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`cluster−lensing`: A `Python` PACKAGE FOR GALAXY CLUSTERS AND MISCENTERING

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ABSTRACT

We describe a new open source package for calculating properties of galaxy clusters, including NFW halo profiles with and without the effects of cluster miscentering. This pure-`Python` package, `cluster−lensing`, provides well-documented and easy-to-use classes and functions for calculating cluster scaling relations, including mass-richness and mass-concentration relations from the literature, as well as the surface mass density $\Sigma(R)$ and differential surface mass density $\Delta\Sigma(R)$ profiles, probed by weak lensing magnification and shear, respectively. Galaxy cluster miscentering is especially a concern for stacked weak lensing shear studies of galaxy clusters, where offsets between the assumed and the true underlying matter distribution This software has been developed and released in a public GitHub repository, and is licensed under the permissive free MIT license. The `cluster−lensing` package can be downloaded through the Python Package Index, https://pypi.python.org/pypi/cluster-lensing, or directly from GitHub, at https://github.com/jesford/cluster-lensing. Full documentation is available at http://jesford.github.io/cluster-lensing/.

Subject headings: gravitational lensing: weak, galaxies: clusters: general, dark matter

1. INTRODUCTION

- Background about clusters and weak lensing.
- NFW halos (Navarro et al. 1997; Wright & Brainerd 2000)
- composite-NFW fits for weak lensing (Ford et al. 2012, 2014, 2015)
- What is new = miscentering (Johnston et al. 2007; George et al. 2012; Ford et al. 2014, 2015)

2. DESCRIPTION OF THE CODE

- Purpose and general use.
- Relation to existing code
- `SurfaceMassDensity`() class, generic to all NFW halos
- `ClusterEnsemble`() class
- mass-richness functions
- mass-concentration functions
- We use units from the `astropy.units` package (Astropy Collaboration et al. 2013).

3. EXAMPLES

- No miscentering
- With miscentering
- others...

4. FUTURE DEVELOPMENT

Plans for the future.

5. SUMMARY

Summary goes here.

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