The weak lensing analysis of CFHTLS and NGVS galaxy clusters

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Introduction

We use weak gravitational lensing signal as a mass proxy for galaxy clusters to constrain the cluster mass-richness scaling relation. To measure the shear profiles, we stack clusters in richness bins and average the tangential shear in logarithmic radial bins, weighting lens-source pairs according to their lensing efficiency and the significance of background galaxy shape measurements. We then fit our data with a Navarro, Frenk & White (1996) profile, applying corrections to take into account cluster miscentring, shear non linearity and the contribution from the large scale structure (i.e., second halo term). Comparing our results obtained with and without applying the corrections, we find that the miscentring term is the main source of systematic error.

Data

We apply our analysis to cluster samples from the Canada-France-Hawaii Telescope Legacy Survey (CFHTLS) and the Next Generation Virgo Cluster Survey (NGVS), detected using the RedGOLD optical detection algorithm of Licitra et al. (2016). With a total of $\sim$ 80 sq.deg, this is the most comprehensive lensing study of a 80% complete and pure optical cluster catalogue at medium to high-redshift. Shear measurements come from the CFHTLenS W1 (Heymans et al., 2012; Erben et al., 2012) and NGVSLenS (Ferrarese et al., 2012; Raichoor et al., 2014) catalogs and were obtained using the *lens*fit algorithm (Miller et al., 2013). Photometric redshifts were determined by Raichoor et al. (2014), using the bayesian code BPZ (Benitez et al., 2000).

Conclusion

From the fit of the shear profiles, we obtained a mean mass M_{200} for each richness bin, applying the same analysis to the CFHTLS clusters and to the CFHTLS and NGVS samples combined. We obtained similar results using both samples. In Fig. 2 we show masses inferred fitting single cluster profiles (grey circles). At low λ values we found a large dispersion that shows the need to use a stacking procedure.

We fitted our results to calculate the slope and normalisation of the mass-richness relation, shown in Fig. 2. Our results are consistent with Simet et al. (2016).

Stacking and fitting

Knowing that the peak in the lensing efficiency is found at $z = 0.3$ and that shear measurements from ground based telescopes are reliable for clusters with redshifts $0.2 < z < 0.5$ (Mansi et al., 2007), we decided to restrain our sample to this range. We also decided to discard clusters with richness $\lambda < 20$ and $\lambda > 50$, because of the lack of completeness and statistics, respectively. We then stacked our clusters in three richness bins ($20 < \lambda \leq 30$, $30 < \lambda \leq 40$, $40 < \lambda \leq 50$), sorting the background galaxies in logarithmic bins from 0.09 Mpc from the centre of the lens to 5 Mpc and performing a weighted average of the lensing signal. We took into account the quality of the shape measurements and the lens-source pair lensing efficiency, and we obtaining the profiles in Fig. 1. The S/N maps in Fig. 1 confirm that in our final sample we have enough lensing signal to reconstruct the shear profiles.

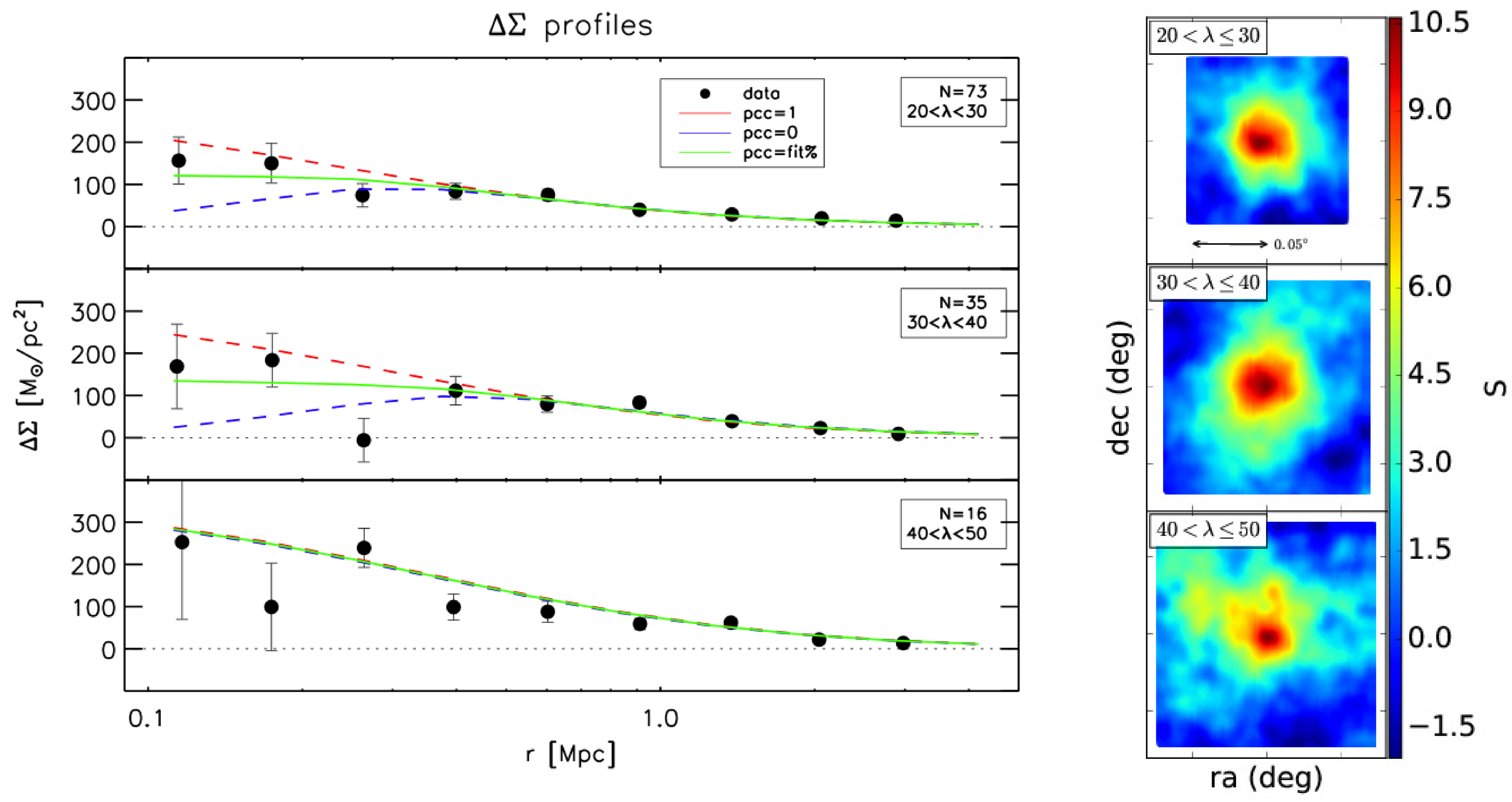
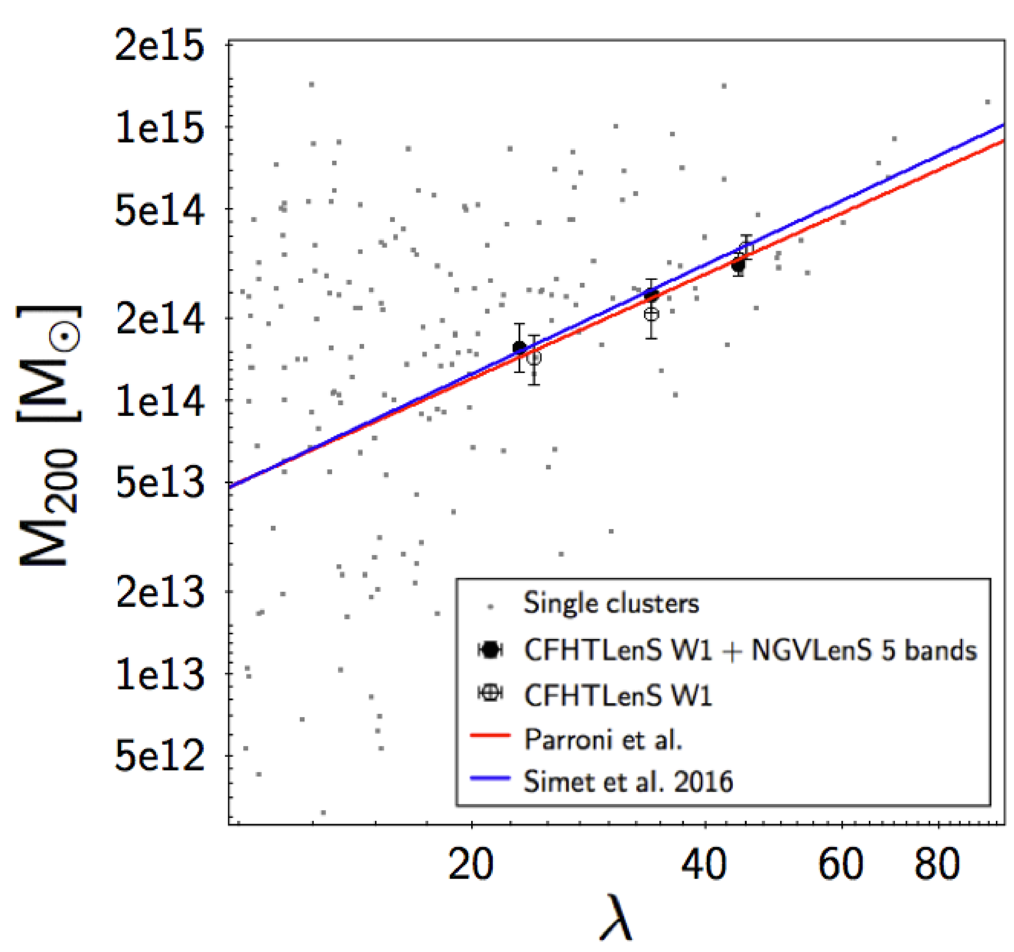


Figure 1: Shear profiles and lensing signal to noise ratio maps for the stacked clusters.

We fit the stacked profiles applying Monte Carlo Markov Chains using *emcee* (Foreman-Mackey et al., 2013) with three free parameters: the radius r_{200}, the percentage of correctly centred clusters in the stack *pcc* and the width of the offset distribution σ_{off}. The red and blue lines in Fig. 1 represent the profile we would get in case of no miscentring and complete miscentring of the clusters in the bin, respectively, while the green line represents the profile obtained using the miscentring percentage that we get from the fit.

Mass-richness relation



$$\log M_{200} = a + b \log(\lambda/\lambda_0)$$

$$a = 14.309 \pm 0.017$$

$$b = 1.27 \pm 0.11$$

Figure 2: Fitted mass-richness relation.

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