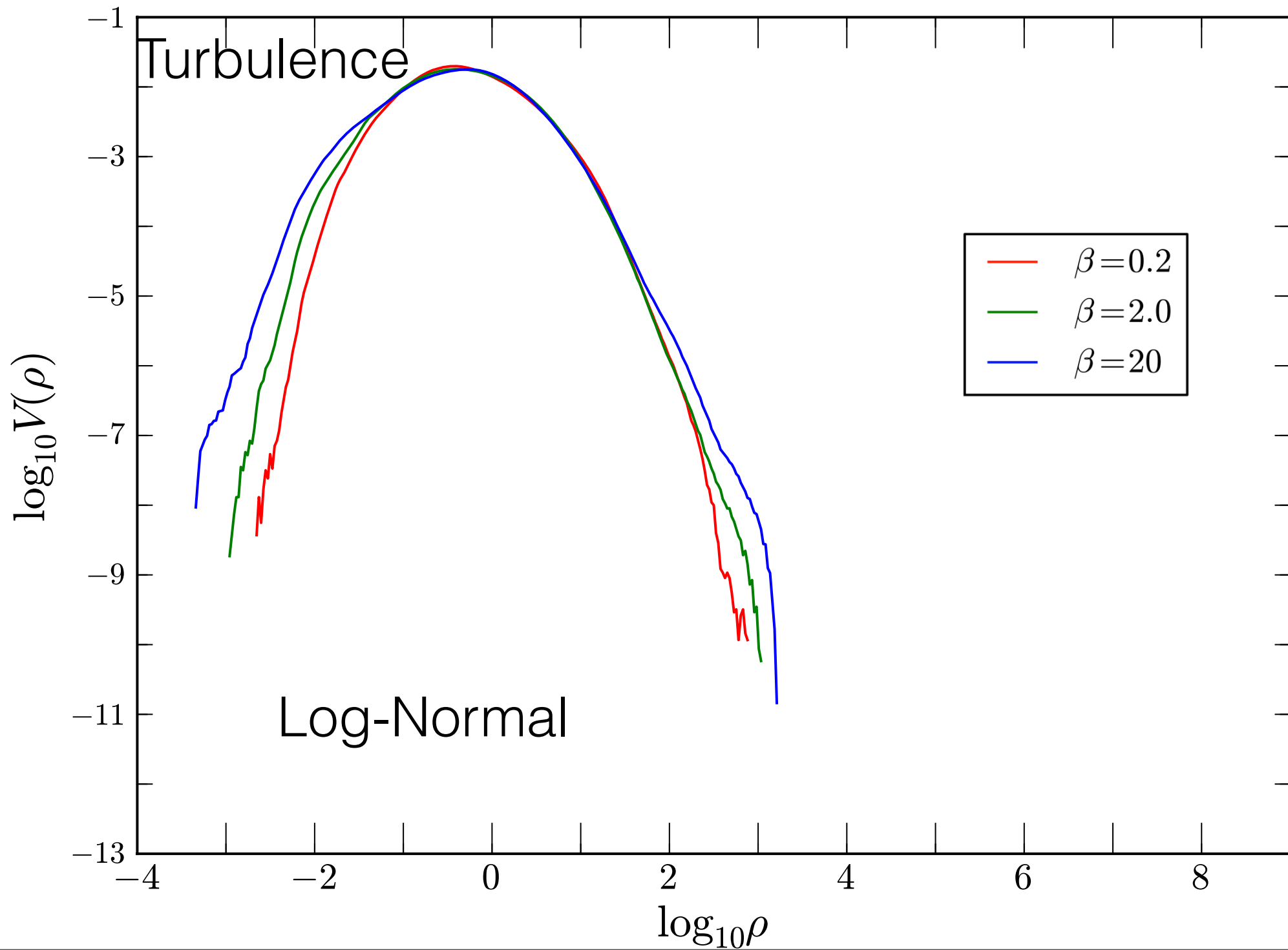
# Next

- Density Statistics
- Velocity Statistics
- Magnetic Field Statistics

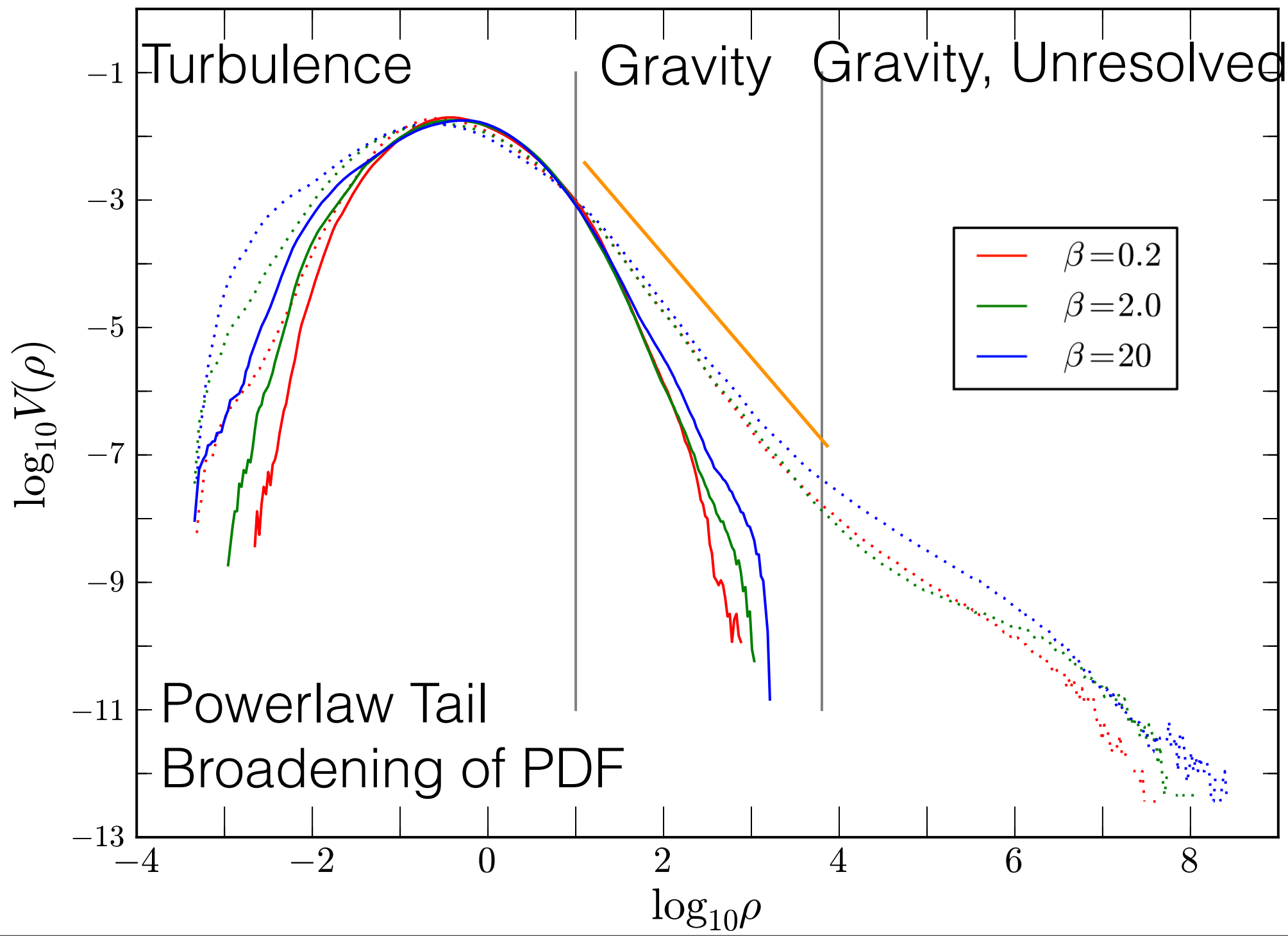
# Density Statistics



# Density PDF



# Density PDF



# Self Similar Collapse

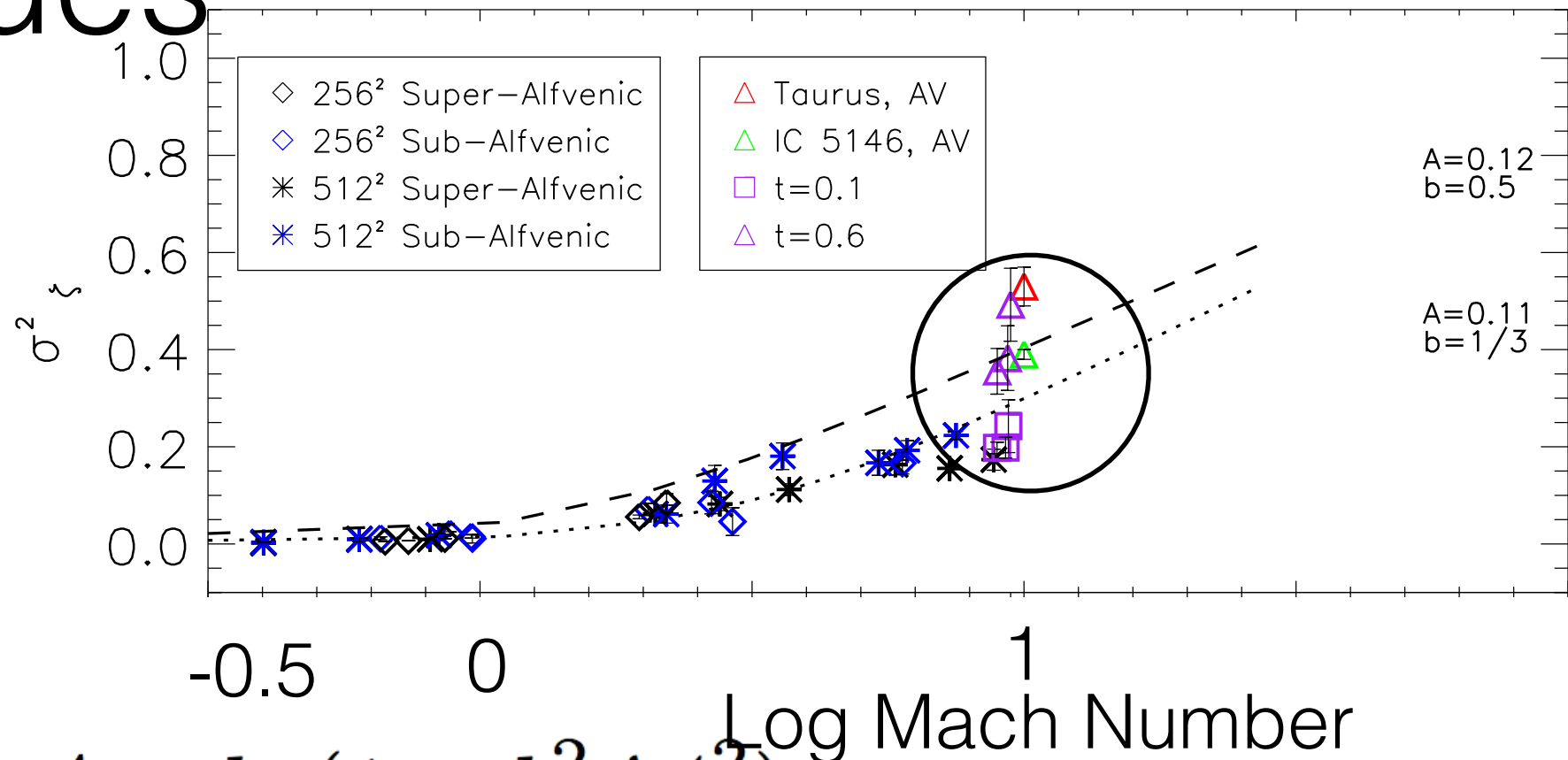
$$\rho \propto r^{-2}$$

$$V(\rho) \propto \rho^{-3/2}$$

(-1.64 measured. Many self similar spherical solutions. Pressure-Free give -1.7)

(Kritsuk + 2011)

# Compressive vs Solenoidal Modes

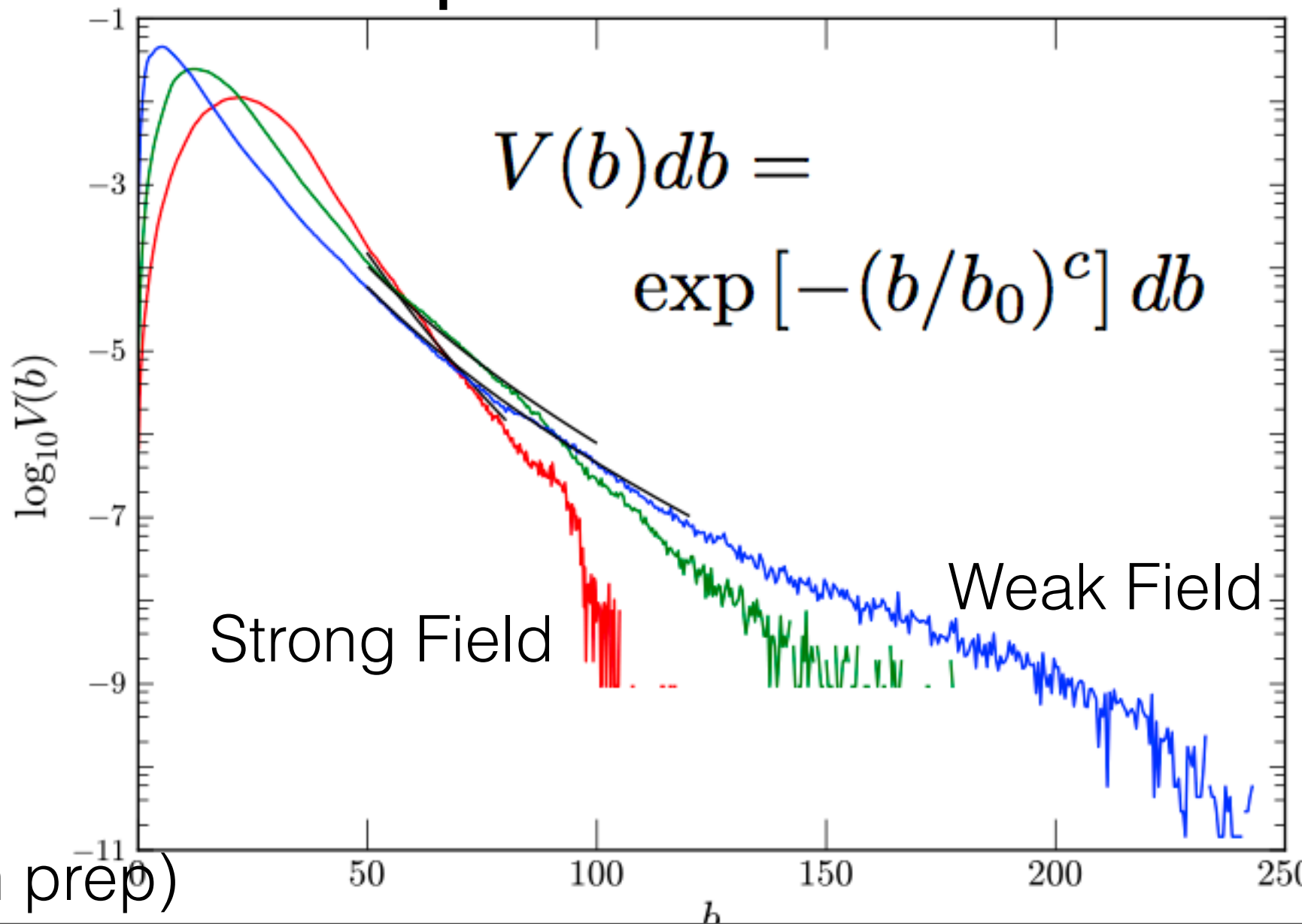


$$\sigma_\zeta^2 = A \times \ln(1 + b^2 \mathcal{M}_s^2)$$

(Burkhart & Lazarian 2012)  
 (Burkhart & Collins 2013?)  
 (Federrath+2010)

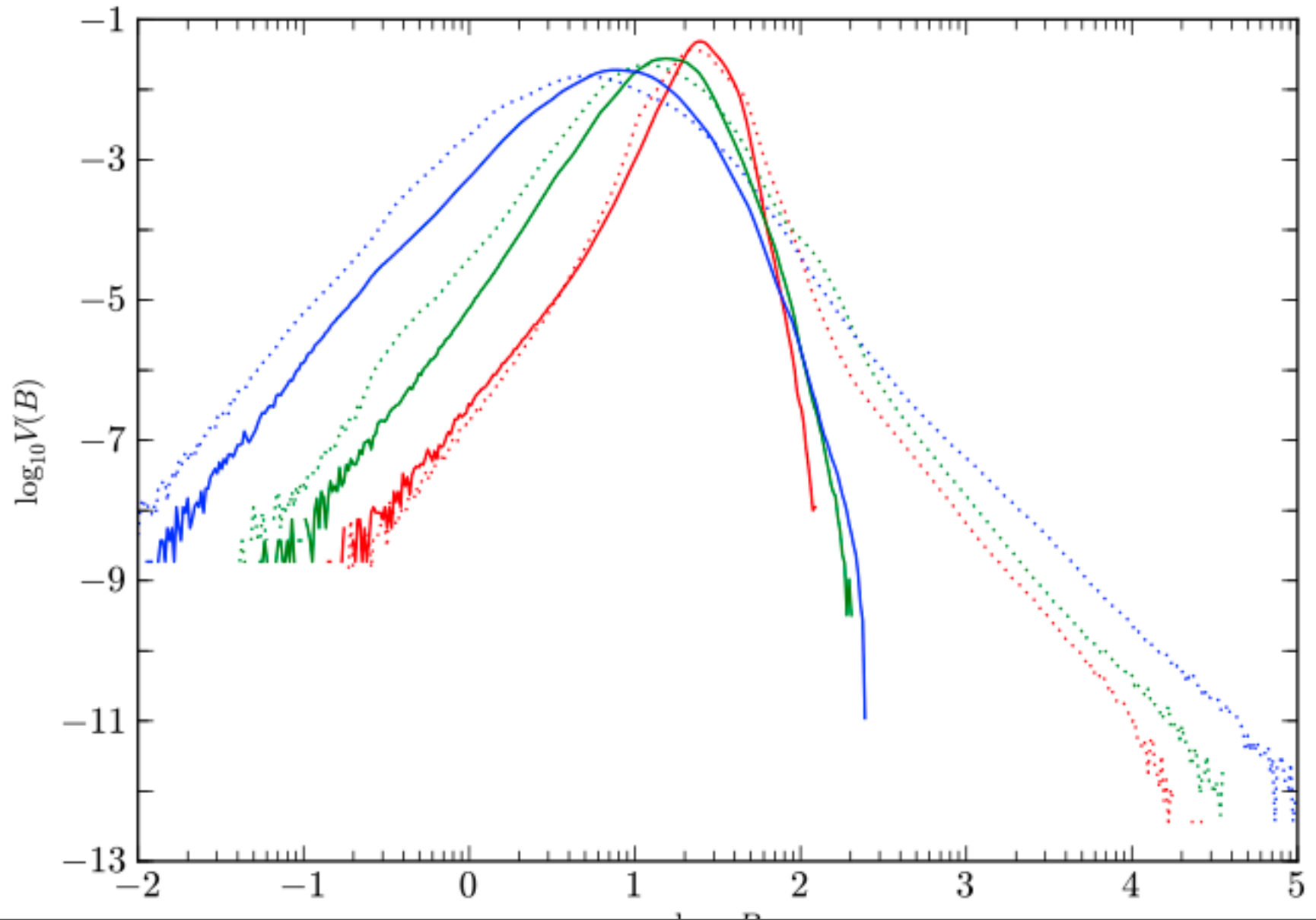
# Magnetic Statistics

# Turbulent Magnetic PDF: Stretched Exponential



(Kritsuk+in prep)

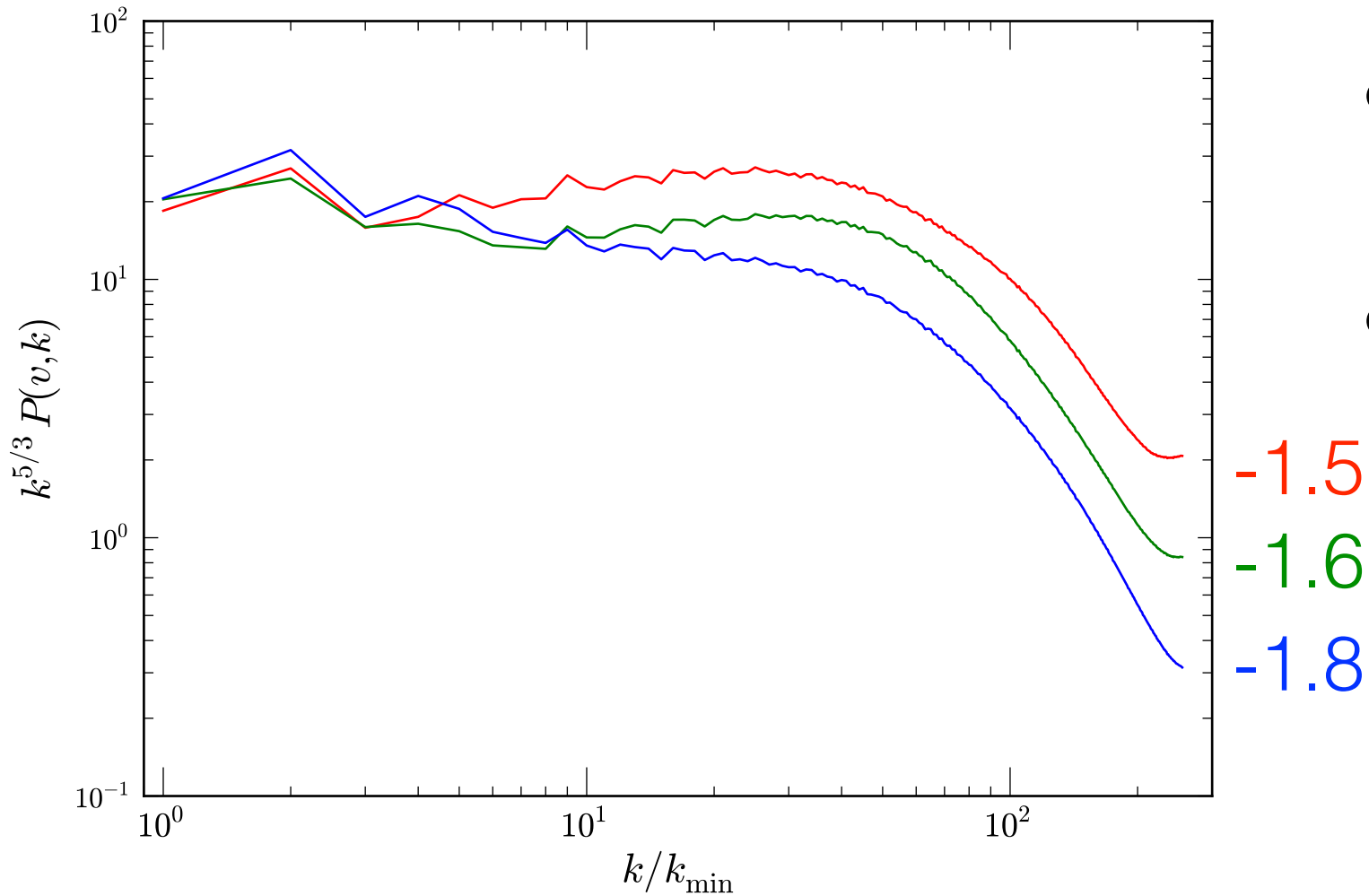
# Gravitating Magnetic PDF: Powerlaw



# Velocity Statistics

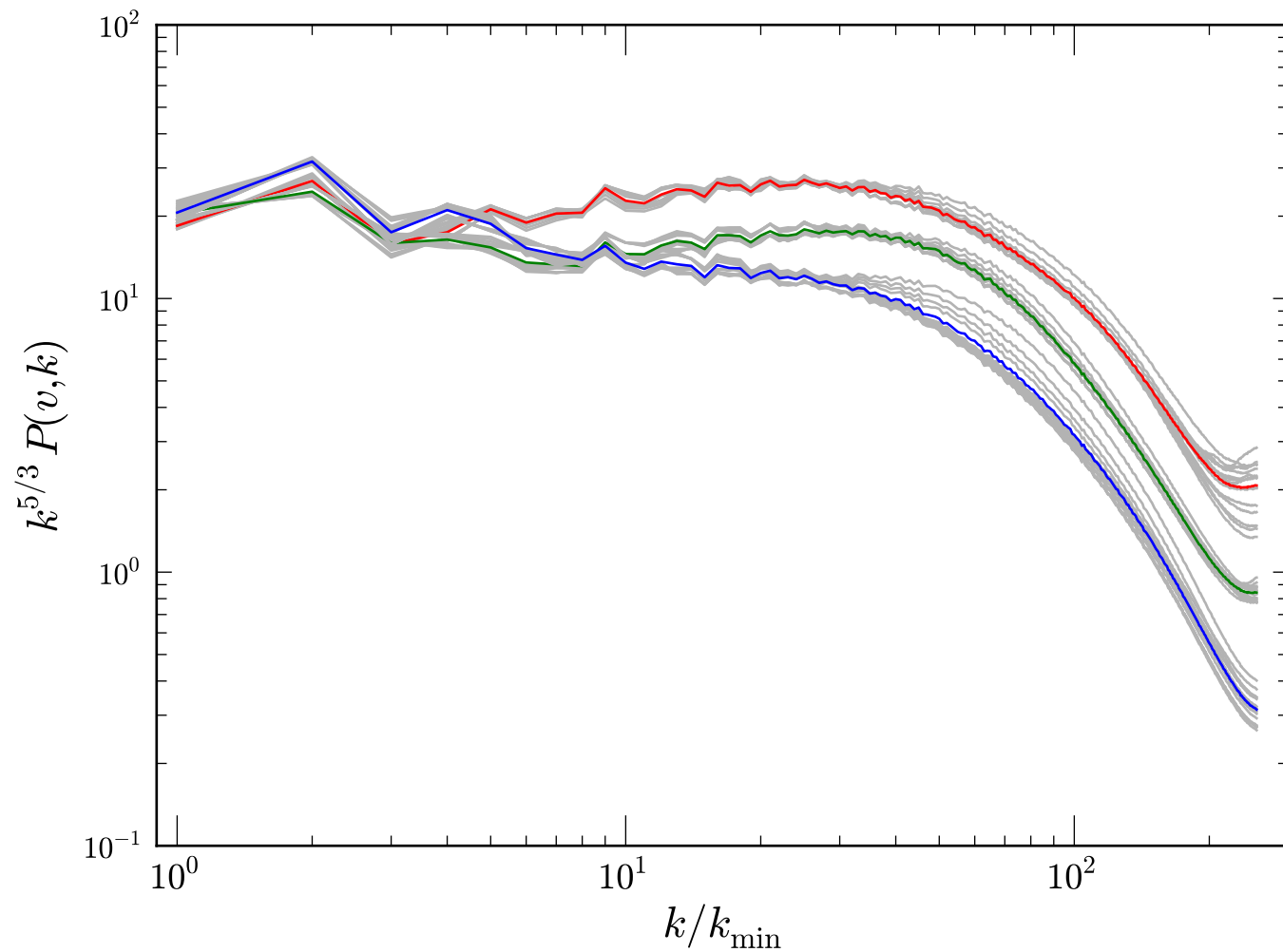


# Velocity Spectra



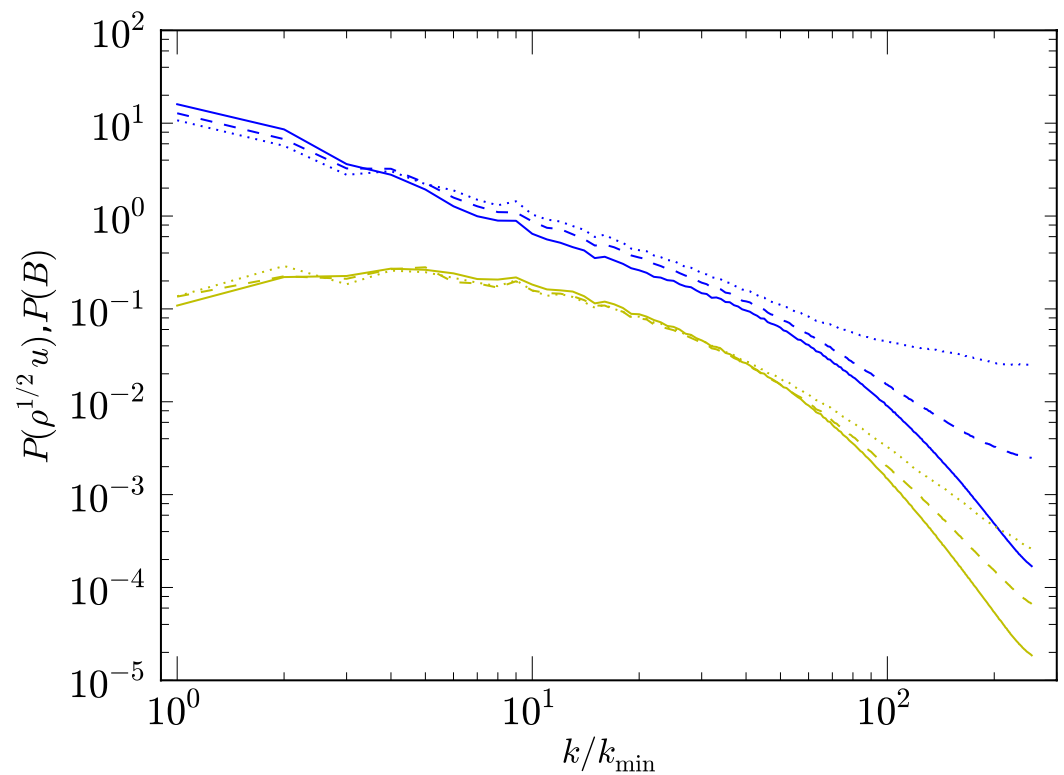
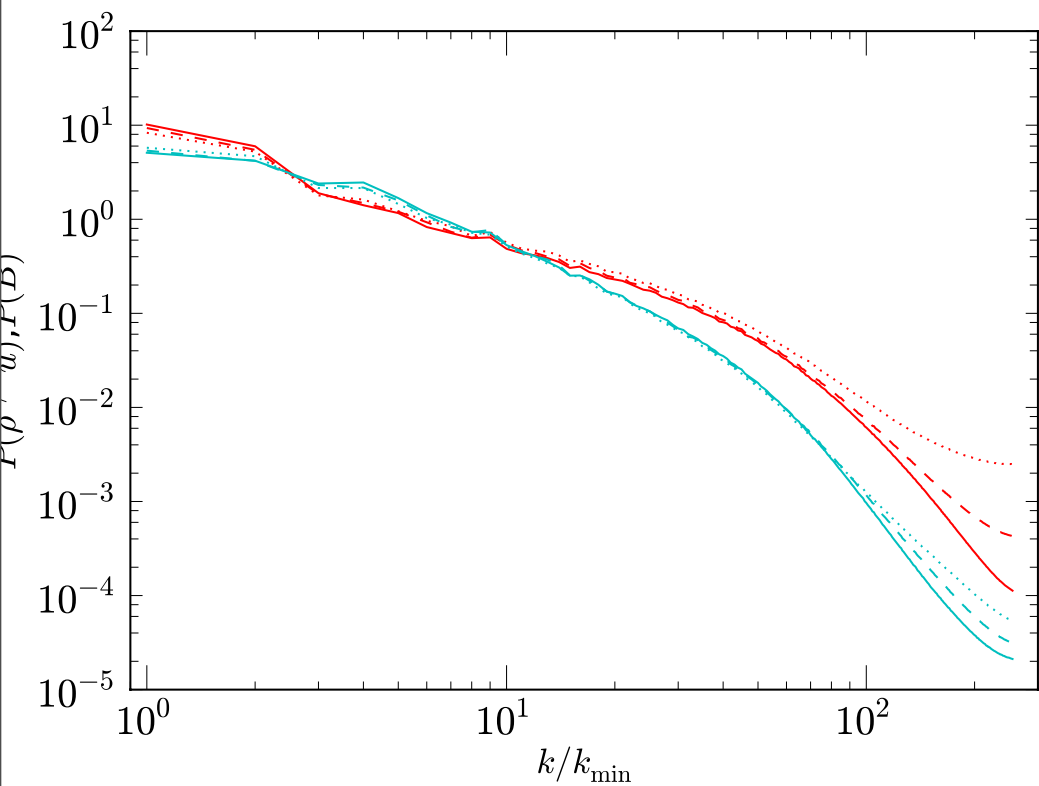
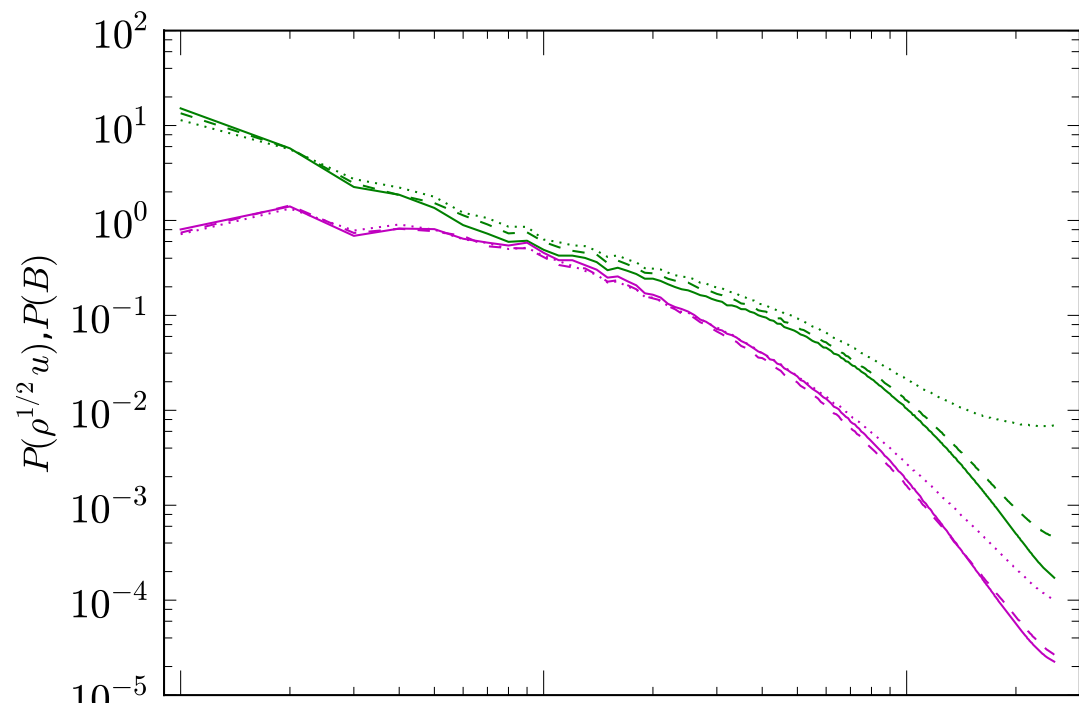
- More Field = More Flat
- Critical Density depends on Scaling?

# With (or without) Gravity

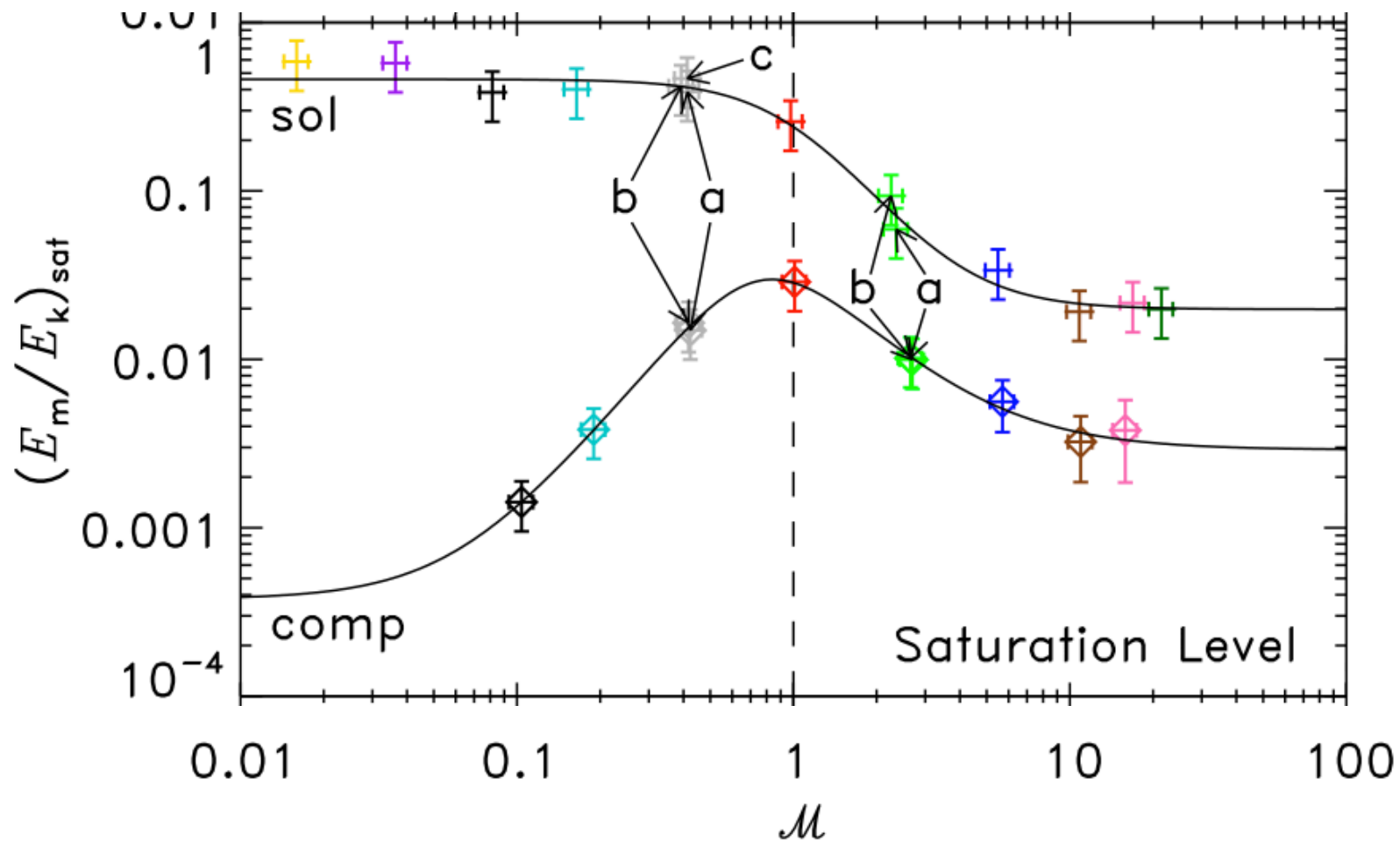


# Energy Spectra

- Saturation depends on scale and mean

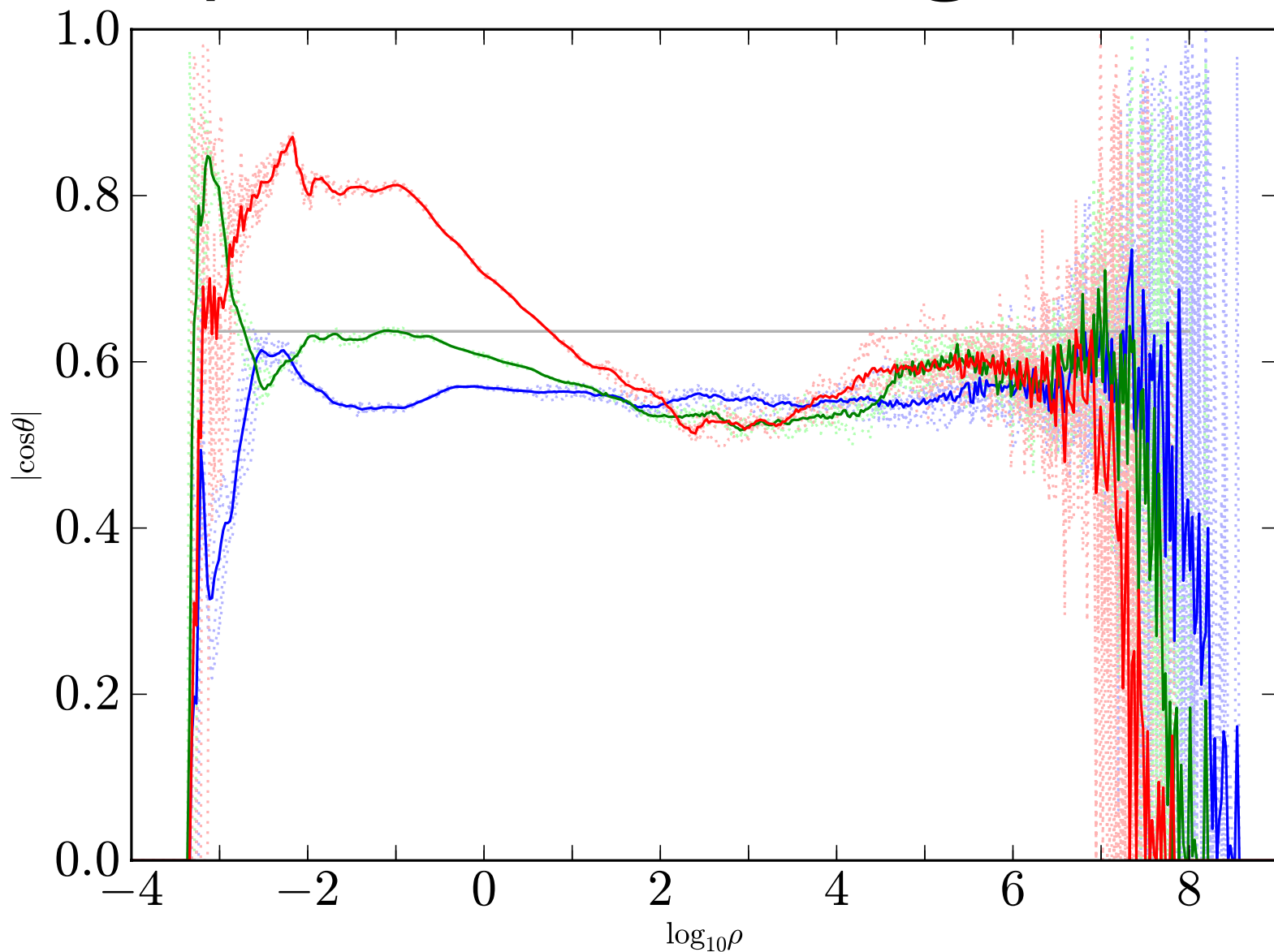


# Supersonic Dynamo



(Federrath+2011)

# Field, Density dependent Alignment

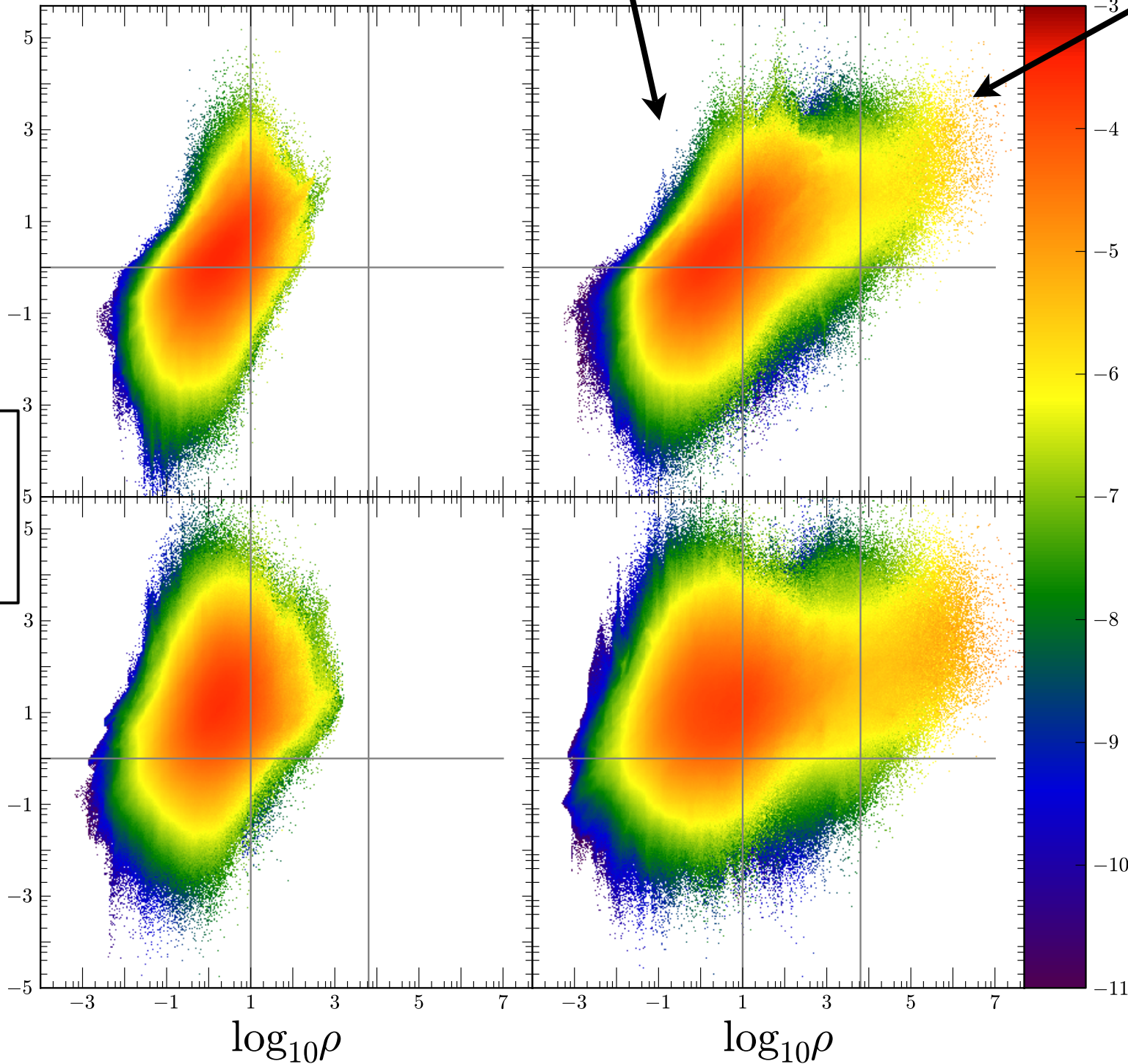


Trans-Alfvenic

Super-Alfvenic

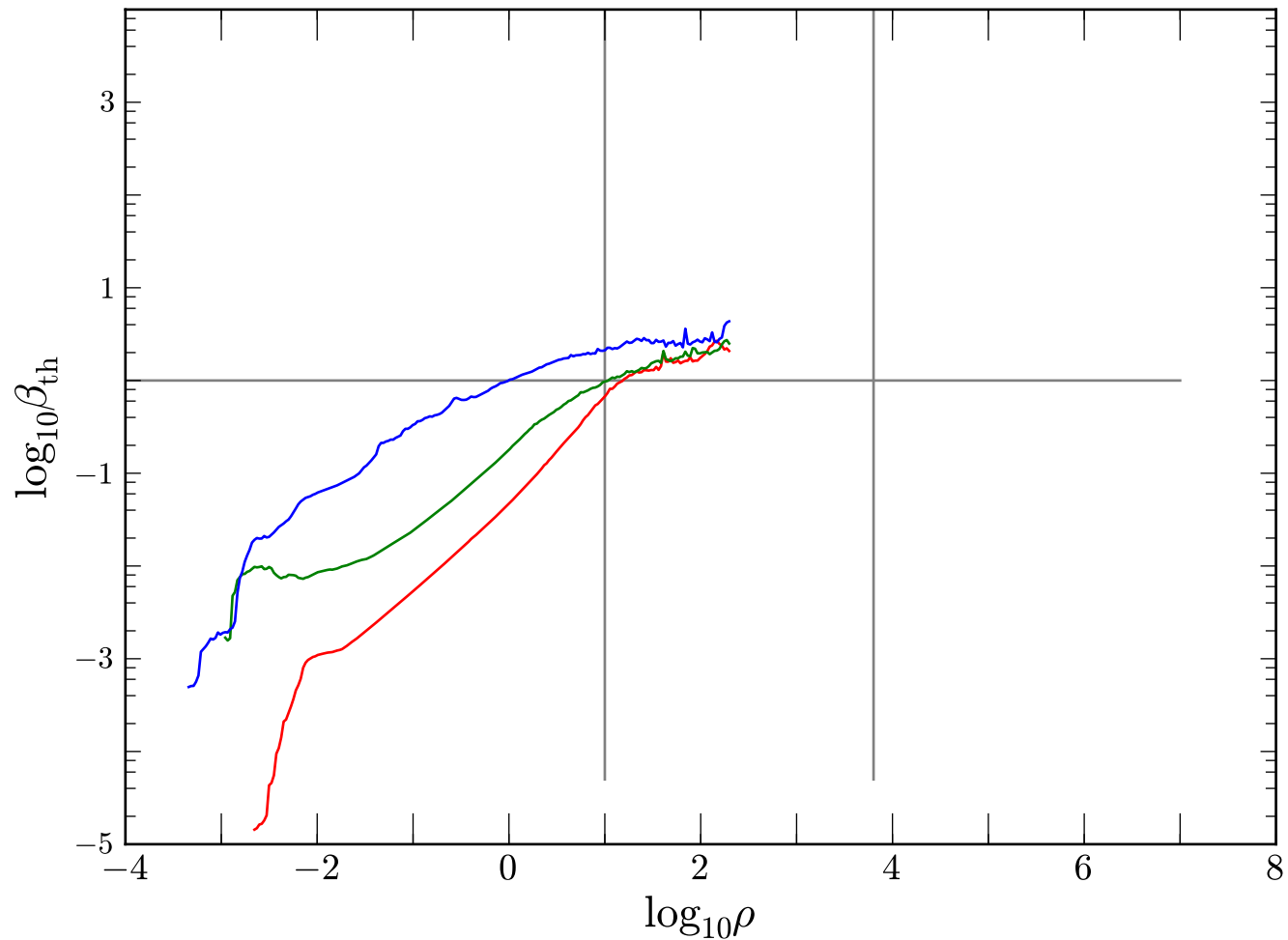
KE/  
BE

$\log_{10}\beta_{\text{dyn}}$

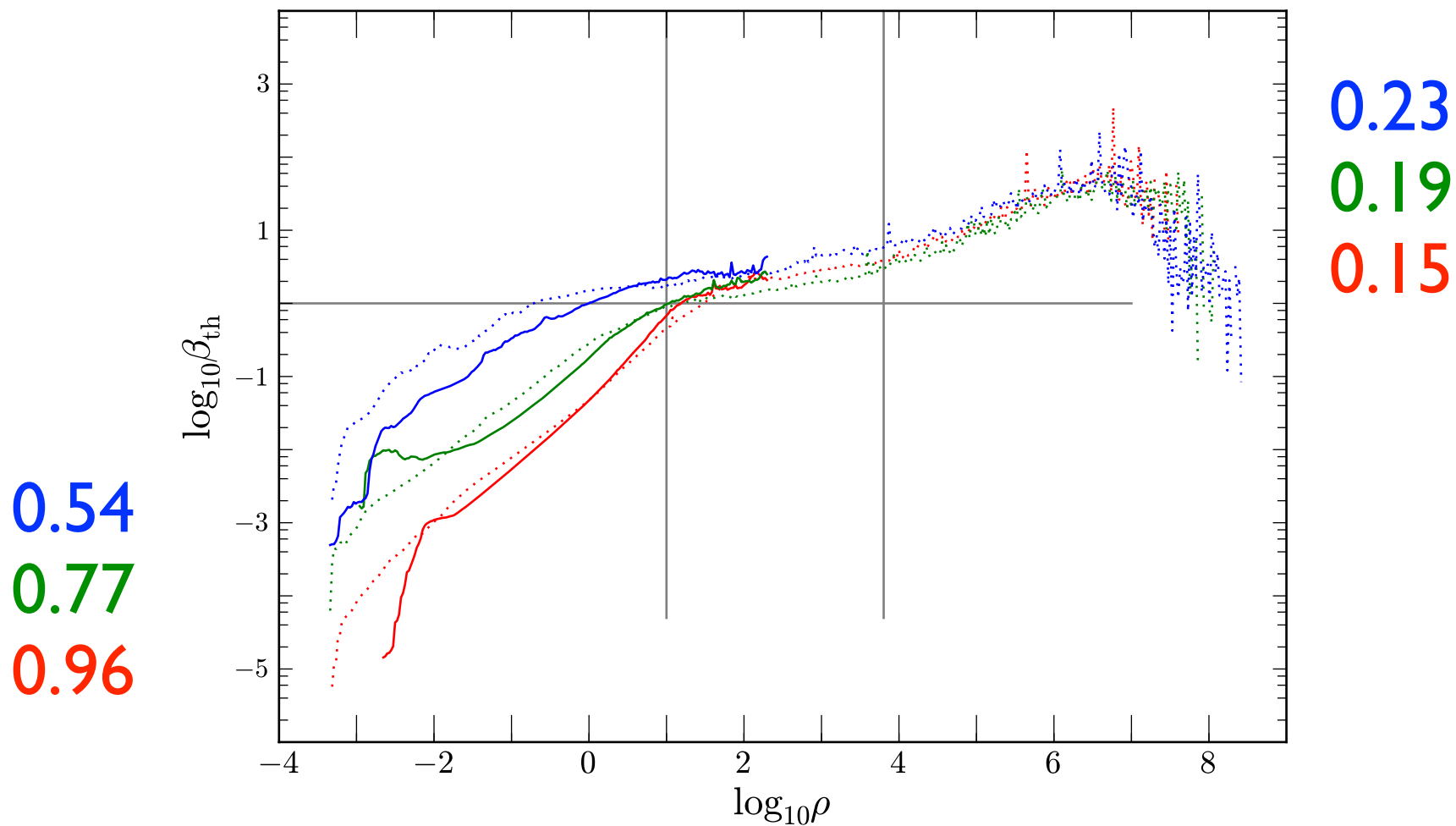


# Thermal-Magnetic Balance

0.54  
0.77  
0.96



# Thermal-Magnetic, Gravity





# Conclusions

- Magnetic Fields:
  - Compressibility
  - Tangled
  - Less is More
- Gravity
  - Compressibility
  - Decoupling
  - Self-similar collapse