Can we use weak lensing to directly probe the baryonic content of galaxies?

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第一回銀河進化研究会, 2014.Jun.04 at NAOJ

Measurement of stellar mass

Stellar mass is a key to galaxy formation and evolution.
But how to measure?

1. **SED**
   with assumptions of galaxy age, metallicity, dust extinction, initial mass function (IMF) …
2. **Stellar kinematics**
   velocity dispersion anisotropy
3. **Strong lensing**
   for massive galaxies
4. **Weak lensing ???**

} Direct measurement of mass

↓ **HSC is promising!**

Consistency between 1 and 4 can put a constraint on IMF.

Goal of my project

Weak lensing allows us to study much wider samples of galaxies compared to strong lensing so that we can include spiral galaxies for example.

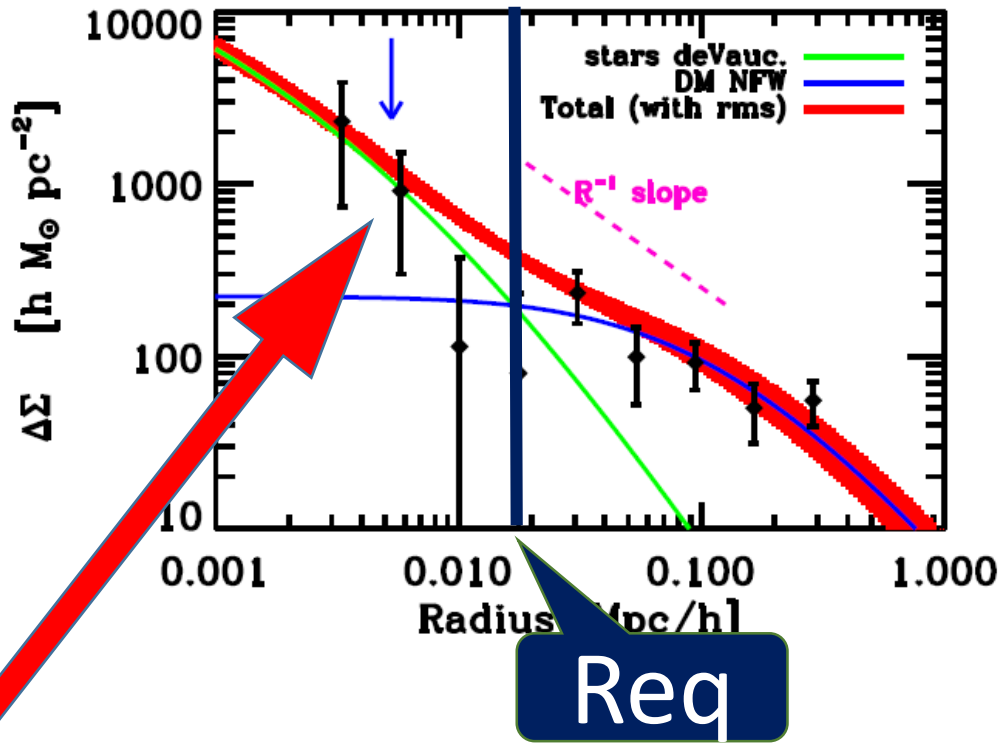
For this, we have to push weak lensing to small radial scales.

How well can we expect to measure stellar mass using the weak lensing technique?

Weak lensing on small radial scales

Projected 2D surface mass density

Gavazzi et al., 2007



Req

How well could we do these measurements with upcoming weak lensing surveys? (e.g. HSC, Euclid)

Weak lensing S/N at Req

Number of lens source pairs

$\propto$ Number of lens * Effective area * Source density

Analytical factors

- Volume effect
- Req (Angular diameter distance, stellar to halo mass relation etc.)
- Critical surface density for lensing

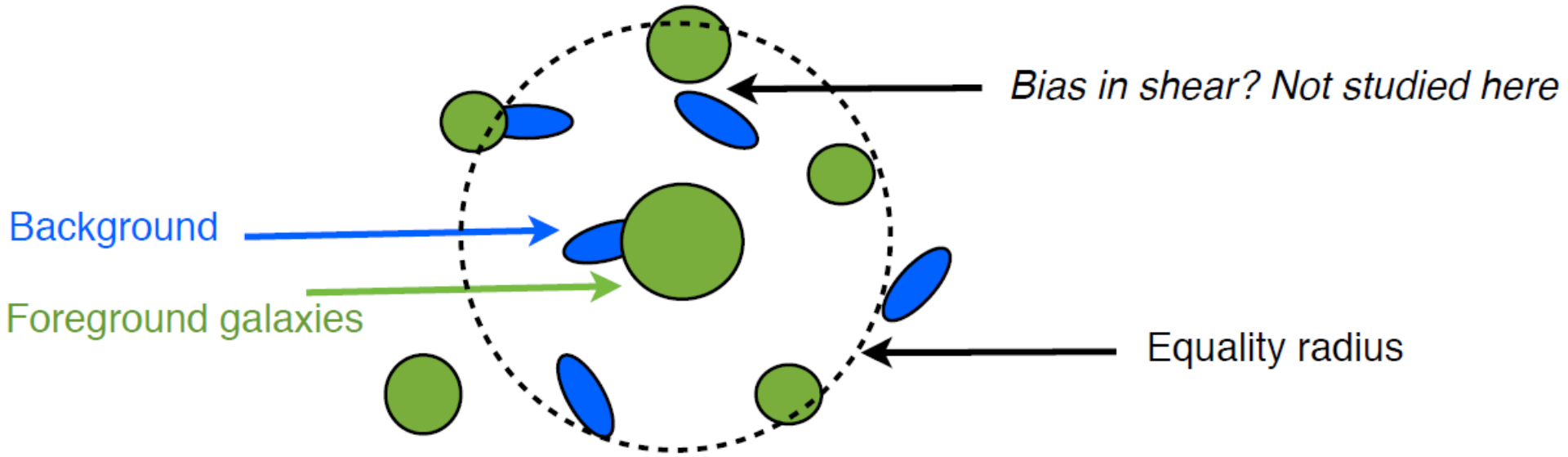
…

Analytically difficult

- Completeness limit
- Overlap of galaxies that prevents shape measurement

…

Overlap is non trivial



- Weak lensing uses background galaxies
- Galaxies are clustered
- As we go to small radial scales, there are more blends between foreground and background galaxies. The number density of usable source galaxies is difficult to estimate.

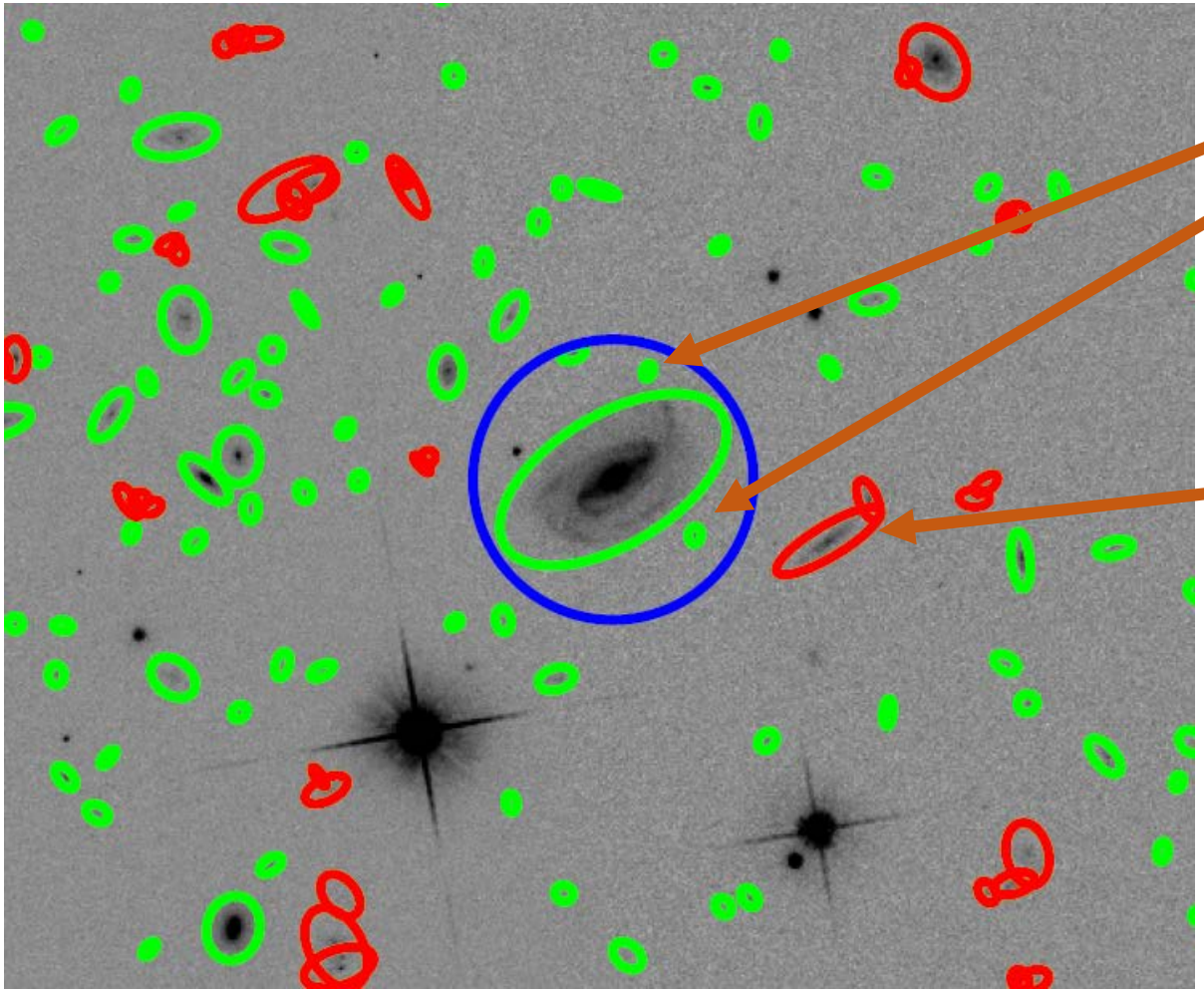
Our solution!

Use real data (HST ACS observing COSMOS field) to "**make predictions**" on the number of source galaxies as a function of radius.

- To what small scale we can/have to push weak lensing?
- How large area required to observe to achieve S/N = 2?

Uncertainty in mass coming from different IMF is about a factor 2. (e.g between Salpeter and Chabrier), so we aim for at least S/N = 2 in weak lensing signal.

Results1: Examples from HST



Shape measurement Okay! :)

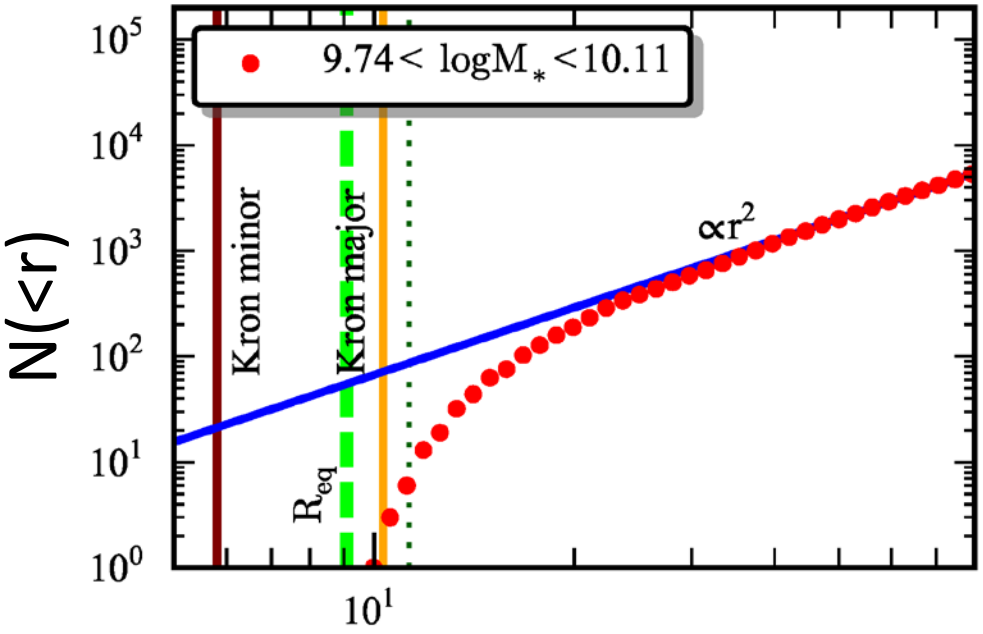
Shape measurement Not okay… :(

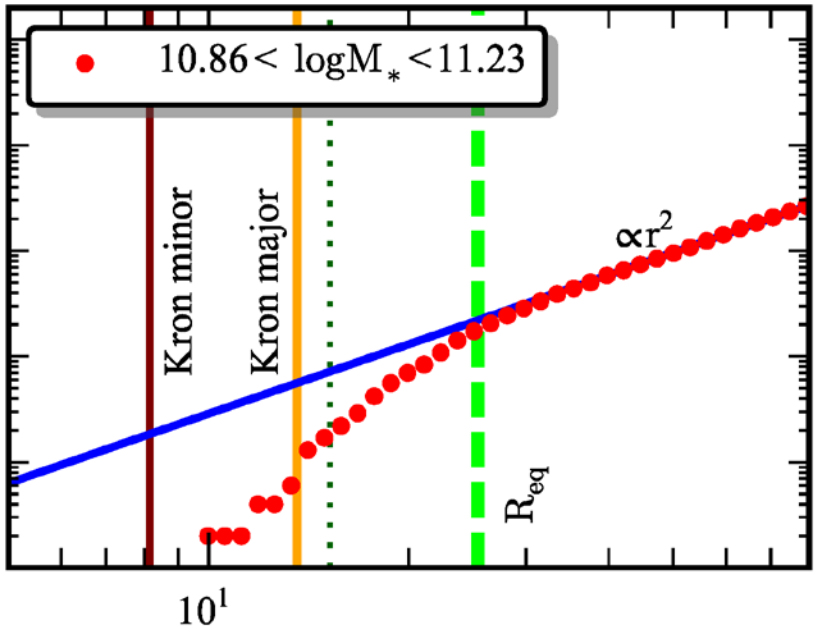
Green: Kron ellipse

Red: Collided Kron

Blue: Req

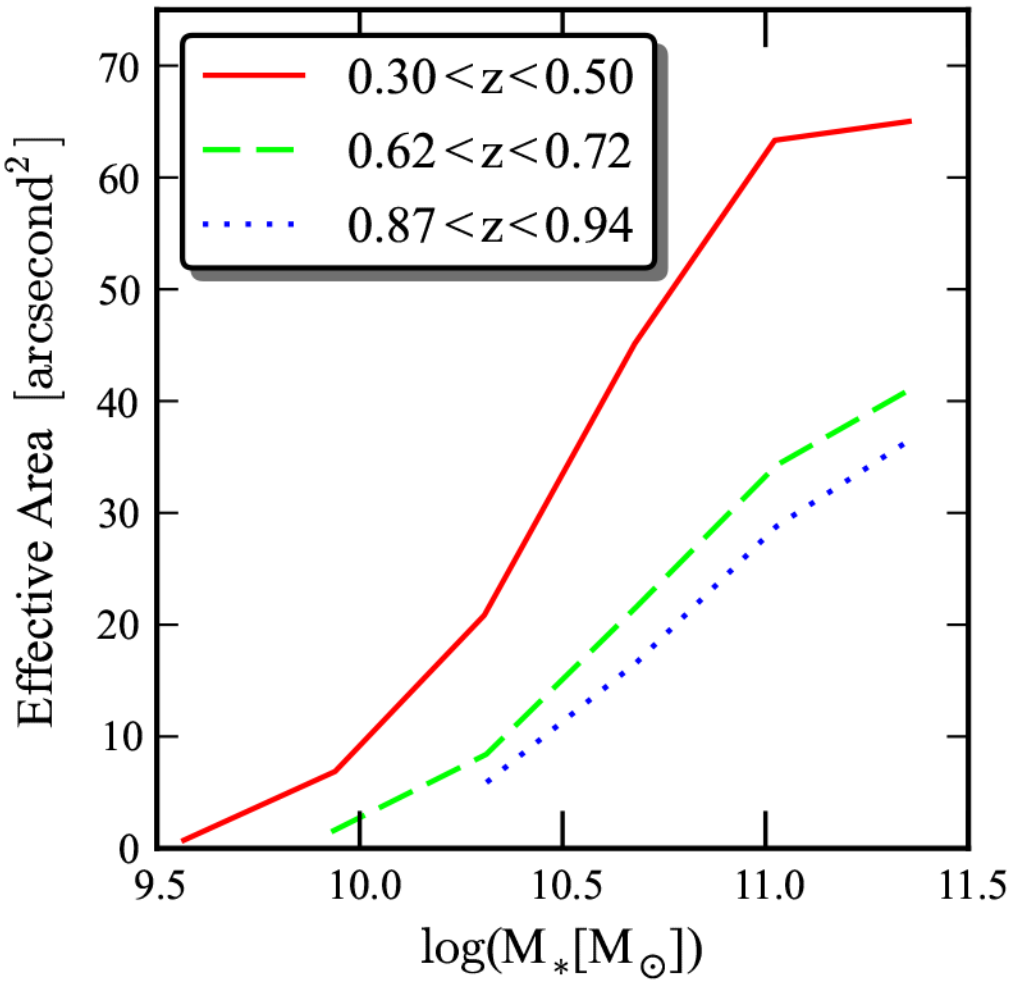
Results2: Source number counts around lenses



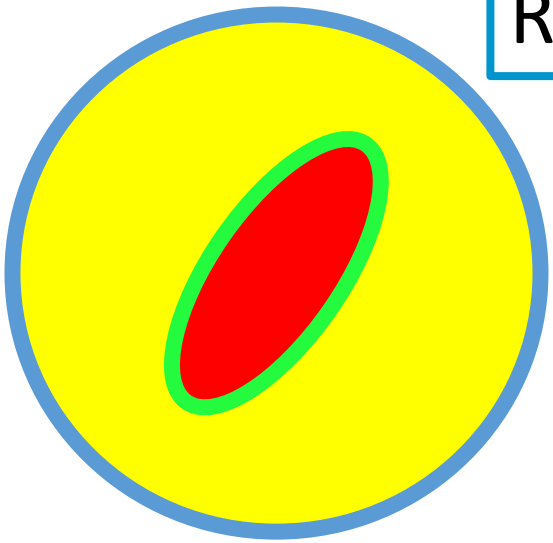


0.62 < z < 0.72

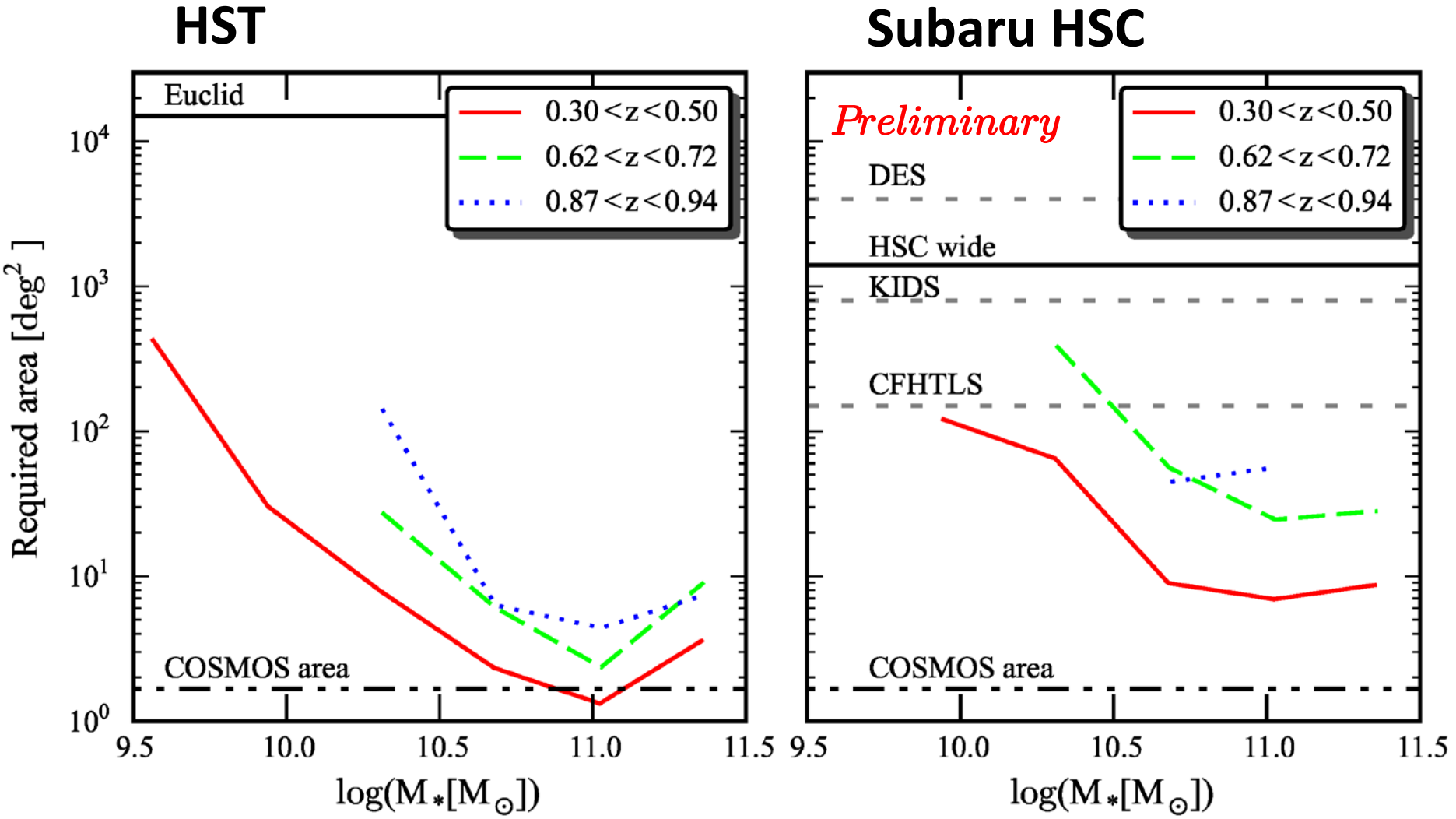
Results3: Effective area



Area in between the Kron ellipse and Req of the lens galaxy.



Results4: Required area to observe



Summary

- Stellar mass is crucial for the discussion of galaxy properties, but still uncertain.

- We can exploit the weak lensing signal even on a small scale about 10 kpc order as “first hand” information of stellar mass in galaxies.

- Future surveys have an enough possibility to detect weak lensing signal coming from stellar mass with at least factor 2 precision. HSC is promising!

Future Prospects

- Analyze ground based data to make better estimations how well future ground based surveys can perform.

- Error from our assumptions

  So far only S/N, how about shear biased or the effect of the baryon profile to the dark matter profile? …

- With those large statistics, towards galaxies with smaller mass (gas contribution on the total mass profile).