CFHTLenS: The Environmental Dependence of Galaxy Halo Masses from Weak Lensing

Bryan Gillis
Gillis, Hudson, Erben et al. (2013)
In Collaboration With...

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Simulated Catalogues Provided by:

| Stefan Hilbert | Jan Hartlap |
Field Galaxies, Groups, and Clusters

Field Galaxies

Unstripped, like field galaxies?

Group Galaxies

Cluster Galaxies

Stripped, like cluster galaxies?
Outline

- Data
- Methods and Models
- Weak Lensing Analysis
- Outlook
- Concluding Remarks
Outline

• Data
  • CFHTLenS Catalogues
  • Simulated Catalogues

• Methods and Models

• Weak Lensing Analysis

• Outlook

• Concluding Remarks
CFHTLenS Catalogues

- 125 deg$^2$ of high-quality shape data to $i' < 24.7$ (11 sources/arcmin$^2$)
- Photo-zs available for full survey, errors of $\sim 0.04$
- Galaxies with $0.2 < z_{\text{phot}} < 0.8$ divided into high- and low- density environment (HDE and LDE) lens catalogues

Simulated Catalogues

- Use semi-analytic galaxy catalogue prepared by Stefan Hilbert *et al.* from Millennium Simulation
- Use 64 deg$^2$ of simulated catalogues, and cut lens catalogues by density as with CFHTLenS data
- Dark matter distributions generated for scenarios with and without tidal stripping in all groups
- Ray-tracing is performed on source catalogues to estimate shears for each scenario; no shape noise is applied to sources
Outline

• Data

• **Methods and Models**
  • Determining environment
  • Assumptions
  • Lensing signal model

• Weak Lensing Analysis

• Outlook

• Concluding Remarks
Determining Environment

- **Photo-z Probability Peaks (P3) Method**
  - Galaxies sorted by S/N in 3D overdensity
  - Only galaxy counts used; method is colourblind
  - Can study tidal stripping of satellites by comparing samples:
    - S/N > 2 (HDE) \( \Rightarrow \) \( \sim \)60% satellites
    - S/N < 0 (LDE) \( \Rightarrow \) \( \sim \)20% satellites

- Illustration of P3 Method on a simulated field at \( z \sim 0.3 \)
  - Galaxies are dots coloured by S/N, groups marked by circles
  - Group galaxies tend to have S/N > 2
Assumptions

- Groups and galaxies have truncated NFW halos
- A fraction $f_{\text{sat}}$ of galaxies in the HDE sample are in groups, the rest are in the field. No LDE galaxies are in groups
- Galaxies within groups are distributed by an NFW profile with concentration $c \sim 2.5$
- In our “Stripping” scenario, galaxies are stripped depending on their distance from group centres (typically 40% mass retained)
Lensing Signal Model

- **LDE Galaxies**: \( \Delta \Sigma = \Delta \Sigma_{1h} + \Delta \Sigma_{UD} \)
  - "One-halo" term
    Use formula for truncated NFW from Baltz et al. (2009)
  - "Underdensity" term
    (ignored by fitting only to low radii)

- **HDE Galaxies**: \( \Delta \Sigma = \Delta \Sigma_{1h} + f_{sat} \Delta \Sigma_{OG} + \Delta \Sigma_{2h} \)
  - "One-halo" term
    Use formula for truncated NFW from Baltz et al. (2009)
  - "Two-halo" term
    (ignored; dwarfed by "offset group" term)
  - "Offset Group" term
    Influence of groups on their satellites' lensing signals

- **Free parameters**: \( M_{sat}, M_{group}, \Sigma_t \) (selection effect)
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  - Conclusions from Simulations
  - CFHTLenS Results
- Outlook
- Concluding Remarks
**Conclusions from Simulations**

- HDE selection covers wide host mass range, from groups to clusters.
- Lensing signal model fits simulated lensing signal well, but not perfectly.
- Simulations predict slight overprediction of HDE one-halo mass by \( \sim 10\% \).
- Stripping only decreases HDE one-halo mass for low mass \((M_{\text{stellar}} < 10^{10.5} M_{\text{sun}})\) galaxies.
CFHTLenS Results

- HDE one-halo mass found to be less than LDE mass at 2.9\(\sigma\) confidence
- Reject “No Stripping” scenario at 4.1\(\sigma\), nearly reject “Stripping” scenario at 1.8\(\sigma\)
- Implies halos in dense environments (groups) are less massive
- Systematic errors analyzed; not likely to cause a false positive detection here
Outline

● Data
● Methods and Models
● Weak Lensing Analysis
● Outlook
  ● Implications
  ● Other surveys
● Concluding Remarks
Implications

- Galaxies are likely stripped in groups as well as clusters
- HDE and LDE samples have red fractions differing by no more than 10%, meaning it's unlikely that stripping is only experienced by red galaxies
- Stripping may be stronger than predicted in simulations, judging by the near-rejection of our simulated “Stripping” scenario
- Further data will be needed to form firmer conclusions
Other Surveys

• Potentially-useful data is already available from:
  • SDSS
  • CFHT Stripe 82 Survey
  • Overlap of GAMA-II spectro-z catalog and CFHTLenS

• Future surveys will provide a wealth of data:
  • KiDS, including overlap with GAMA-I spectro-z catalog
  • DES, Euclid, LSST from 2018 onward
Concluding Remarks

Field Galaxies

Unstripped, like field galaxies?

Disfavored by our results

Group Galaxies

Stripped, like cluster galaxies?

Cluster Galaxies

Consistent, but questions remain