



LMU



USM



Self-enhanced Faraday rotation by extragalactic jets

(a) $\log(\rho_{ICM})$, $t_{jet} = 0$ Myr

(b) $\log(\rho_{ICM})$, Mach=40, $\eta = 0.01$ & $t_{jet} = 8.3$ Myr

(c) $\log(\rho_{ICM})$, Mach=130, $\eta = 0.001$ & $t_{jet} = 4.7$ Myr

(d) $\log(|B|^2)$, $t_{jet} = 0$ Myr

(e) $\log(|B|^2)$, Mach=40, $\eta = 0.01$ & $t_{jet} = 8.3$ Myr

(f) $\log(|B|^2)$, Mach=130, $\eta = 0.001$ & $t_{jet} = 4.7$ Myr

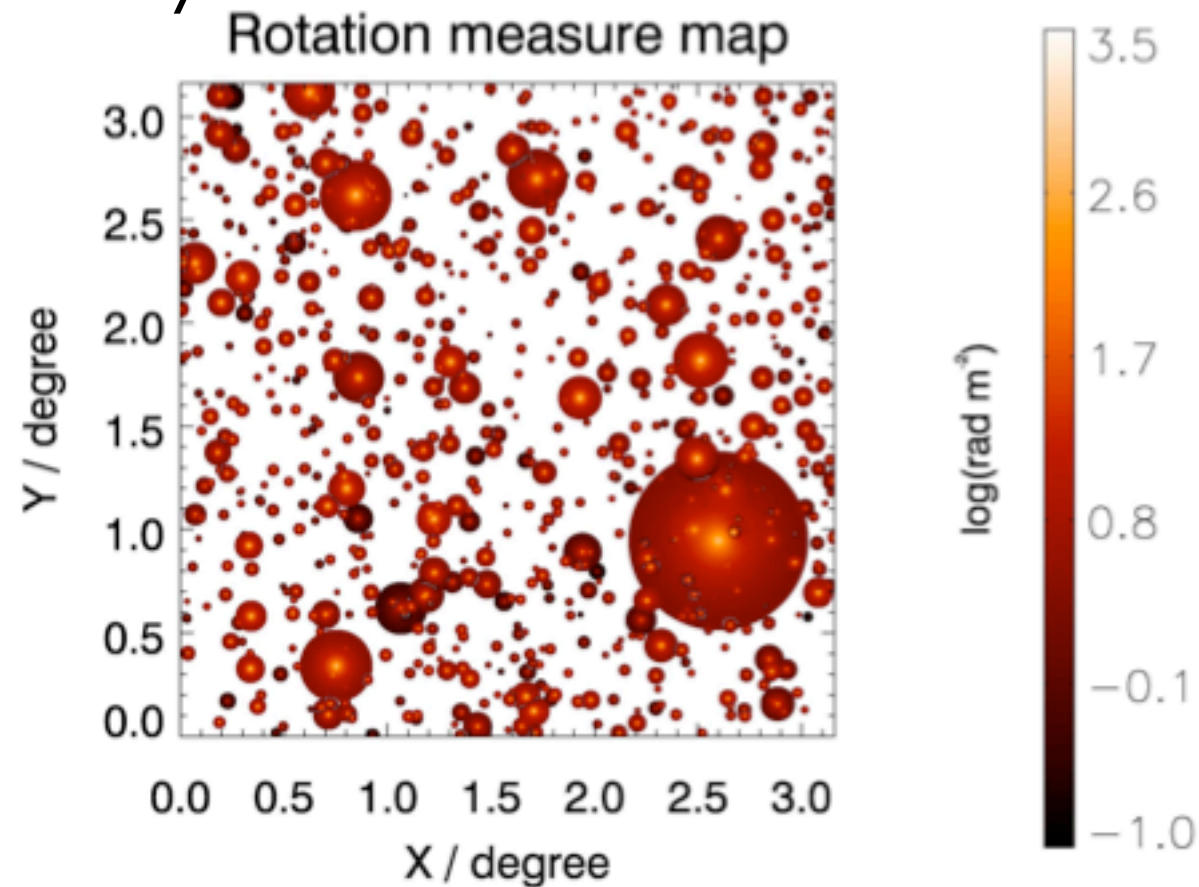
Martin Krause (MPE Garching & LMU München)
with: Martin Huarte-Espinosa, Paul Alexander, Julia Riley & Christian Kaiser

Annual meeting of the Astronomische Gesellschaft, September 2010, Bonn

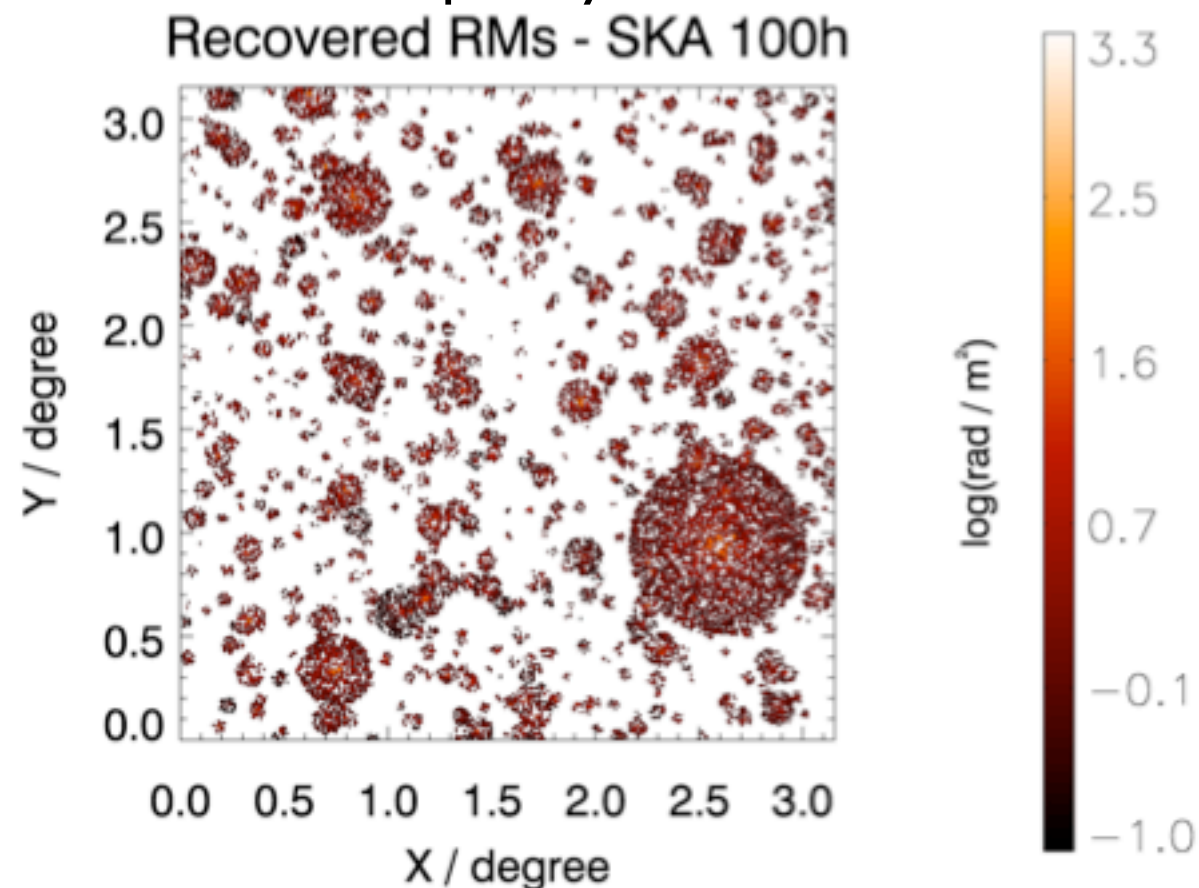
Overview

- Introduction: Faraday rotation in clusters (& groups) of galaxies
- FR II jets in magnetised Intra-cluster gas:
 - enhance rotation measure
 - change structure function

Semianalytic cosm. model.:



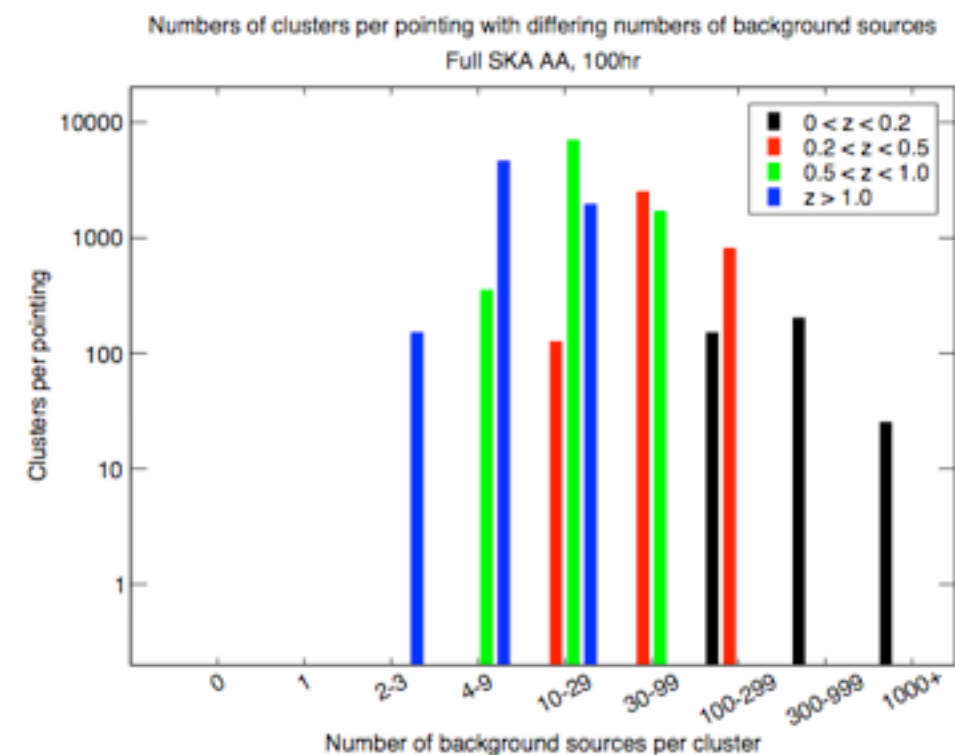
Pred. SKA mid freq. array:



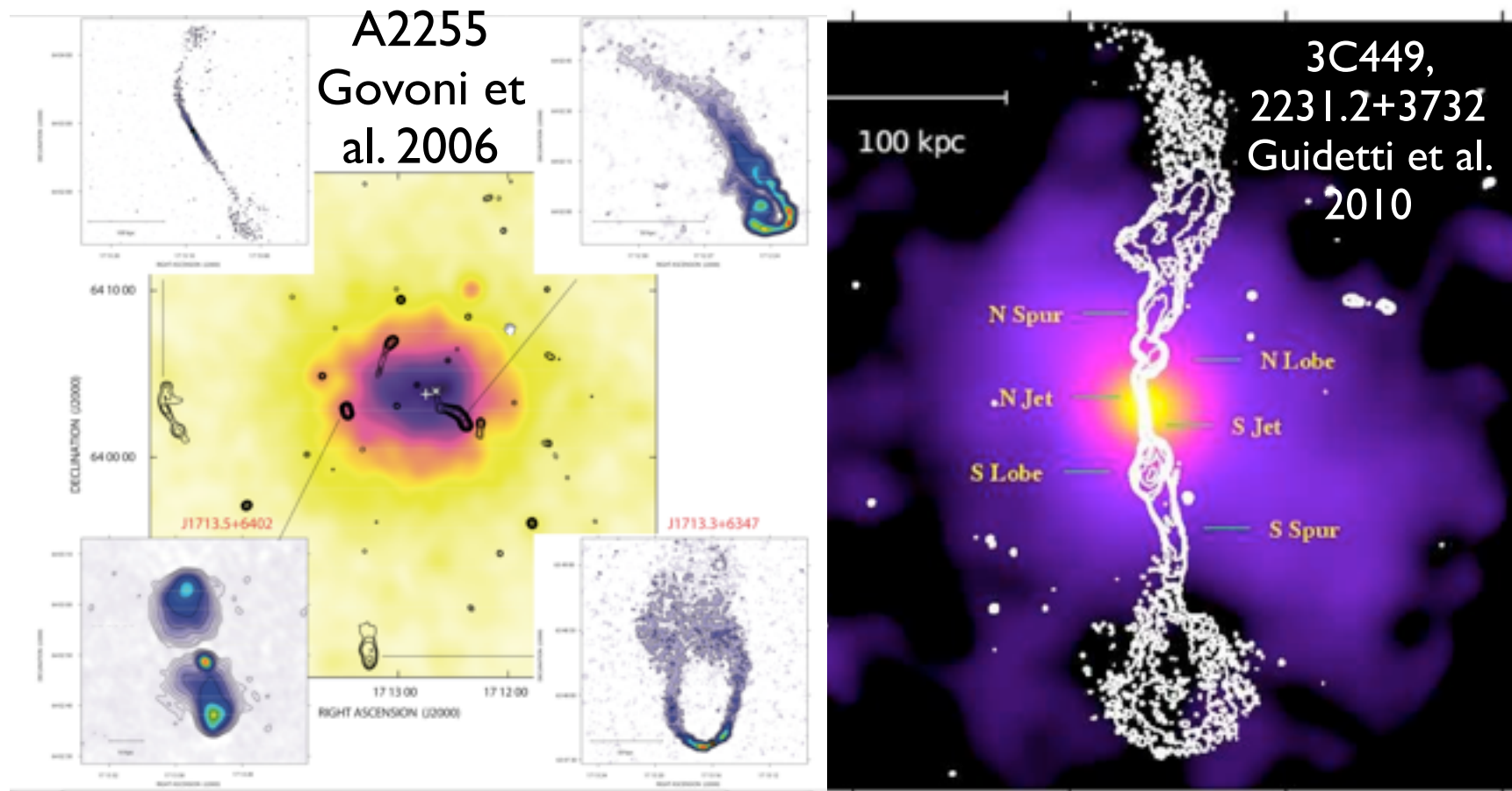
Magnetic fields in clusters of galaxies: Upcoming surveys → Square Kilometre Array

- pol. background sources measure mag. field in clusters
- SKA will measure Faraday rotation in 1000s of gal. clusters w. redshift > 1
- SKA: mainly weaker star forming galaxies
- currently/ near future: mainly stronger jet sources

Detection statistics:



Faraday rotation in clusters (and groups) of galaxies: current observations

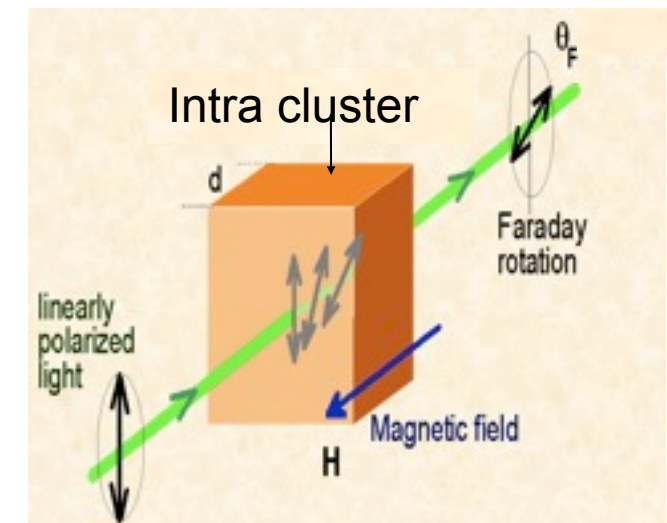


$$RM = 812 \int n_e B_{LOS} dl$$

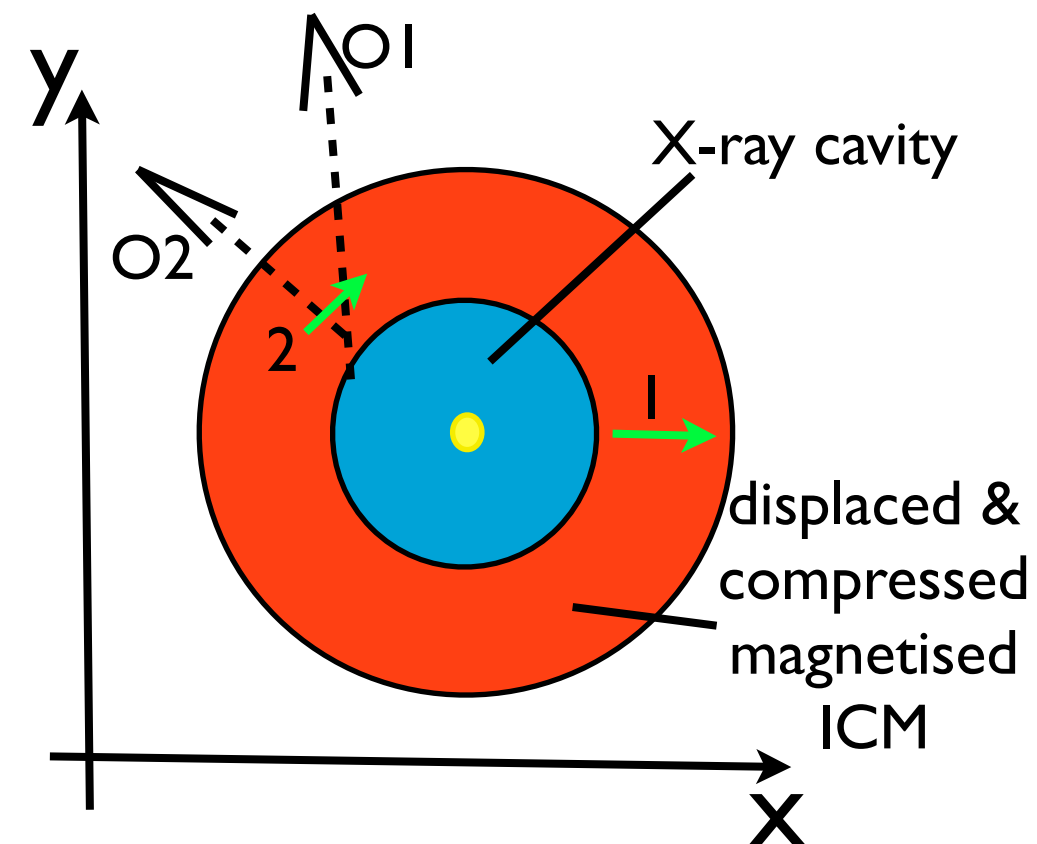
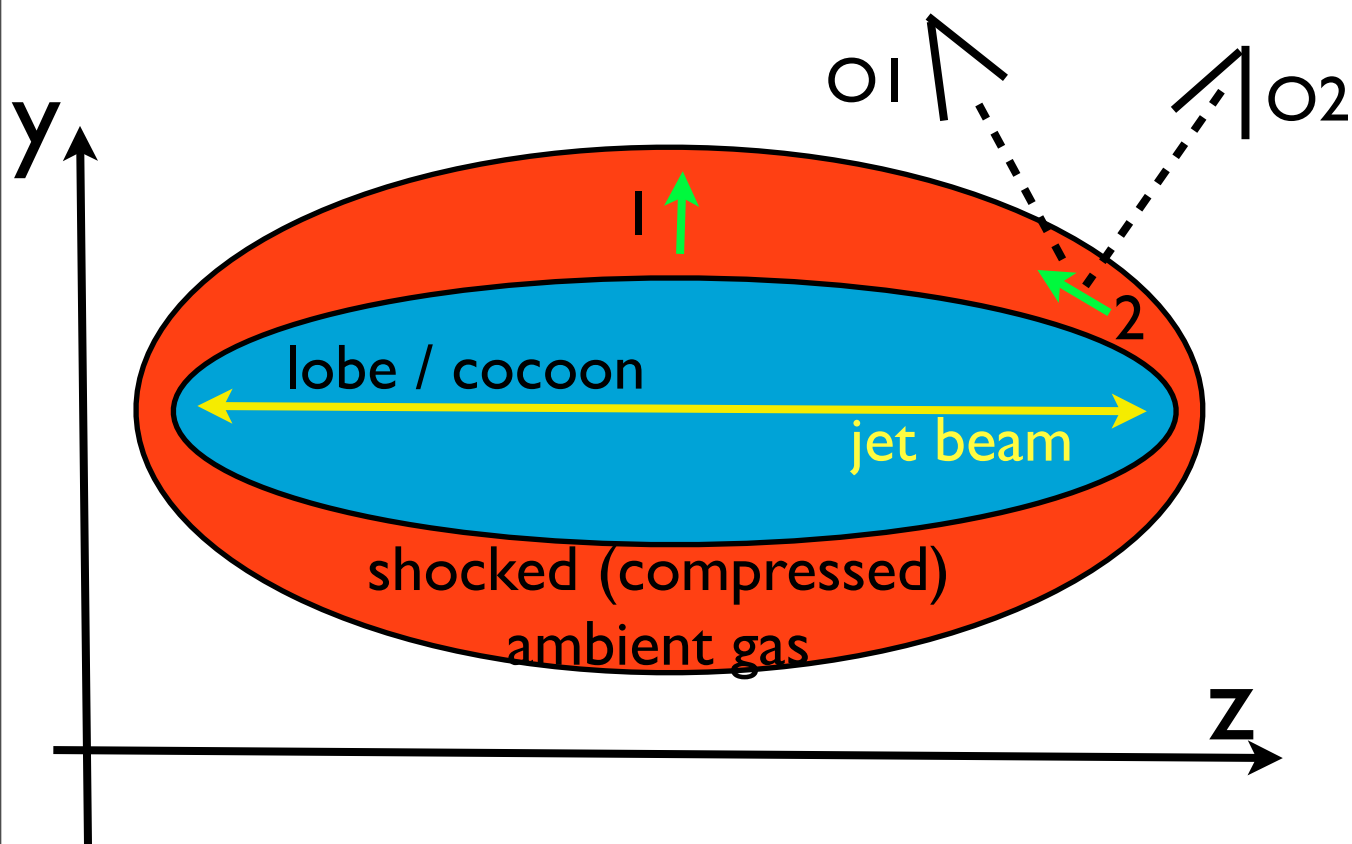
(Radians m⁻²)

$$\Delta\vartheta = RM \times \lambda^2 / (1+z)^2$$

- Faraday rotation is measured against polarised radio emission of typically embedded radio jets.
- What is the local effect of the jets on the measured RM?



Jet-effect on RM: sketch version



- Tangled field
- Non-radial component amplified by compression, expansion energy $\rightarrow$ MF
- If observer not $\perp$ MF, RM enhanced
- RM-Enhancement for observer O1 $\Rightarrow$ edge effect

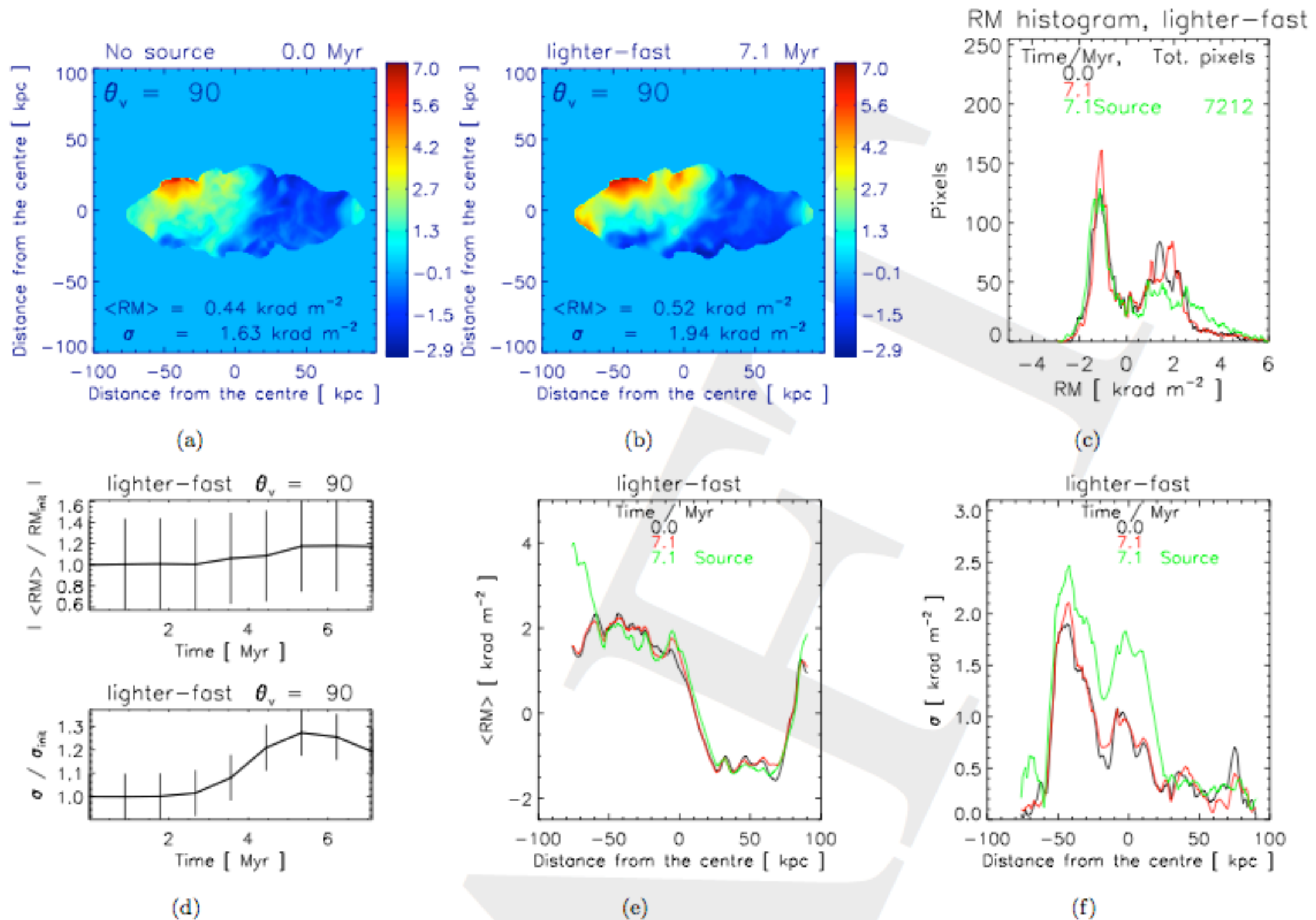
Magnetic field vectors:
1 - radial
2 - non-radial

Jet $\Leftrightarrow$ cluster magnetic fields: simulations

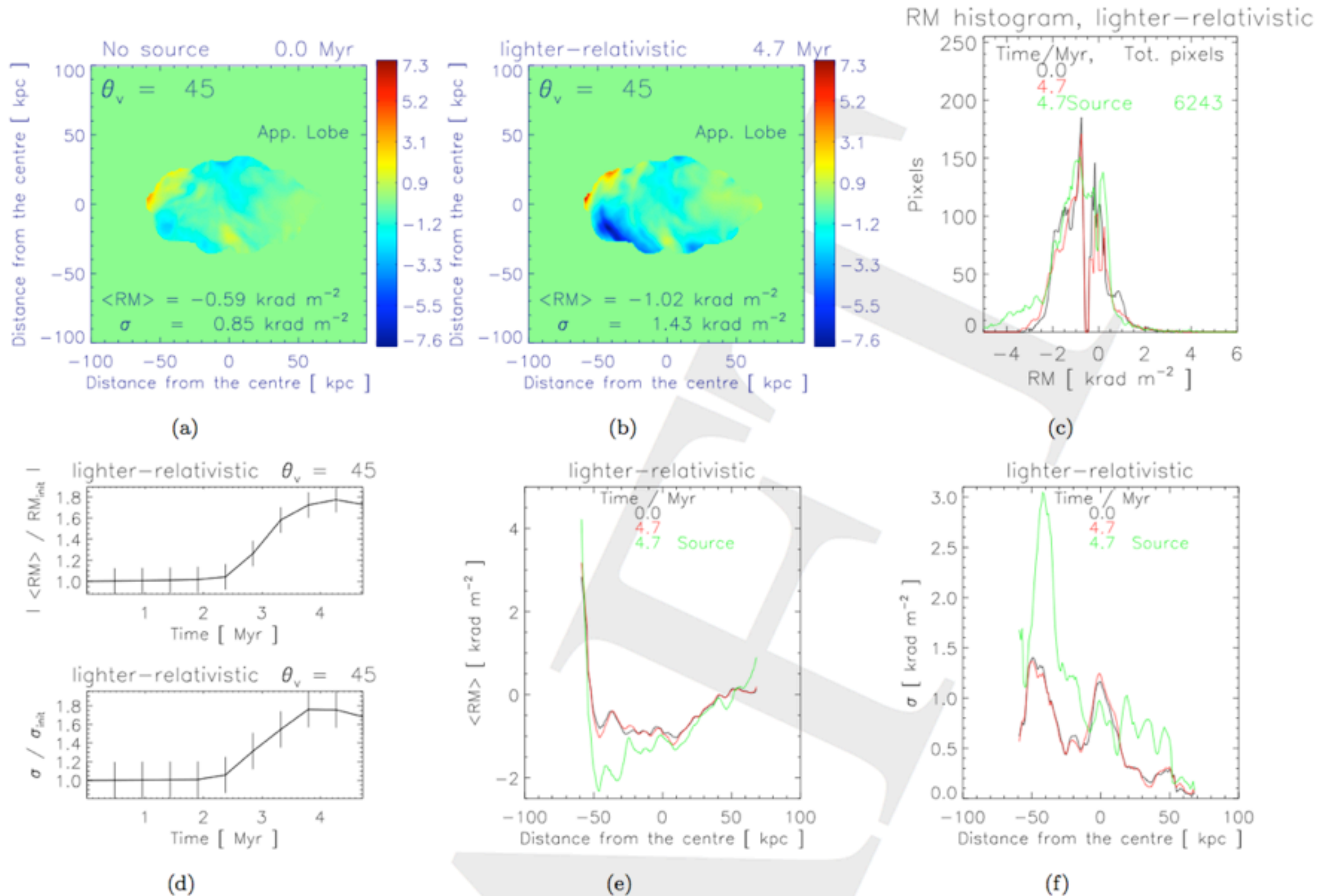
- Flash v3, 3D, MHD, no AMR, constrained transport
- generate turbulent magnetic field cube by the Tribble/Murgia et al method, $B_k \propto k^{-1/3}$
- multiply with King profile
- let cluster gas relax
- inject bipolar FR II jets in the middle
- vary density & velocity of the jets
- $\forall$ sim., do sim without jet
- compare RM + statistics: jet-sim. vs. no-jet sim.

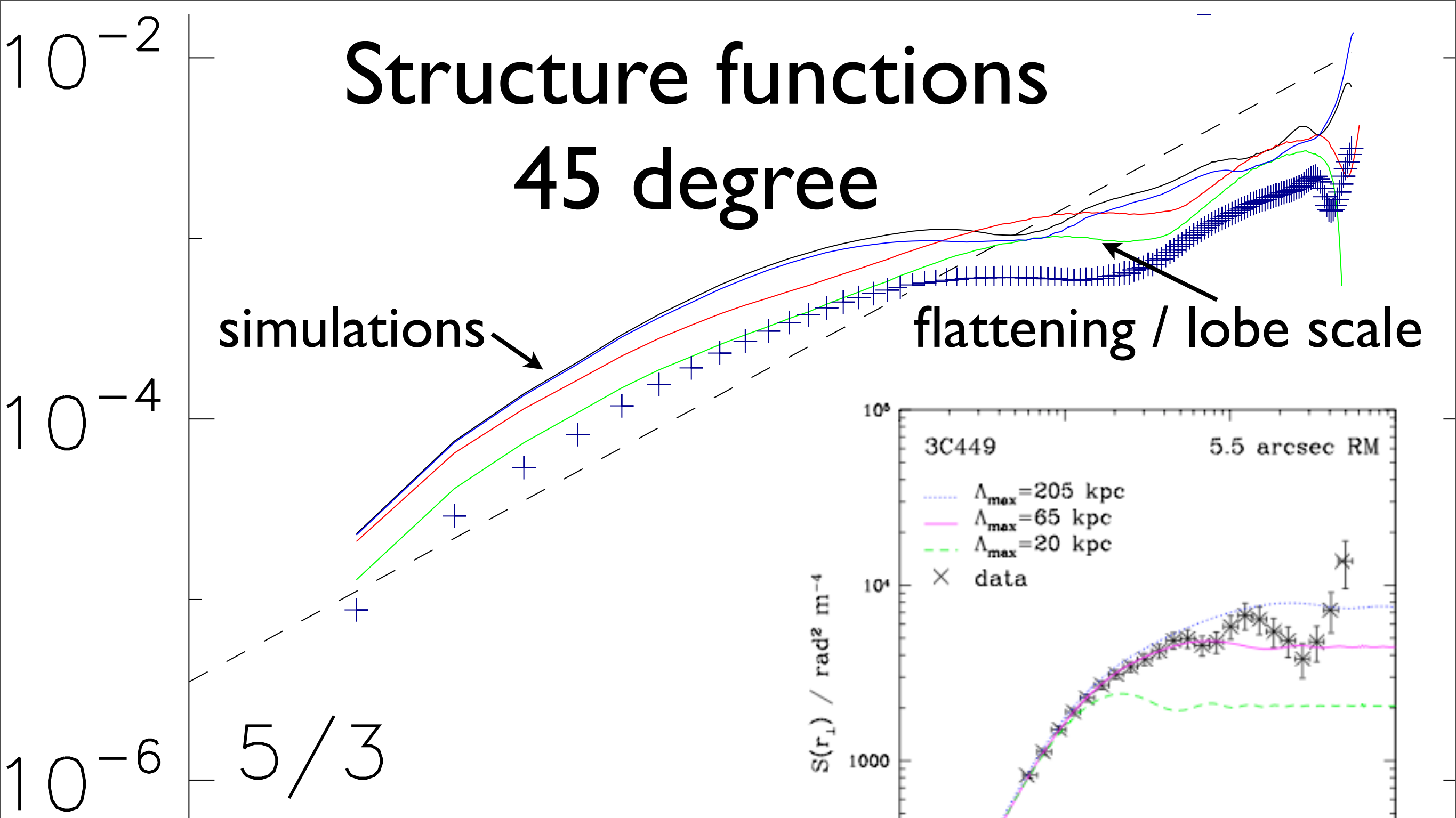
Simulation name	v_j^a [Mach]	η^b [$1/\rho_c$]	L_j^c [$\times 10^{38}$ W]	t_e^d [Myr]
lighter-slow	40	0.001	3.8	14.2
light-slow	40	0.010	16.0	8.3
lighter-fast	80	0.001	15.0	7.1
light-fast	80	0.010	110.0	4.4
lighter-relativistic	130	0.001	53.0	4.7
no-jets	0	0.000	0.0	all of the above

Results [90 deg]: $RM \approx +20\%$

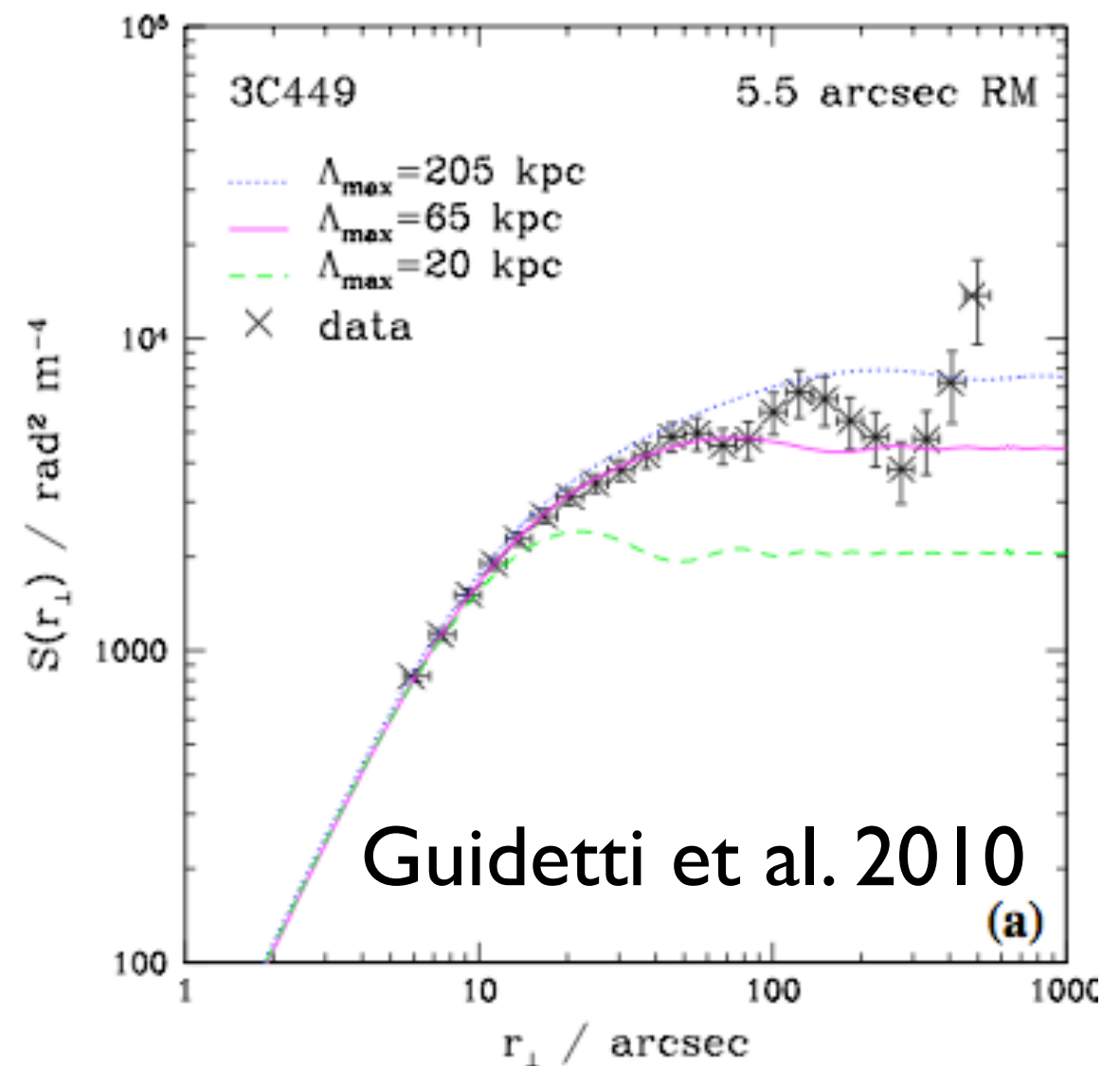


Results [45 deg]: $RM \approx +70\%$





- reproduce observed flattening without intrinsic outer scale of MF



Conclusions

- Simulated FR II jets in turbulent cluster mag. fields
- RM enhanced @ edges, by about $\times 2$
- $\propto$ cocoon width / inclination
- structure function reproduces obs.
- FR Is also done, but so far HD, only
- expect. similar, maybe weaker effect for FR Is