Survey Science Group Meeting 2024

Probing galaxy size-dark matter halo radius relation using weak lensing

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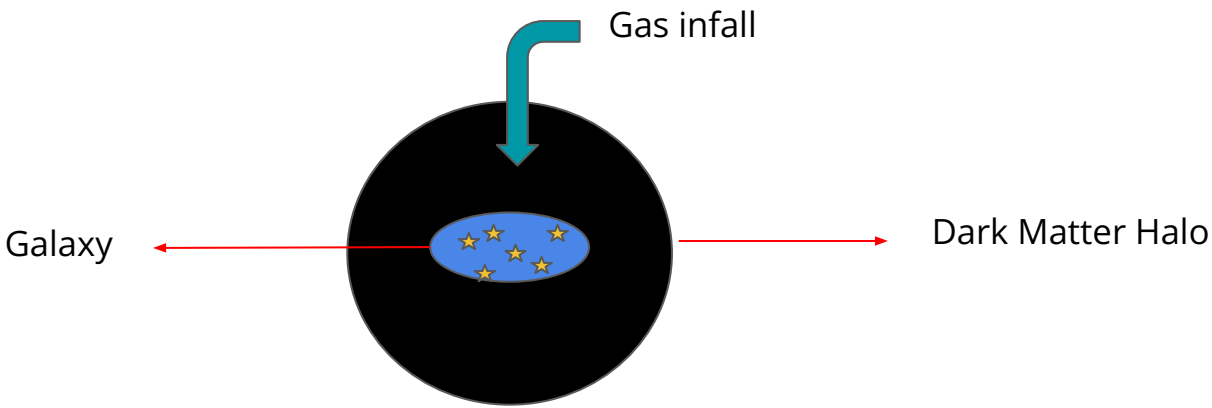
Observations that constrain models: galaxy-halo connection

In Lambda-CDM universe, growth of galaxies over cosmic time is connected to the growth of halos.



Galaxy formation models → Galaxy property (z) = f (halo properties)

Observations

Where do we start?

Galaxies: Some amount (mass) of stars spread over some finite extent (size) in certain shape (morphology).

Stellar mass ⟶ Halo mass

Galaxy size ⟶ Halo size

. . . . . so on

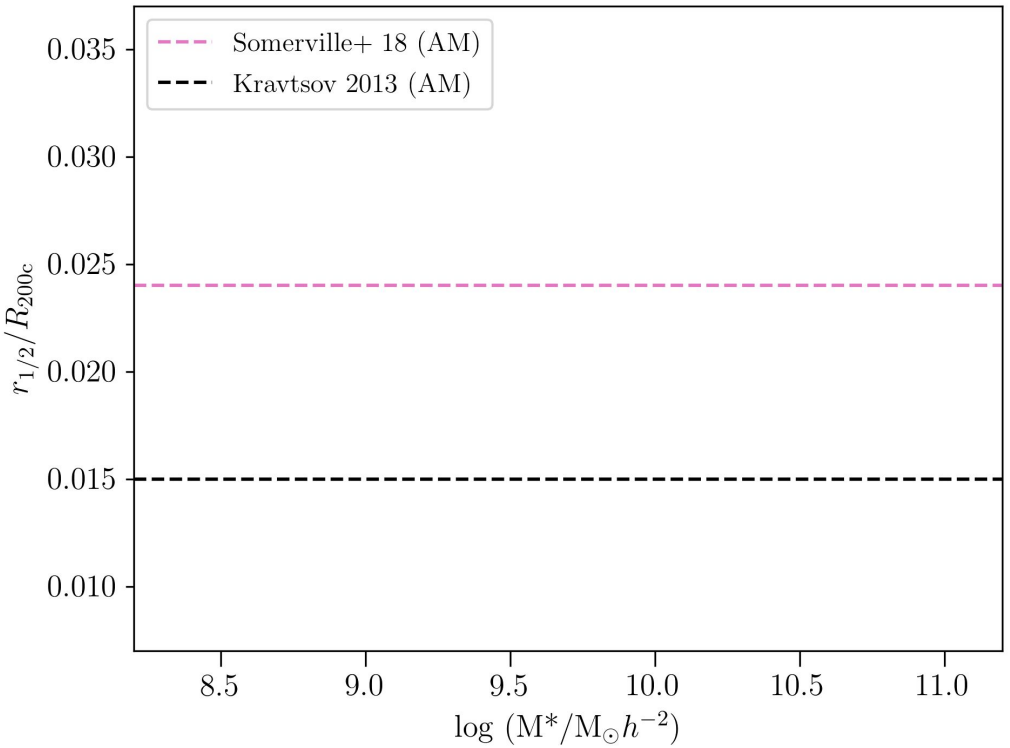
Stellar mass - halo mass relation is well studied by a number of theoretical and observational works

There is a lack on agreement on the galaxy size - halo radius connection.

Mostly model predictions

Linear galaxy size - halo radius relation

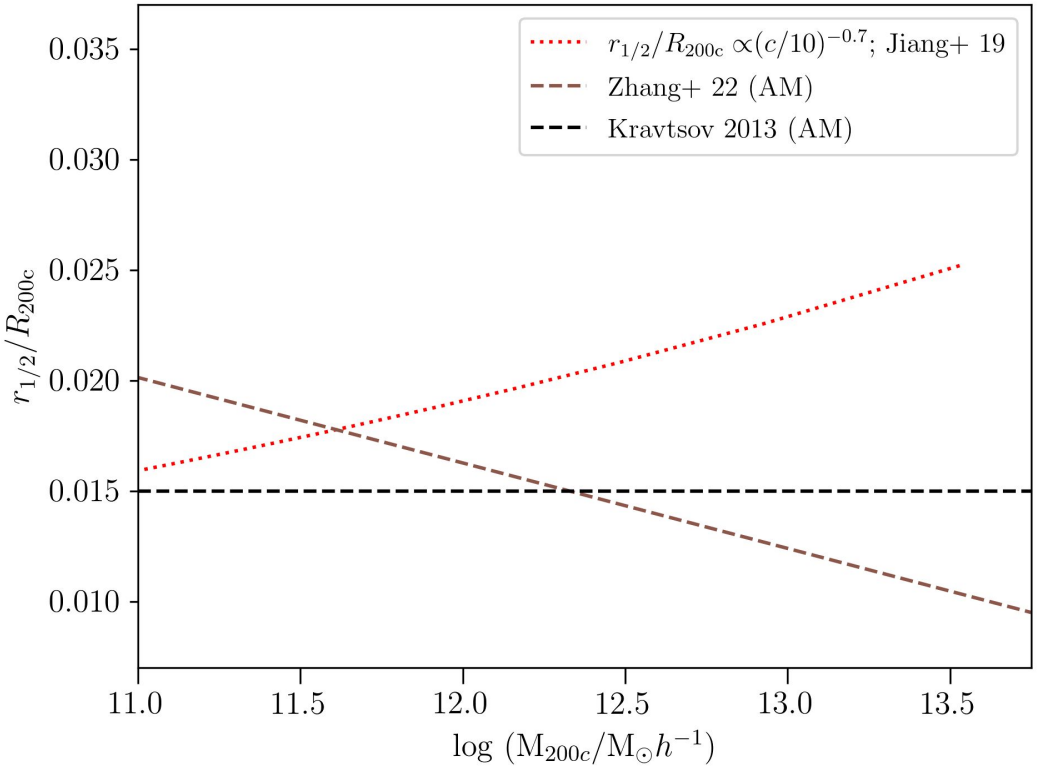
$r^*_{1/2}$ ~ constant x R200 for all types of galaxies at all stellar mass



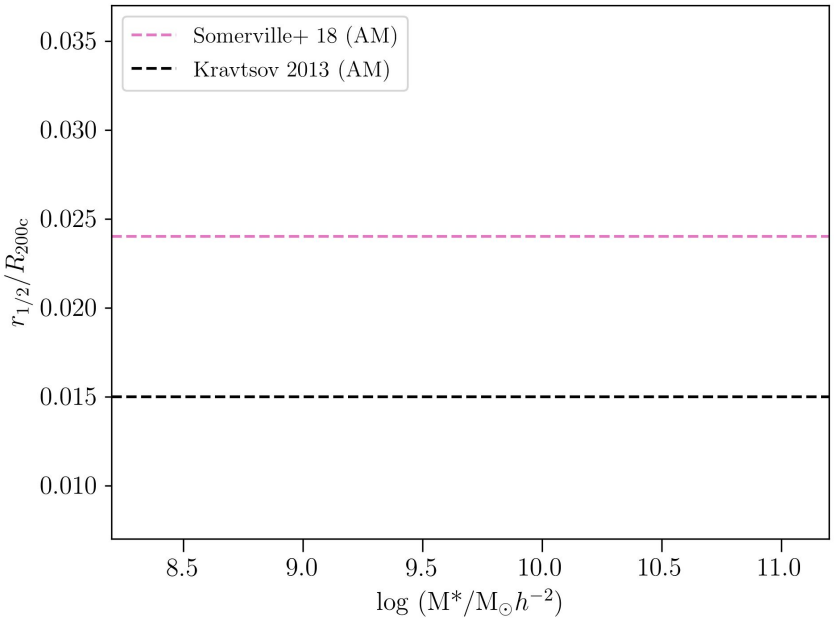
r*/R200 is constant and independent of M*

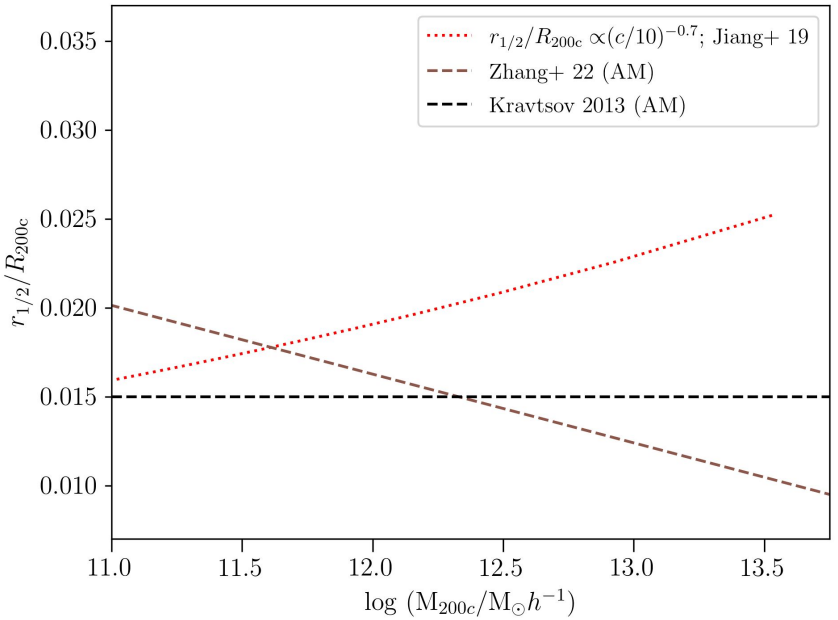
Nonlinear galaxy size - halo radius relation?

Galaxy size -halo radius connection depends on halo concentration or else is non-linear.



Conflicting model predictions?

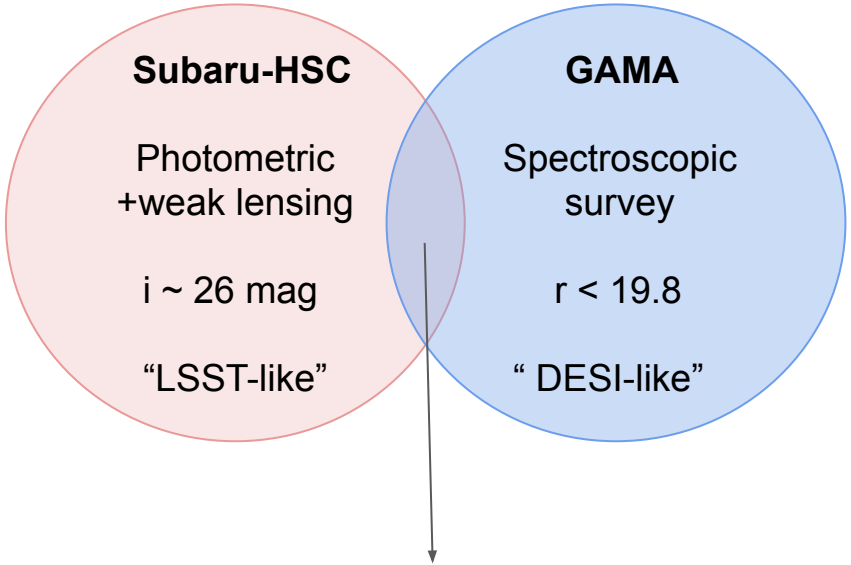




Which one is true?

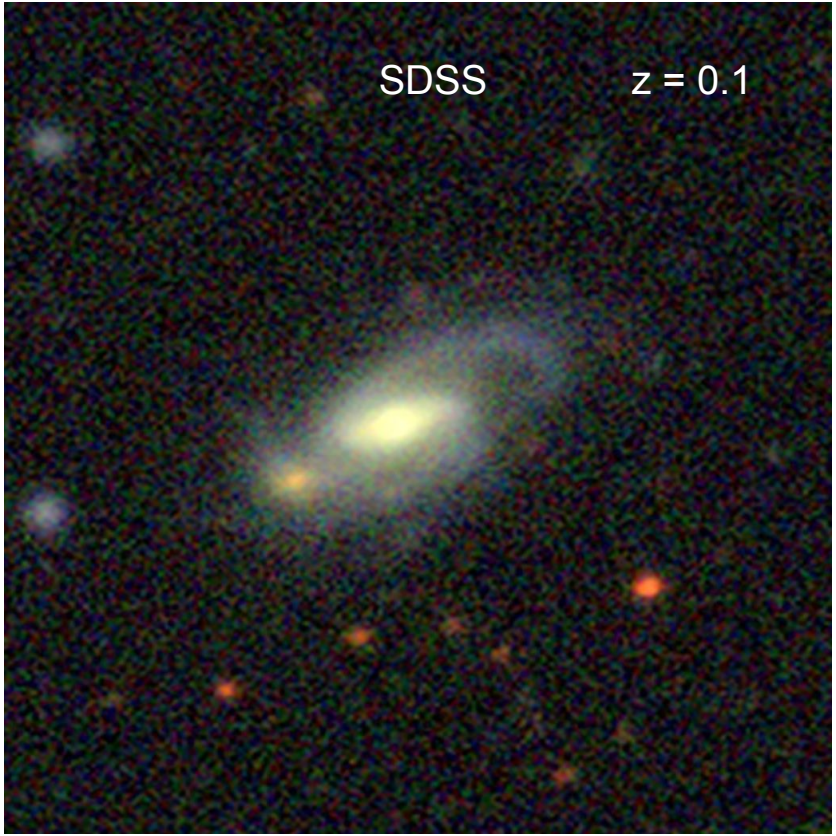
We wanted to probe this via observations

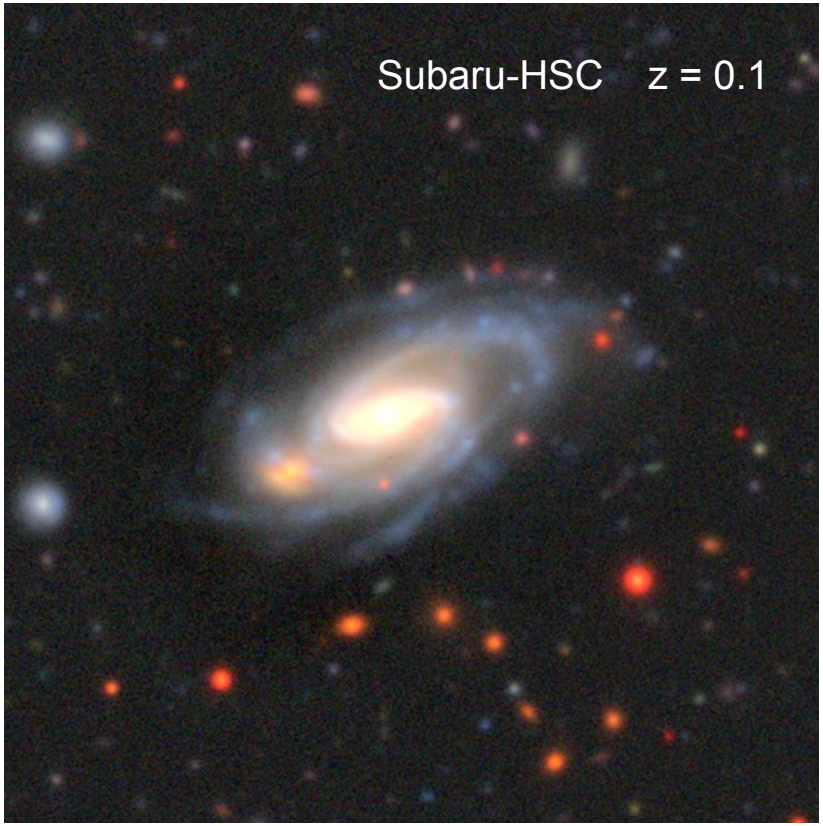
Sample



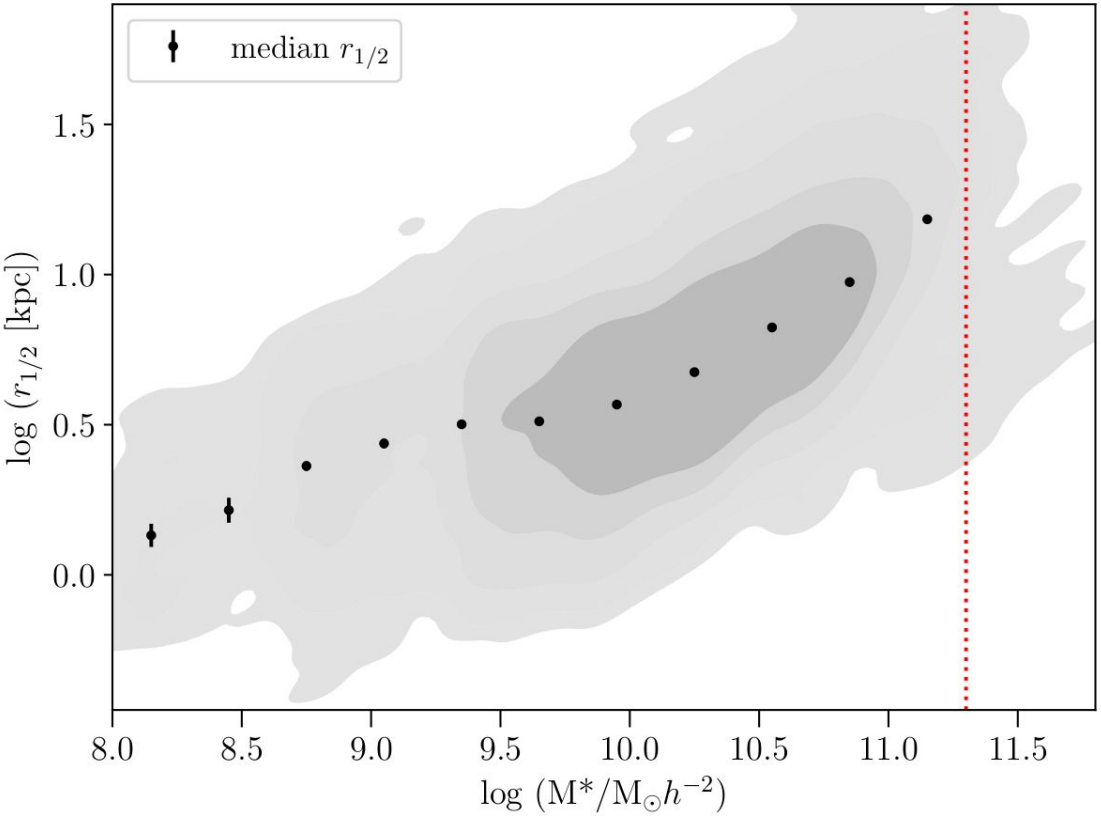
38,000 galaxies within z<0.3

Subaru-HSC advantage





Galaxy size - mass relation

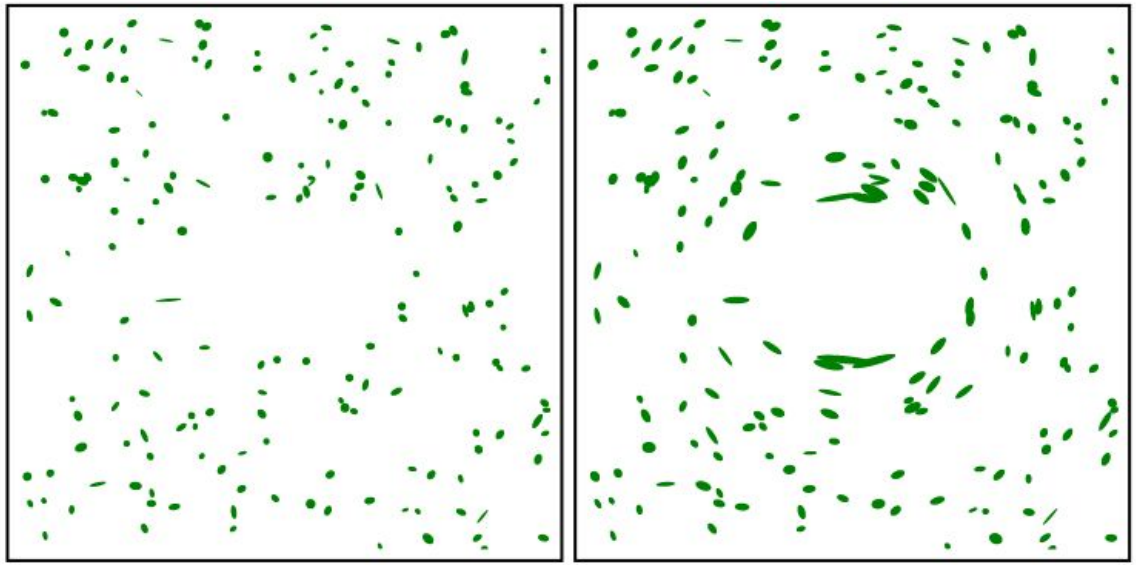


Mishra, Rana & More ('23)

Subaru-HSC Advantage: Gravitational lensing survey

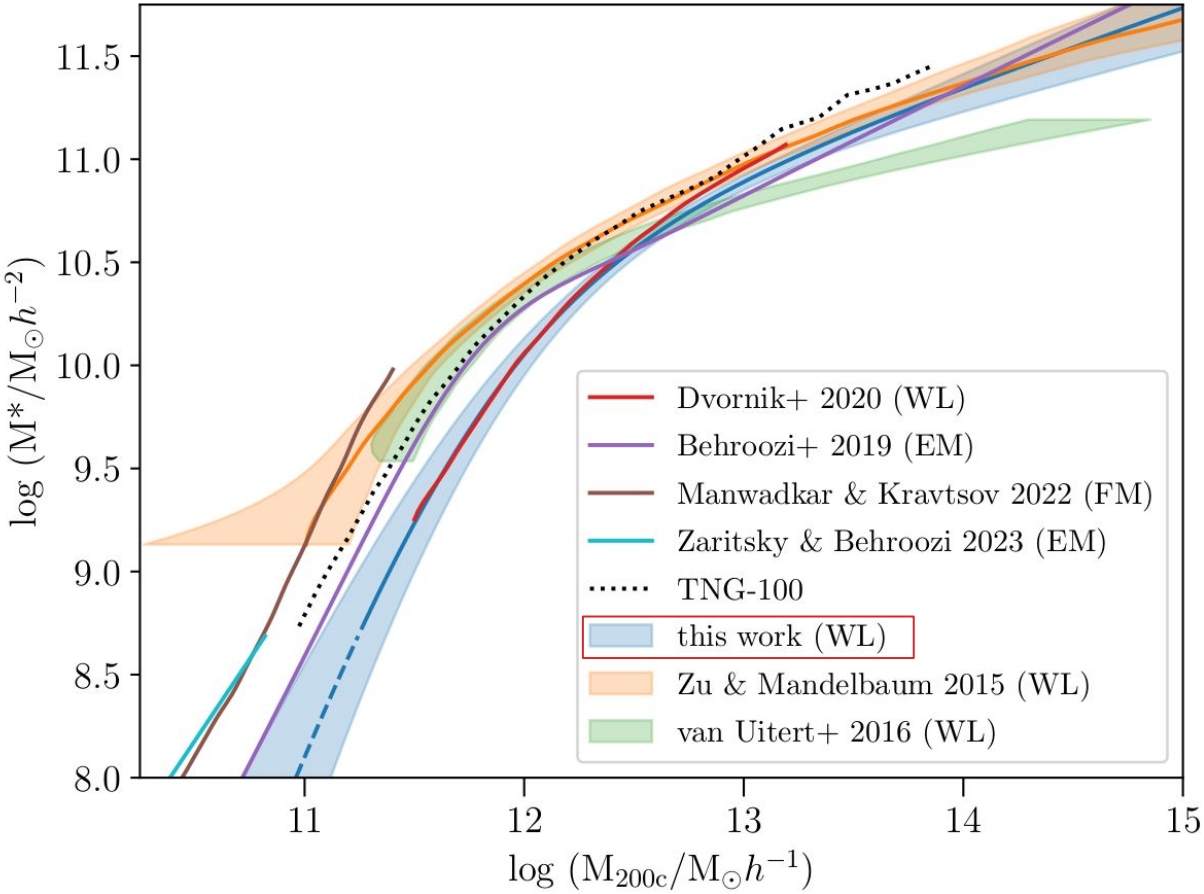
Presence of foreground mass distribution (lens) distorts shape of background galaxies.

Distortions are related to foreground mass distribution



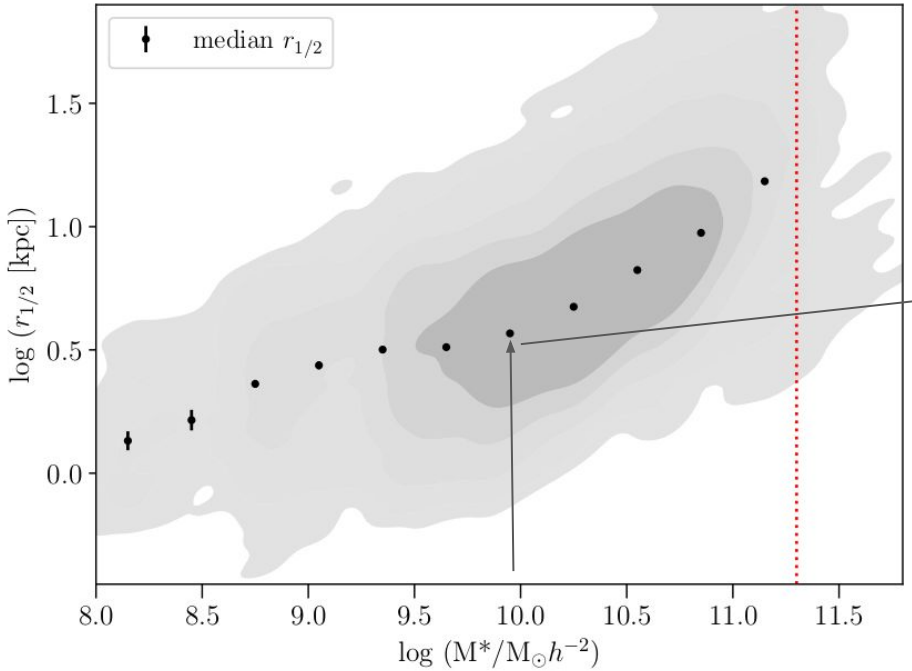
The shape measurements / weak lensing catalog is available for Subaru-HSC PDR2

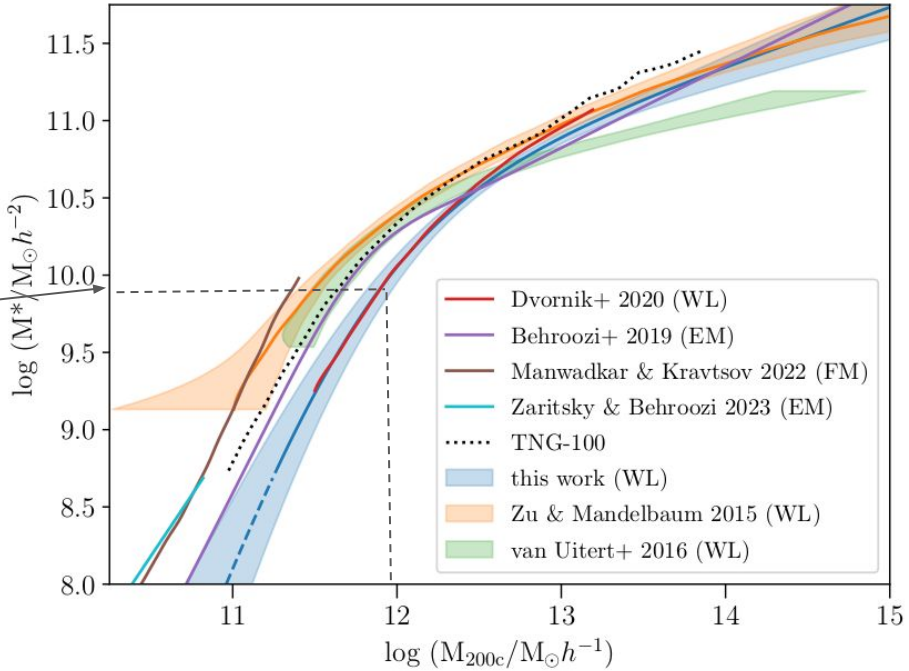
Stellar mass-halo mass relation (SMHMR)



Mishra, Rana & More ('23)

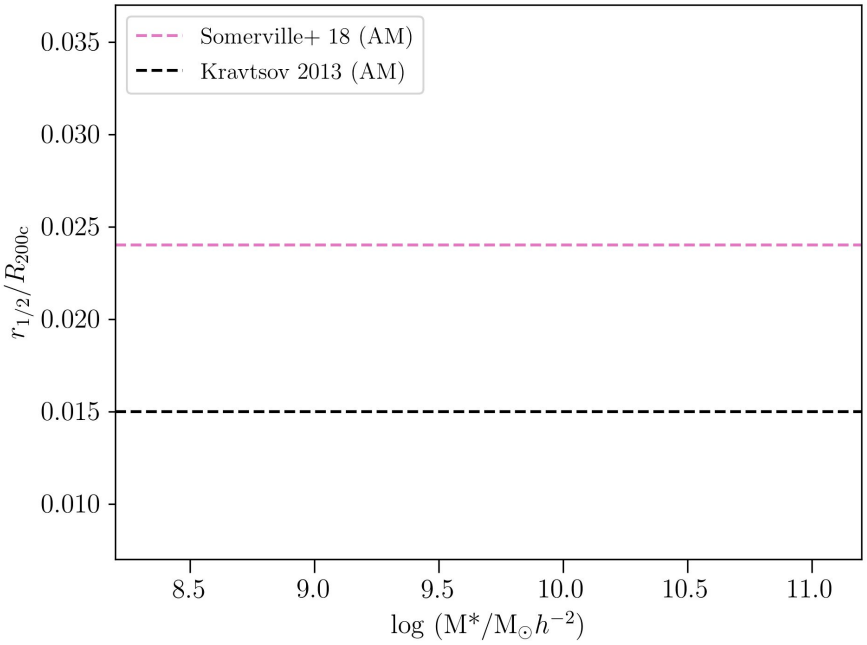
Galaxy size - halo radius linking

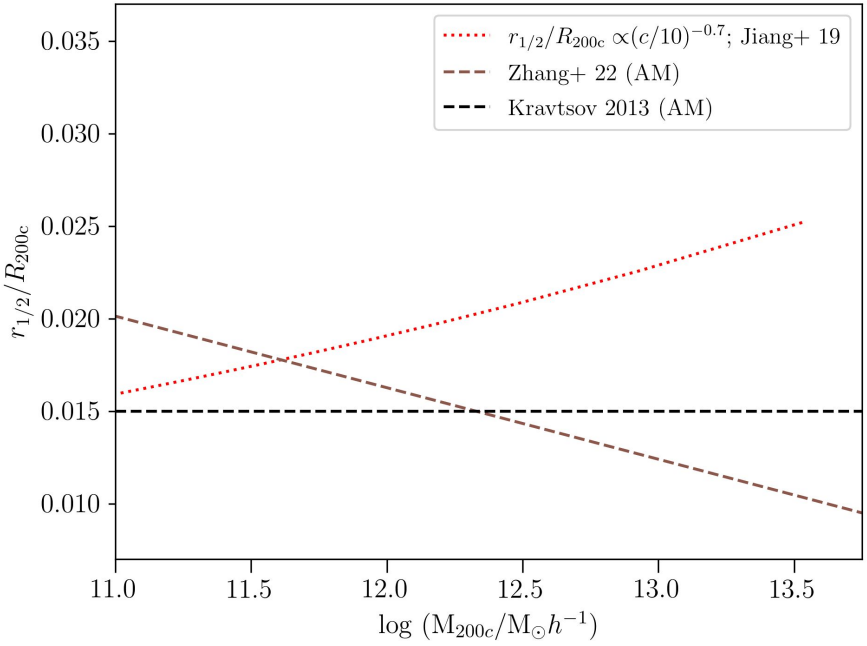




$r_{1/2}$ --------> M^* ----> M_{200c} ----> R_{200c}

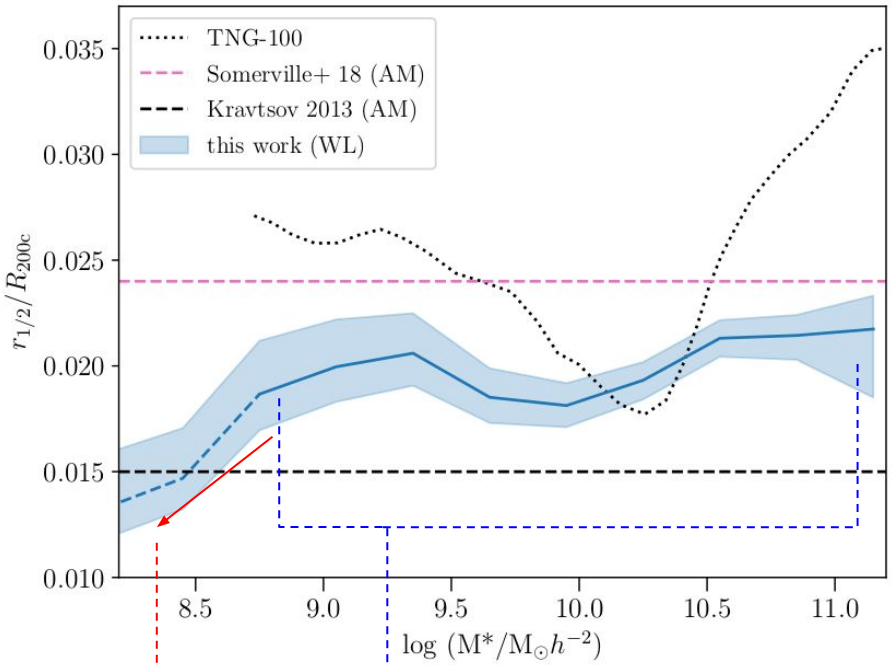
Galaxy size halo radius relation

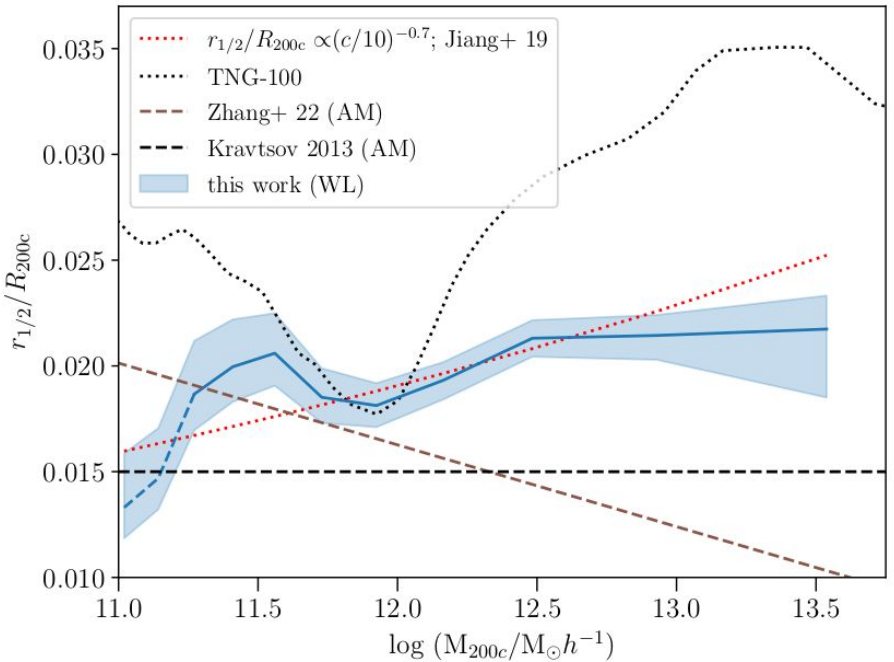




Galaxy size halo radius relation

Mishra, Rana & More ('23)





Galaxy size - halo radius ratio constant within errors for ~ 2 orders of magnitude in stellar mass.

Some indication of declining r*/R200 with declining stellar mass => possible nonlinear relation for dwarfs?

Summary

> Linear galaxy size -halo radius relation ($r^* \sim$ constant x R_{200}) for galaxies more massive than $\log M^* \sim 9$

> Ours is first study exploring this relation with direct weak lensing observations. [*Mishra, Rana & More ('23)*]

> Some indication of mass dependent galaxy size-halo radius relation for dwarf galaxies ($\log M^* < 9$)

> We are currently studying the differences in galaxy-halo connection for spirals vs elliptical galaxies.