

The dynamics of clusters of galaxies from the projected phase-space distribution of cluster galaxies

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Start of the project: January 2023 (*date of MiniGrant funds allocation*)

Aims of the project: constraining

- 1) the inner and outer slope γ_0 and γ_∞ of the mass density profile of clusters
- 2) the mass density profile $\rho(r)$ of low-mass clusters (groups)
- 3) the velocity anisotropy profile $\beta(r)$ of different classes of cluster galaxies
- 4) the relation between $\gamma(r)$ and $\beta(r)$

Based on 3 data sets: CLASH-VLT, OmegaWINGS, WEAVE Nearby Cluster Survey

Results (*Jan – Nov 2023*):

- (1) γ_0 constrained for two massive clusters (CLASH-VLT data set)
⇒ supports the Cold DM scenario and questions previous observational results
- (2) dichotomy in $\rho(r)$ of groups: X-ray detected groups follow CDM predictions, X-ray undetected groups are less centrally concentrated (SDSS+eROSITA data sets)
- (3) $\beta(r)$ of ram-pressure stripped candidate galaxies in clusters (OmegaWINGS and GASP data sets) indicate very radially elongated orbits

Scientific results in a nutshell

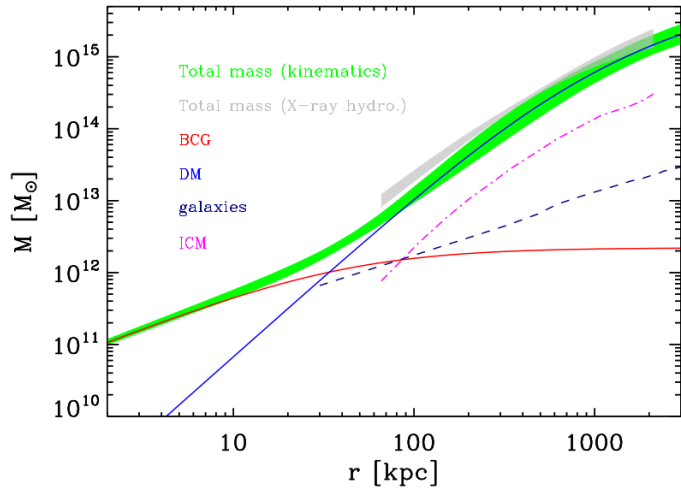


Figure 7. Total mass profiles $M(r)$ of the MACS 1206 cluster. Green (grey) shading: 68% confidence region for the total mass profile obtained from the kinematical analysis – Model 1 (respectively: from the X-ray hydrostatic analysis). Blue (resp. red) solid line: DM profile (resp. BCG stellar mass profile). Navy blue dashed line: satellites stellar mass profile. Magenta dash-dotted line: intra-cluster gas mass profile.

1) from Biviano et al. 2023, ApJ, in press

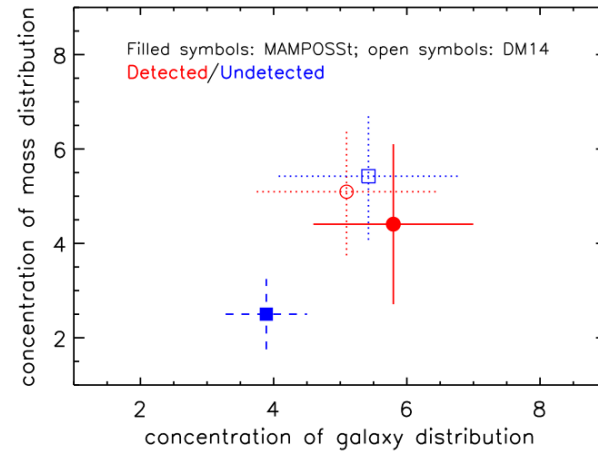


Figure 7. Concentration of the distribution of mass, c_ρ , vs. the concentration of the distribution of group galaxies, c_g for X-ray detected groups (red dot and solid $1-\sigma$ error bars), and undetected groups (blue square and dashed $1-\sigma$ error bars). Filled symbols indicate the results of the MAMPOSSt analysis. Open symbols and dotted lines indicate predictions from numerical simulations (Dutton & Macciò 2014) for halos with the same mean R_{200} of the detected and undetected systems (1.0 and 0.8 Mpc, respectively).

2) from Popesso, Biviano et al. 2023, MNRAS, in press

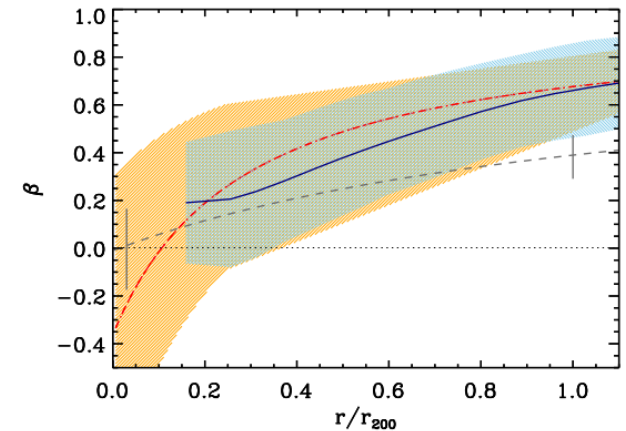


Figure 4. Median $\beta(r)$ (red dash-dotted line) and its 68% confidence region (orange shading), as obtained from the MAMPOSSt analysis with MCMC sampling. Median $\beta(r)$ (blue solid line) and its 68% confidence region (cyan shading), as obtained from the JEI analysis with bootstrap resamplings. For comparison we show the $\beta(r)$ for spirals in WINGS clusters (grey dashed line) and its uncertainties at $0.03 r_{200}$ and r_{200} (vertical grey segments), from Table 3, model 1 of Mamon et al. (2019). The dotted line represents orbital isotropy.

3) from Biviano et al. 2023, ApJ, submitted

Products: *publications*

- (1) Biviano et al. ApJ, in press: “CLASH-VLT: The inner slope of the MACS J1206.2-0847 mass density profile”
- (2) Popesso, Biviano et al. MNRAS, in press: “The X-ray invisible Universe. A look into the halos undetected by eROSITA”
- (3) Biviano et al. ApJ, submitted: “GASP. The radial orbits of ram-pressure-stripped galaxies in clusters”

Products: *talks & seminars*

- ◆ Invited (remote) seminar at NAT-UNICID Sao Paulo, Aug 28, 2023: “The inner slope of the cluster mass density profiles”
- ◆ Invited talk at the “Cosmology in Miramare” meeting in Trieste, Aug 31, 2023: “Dark matter in clusters of galaxies”
- ◆ Talk at the Zooming collaboration workshop in Milano, Jan 25, 2023: “MACS1206: the inner slope of the mass density profile”
- ◆ Talk at the Hydrosim collaboration workshop in Sesto, July 13, 2023: “The inner slope of the mass density profile (you cannot always trust observations)”
- ◆ Talk at the SIF meeting in Salerno, Sep 13, 2023: “The inner slope of the dark matter density profile of clusters of galaxies”
- ◆ Talk at the meeting “A journey through galactic environments” in Porto Ercole, Sep 25, 2023: “The X-ray invisible Universe: a look into the halos undetected by eROSITA”

Financial situation (in €):

Requested: 11650, Funded: 11500

2023:

Used so far: 273 (collaborator's mission to Trieste)
906 (my mission to the Hydrosim collaboration workshop in Sesto)

Committed: ~ 600 (graphic tablet)
~ 1000 (desktop)
~ 1300 (ApJ publication charges)

Total: ~ 4100

2024 (*forecast*):

My missions: 4000
Missions for collaborators to OATs: 1500
Publications: 1200
Overheads: 200 (electricity costs at OATs)

Total: ~ 6900

Scientific questions for 2024:

- CLASH-VLT data set: $\beta(r)$ for ~ 12 clusters; what is the variance in the orbital configuration of cluster galaxies, and is it related to the cluster dynamical state?
- CLASH-VLT data set: comparison of mass density profiles obtained via kinematics, X-ray and lensing probes; what are the systematics in the cluster mass determination, how strong is the hydrostatic mass bias?
- OmegaWINGS data set: study the $\beta(r)$ - $\gamma(r)$ relation, is there a fundamental law of cluster dynamics as suggested by numerical simulations?

Criticalities:

Data from the WEAVE Nearby Cluster Survey not available yet