Gravitational lensing in WDM cosmologies: the cross section for giant arcs

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INTRODUCTION

- There are several motivations for the WDM cosmology as an alternative to the standard ΛCDM cosmology, such as resolving the missing satellite galaxy problem (Klypin et al. 1999; Moore et al. 1999, Lovell et al 2014).
- There is also tensions between ΛCDM and observations, the key one here is that observed galaxy clusters' gravitational lensing efficiencies are significantly higher than predictions based on ΛCDM (Bartelmann et al. 1998).
- Here we explore the effects WDM would have on the lensing profiles of clusters, since astronomical observations of small-scale structures like satellite galaxies appears to favour this scenario.

METHODLOGIES

- We analysed the lensing properties of 10 pairs of simulated galaxy clusters in the ΛWDM and ΛCDM cosmologies along multiple lines of sight (los). Lensing signature is characterised by cross section for giant arcs and Einstein radius.
- The lensing cross section is the area on the source plane where a source must be located in order to be lensed as a giant arc. Einstein radius is the size of the tangential critical line. We estimate Einstein radius as the median distance of critical points on the tangential critical line with respect to the centre of lens (Meneghetti et al. 2011),

$$\theta_E = median\sqrt{(\theta_{i,x}-\theta_{c,x})^2+(\theta_{i,y}-\theta_{c,y})^2}$$

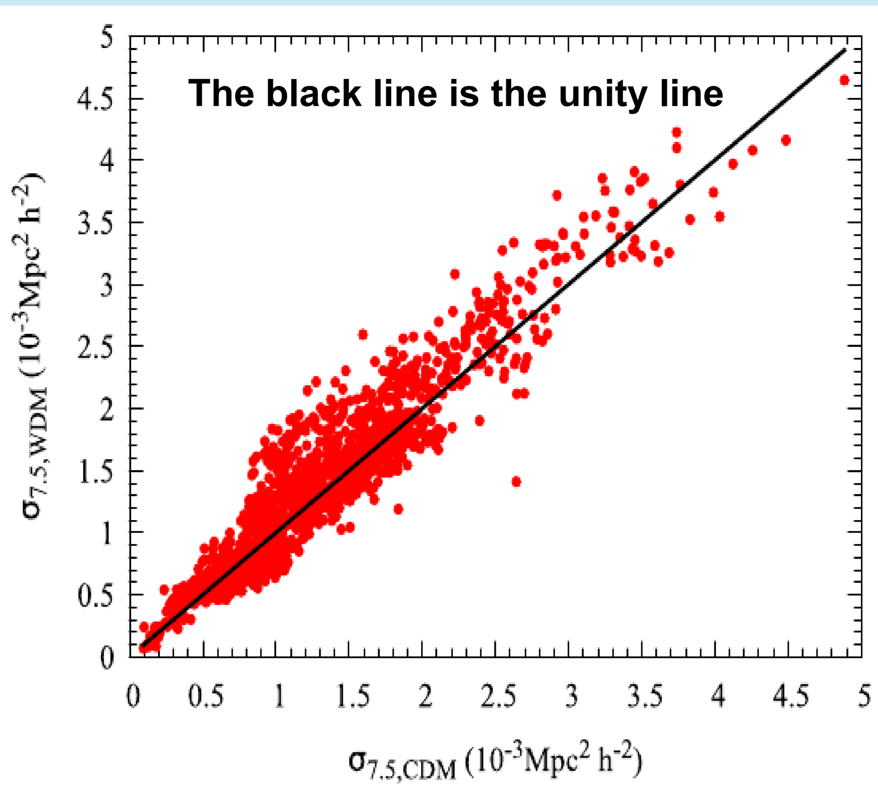
RESULTS AND CONCLUSIONS

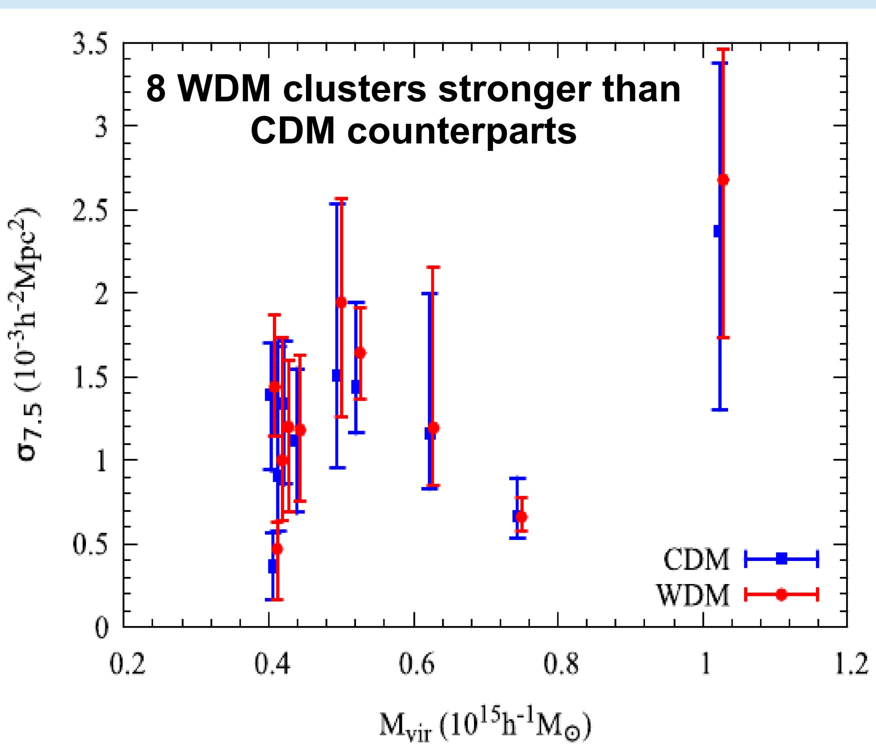
NAIVE PREDICTION

The WDM clusters are less concentrated and have fewer subhaloes than the CDM counterparts, therefore, one would naively expect that the WDM clusters to be weaker lenses than the CDM counterparts.

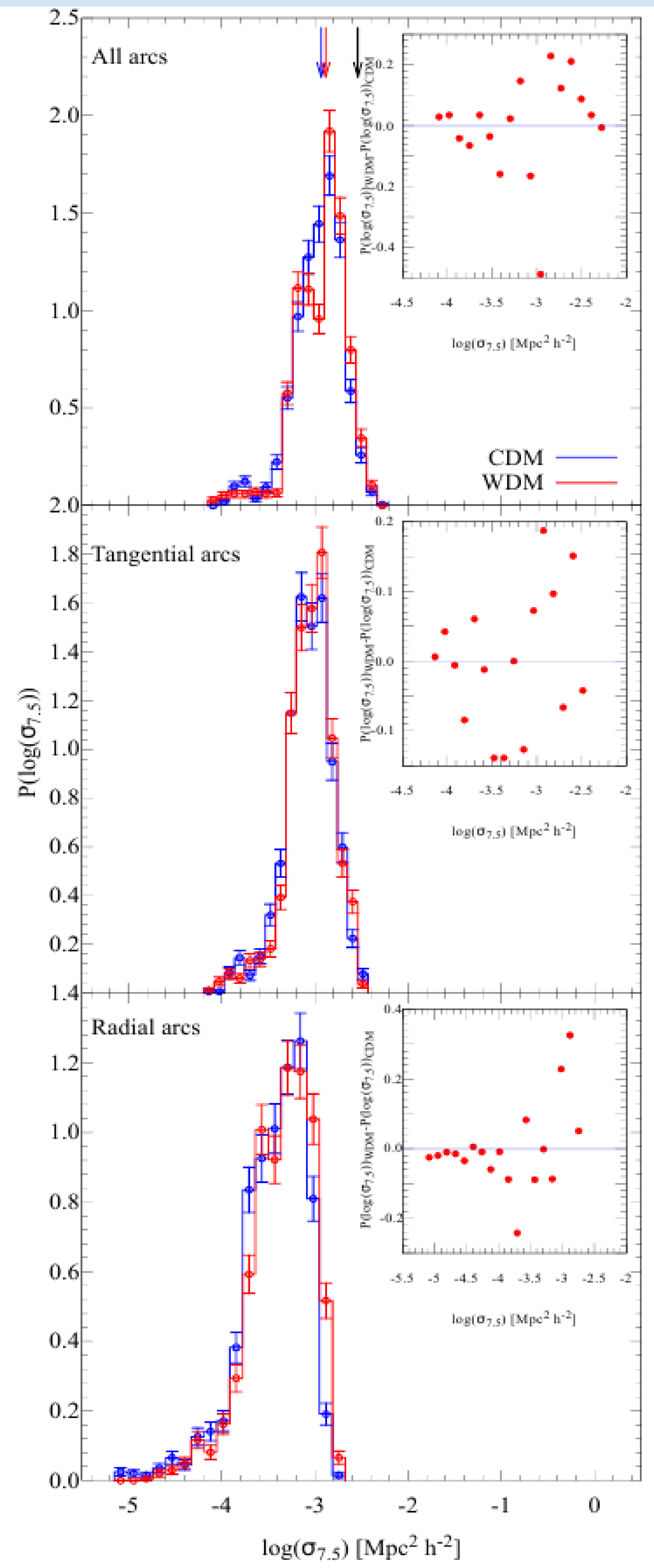
WDM SLIGHTLY STRONGER LENSES THAN CDM!!!

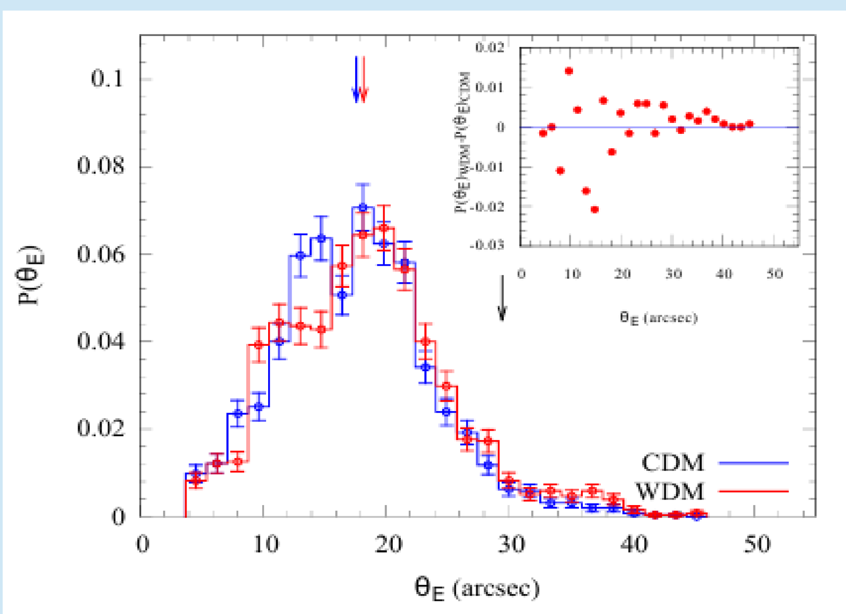
We found that the WDM version of most clusters has larger Einstein radius and cross section than the CDM version.





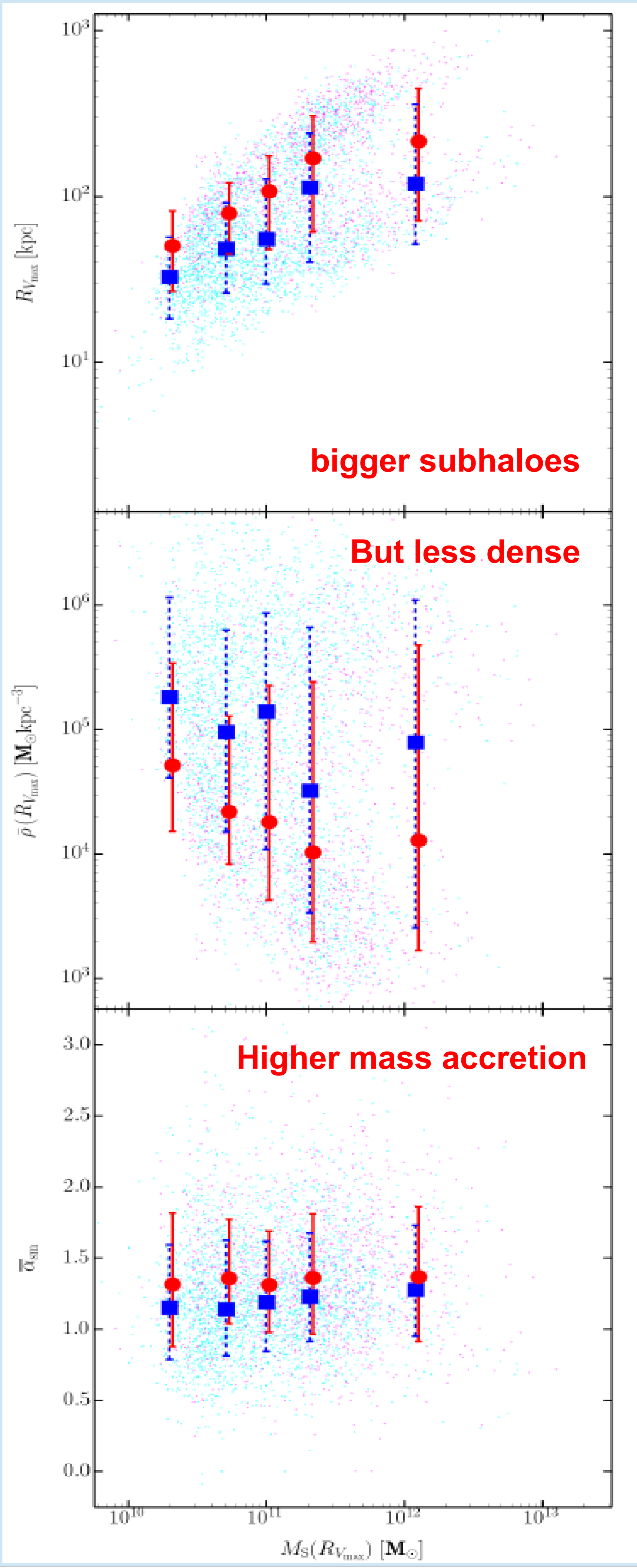
PDFs of cross sections and Einstein radii of both versions



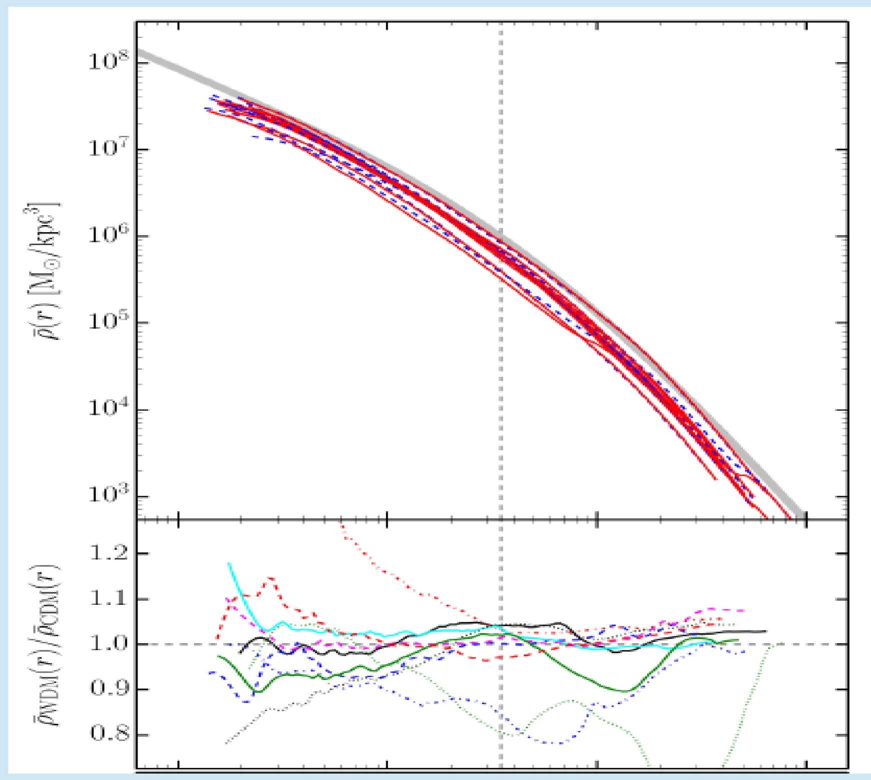


BUT WHY?

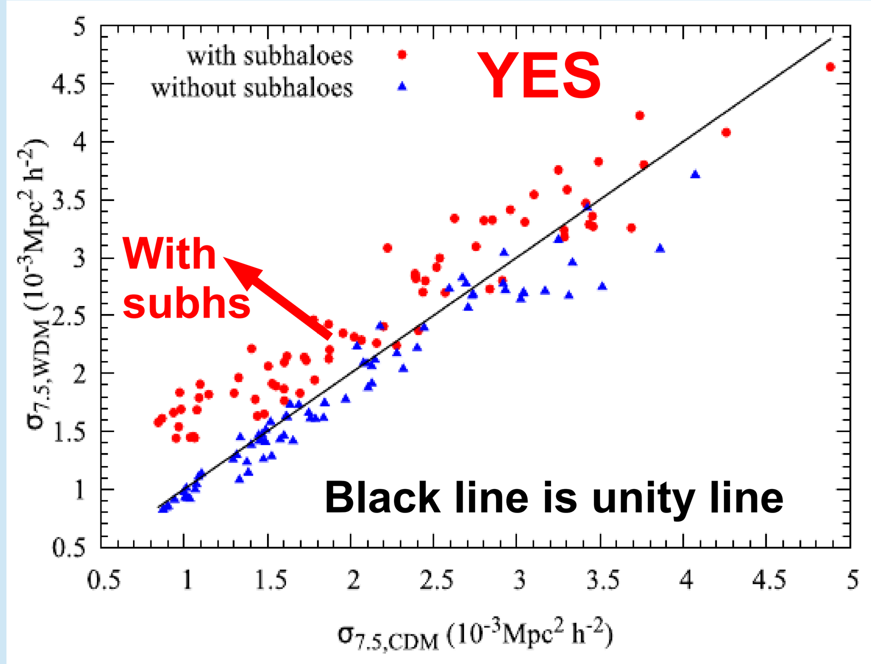
The WDM subhaloes are more massive and more physically extended than the CDM counterparts. They gain significantly more mass via smooth accretion. These strong subhaloes significantly enhance the lensing efficiency at producing giant arcs.



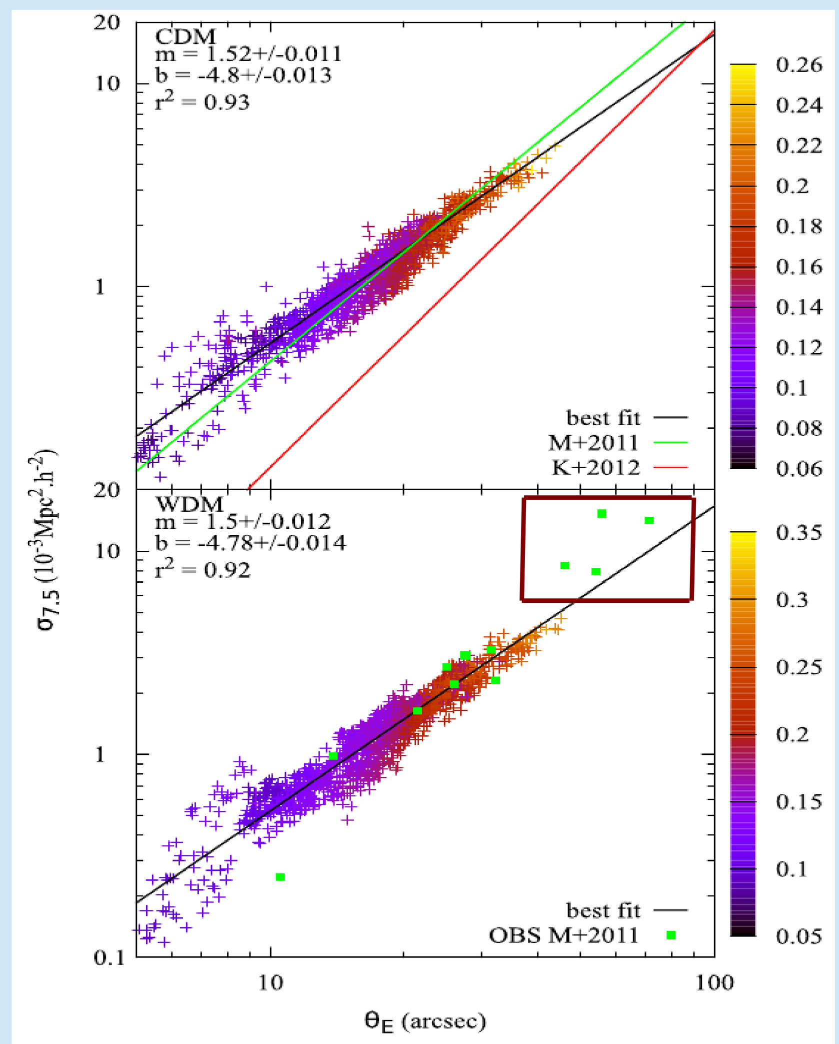
DENSITY PROFILE



Do the WDM subhaloes really boost the lensing efficiency?



Despite the slight enhancement, the WDM clusters cannot reproduce the efficiency of a few observed clusters.



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Mahdi et al. 2014, MNRAS, 441, 1954
Arxiv: 1404.1644v1
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Elahi et al. 2014
Arxiv: 1406.3413
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