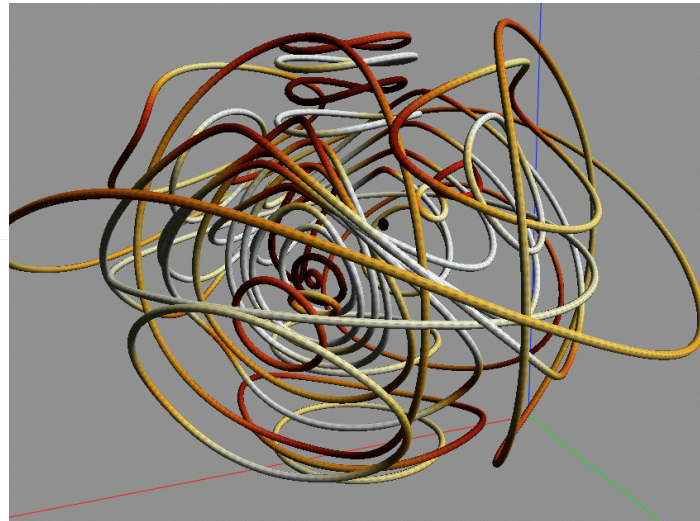


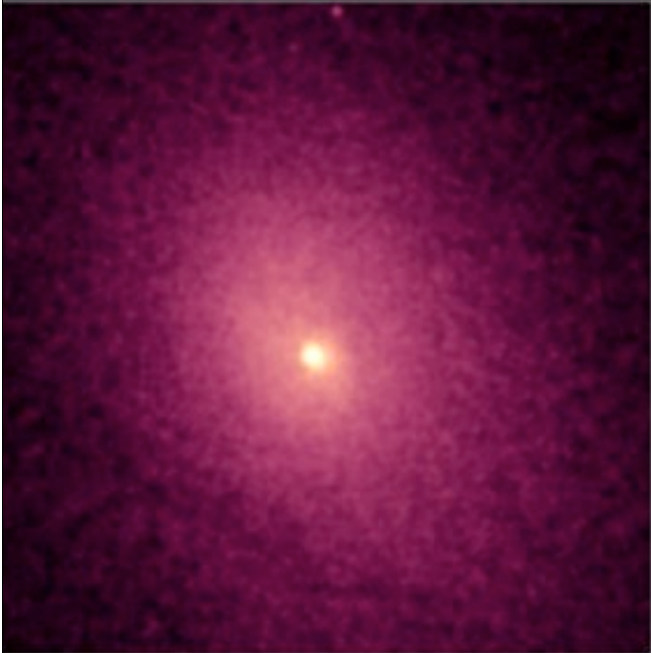
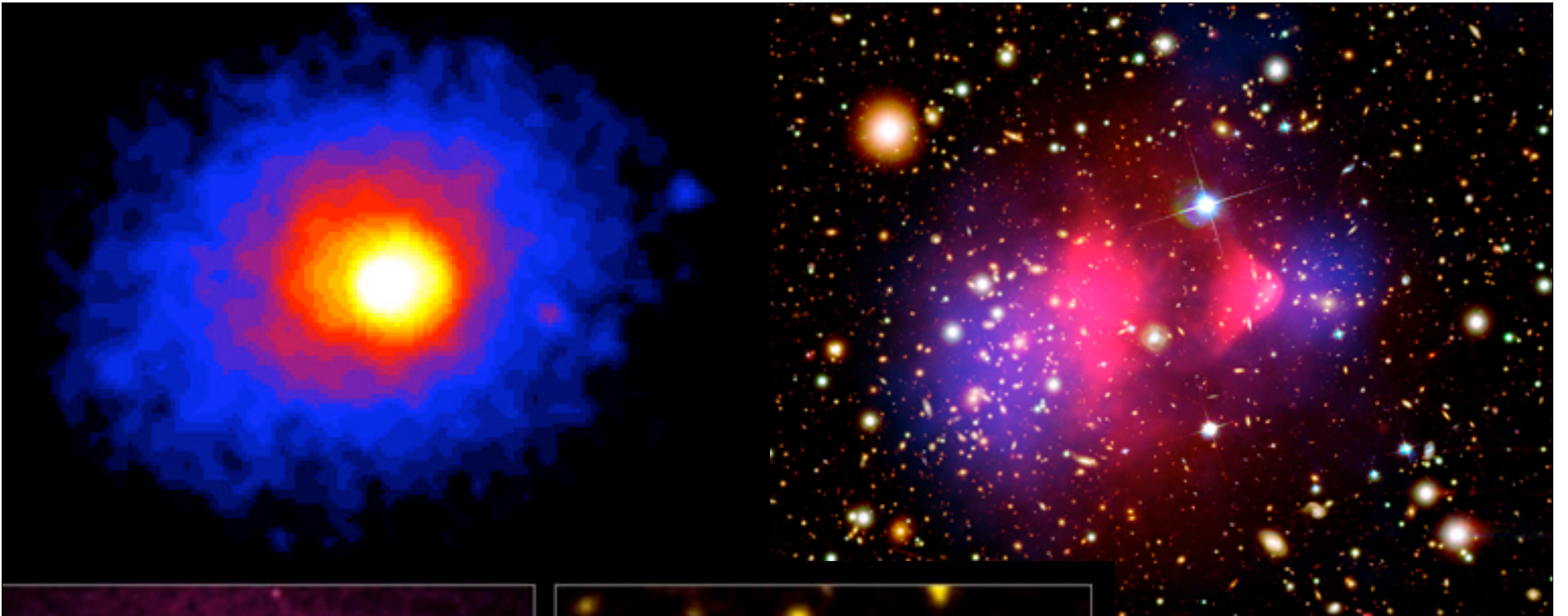
Physics of ICM, Aug 23, 2010

MHD Instabilities, Overstabilities and Faraday Rotation

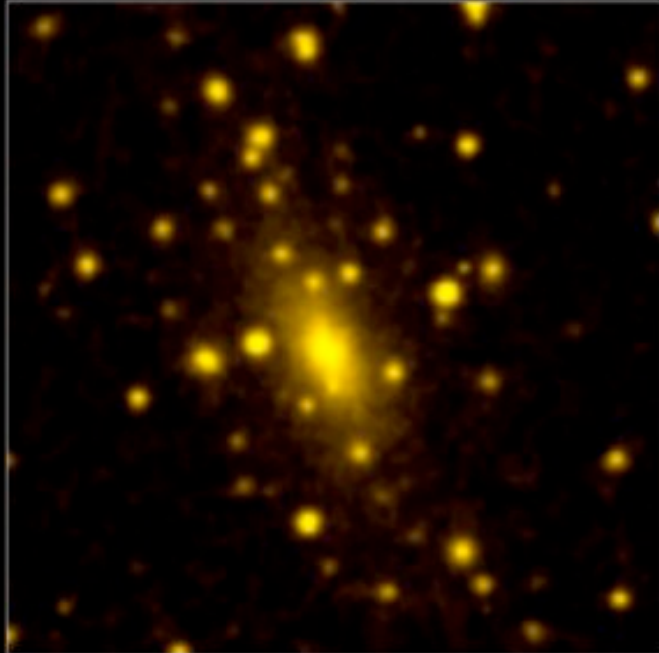


Tamara Bogdanović
University of Maryland

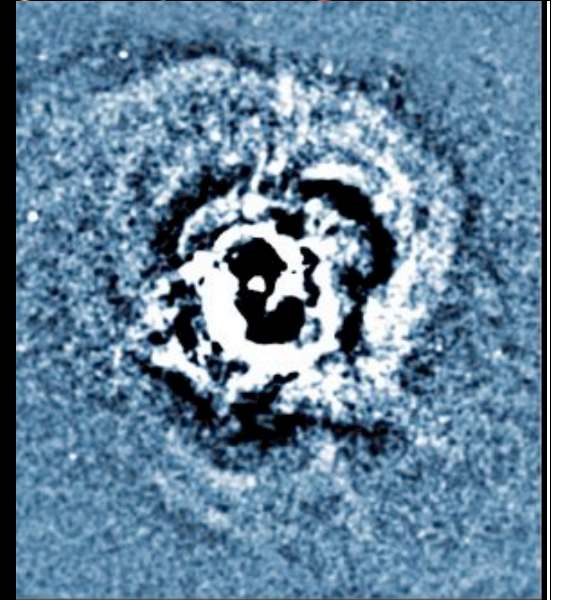
*Collaborators: Chris Reynolds (UMd), Steven Balbus (ENS),
Richard Massey (Edinburgh)*



CHANDRA X-RAY

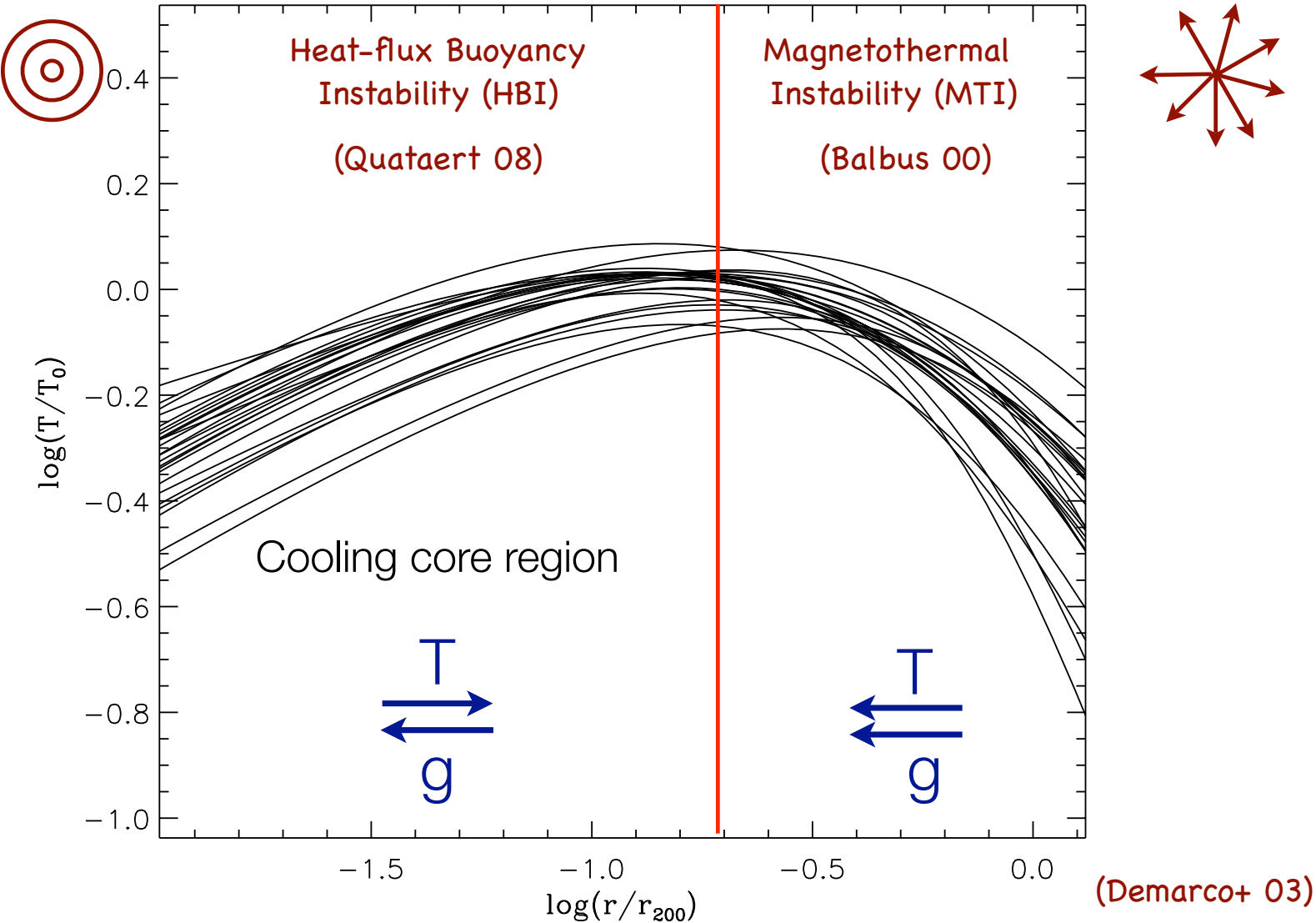


DSS OPTICAL



CHANDRA X-RAY [SOUND WAVES]

MHD instabilities at all radii in ICM



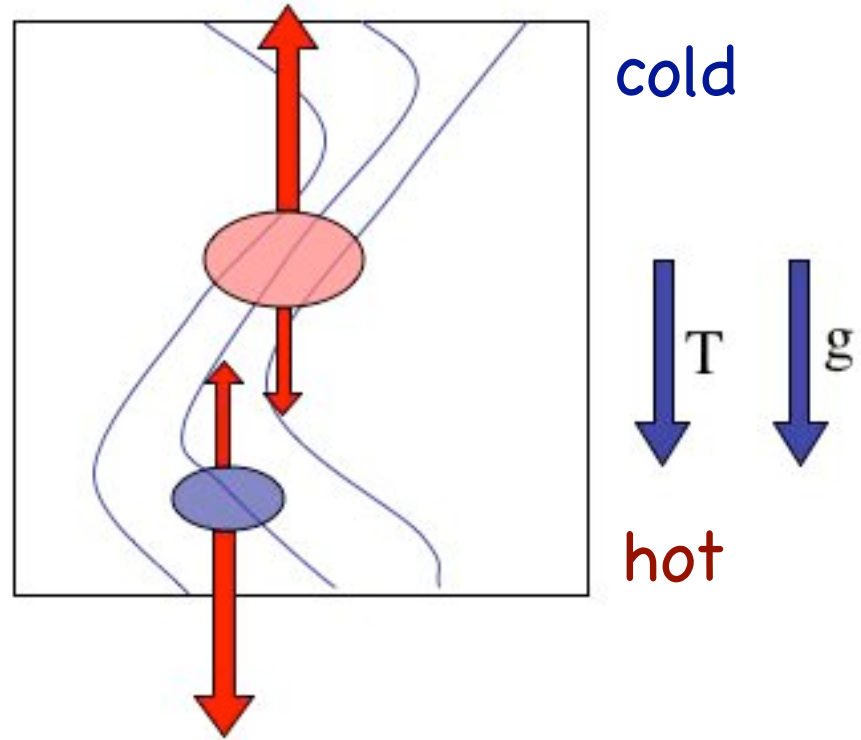
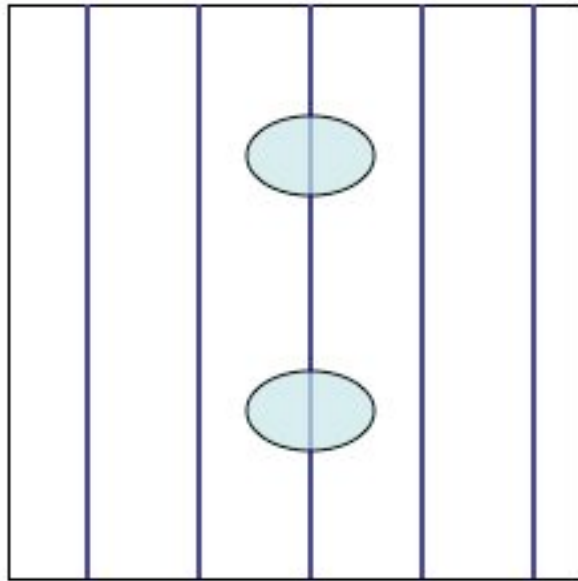
Recently discovered MHD overstabilities

(Balbus & Reynolds 10)

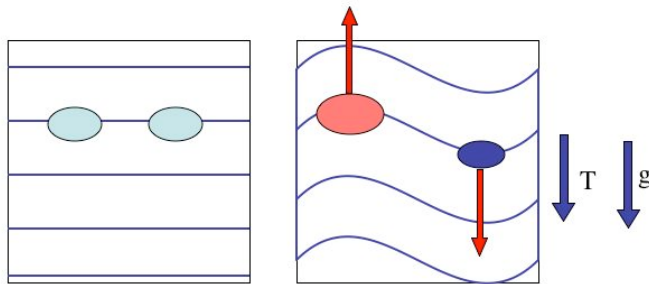
b_z \ $\frac{dT}{dz}$	<0	>0
≈ 0	MTI	g-mode driven overstable by radiative cooling
≈ 1	g-mode driven overstable by conductive heat flux	HBI

(Balbus & Reynolds 10)

Heat-flux Driven Buoyancy Overstability (HBO)

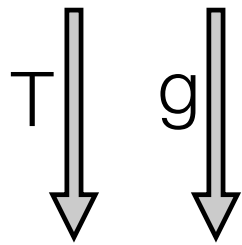


MTI

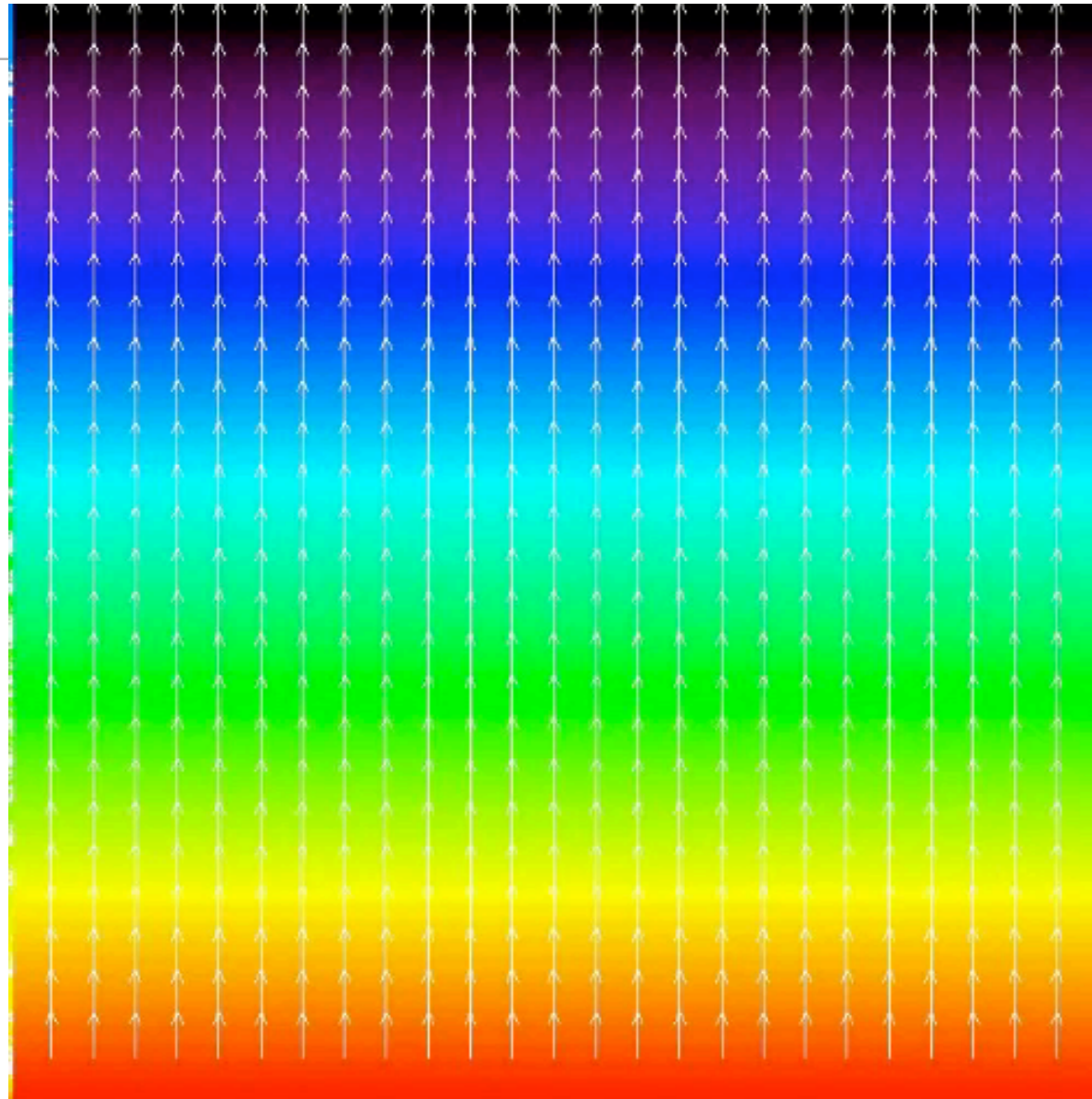


Heat flux driven buoyancy overstability (HBO)

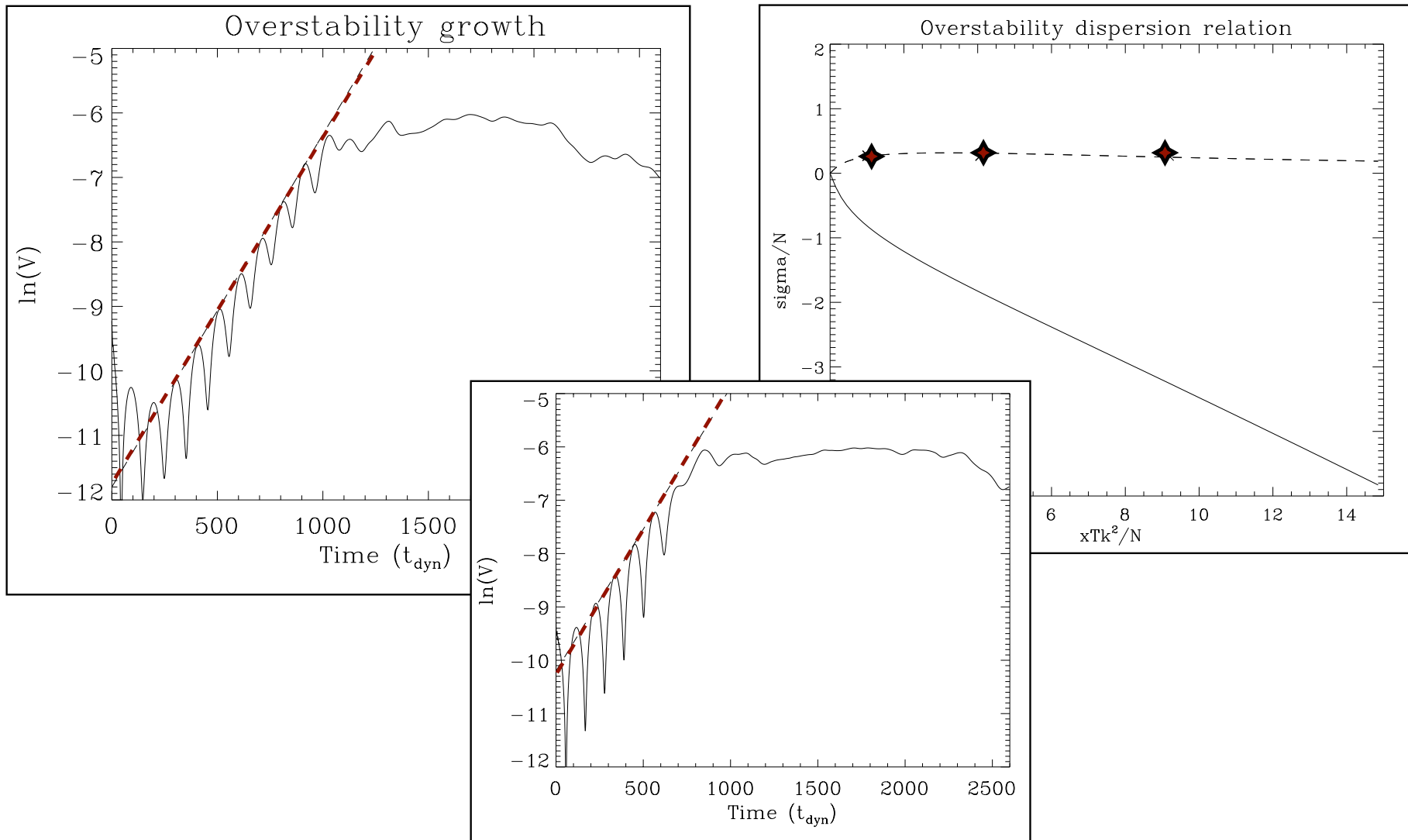
cold



hot

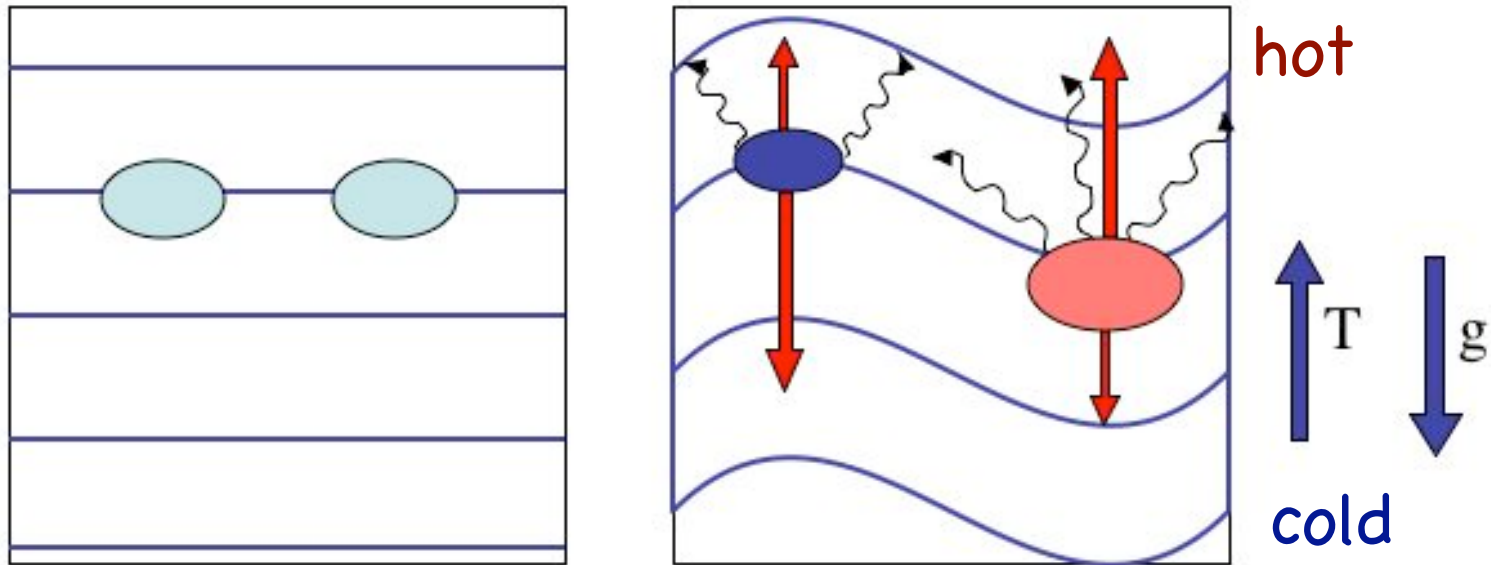


Heat flux driven buoyancy overstability (HBO)

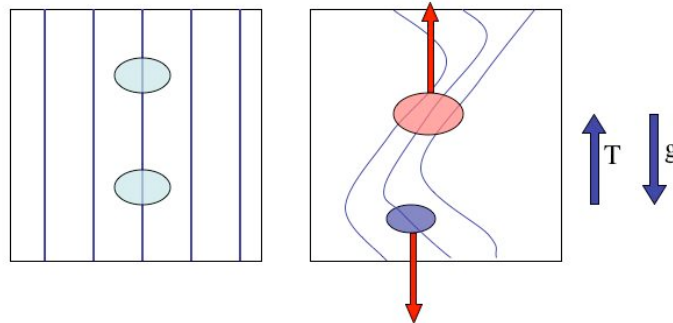


(Balbus & Reynolds 10)

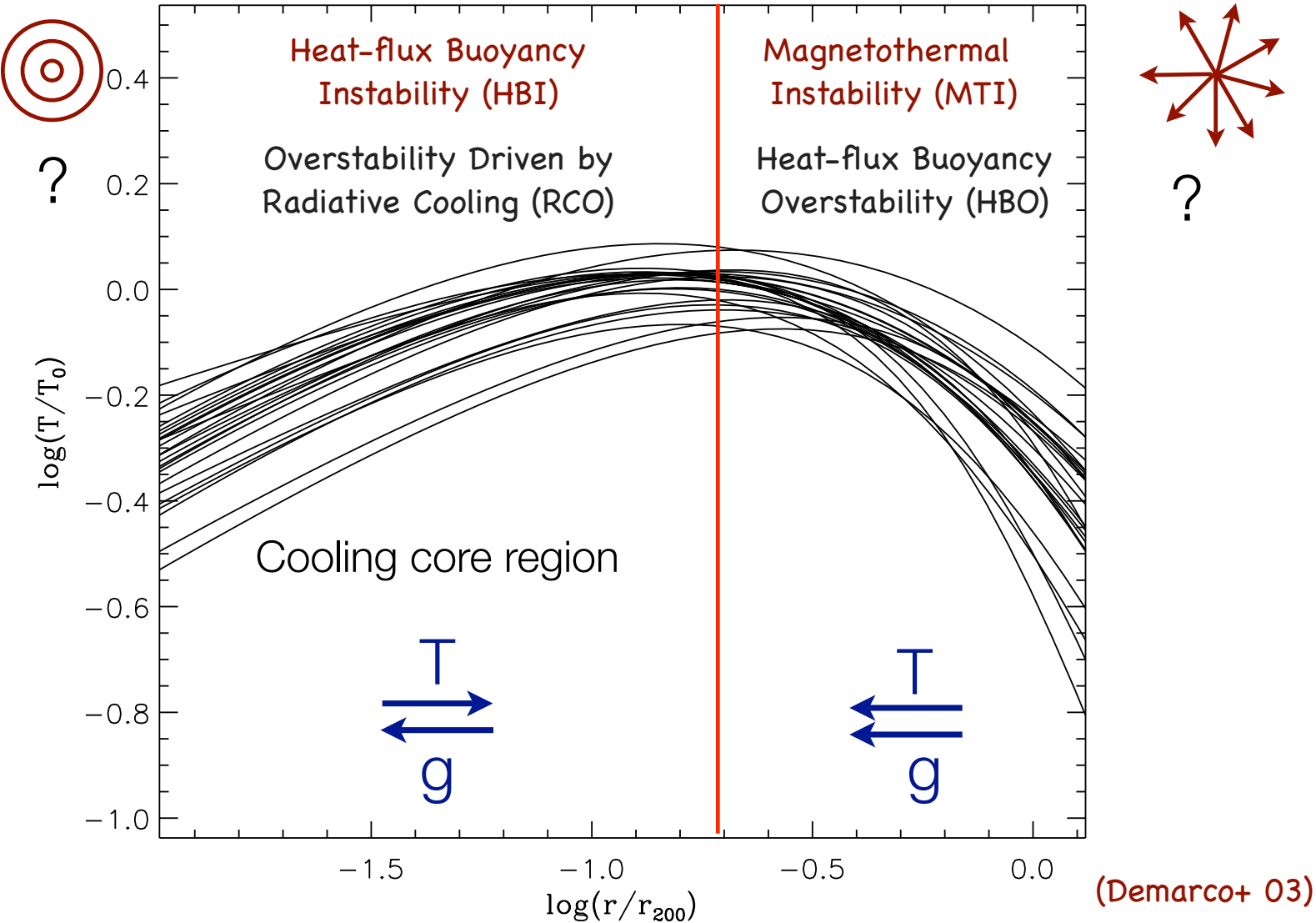
Overstability driven by radiative cooling (RCO)



HBI

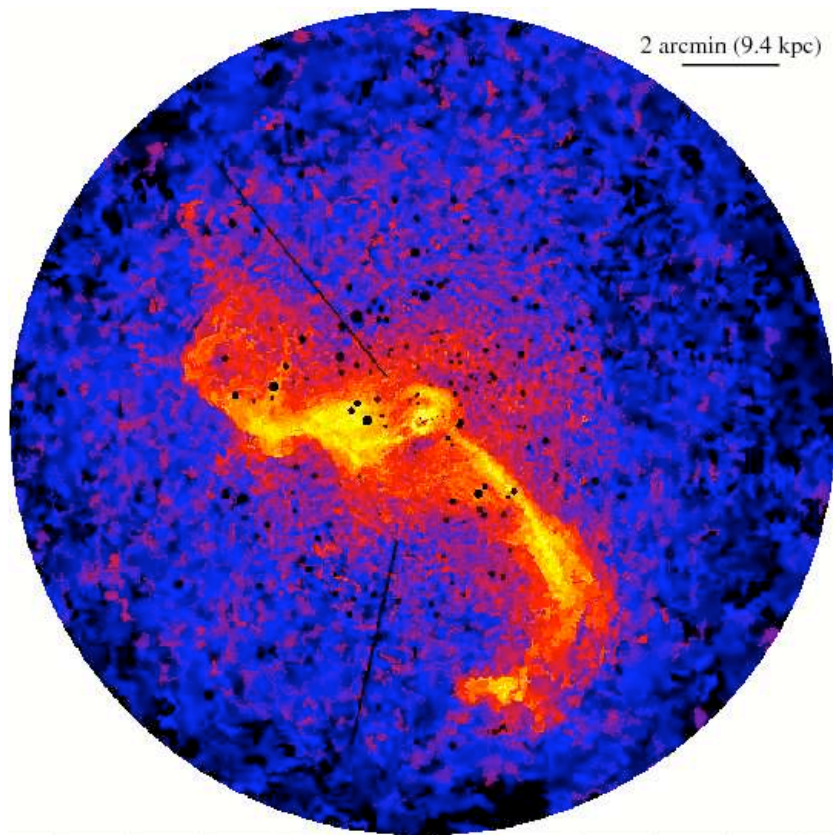


MHD instabilities/overstabilities at all radii in ICM



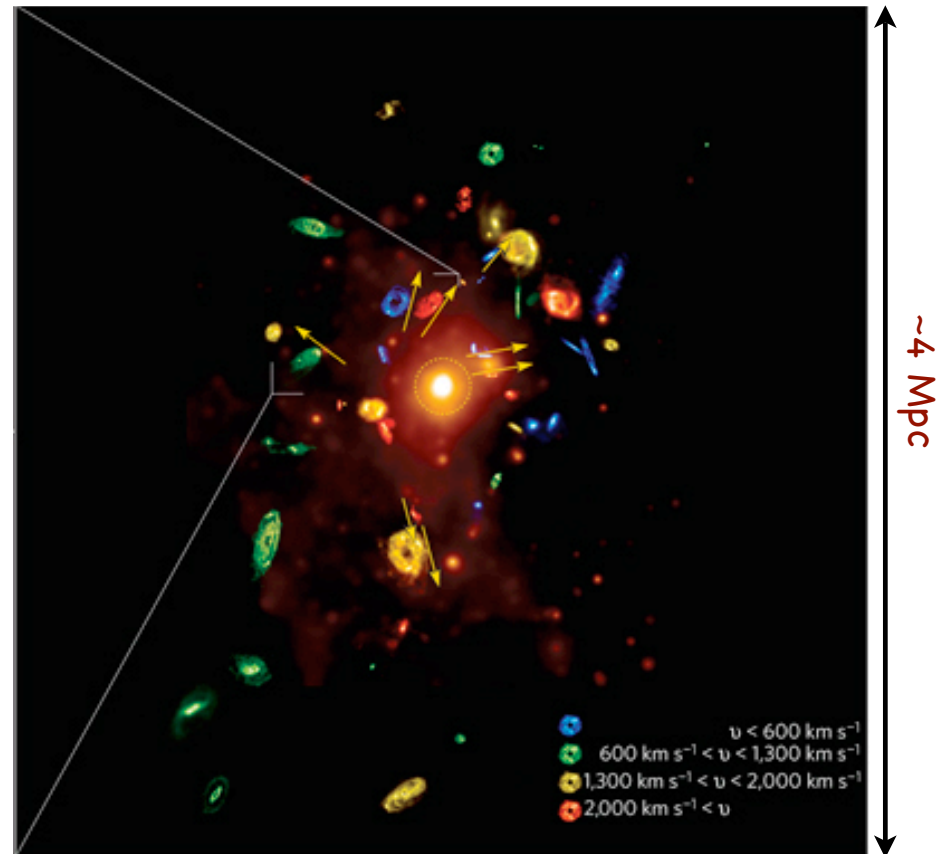
HBI/RCO and MTI in Virgo cluster?

Temperature map of central
40 kpc (M87)



(Million+ 10)

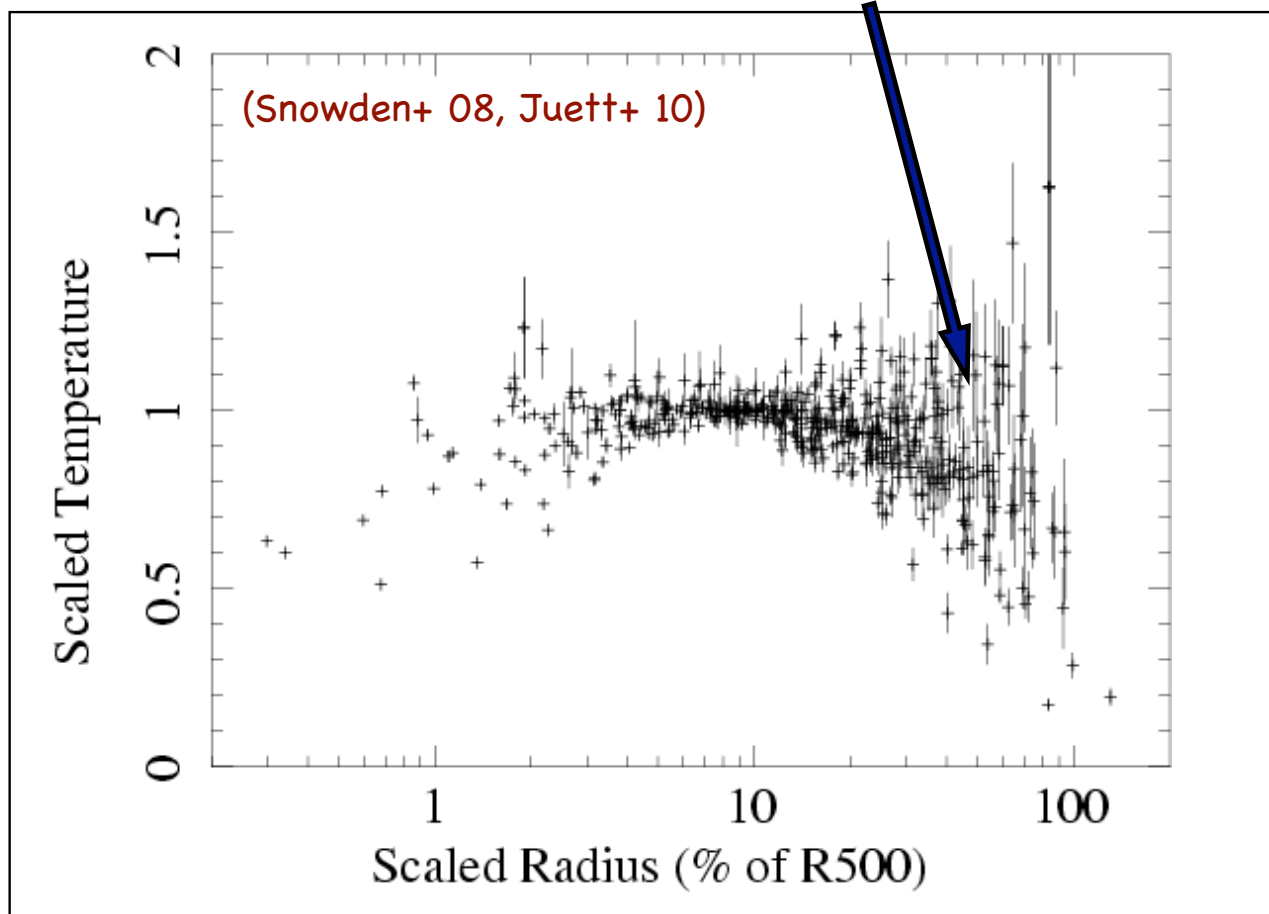
Magnetic field is preferentially oriented radially
(composite: ROSAT X-ray + HI emission +
polarized intensity @ 6cm)



(Pfrommer & Dursi 10)

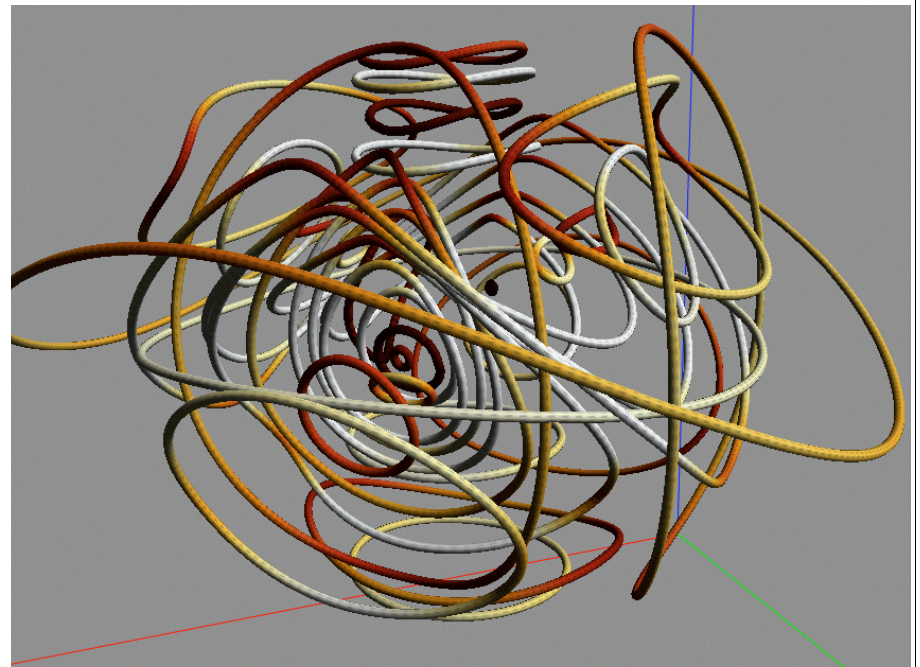
MTI in outer regions of other clusters?

20% (14/70) clusters in the sample have puzzling temperature profiles that appear isothermal at Mpc radii. The clusters appear isolated.



Models of Faraday Rotation Measure Signature

- Modeling of RM of a cluster includes:
(1) density distribution, (2) 3D structure of magnetic field and (3) density and fluxes of polarized background sources
- **Two scenarios:** field structure characterized by conduction-driven MHD instabilities and turbulent motions.
- Faraday rotation maps for Perseus-like cluster seen by an observatory with capabilities of the SKA

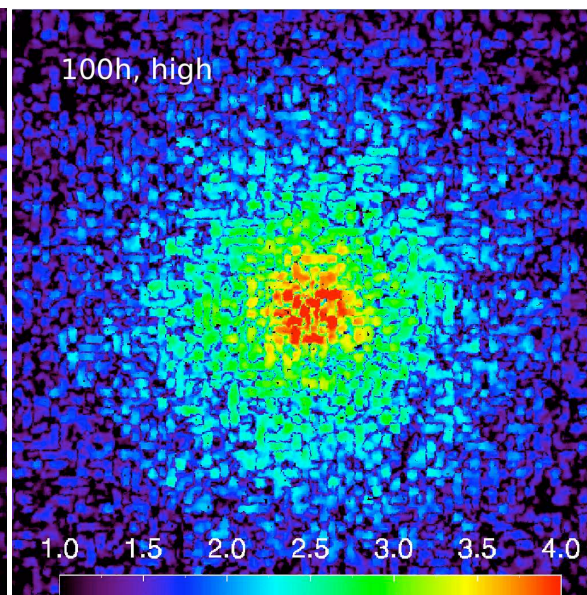
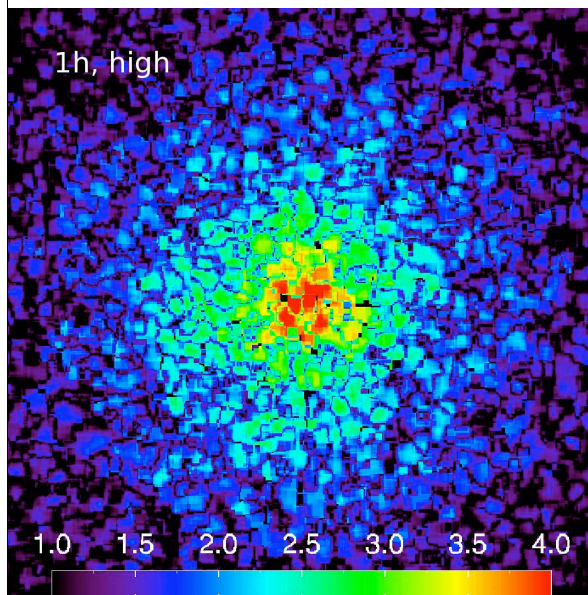
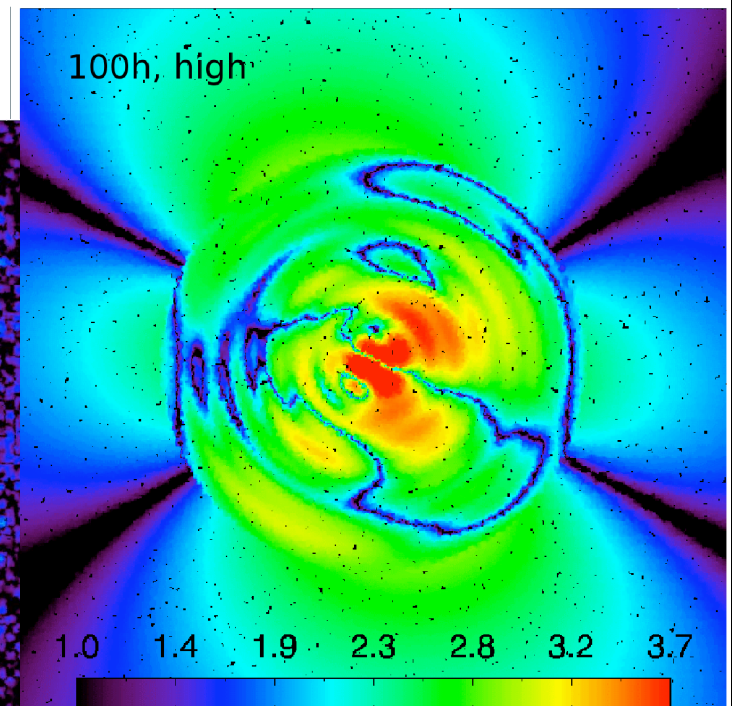
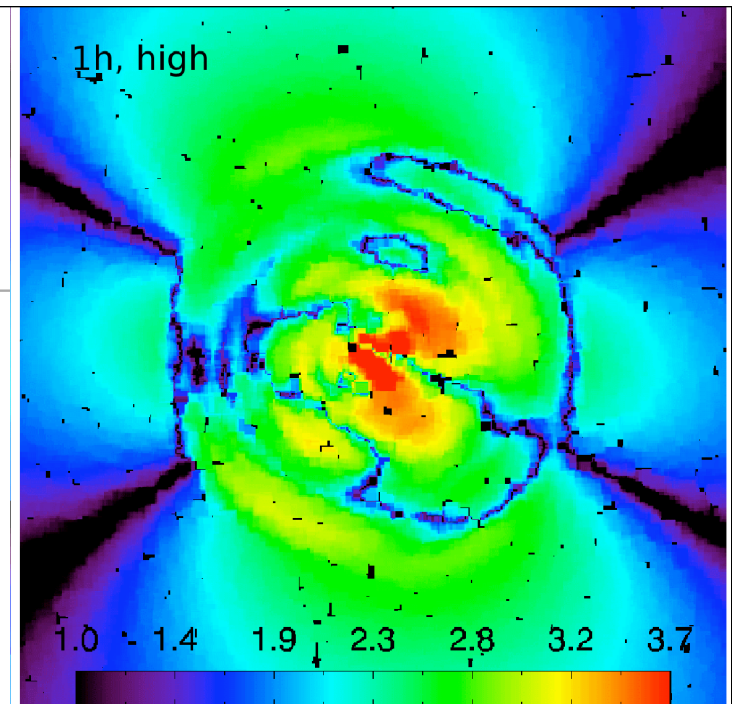


(TB+ 2010)

(TB+ 2010)

Simulated observations with SKA

- **Key idea:** Search for imprints of instabilities in dynamically relaxed cooling core clusters.
- Field geometry likely to be perturbed by AGN activity, mergers, shocks, bubbles, relics.
- eVLA will also offer improved sensitivity



Conclusions & prospects

- MHD instabilities may be present at all radii in ICM and have a profound effect on structure of magnetic field and thermal state of clusters.
- **Theory:** Need for thorough understanding of plasma processes
- **Computation:** Understanding the relative importance of individual plasma instabilities and their connection. Modeling the interplay of AGN and MHD turbulence.
- **Observations:** Sensitivity of future spectro-polarimetric measurements will be sufficient to test the presence of MHD instabilities in ICM, even with modest exposures.