Faraday Rotation Measurements dependence with galaxy clusters dynamics

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Outline

- How we measure Magnetic fields?
- Galaxy Clusters and RMs
- Dynamical classification of Galaxy Clusters
 - Relaxed
 - Merging
- RM dispersion
- Conclusions



Abell 1689, NASA, ESA, L. Bradley (JHU), R. Bouwens (UCSC), H. Ford (JHU), and G. Illingworth (UCSC)

Magnetic fields and GC?

When looking for Magnetic Field in Galaxy Clusters, the prefered tool is Faraday RM maps

Galaxy Clusters: Galaxies (~5% Mtot) + DarkMatter (~80% Mtot) + Intra Cluster Medium (~15% Mtot)







Feretti et al. 1999



Magnetic fields and GC?



CLASSIX & RM



CLASSIX & RM



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Gas density

Magnetic field strength



• α : This parameter quantify the asymmetry of the galaxy distribution.

• β : Smoothed optical map of relaxed cluster has a steep surface brightness profile in all directions, while in the other hand, the presence of substructures imprint a 'ridge' in a certain direction in the smoothed map. This parameter quantify the difference in the light profile in the direction of the ridge comparing with the other directions.

• δ : As relaxed clusters have very similar light profile in all directions, their optical map can be fitted by twodimensional elliptical King model, while in the other hand, clusters with a lot of substructures would deviate more from this model. The normalized deviation δ quantify the deviation of the optical map of the cluster from this twodimensional King model.

Finally, using this parameters and the clusters with well known dynamical status, they defined the relaxation parameter Γ as

$$\Gamma = \beta - 1.90\alpha + 3.58\delta + 0.10 \tag{1}$$

and find that relaxed clusters have $\Gamma > 0$ and unrelaxed clusters have $\Gamma < 0$.

50 100 150

N200

Wen & Han 2016 Red: Merging Blue: Relaxed

9

Spacial distribution



Red: Merging / Blue: Relaxed / Green: RM catalog from Tayler

RM vs cluster state



RM dispersion given as a distance of the Galaxy clutser center The Relaxed clusters have larger dispersion even at 5 Mpc.

RM vs cluster state

 Merging Clusters
Relaxed Clusters 8 20 **Merging Clusters** All **Relaxed Clusters** > 40 members 8 Same R distr. - - - -Frequ 8 4 8 30 sigma(RM) 14 15 16 17 18 R Magnitude Histogram of clusters - Selected 20 Merging Clusters
Relaxed Clusters 80 5 Frequi 0 20 10 2 5 1 14 15 16 17 18 Projected Distance [Mpc] R Magnitude

When selecting the same R magnitude distributions, we reduce the difference!

Note: Foreground substraction / No infromation of the RM sources

Histogram of clusters

RM vs cluster state



Xu & Han 2016 Compiled a RM catalog of extragalactic sources

However it reduces the sample from 37000 to 4500, and is not homogeniously sampled.

Fig. 1 The sky distribution of the compiled RMs in the Galactic coordinates (*upper*) and that of the NVSS RMs (*lower*). The linear sizes of the symbols are proportional to the square root of the RM values with limits of ± 10 and ± 300 rad m⁻². Red pluses indicate positive RMs, while blue circles indicate negative RMs.

RM vs distance



Howeever the difference is still significant!

Take home....

- For two samples of galaxy clusters given their dynamical state, we found that Galaxy clusters that are 'relaxed' have stronger RM dispersion, even at larger radii *!*!*!*!!!!.
- We infer a magnetic field to thermal energy larger in those cases, reaching a 10% fraction of thermal energy
- There is a slight dependencence in the luminocity of the clusters?

Thank You !

Joing us to the open discussion about the global and regional status of science policies (tomorrow at lunch!)