Validation of the Euclid Catalogue of Galaxy Clusters with external data

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Scientific context - Galaxy Clusters

- Largest and most massive known gravitationally bound structures: 10^{14} - 10^{15} $M_{\odot}$, 1 - 5 Mpc, 20 ~ 1000 galaxies

- Galaxies, gas, dark matter

- Multiple wavelengths: optical, X-rays

Euclid, ESA

- Dark Matter: does not interact with light, detected by gravitation
  ~25% of the actual Universe

- Dark Energy: responsible for the accelerated expansion of the Universe
  ~70% of the actual Universe

➔ Unknown natures

➔ Cluster formation very sensitive to quantities of dark matter and dark energy

Scientific context - Euclid mission

- Launched in July 2023 to the Earth-Sun Lagrange point L2

- Beginning of nominal survey operations: February 2024

- 6 years, 15 000 deg^2 of its extragalactic sky survey

➔ Catalogue of hundred of thousand clusters

ESA

Validation of Euclid catalogue: motivation

Identification of counterparts: association with and comparison to known clusters from other surveys

➔ Check for newly discovered clusters

➔ Prepare analyses of scaling relations

➔ Characterize *Euclid* selection function

J.-B. Melin, A. Stanford, A. Widmer, P. Tarrío, J.G. Bartlett, …, *Euclid preparation: Validation of the Euclid Catalogue of Galaxy Clusters with external data*, in prep.
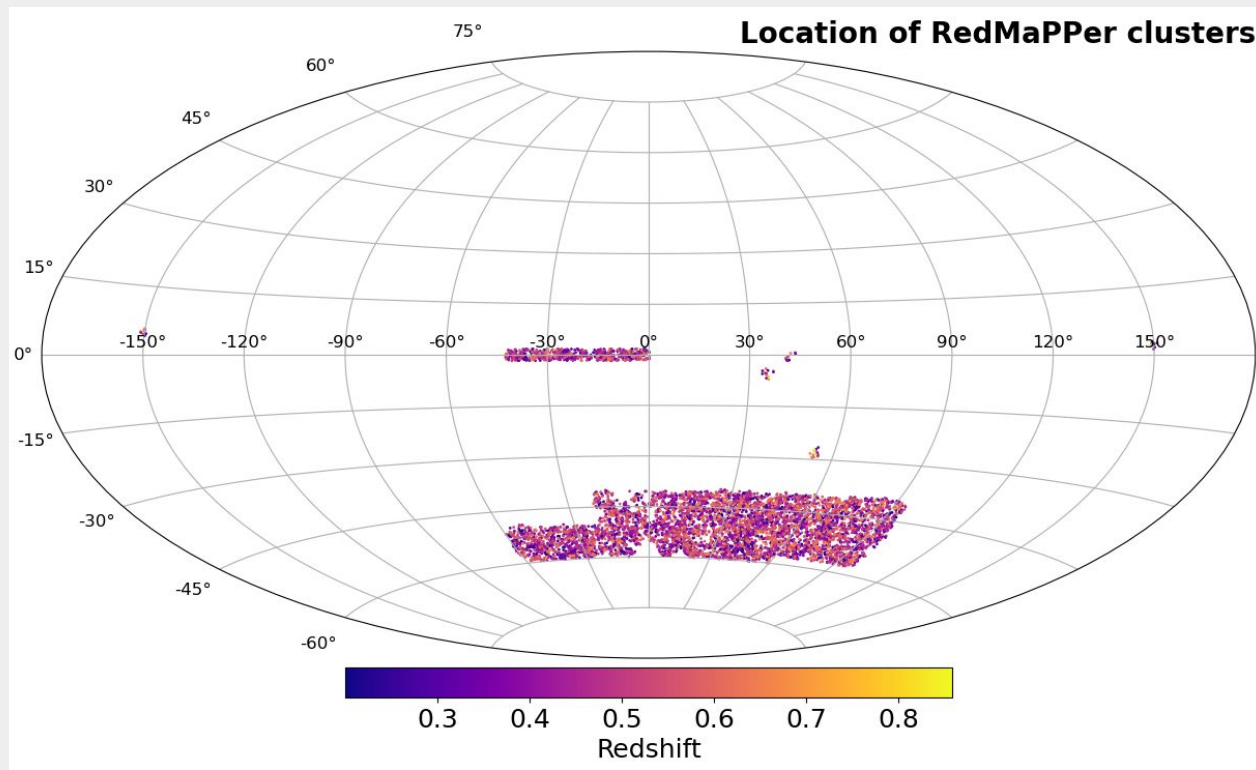
Catalogues and Meta-Catalogues
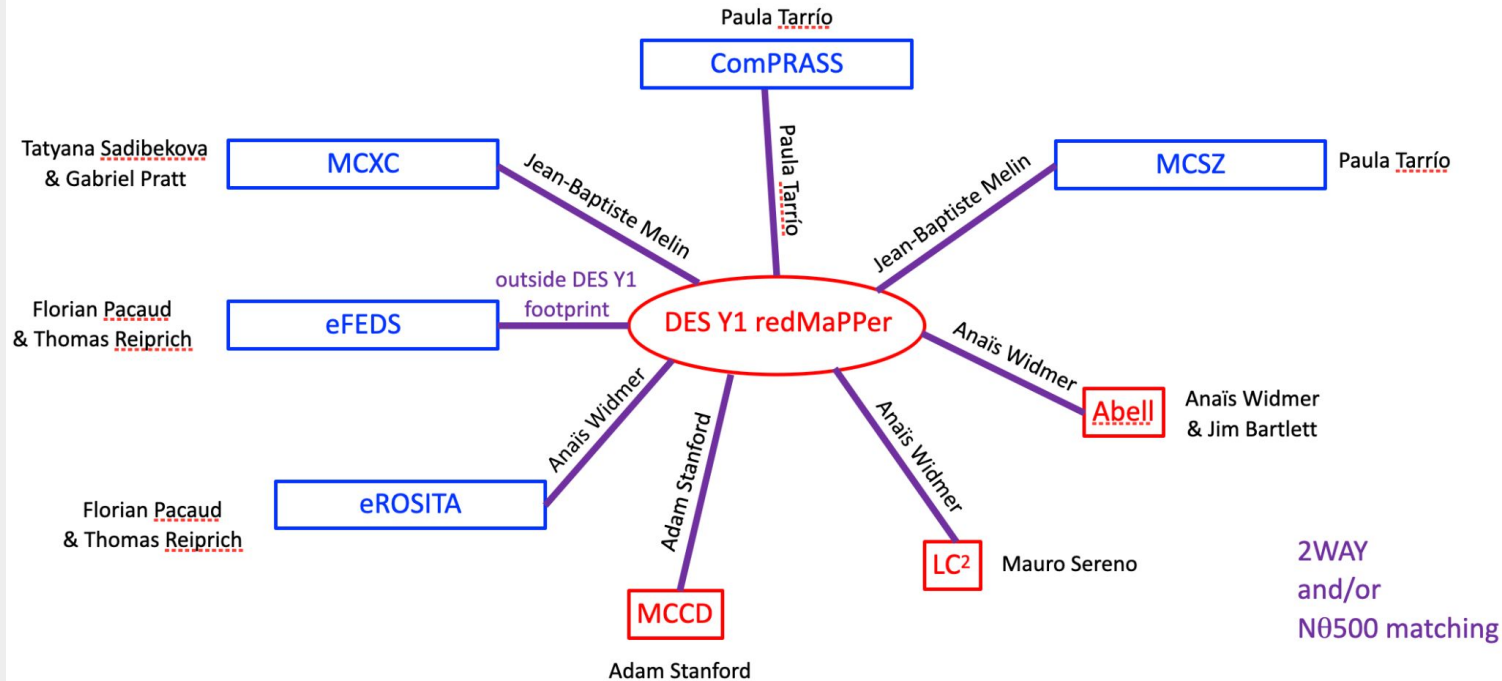
Surrogate for the future Euclid Catalogue

Similar features: optical selection based on galaxies.

6729 detections over about 1650 deg^2

Rykoff et.al., 2016 (arXiv:1601.00621)
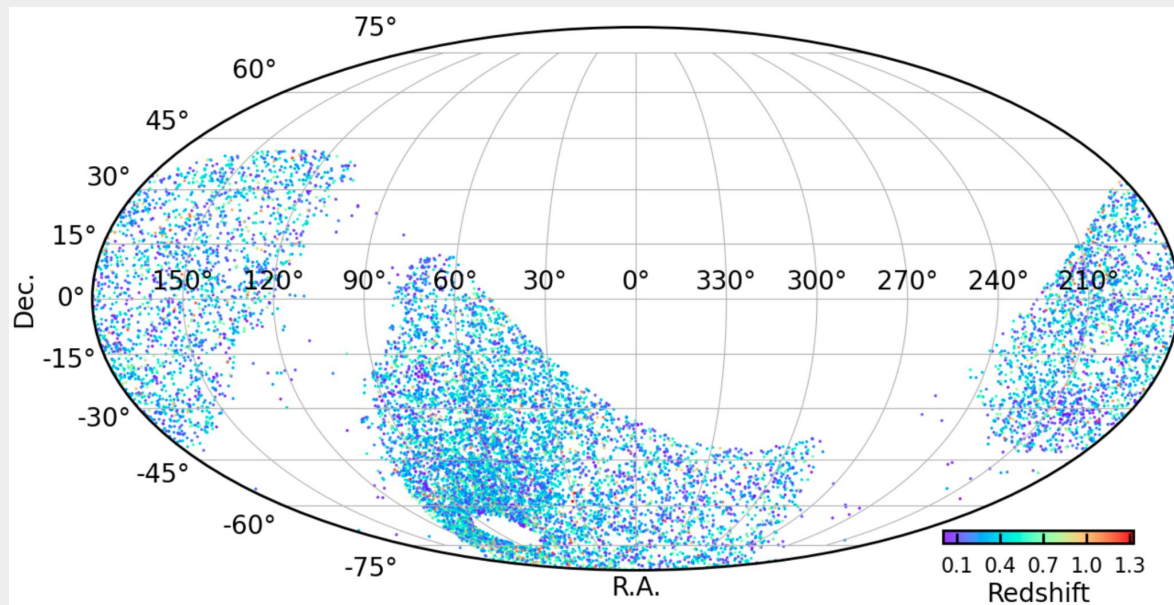Abbott et.al., 2020 (arXiv:2002.11124)

Location of RedMaPPer clusters

X-ray telescope, energy range 0.2 - 2.3 keV

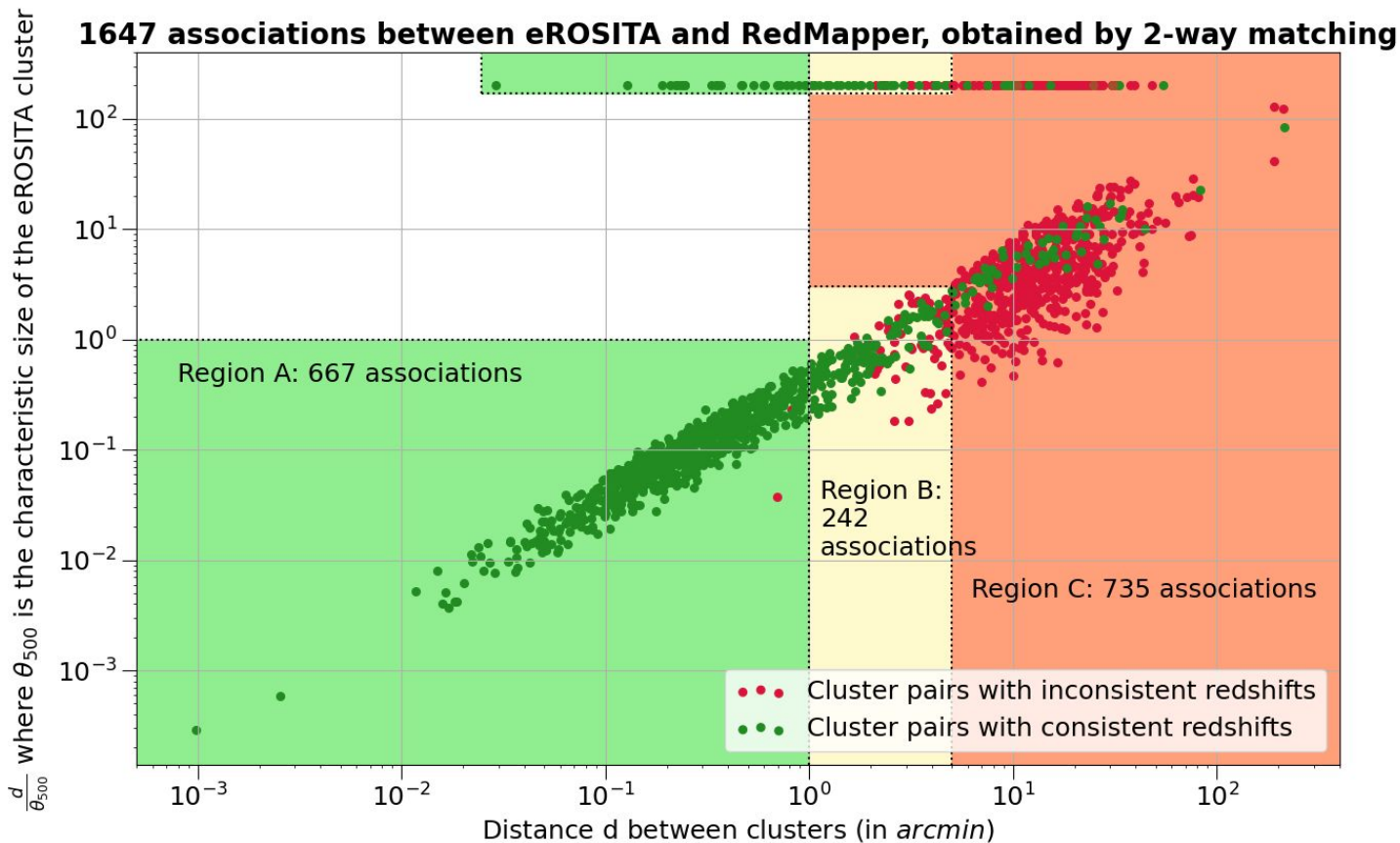First catalogue covers the Western Galactic hemisphere

12,247 sources over 13,166 deg^2

Bulbul et.al., 2024 (arXiv:2402.08452)
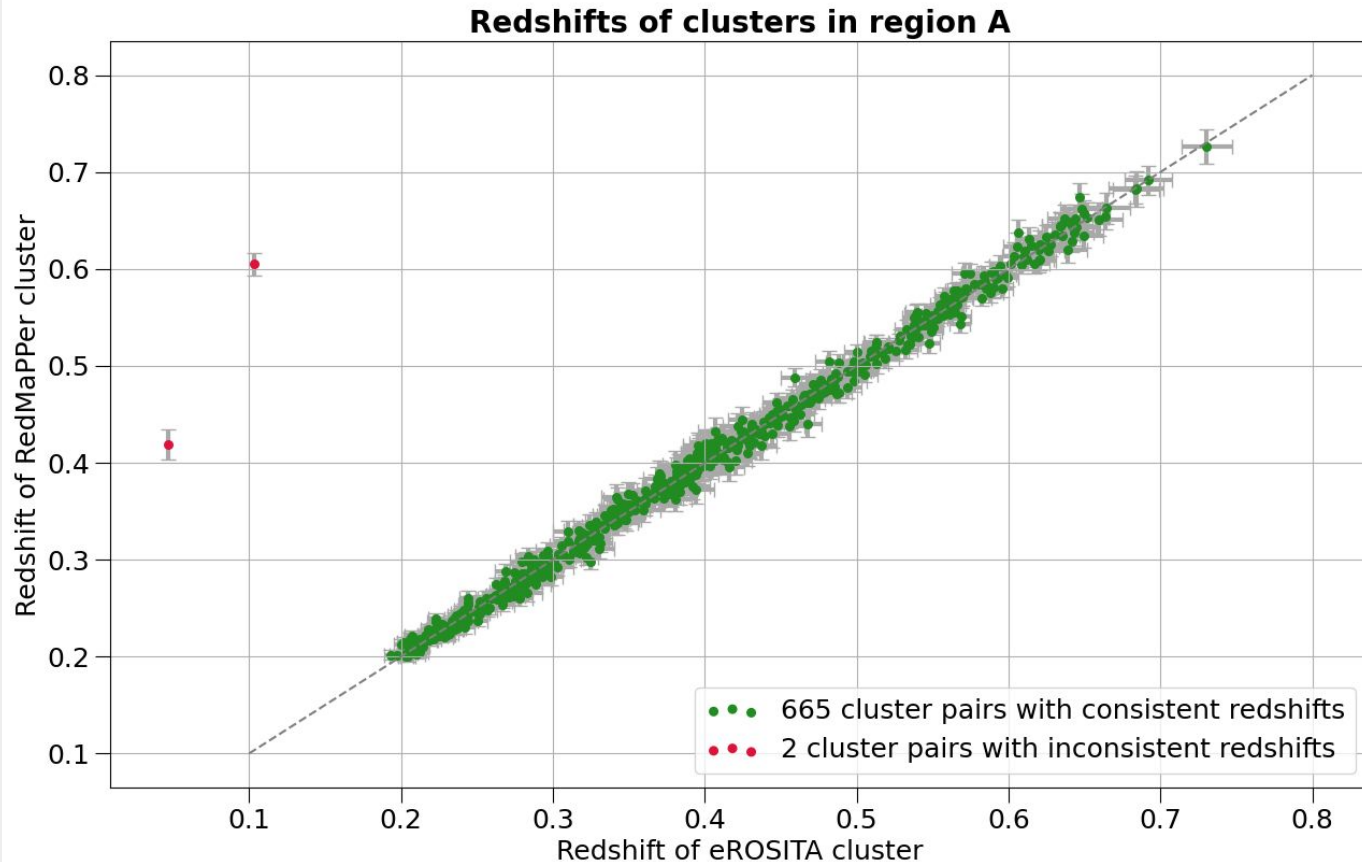
- For each RM cluster, compute distance to eR clusters and keep the closest eR cluster.

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- Keep only the pairs that are the same.

➔ Plot the distance between the two clusters normalized to the characteristic size θ_{500} of the eR cluster as a function of distance.

1647 associations between eROSITA and RedMapper, obtained by 2-way matching

Redshifts of clusters in region A

$$\frac{\Delta z}{1+z_{eR}} < 0.03$$
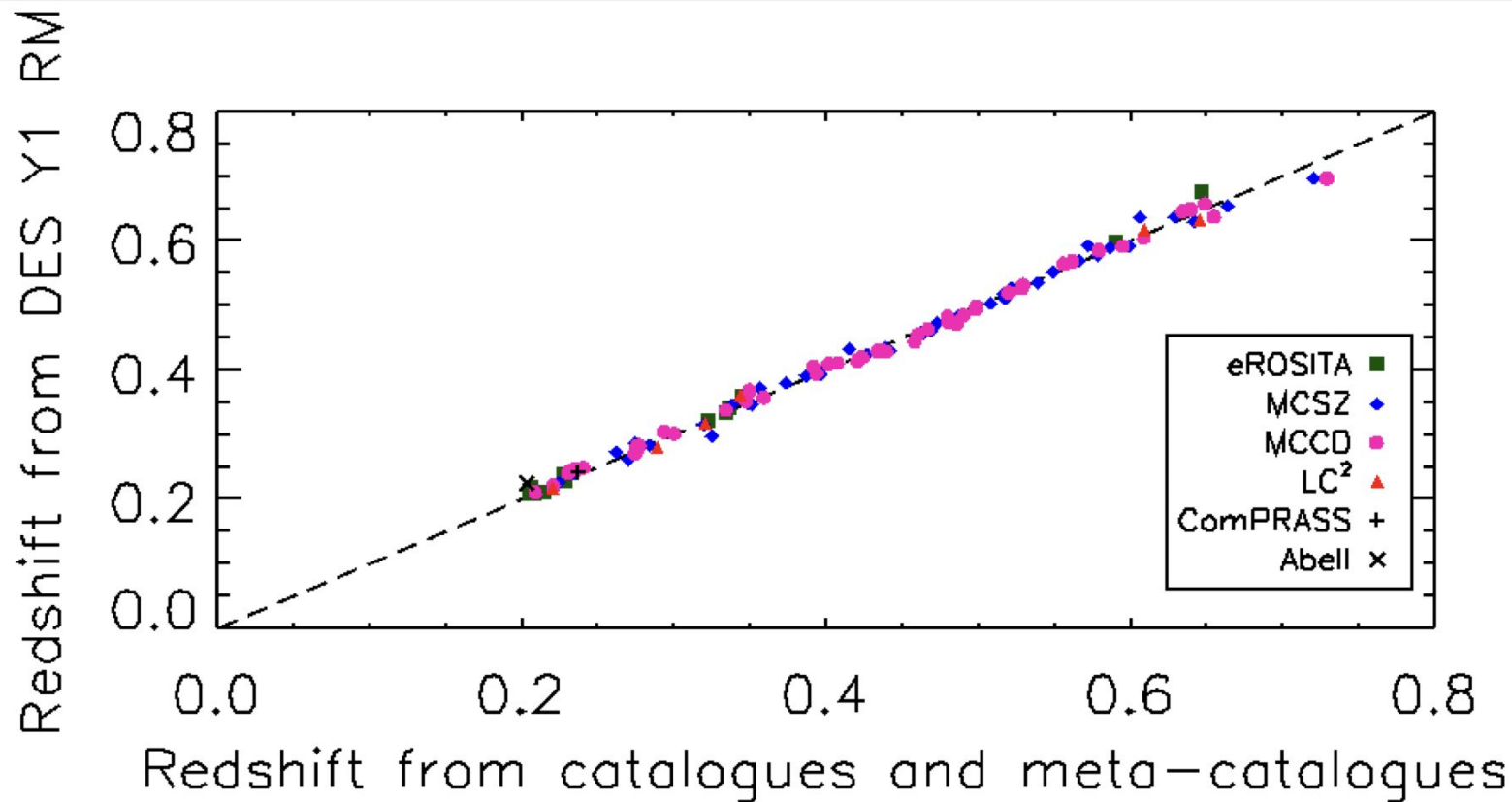
For each eR cluster :

- Select all the RM clusters that are inside a circle of radius N θ_{500} (N = 3) around the eR cluster.

- Keep the RM cluster with the closest redshift.

- Keep only the pairs with $\frac{\Delta z}{1+z_{eR}} < 0.03$.

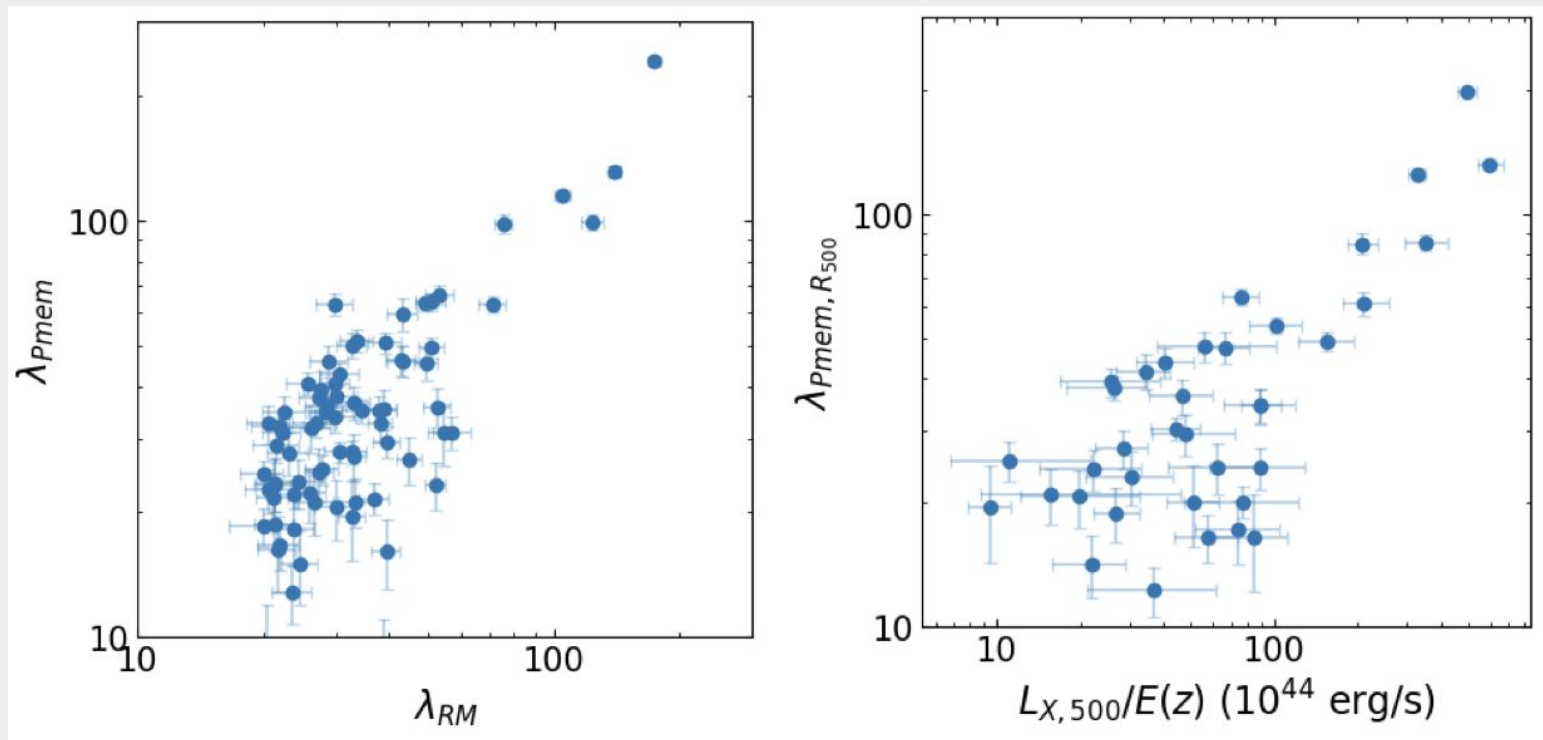784 associations between eROSITA (for clusters with available masses) and RedMaPPer obtained by NT500 matching
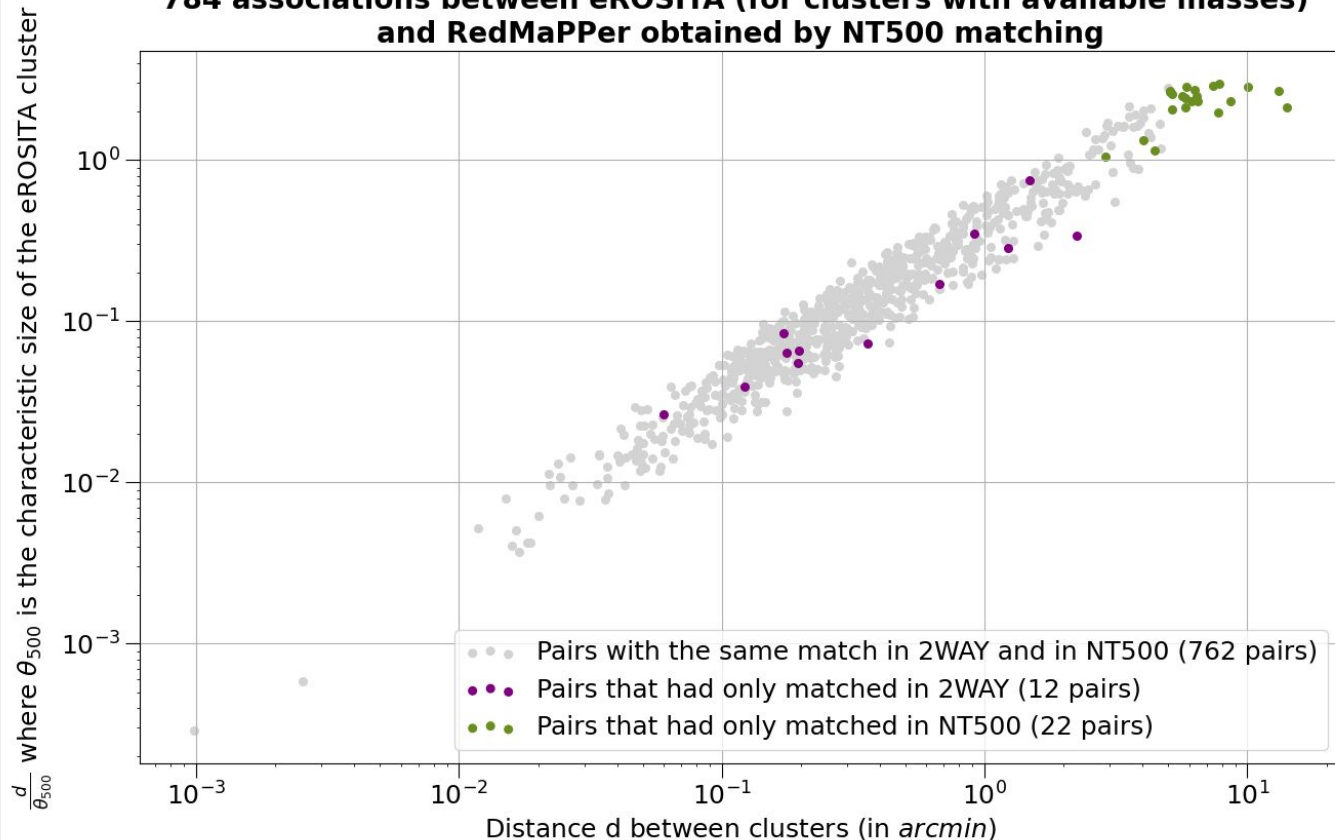
J.-B. Melin et. al., in prep

Bhargava et. al., 2025

Conclusion

- Efficient method for cross-matching the DES Y1 RM catalogue with external data: plan to use it for validating the Euclid catalogue (for the DR1 data)

- Limitations: time and human resources

- Other catalogues (XCLASS, MARD Y3, …)