

Halo Mass Recovery Comparison PCx & PFx Method Descriptions

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Our Methods

- For this comparison, we use four methods based upon:
 - Group Richness
 - Galaxy Number Overdensity
 - Characteristic Radius
 - Galaxy dynamics
- Two basic galaxy selection methods are also used
 - σ clipping
 - Friends-of-Friends
- Use a *Chandra* X-ray selected sample of 22 groups and clusters from Sun et al (2009) and Sanderson et al (2010) to calibrate mass (M_{500}) – proxy relations
- Proxies are derived from SDSS/NYU-VAGC data for these groups

Selection Methods

σ clipping

- Extract galaxies in a cylinder of radius 5 Mpc and depth ± 1000 km/s centred on known halo positions
- Using galaxies within 1 Mpc, determine velocity dispersion, σ , and iteratively refine cylinder using a 3σ clip
- Two classes of galaxies:
 - Galaxies within 1 Mpc we consider member galaxies
 - Galaxies at 3-5 Mpc we consider to be field and representative of interloper populations

Selection Methods

Friends-of-Friends

- Use the FoF algorithm described by Eke et al, (2004), for the 2dFGRS
- We use their optimisation with SDSS luminosity functions
- We construct a FoF group catalogue and match each halo to the closest FoF group
- Only use FoF groups with $N_{\text{FoF}} \geq 10$
- All galaxies in each group are considered member galaxies with no interloper contamination

Mass Estimation

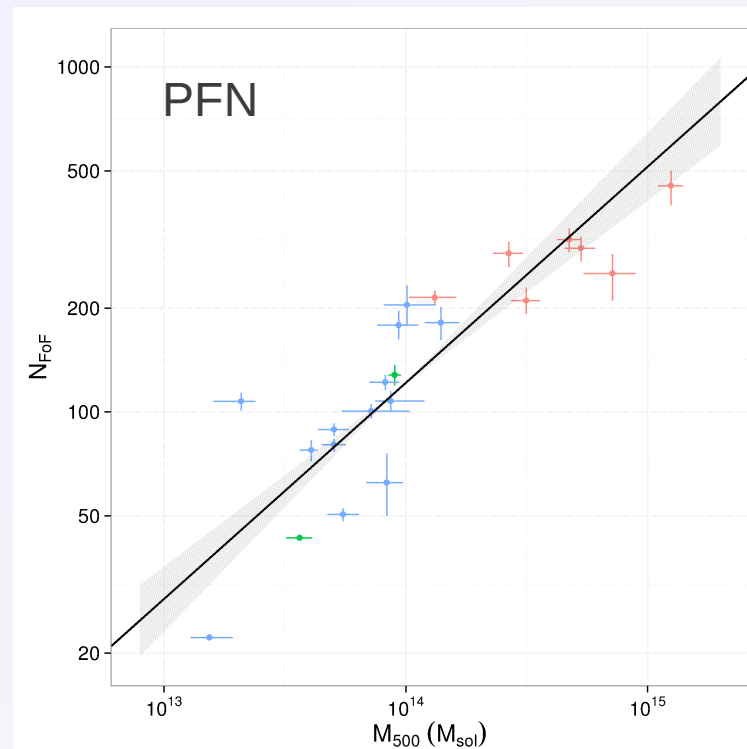
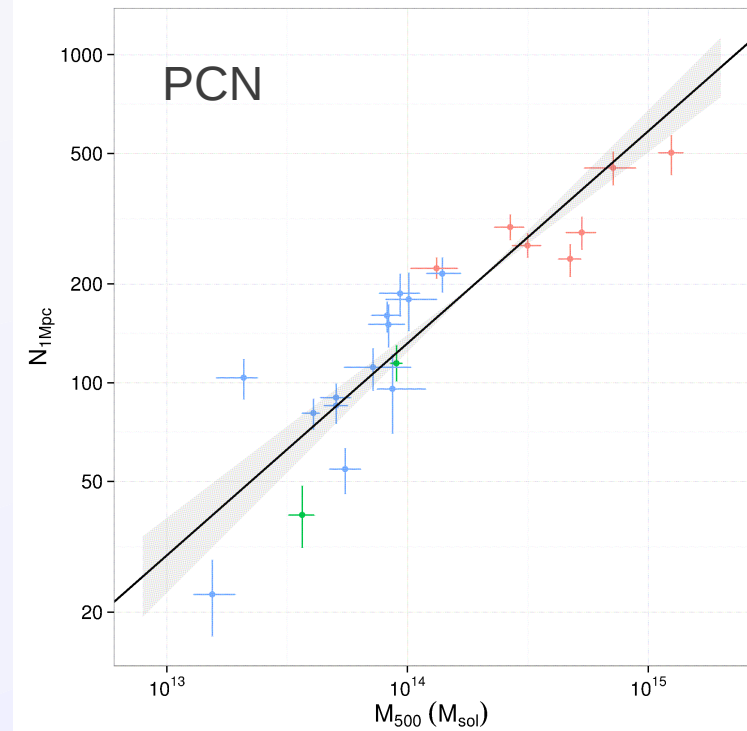
Richness

PCN

- Richness of galaxies brighter than $M_r = -16.5$ (extrapolated when necessary), within a 1 Mpc aperture around group centre
- Corrected for interloper contamination using galaxies at 3-5 Mpc

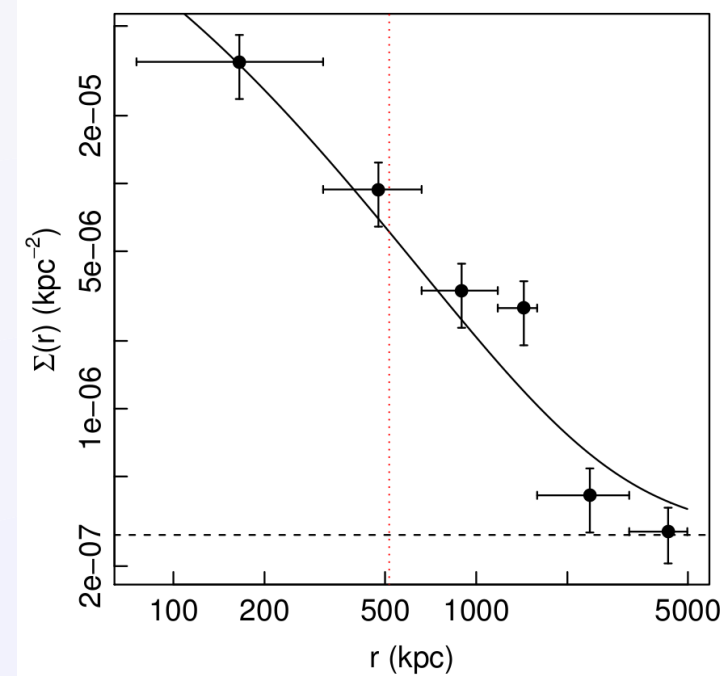
PFN

- Total FoF richness of galaxies brighter than $M_r = -16.5$
- No corrections applied for interlopers



Mass Estimation Overdensity

- Assume that galaxies trace the halo potential, and that halos are spherically symmetric
- Fit a projected NFW profile to the radial distribution of galaxies
- Use fit results with a 3D NFW profile to produce mean galaxy density profile
- Define r_{500} to be the radius that encloses an overdensity of $500/\Omega_m$ relative to the mean galaxy number density (given by a global SDSS luminosity function)



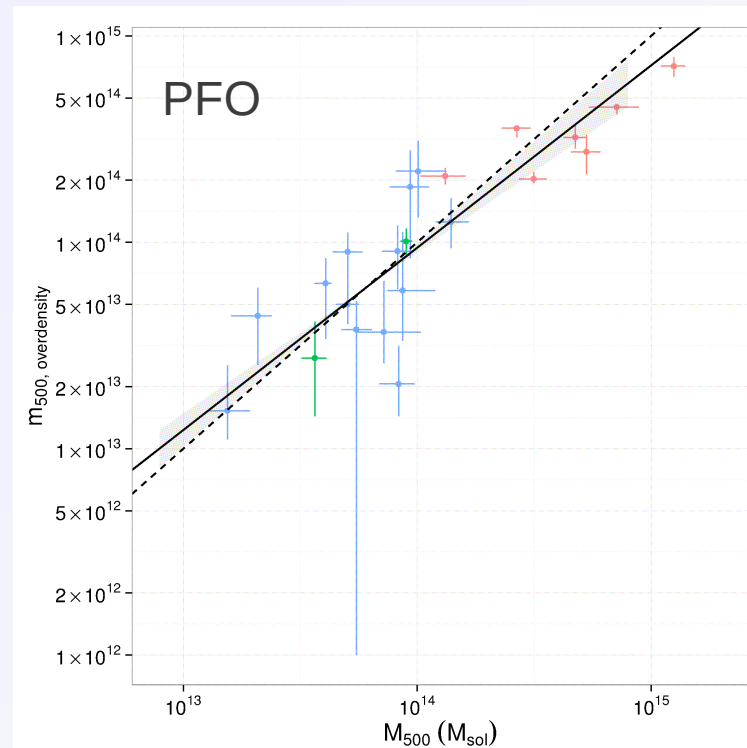
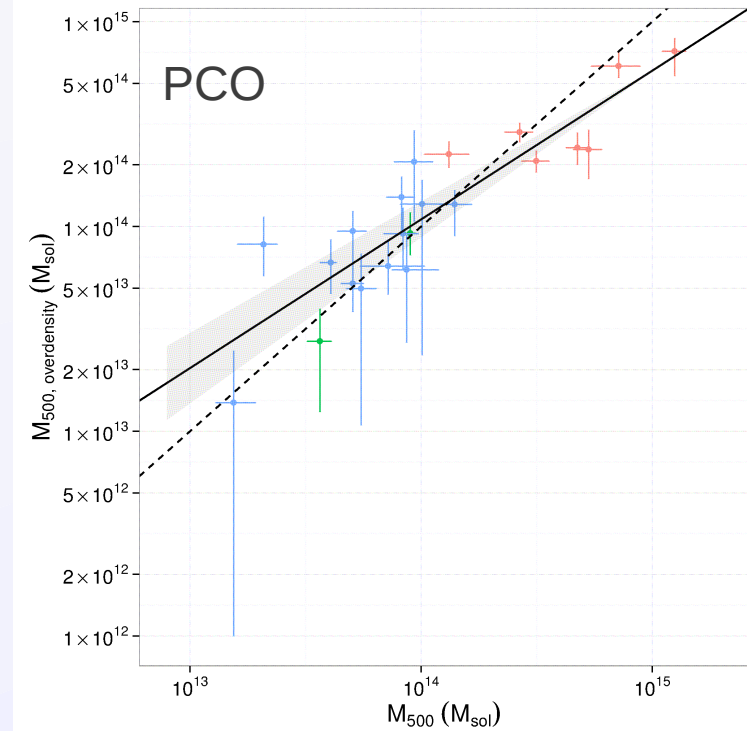
Mass Estimation Overdensity

PCO

- Fit to all galaxies within each 5 Mpc cylinder
- Add a flat radial component to fit the distribution of interlopers

PFO

- Use all FoF galaxies for the NFW fit
- Assumes no interloper contamination



Mass Estimation

Characteristic Radius

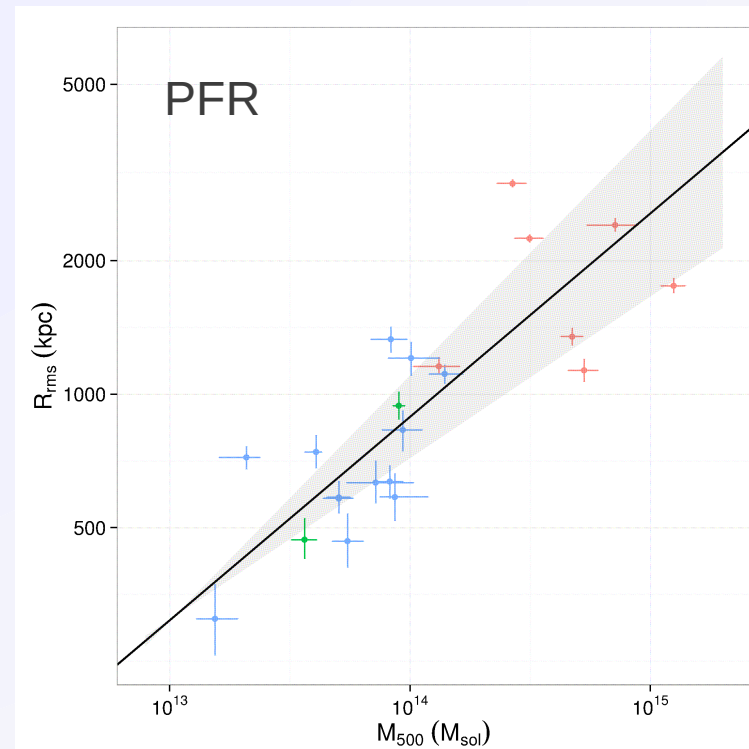
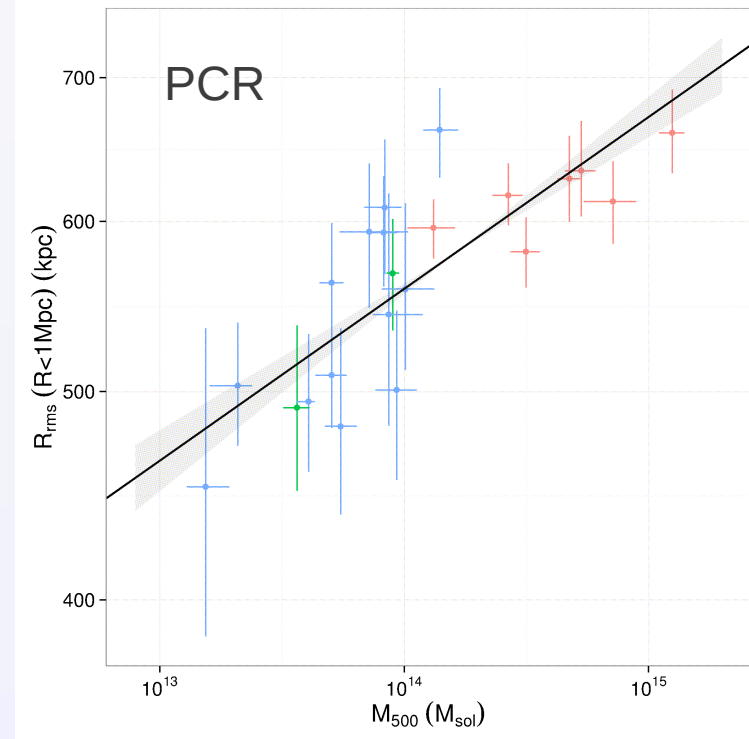
Define the characteristic radius as the projected r.m.s. radius of the group

PCR

- Using galaxies within 1 Mpc

PFR

- Using all FoF member galaxies



Mass Estimation Galaxy Dynamics

Based on the application of
the virial theorem as used by
Ramella et al (2004)

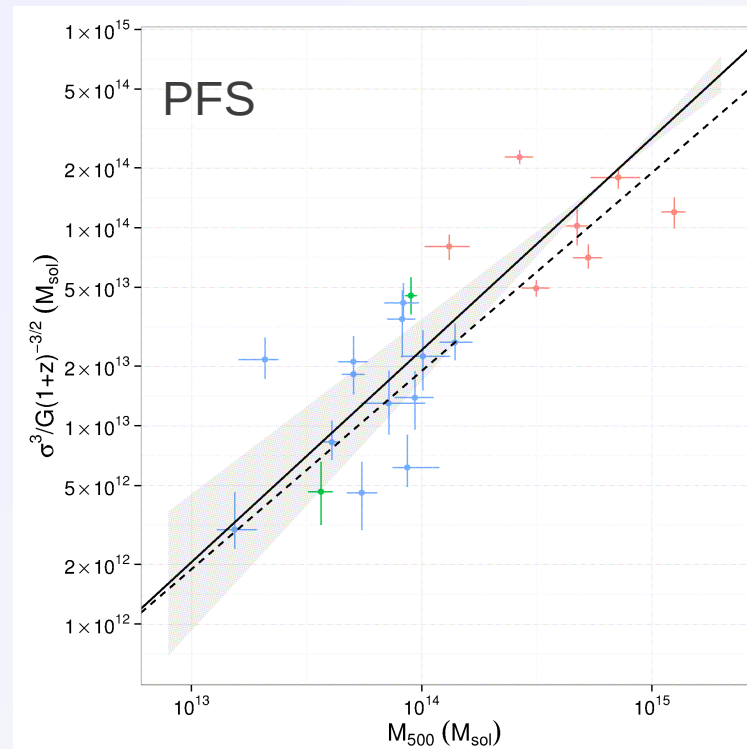
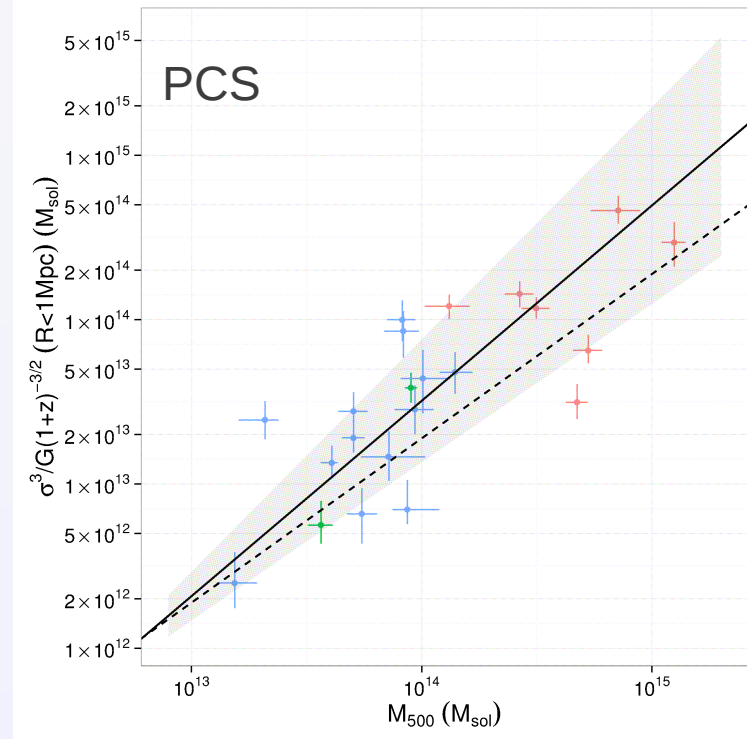
$$M \propto R \sigma^2 \propto (1+z)^{-3/2} \sigma^3$$

PCS

- Using galaxies within a 1 Mpc aperture around group centre

PFS

- Using all FoF member galaxies



Performance on Calibration Sample

	Proxy - M_{500} Slope	Correlation	Intrinsic Scatter in proxy (dex)	Intrinsic Scatter in M_{500} (dex)
PCN	0.65 ± 0.09	0.94	0.13	0.21
PCO	0.73 ± 0.09	0.88	-	0.23
PCR	0.08 ± 0.01	0.81	-	0.34
PCS	1.2 ± 0.2	0.80	0.36	0.31
PFN	0.63 ± 0.10	0.92	0.15	0.24
PFO	0.88 ± 0.10	0.89	0.16	0.24
PFR	0.46 ± 0.09	0.84	0.14	0.31
PFS	1.1 ± 0.2	0.82	0.30	0.29

Calibrated relations are assumed to be power laws of the form:

$$Proxy \propto M_{500}^{\alpha}$$

Open Issues

- X-ray selected calibration sample – may not reflect the true mass proxy relations
- Calibrated on a low redshift sample
- Richness and Overdensity based proxies are subject to variations in star formation efficiency
- Effect of imposing apertures on PCN, PCR and PCS
- Effect of interloper contamination for radial and dynamical based proxies

Summary

- PCN – σ clipped richness within 1Mpc aperture
- PCO – σ clipped galaxy overdensity derived mass
- PCR – σ clipped r.m.s. radius using galaxies within 1 Mpc
- PCS – σ clipped dynamical mass using galaxies within 1 Mpc
- PFN – FoF galaxy richness
- PFO – FoF galaxy overdensity derived mass
- PFR – r.m.s. radius of FoF galaxies
- PFS – FoF galaxy dynamical mass