Optical spec-z follow-up for cluster cosmology

HIFLUGCS: Calibrating redshifts, dynamical masses and X-ray luminosity–mass relations of X-ray galaxy clusters

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In prep.

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Cluster cosmology

- X-ray clusters + optical spectroscopy of gal members

For free for a subset of clusters in *eROSITA* follow-up programs

Flux: F_X

Redshift: z

Dynamical mass: M

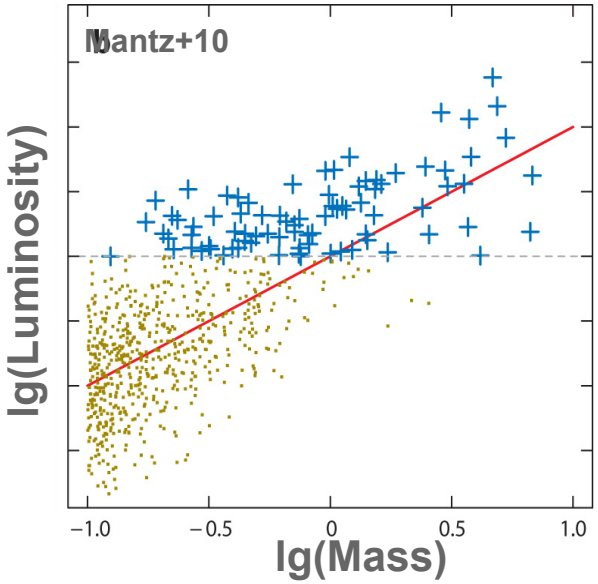
Luminosity: L

L & M independently measured

L–M → Selection function

Cosmological parameters → Tinker Mass function

ML fit to $N(L,M)$ for (Ω_m & σ_8), $L=B*M^A$, and σ_{lgL} simultaneously



$$\ln \mathcal{L}(\boldsymbol{p}) = \sum_i \ln \frac{\mathrm{d}N(l_i, m_i)}{\mathrm{d}l\,\mathrm{d}m} - \int\int \frac{\mathrm{d}N(l,m)}{\mathrm{d}l\,\mathrm{d}m}\,\mathrm{d}l\,\mathrm{d}m\,. \qquad (13)$$

Cluster cosmology

$$\frac{\mathrm{d}N(l,m)}{\mathrm{d}l\,\mathrm{d}m} = \int P(l,m|m')P(m')\mathrm{d}m'$$

$$= \int P(l|m')P(m|m')P(m')\mathrm{d}m' \ . \qquad (5)$$

$$P(l|m') = \frac{P(m'|l)P(l)}{P(m')}$$

$$= \int P(m|m')P(m'|l)\mathrm{d}m'P(l) \ . \qquad (7)$$

$$= \int P(m|m')P(m'|l)\mathrm{d}m' \int P(l|m')P(m')\mathrm{d}m'$$

$$= P(m|l)\frac{\mathrm{d}N(l)}{\mathrm{d}l} \ . \qquad (8)$$

mass calibration

optical spectroscopy: dynamical masses

cluster number count

$$\frac{\mathrm{d}N(l)}{\mathrm{d}l} = \int P(l|m')\,n(m')\,v_{\max}(l,m')\,\mathrm{d}m'$$

Preliminary results: *L-M*

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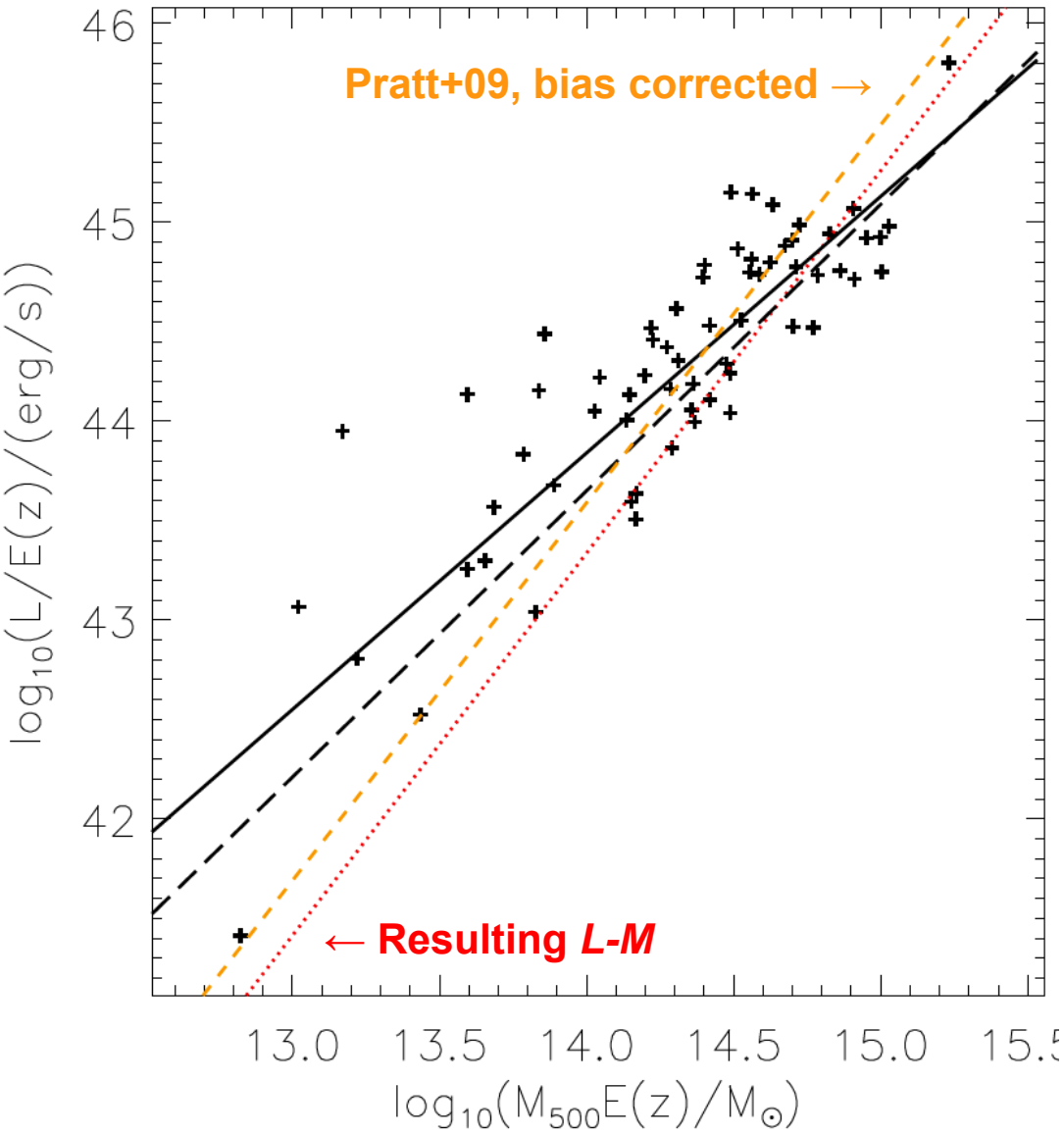


63 clusters __
57 clusters - - -

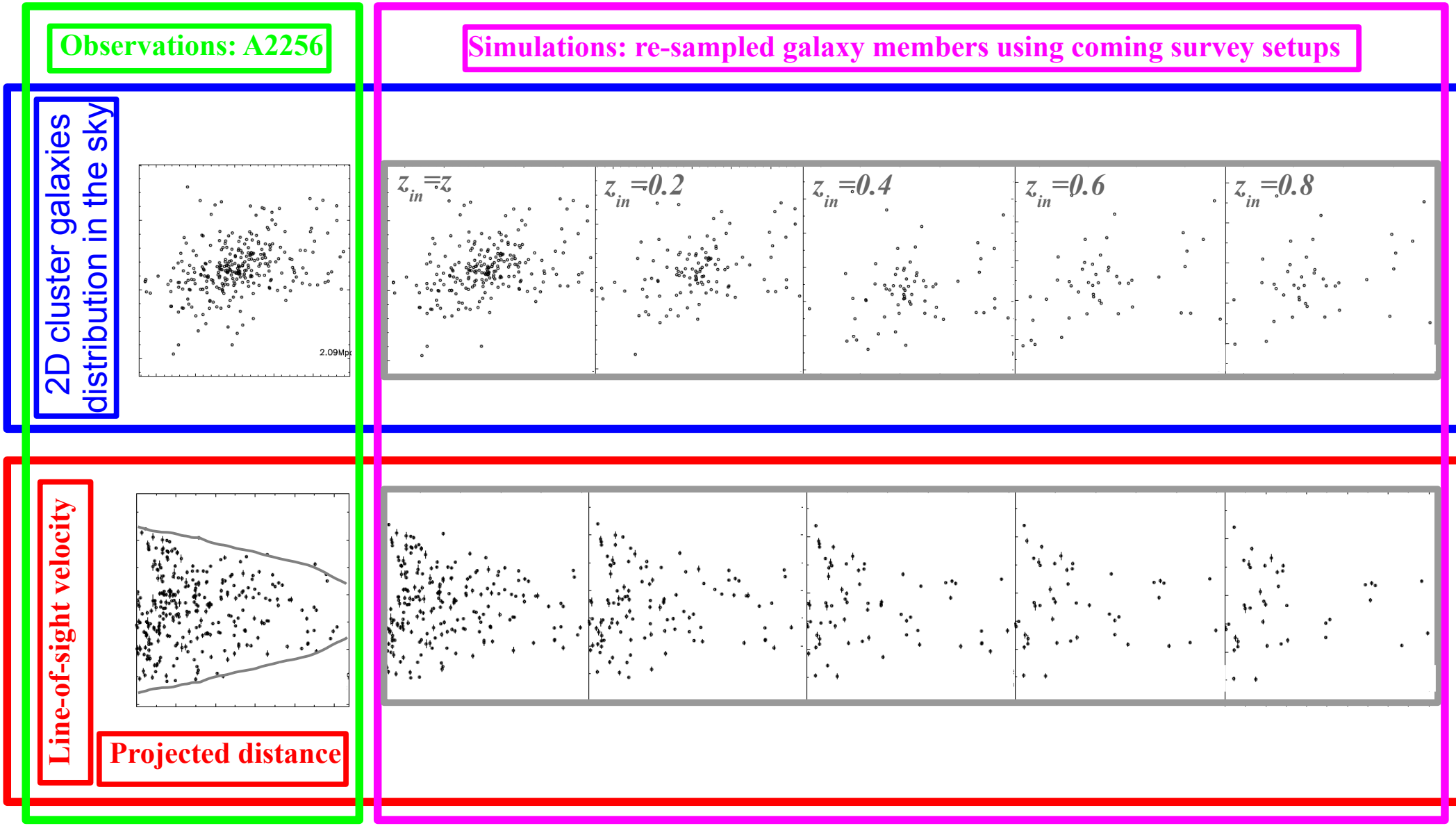
eROSITA survey & its spec-z follow-up

- North: SDSS IV/SPIDERS (2014-2020)
  - More than 35,000 spec-redshifts in 4500 RASS+RedMapper (CODEX) clusters: 50% of all clusters (75% of rich clusters of richness >50) with **more than 10 spec-z per cluster**
  - eROSITA follow-up over a ~2000 deg^2 area in the NGC: reach >80% completeness for eRASS:4
- South: VISTA/4MOST (2020-2025)
  - Complete, systematic follow-up of both Clusters and AGN from eROSITA: reach >80% completeness for eRASS:8
  - **1.4 Million spec-z** for 70k clusters: 24k/36k of clusters with richness >30, and 10.5k/14k of clusters with richness>50, will have **more than 20 spec-z per cluster**

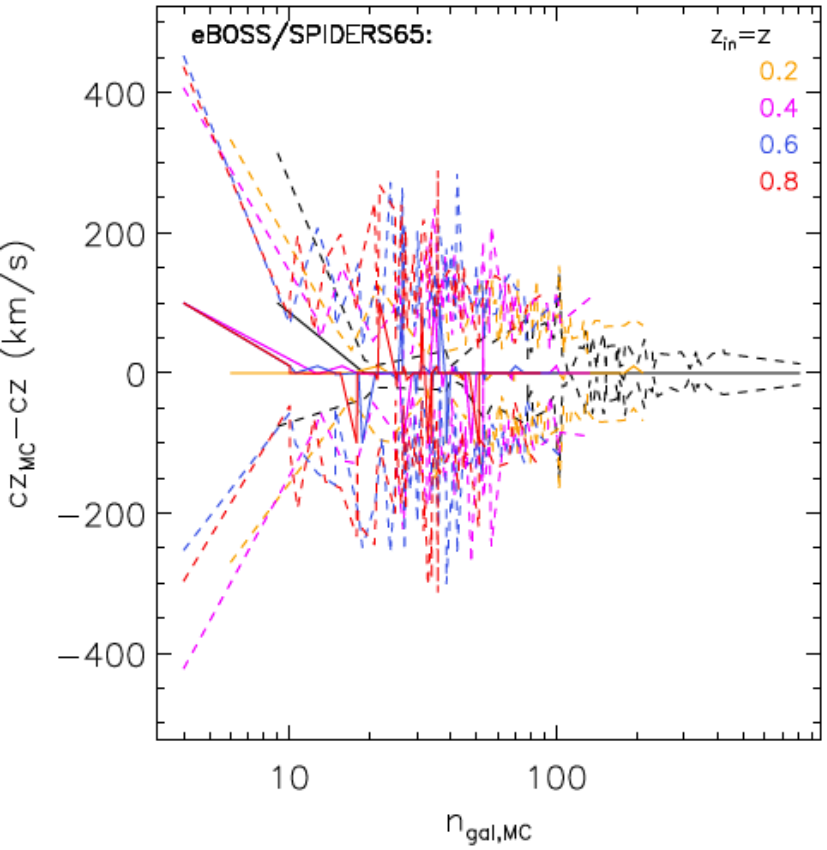
More see talks from Andrea, Nicolas and Roelof

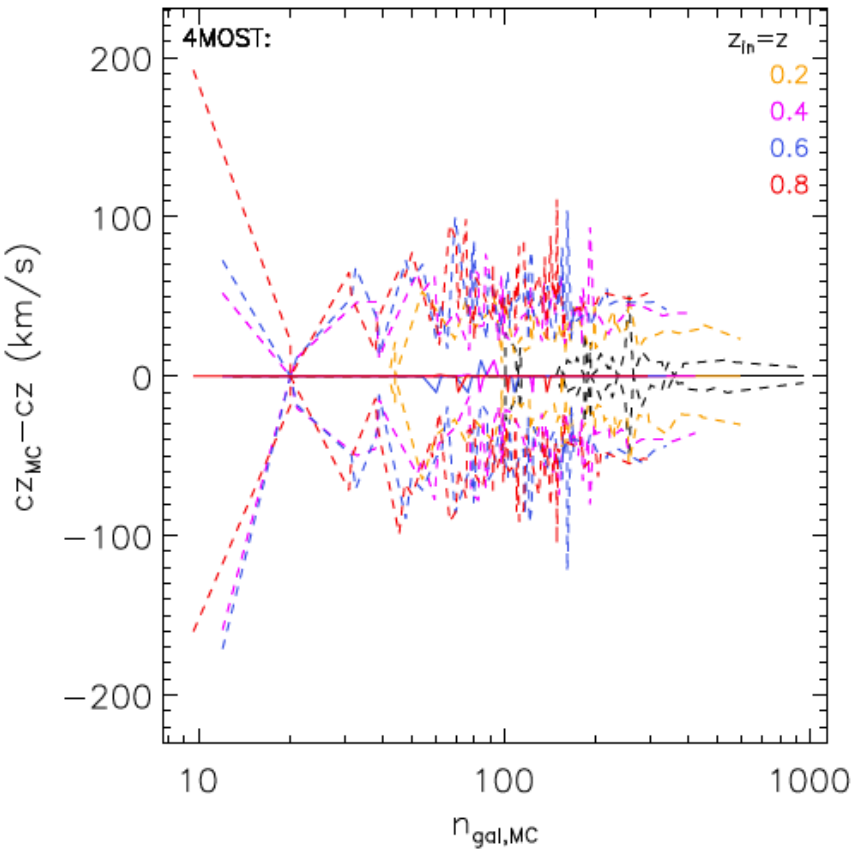
Mocking spec-z survey data

- Re-sampled 13467 spec-z: (e.g. 4MOST configuration below)
  63 clusters x 5 redshift bins x 2 survey configurations x 500 realizations

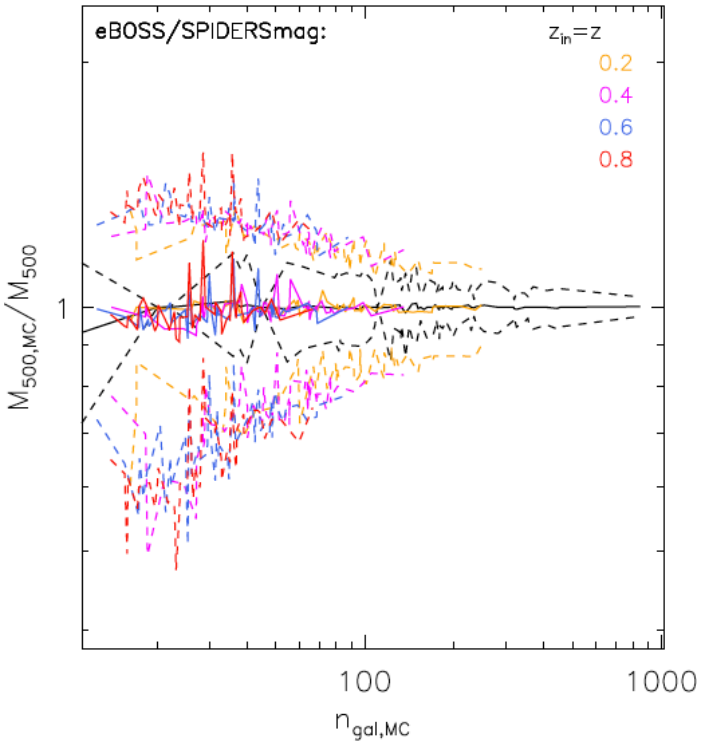


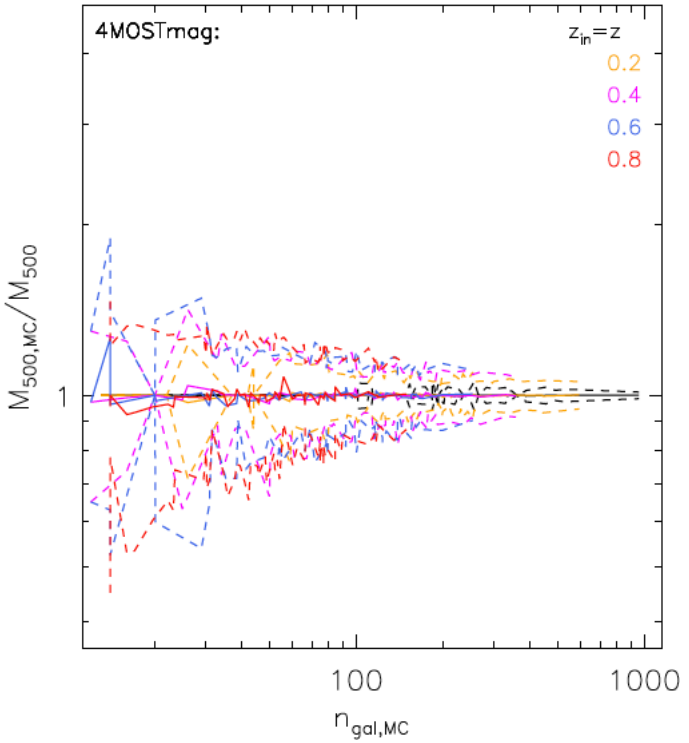
Results: z uncertainty in spec-z surveys





Results: mass uncertainty in spec-z surveys





Summary and pespective

- Independent measurements from multi-wavelength surveys can break the degenerate between mass calibration and cosmological constraints.

- We can mock optical spec-z surveys based on
  - either your observations
  - or our simulations/observations
    to model the error estimates of the cluster redshift, velocity dispersion and dynamical mass estimates.

- In progress in predicting the SPIDERS and 4MOST mock surveys using simulations.