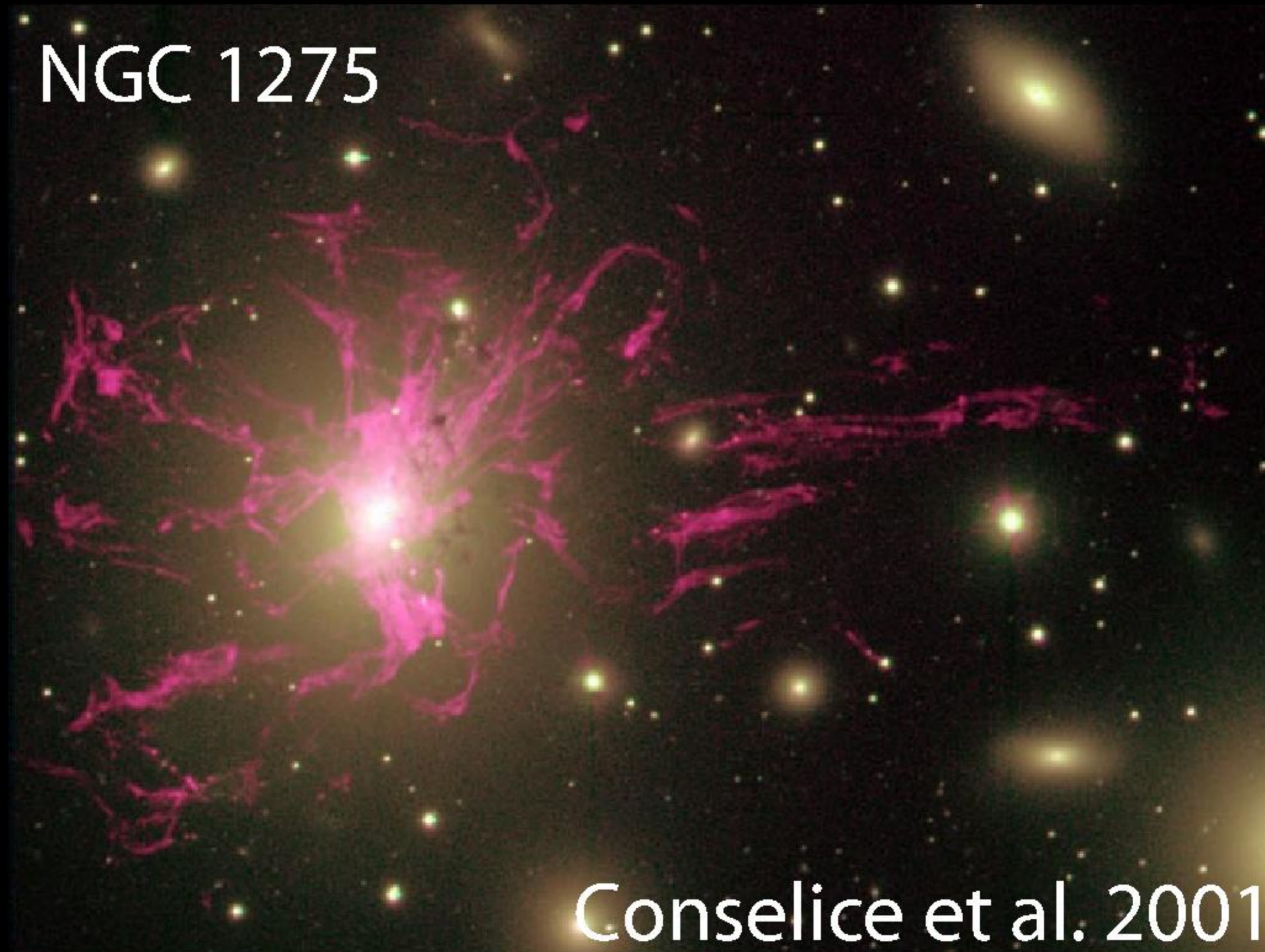


Thermal Instability with Anisotropic Conduction

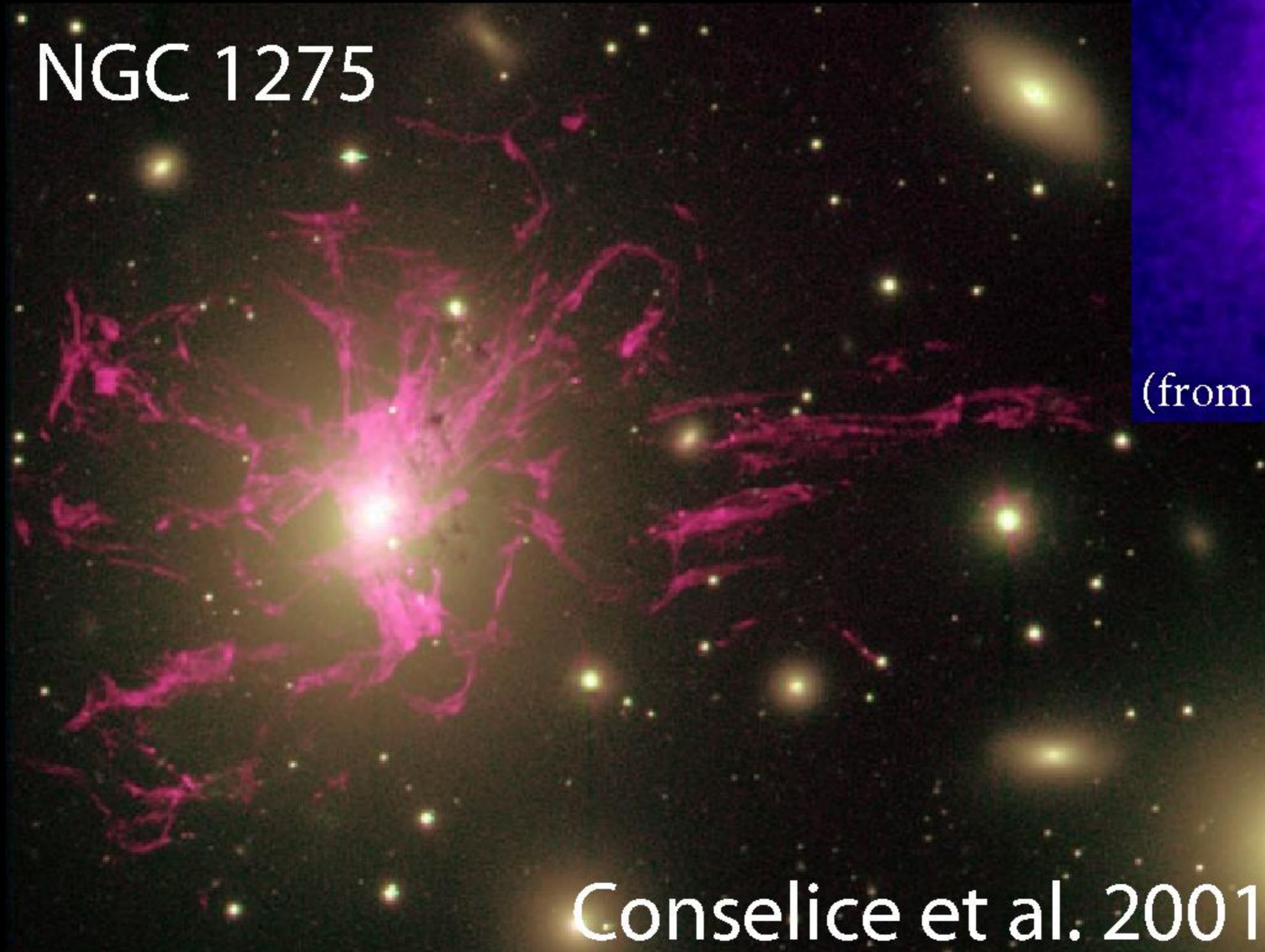
Mike McCourt, Prateek Sharma, Eliot Quataert and Ian Parrish

Introduction



Introduction

NGC 1275



Conselice et al. 2001



Hydra A

(from the *Chandra* website)

Introduction

$\Theta \equiv$ *Net cooling rate*

$\left(\frac{\partial \Theta}{\partial T}\right)_P < 0$ *Thermally unstable*

Introduction

“This seems such an economical and elegant way to make cloudy media, one feels nature would be inexcusably remiss not to have taken advantage of it at some point.”

Balbus 1995

Overview

Focus on the thermal evolution of the plasma:

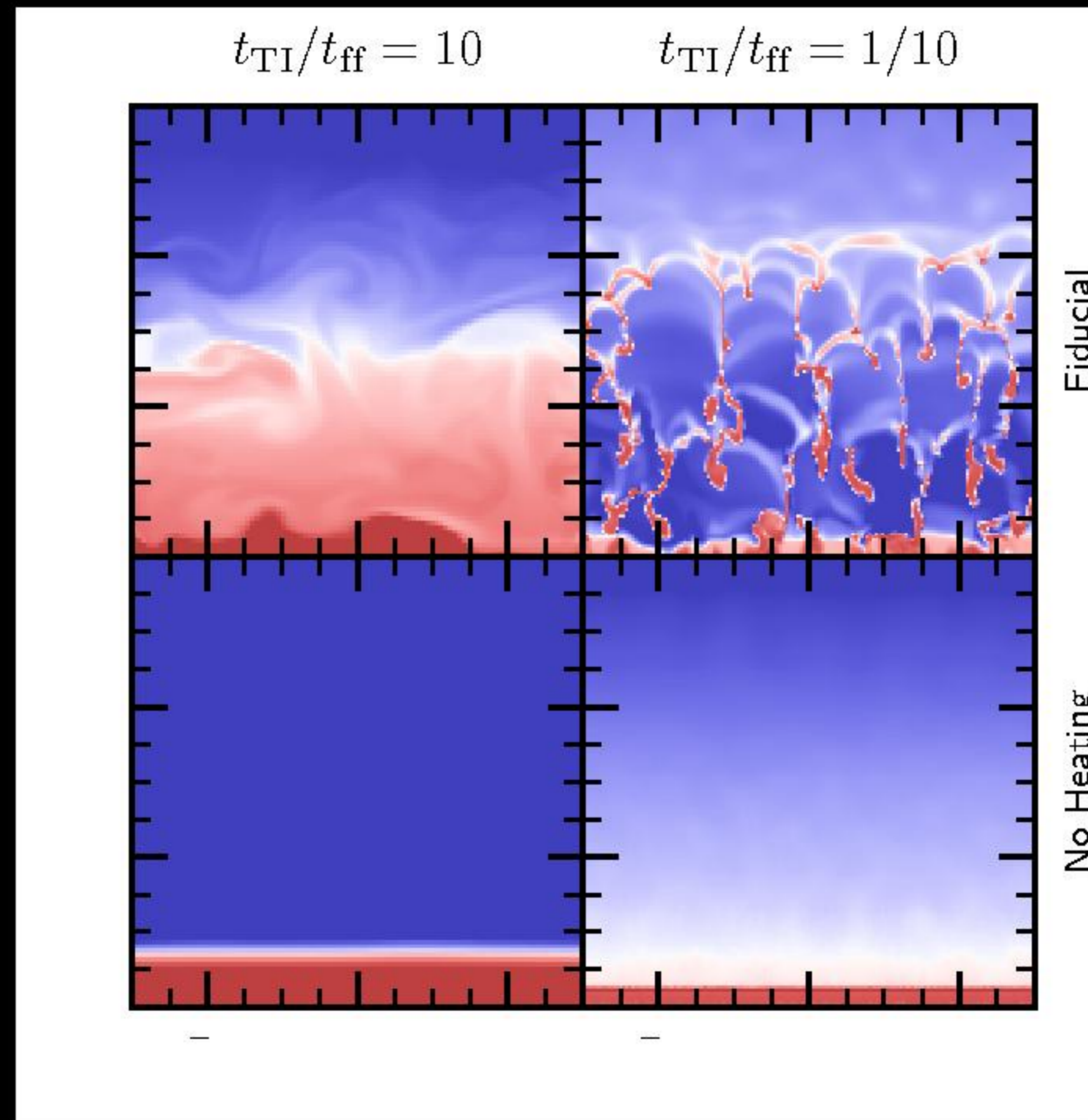
$$\rho T \frac{ds}{dt} = \mathcal{H} - \mathcal{L} - \nabla \cdot \mathbf{Q}_{\text{cond}}$$

Heating Prescription

Average thermal balance: $\mathcal{H} = \langle \mathcal{L} \rangle$

(i.e. feedback works)

The Need for Heating

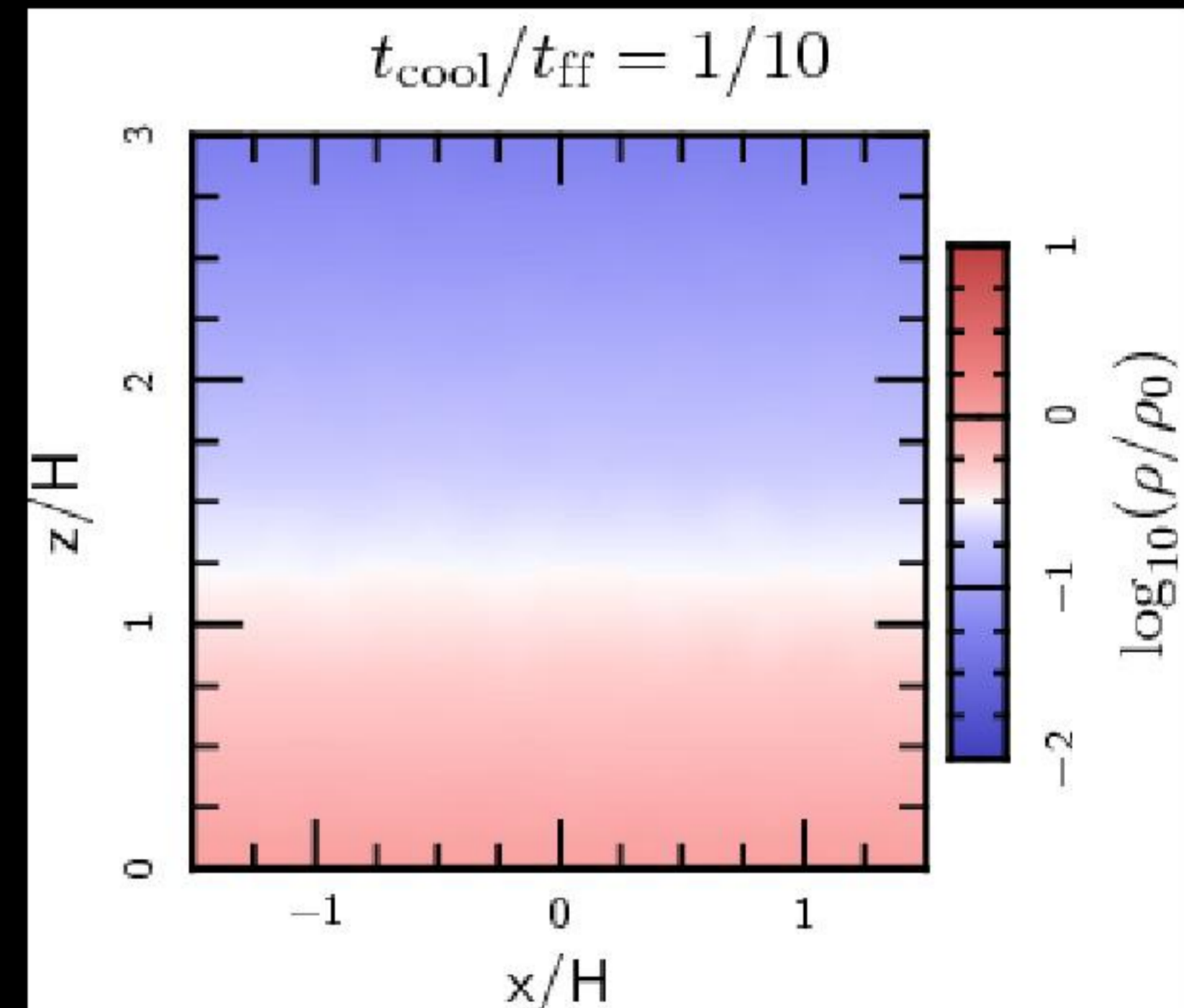
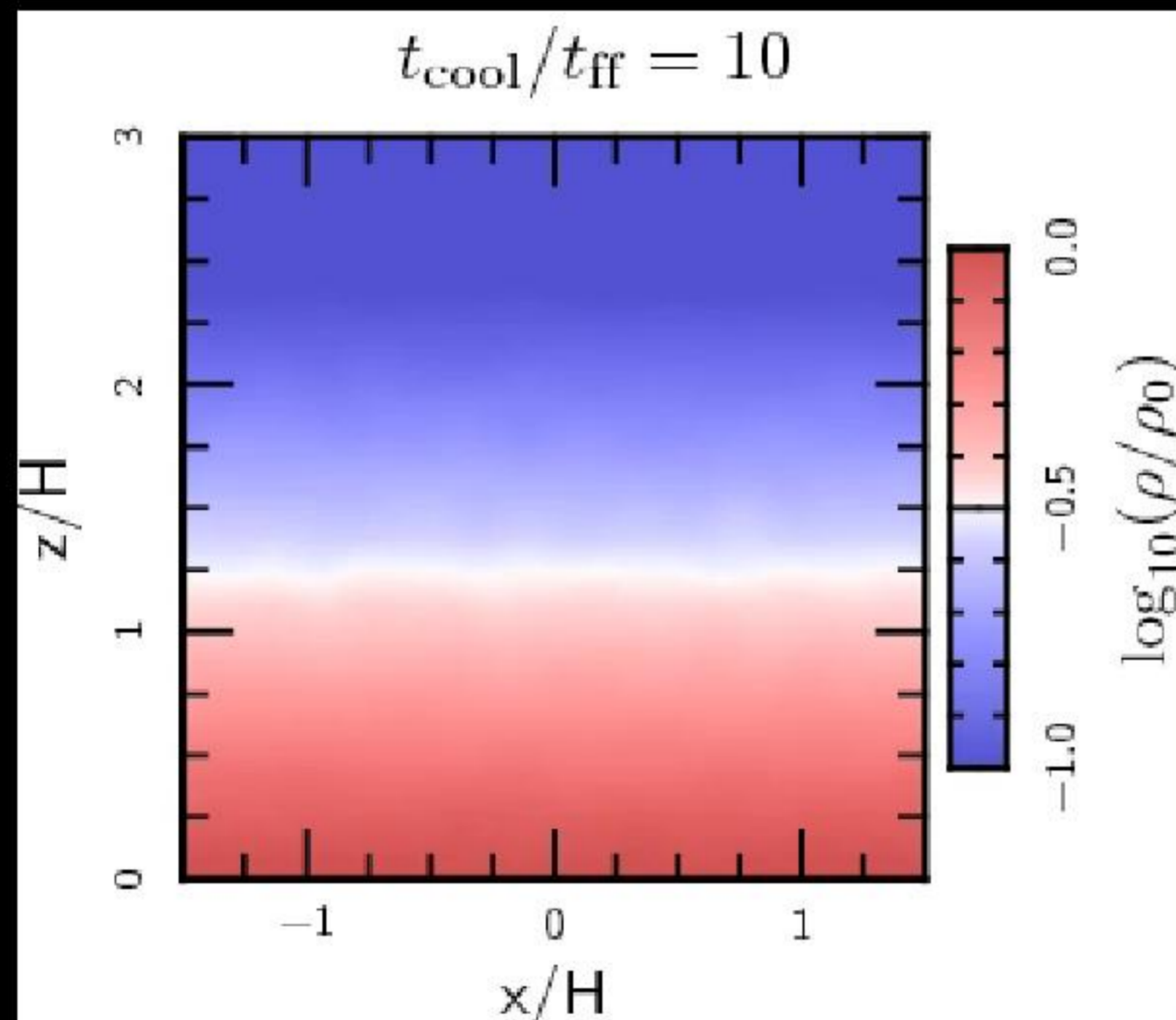


Results without Conduction

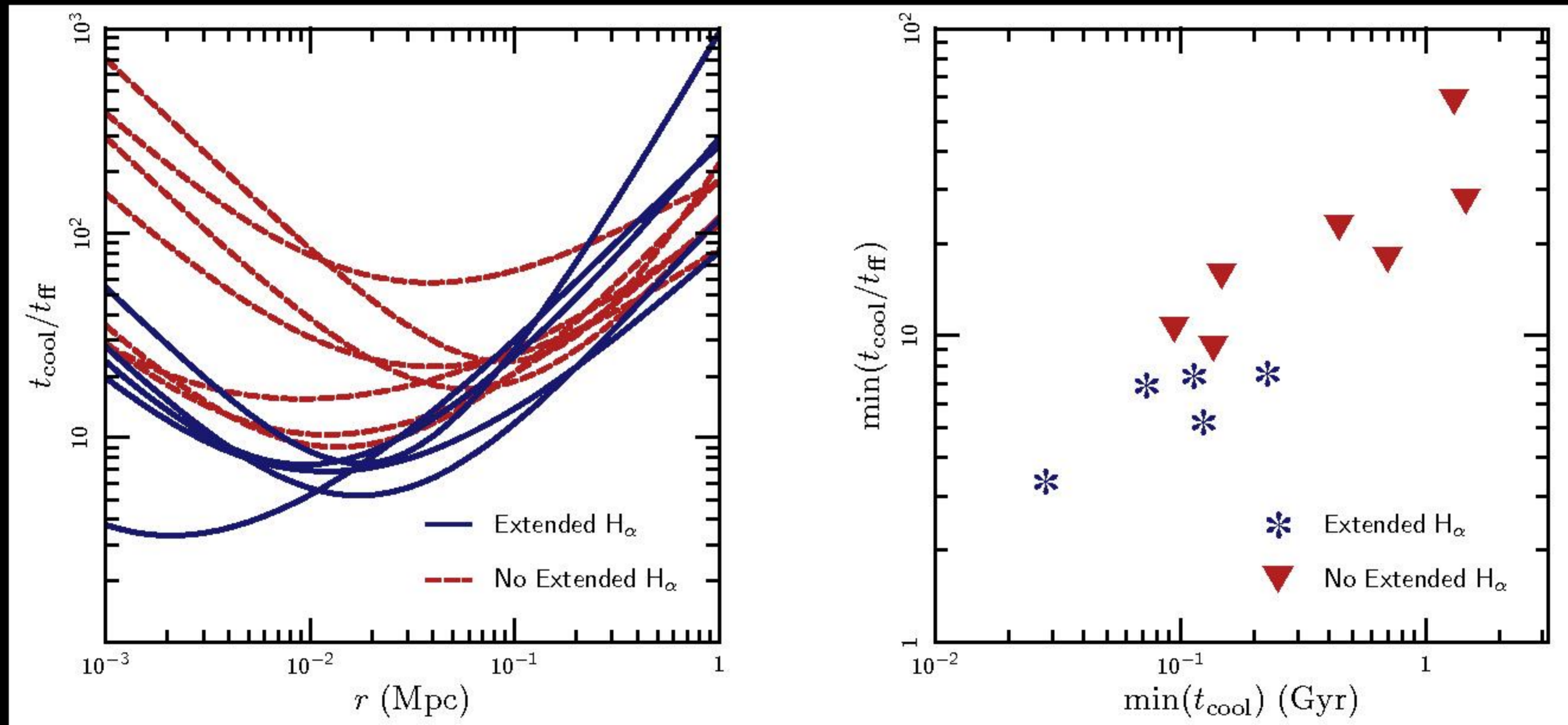
The competition between cooling and gravity (buoyancy) determines whether the plasma shows multiphase structure

$$\frac{t_{\text{cool}}}{t_{\text{ff}}}$$

Results without Conduction

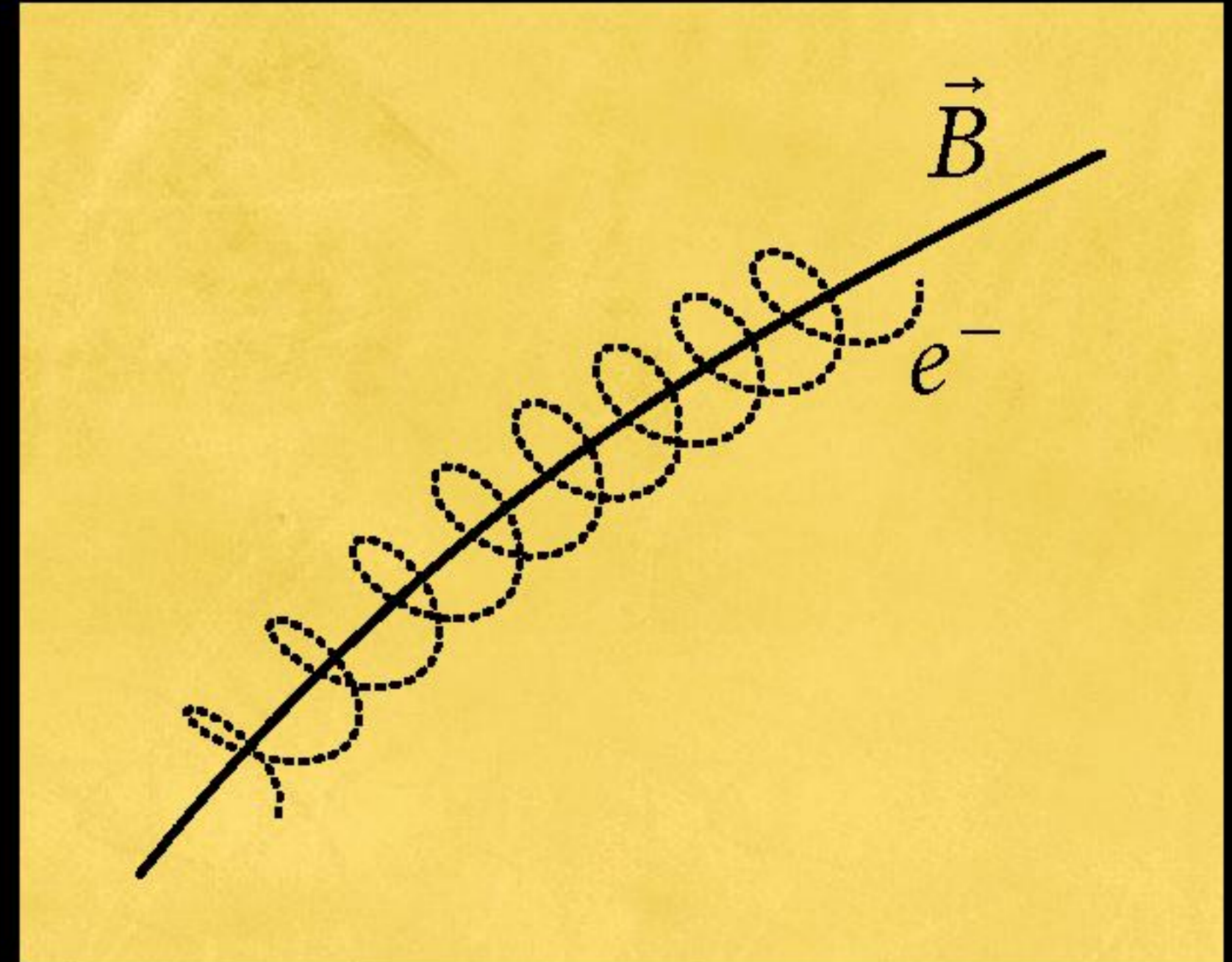


Results without Conduction



What about Conduction?

$$\rho T \frac{ds}{dt} = \mathcal{H} - \mathcal{L} - \nabla \cdot \mathbf{Q}_{\text{cond}}$$



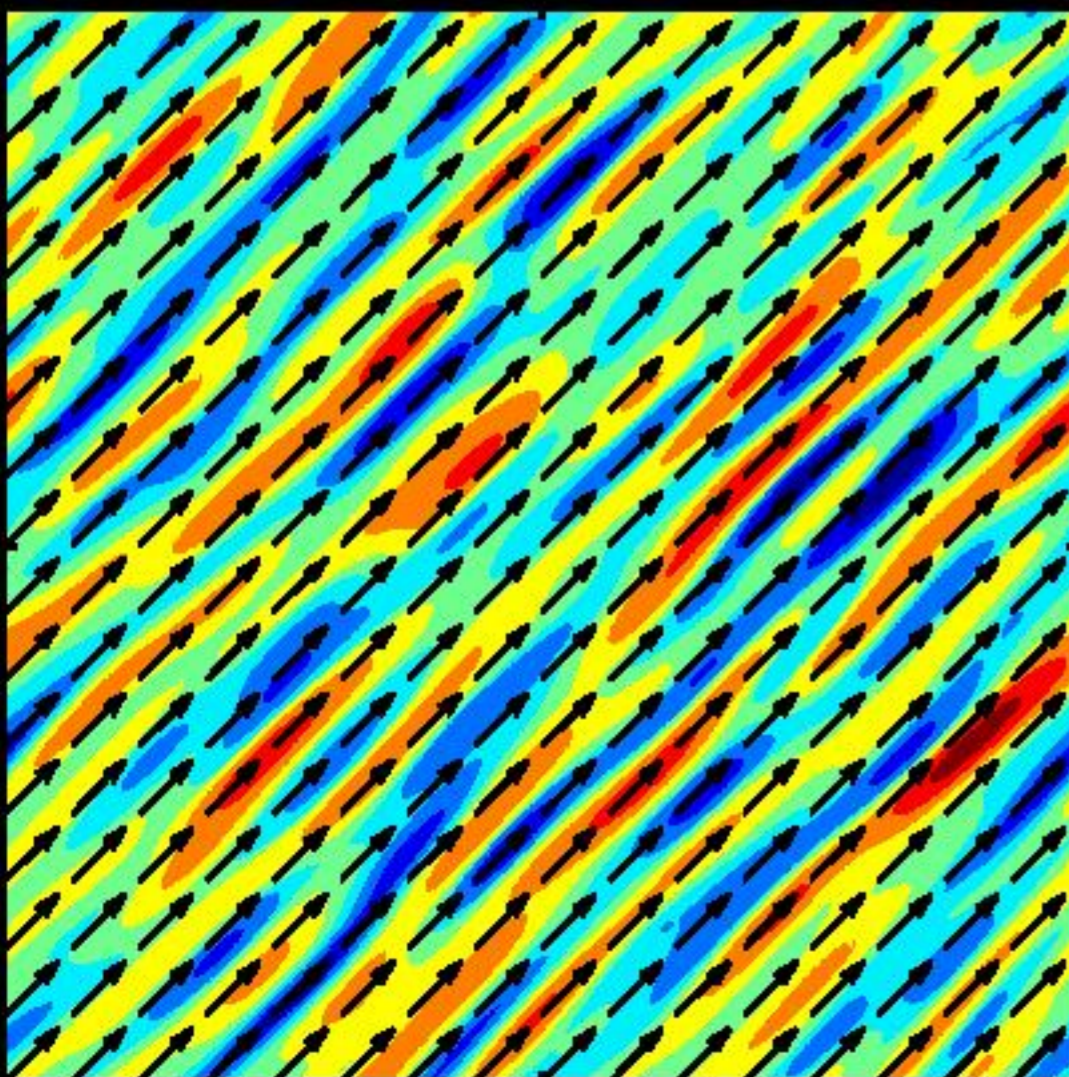
$$\mathbf{Q}_{\text{cond}} = -\kappa_e \hat{\mathbf{b}} (\hat{\mathbf{b}} \cdot \nabla) T$$

Including Conduction

Conduction wipes out structure on scales smaller than the Field length:

$$\lambda_F \propto (\hat{\mathbf{b}} \cdot \hat{\mathbf{k}}) \times (\chi_e t_{\text{TI}})^{1/2}$$

Field (1965)



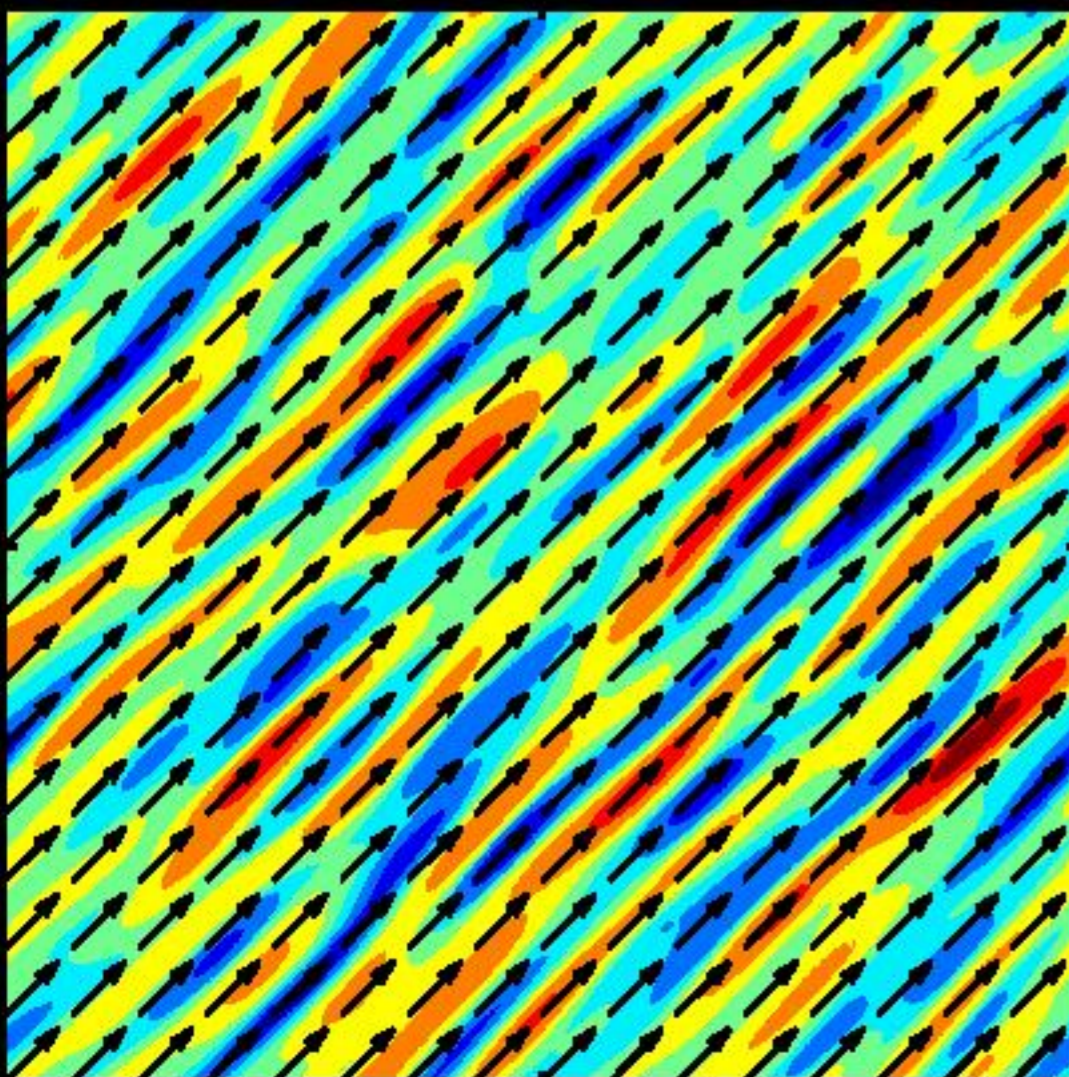
Sharma et al. (2010)

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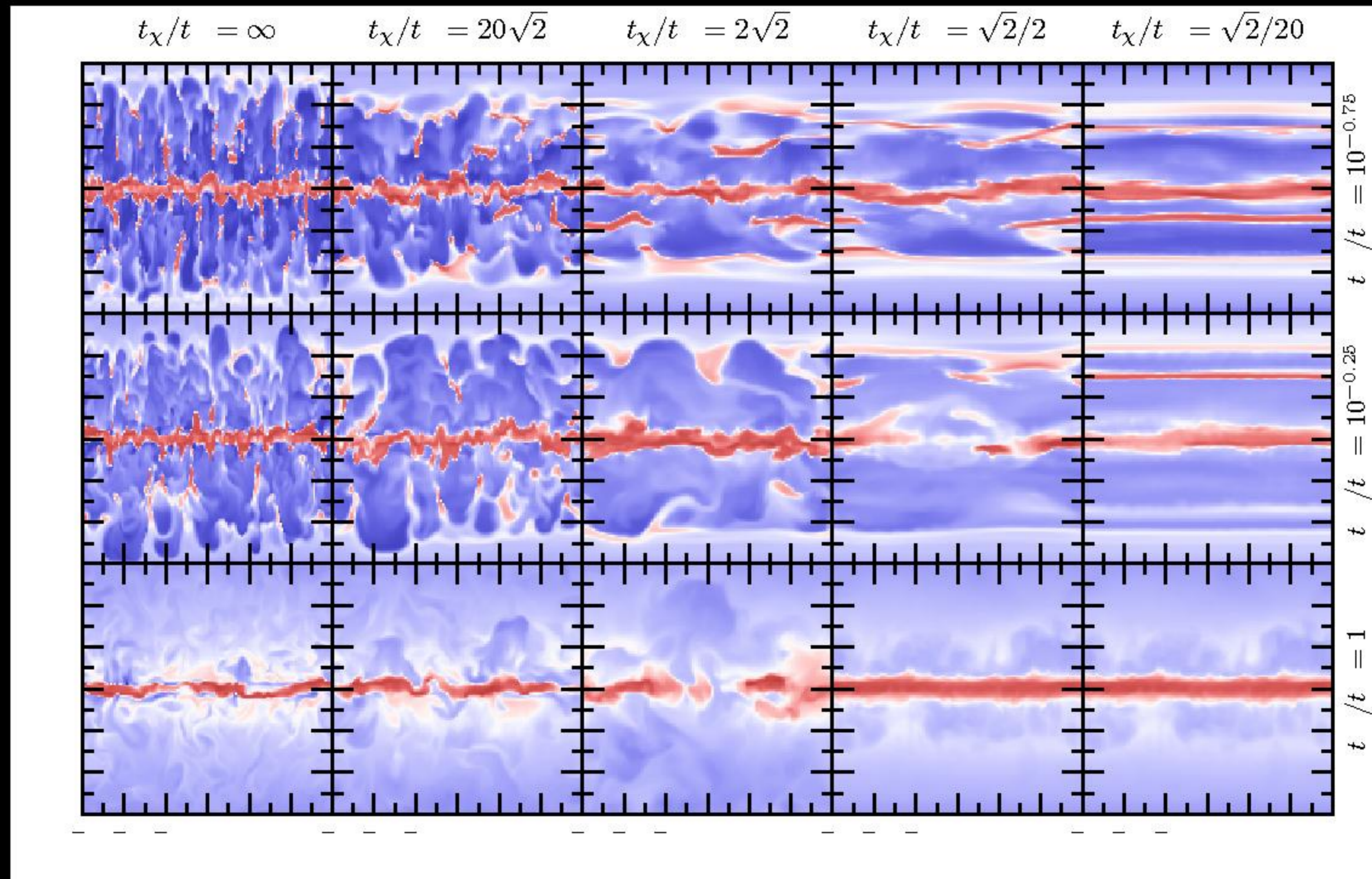


Sharma et al. (2010)

Qualitative Effect of Conduction

Increasing Conductivity \rightarrow

Increasing Cooling \rightarrow



Quantitative Effect of Conduction

