DARK ENERGY:
Probes and current observations

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Outline

1. Introduction
2. Probes
3. Current surveys
4. Conclusion

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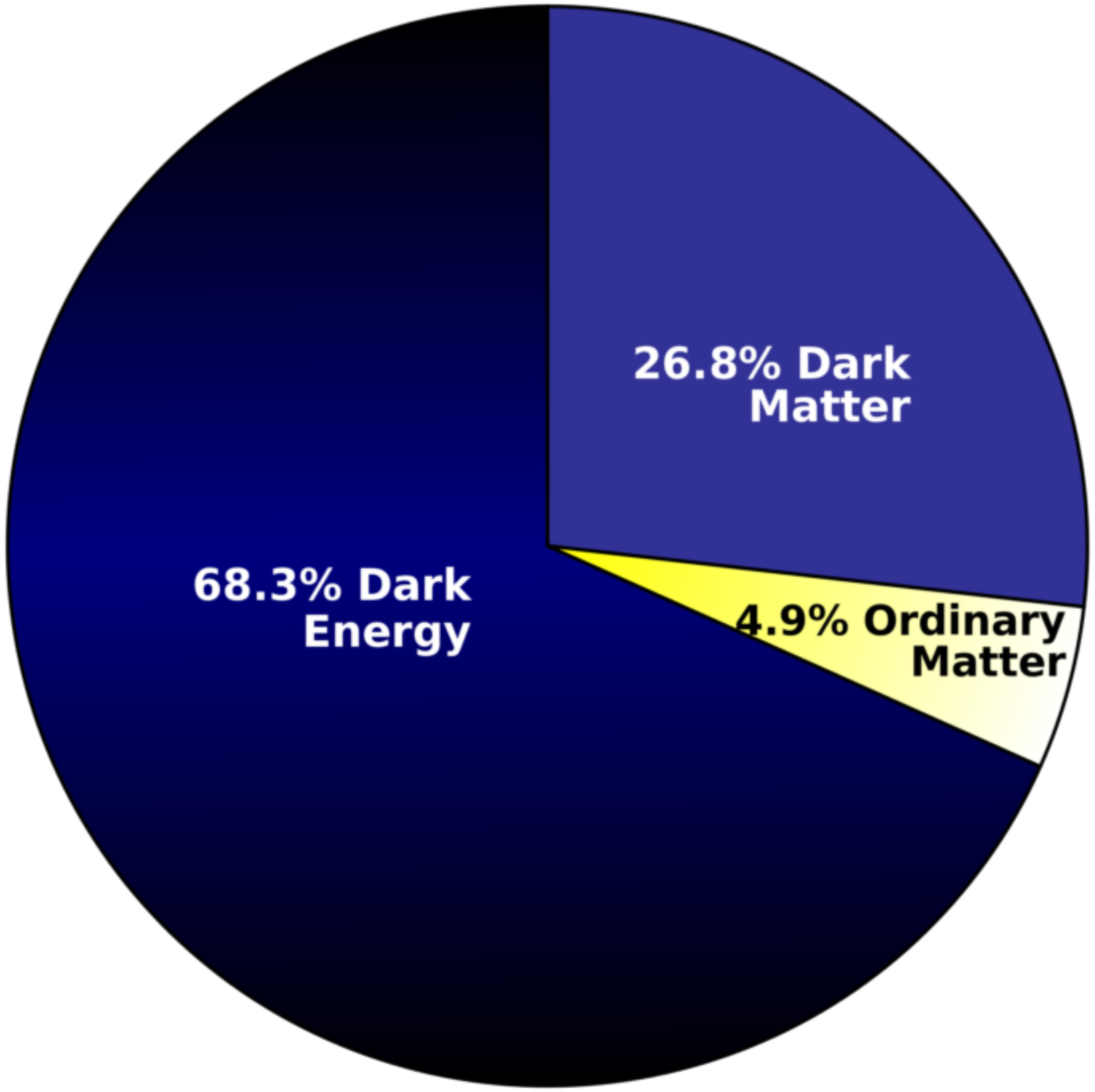
Dark Energy

- Does it really exist ?
  - ΛCDM works very well
  - Other models are also investigated



- What is the nature of dark energy ?
  - 70% of the Univers content
  - Try to set constraints with future surveys

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Dark Energy

Dark Energy drive the accelerated expansion of the Universe

Time dependence

Measurement at different redshifts

Measure of distances

Supernovae

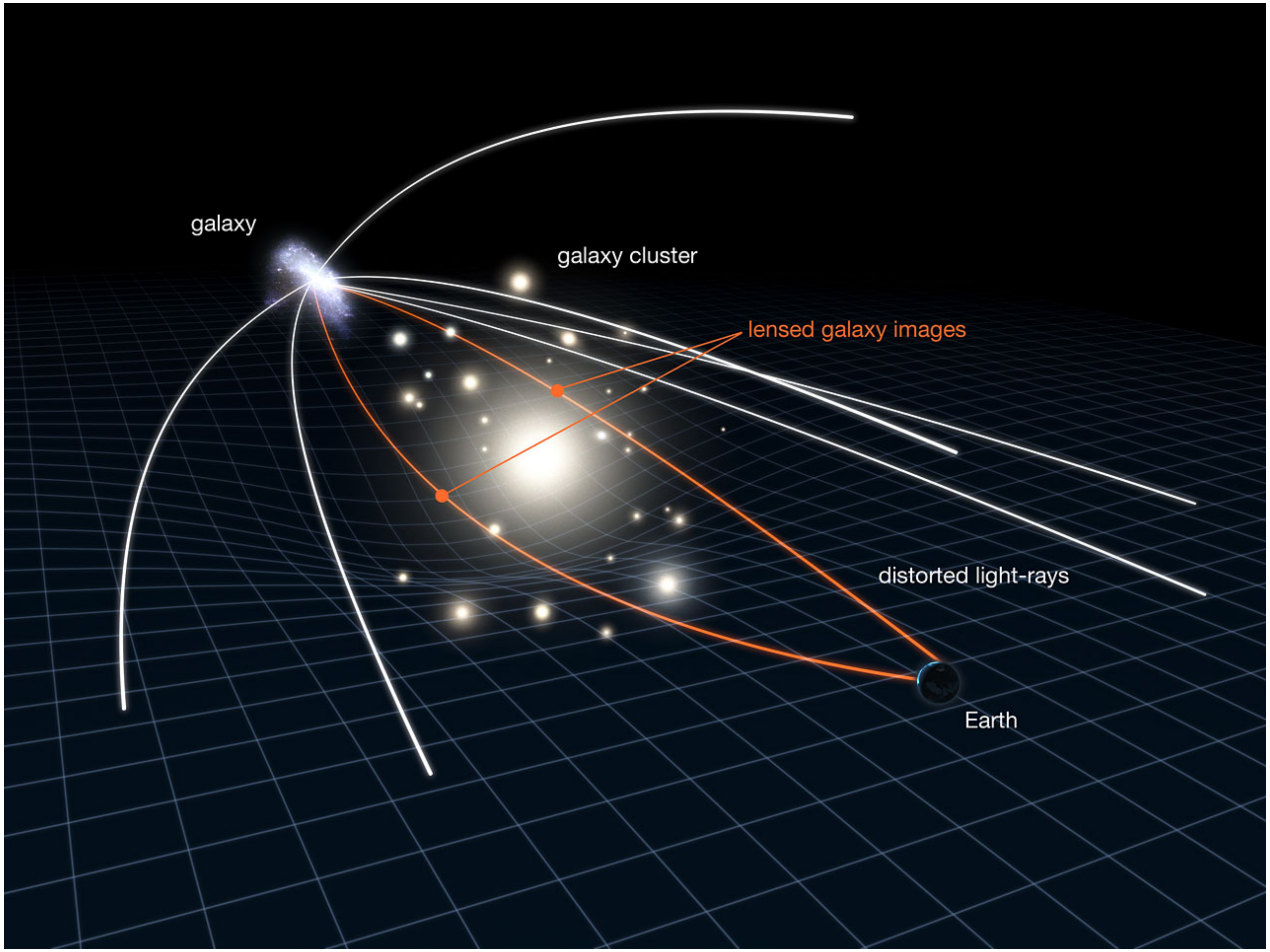
Study of Large Scale Structures

Clustering

Weak Lensing

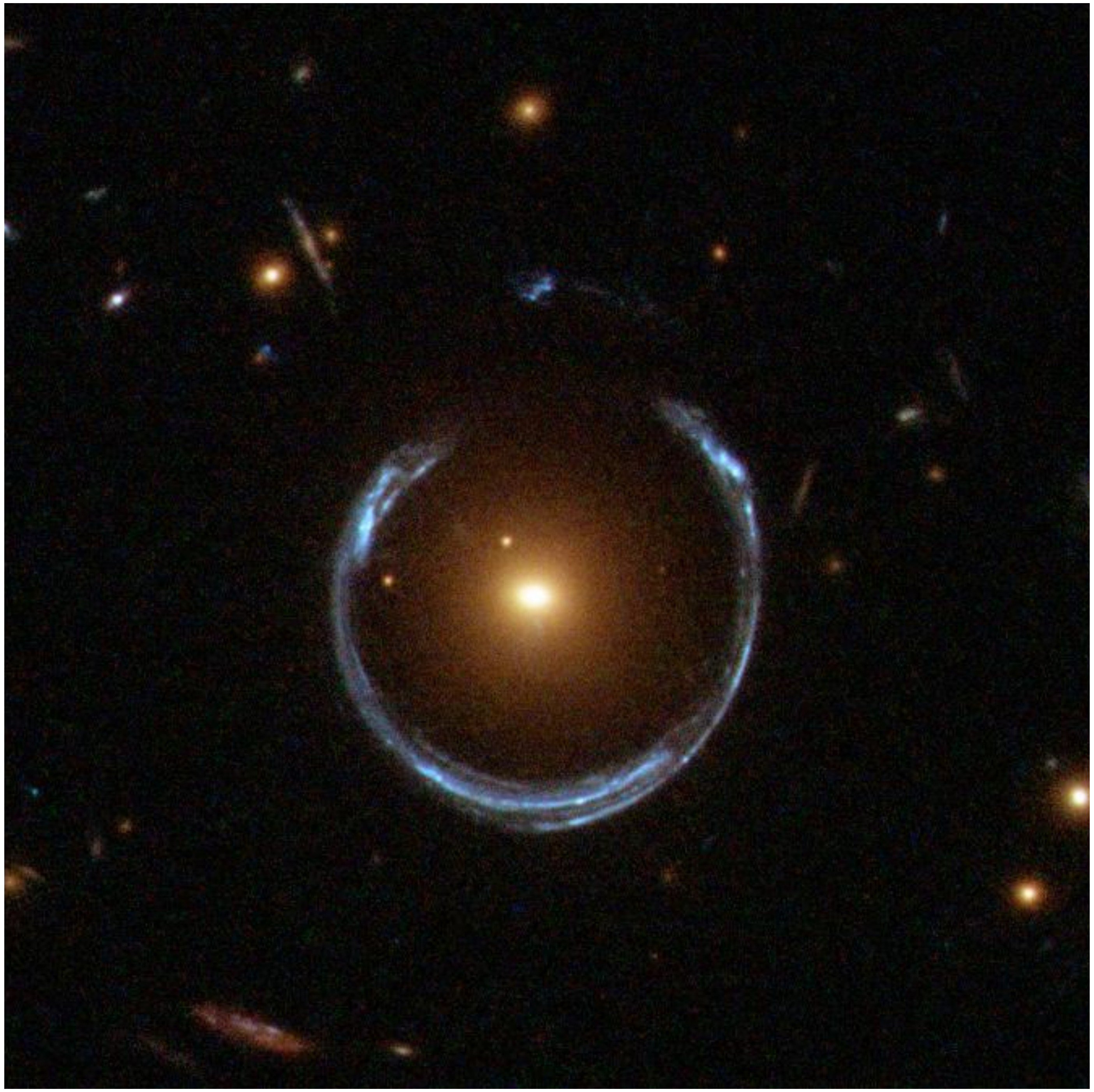
Probes

Gravitational lensing



(Ref : NASA/ESA)

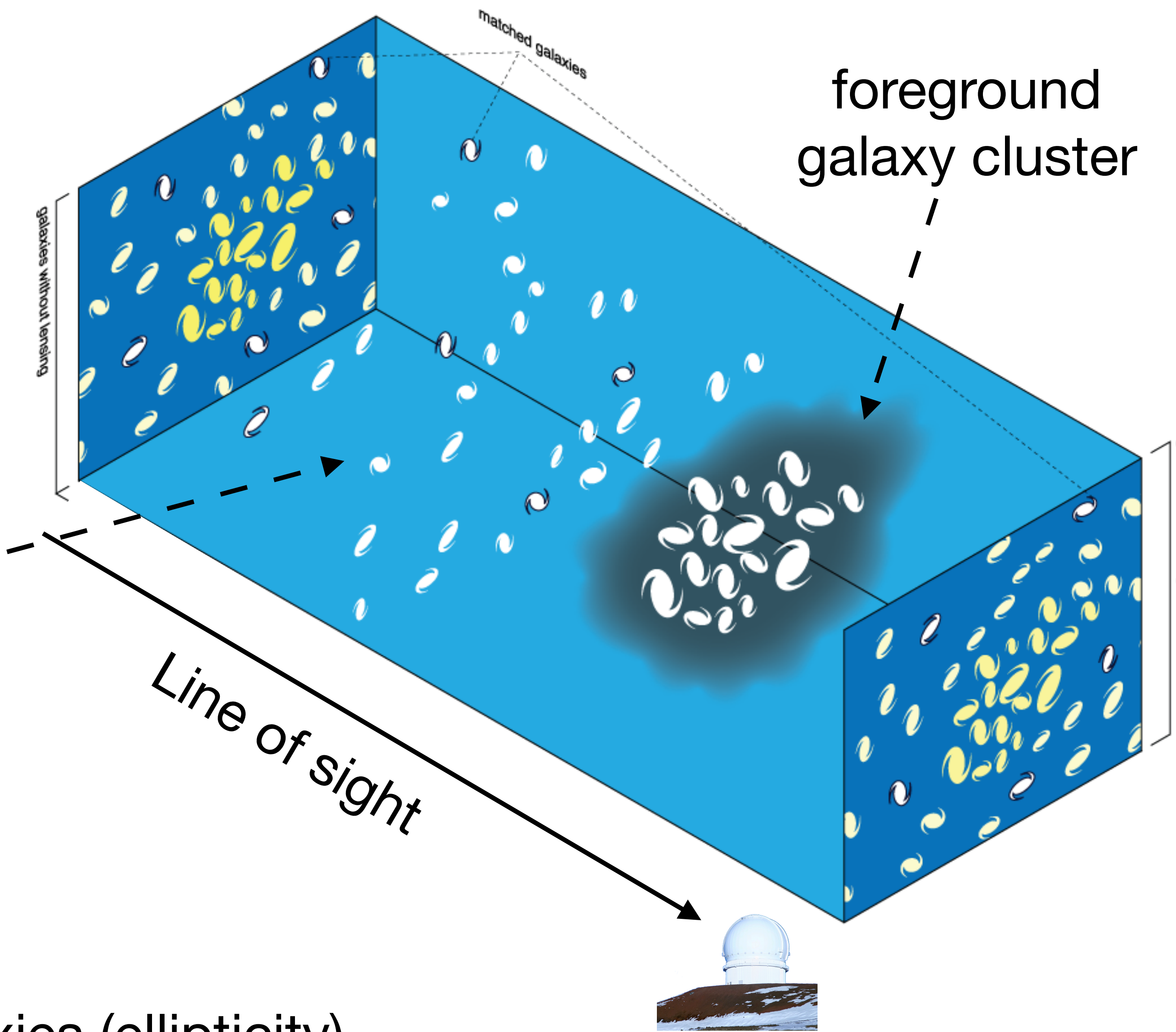
Strong lensing



(Ref : Hubble)

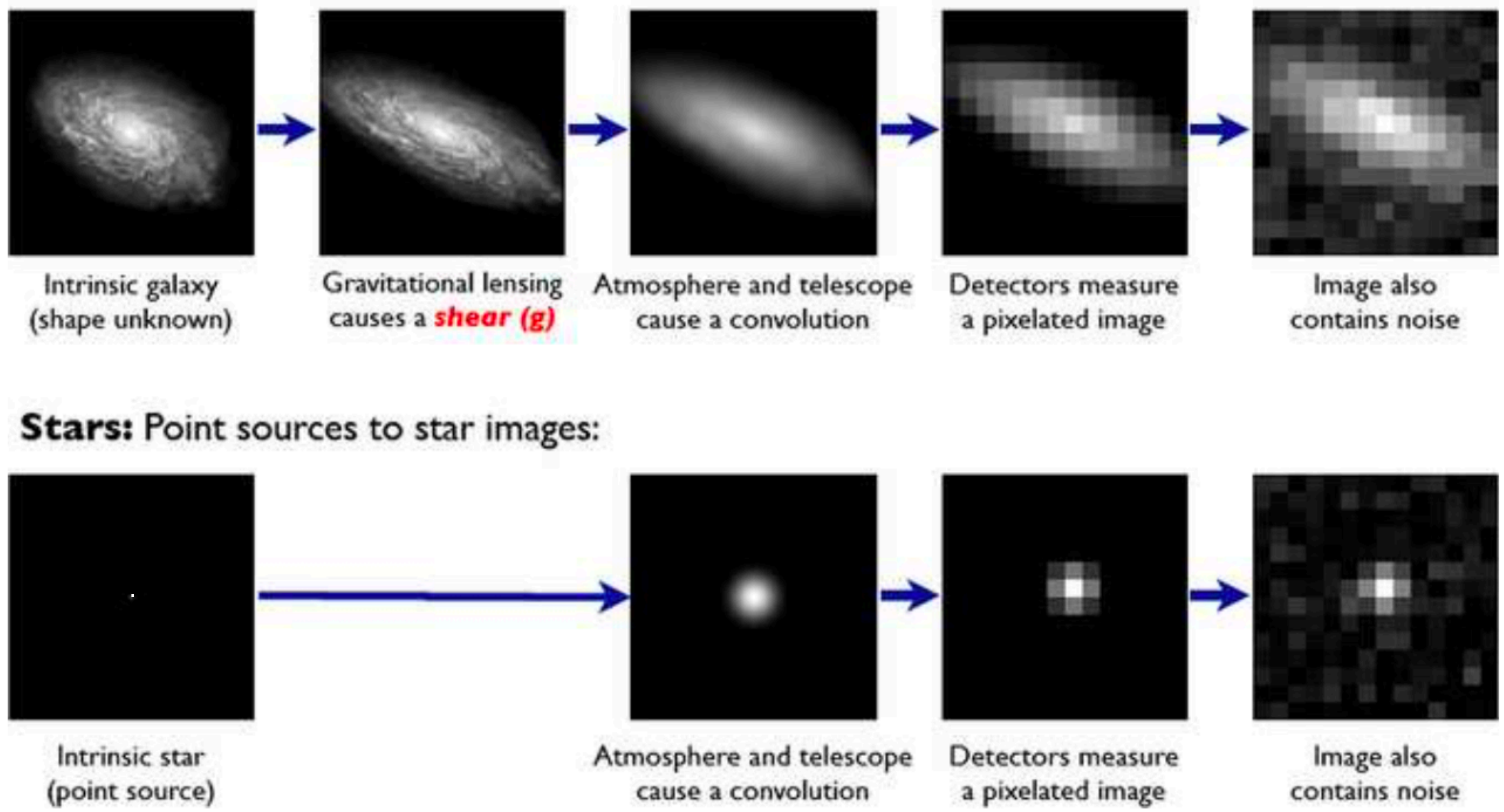
Weak lensing

$$\langle e^{obs} \rangle \longrightarrow \langle \cancelto{0}{e^{int}} \rangle + \gamma$$



- Based on shape measurement of galaxies (ellipticity)
- Effect ~1% of galaxy ellipticity
- Statistical studies on large area

Weak lensing



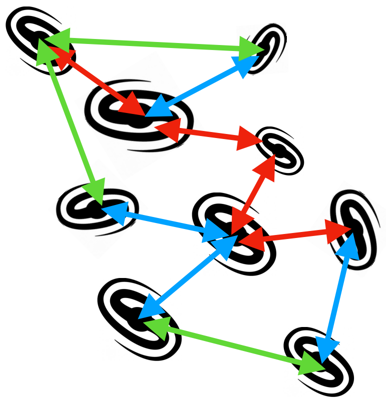
Other sources of contamination:

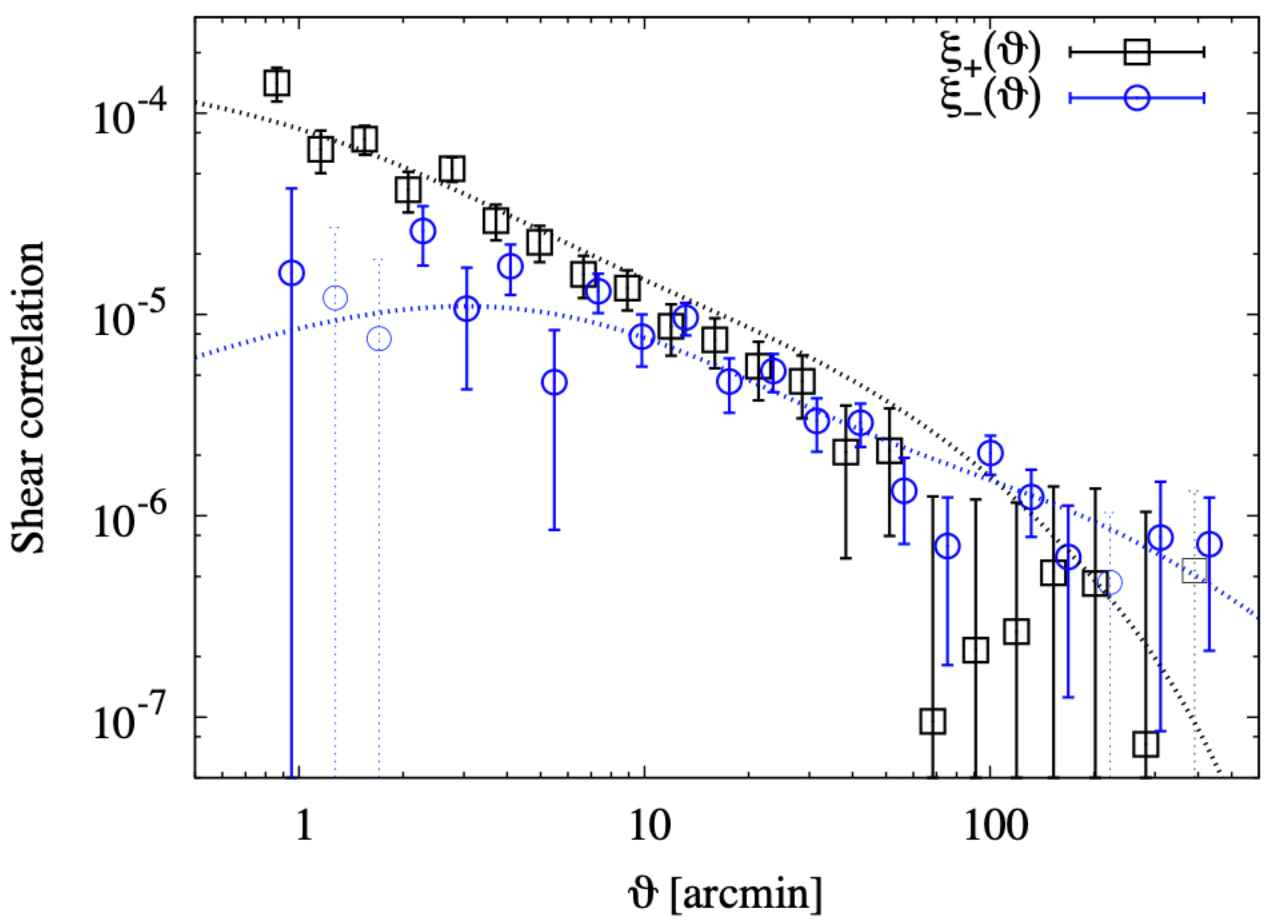
- Masking
- Purity of the galaxy sample
- PSF (star selection, model, interpolation,…)
- Shape measurement
- Intrinsic Alignement
- Cosmic variance

(Ref : GREAT 8)

Weak lensing

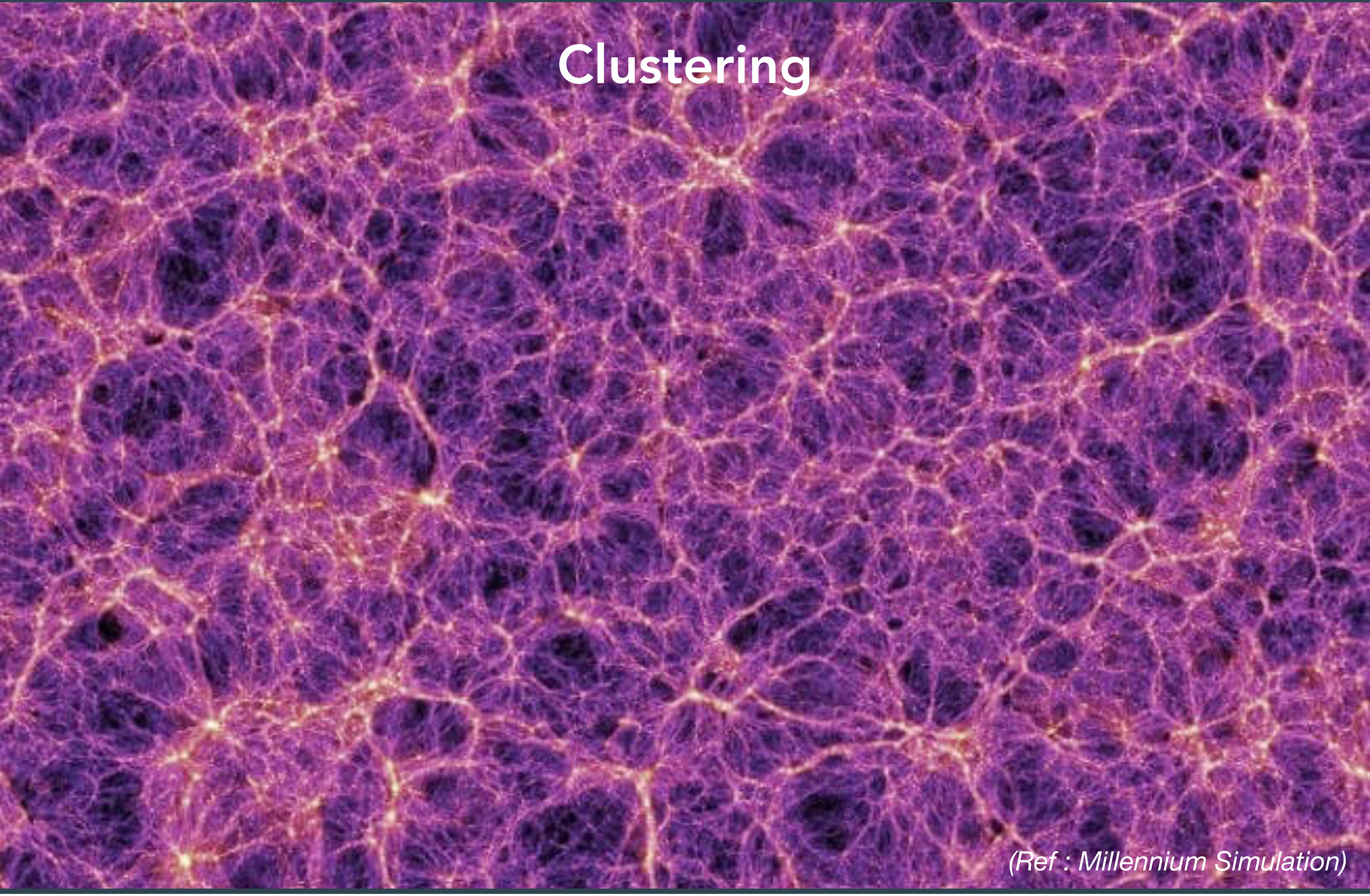
$$\xi_{\pm}(\theta) = \frac{\sum_{ij} w_i w_j (\epsilon_{t,i}\epsilon_{t,j} \pm \epsilon_{\mathrm{x},i}\epsilon_{\mathrm{x},j})}{\sum_{ij} w_i w_j}$$





(Ref : Kilbinger 2013)

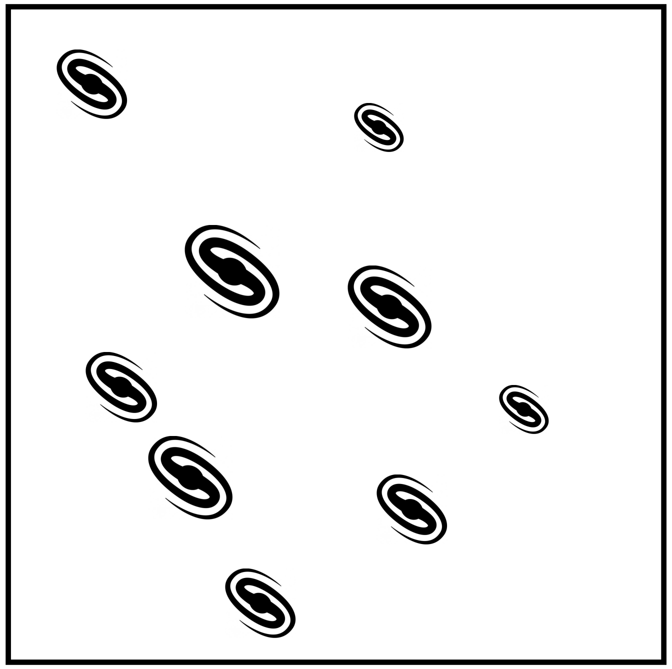
Clustering



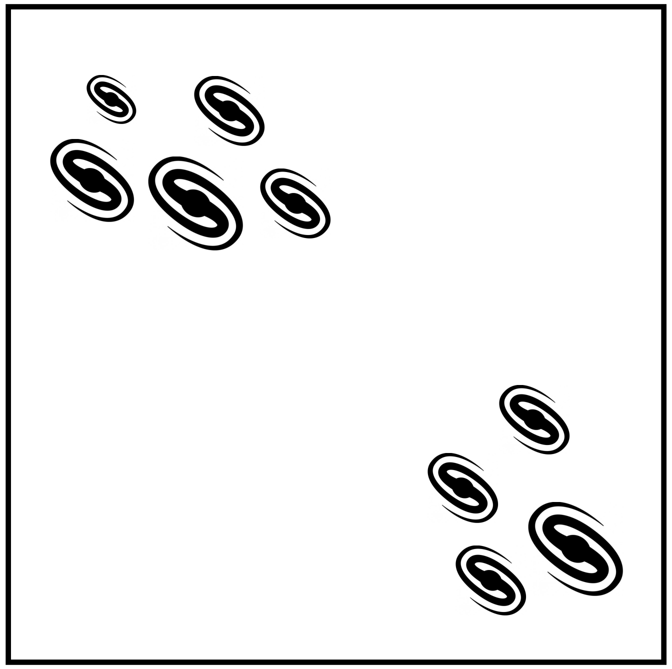
(Ref : Millennium Simulation)

Clustering

Without clustering



With clustering



Clustering: Higher probability to found a galaxy close to you if you are already at the position of a galaxy

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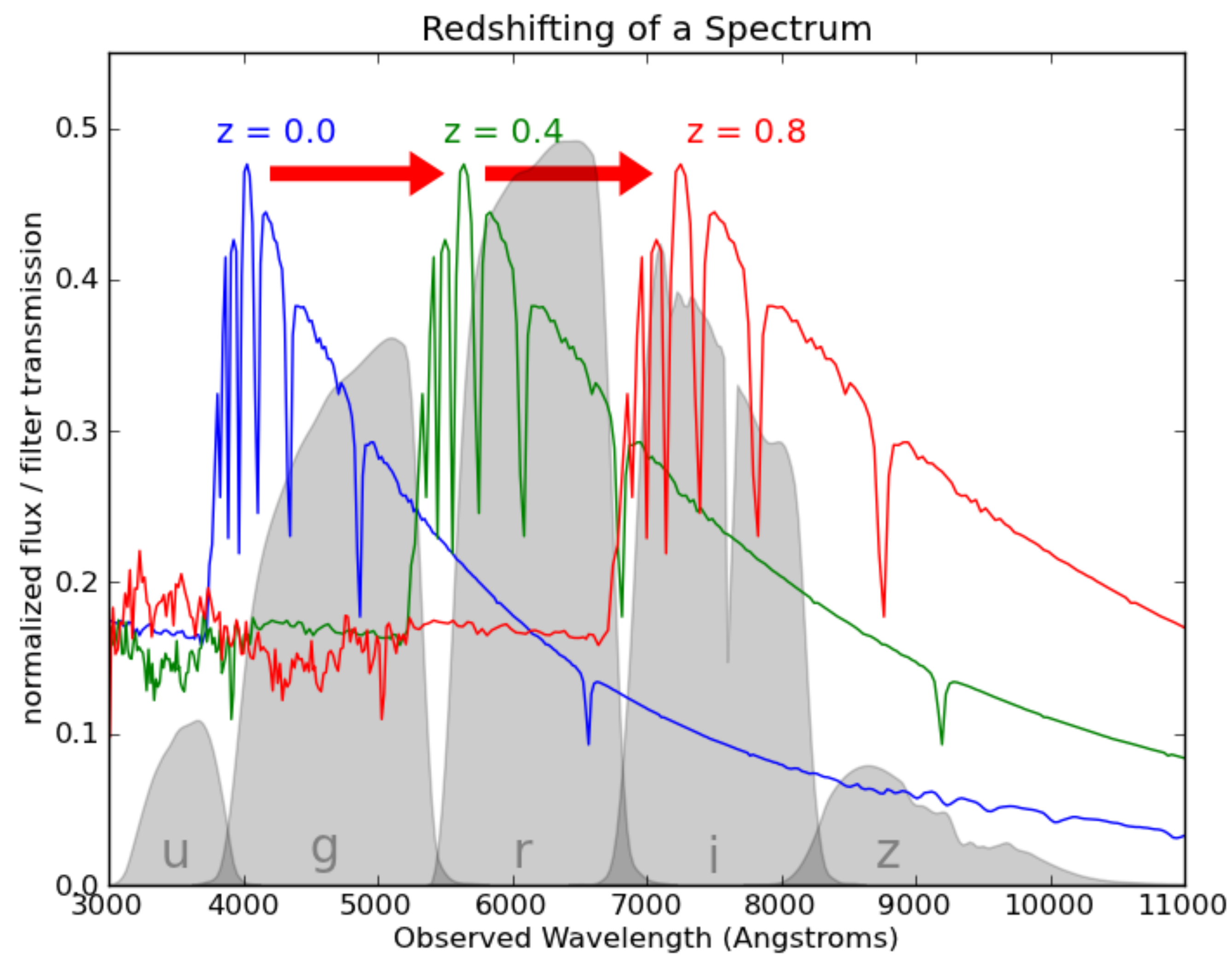
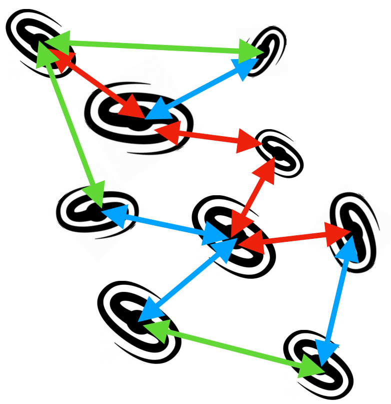
Clustering

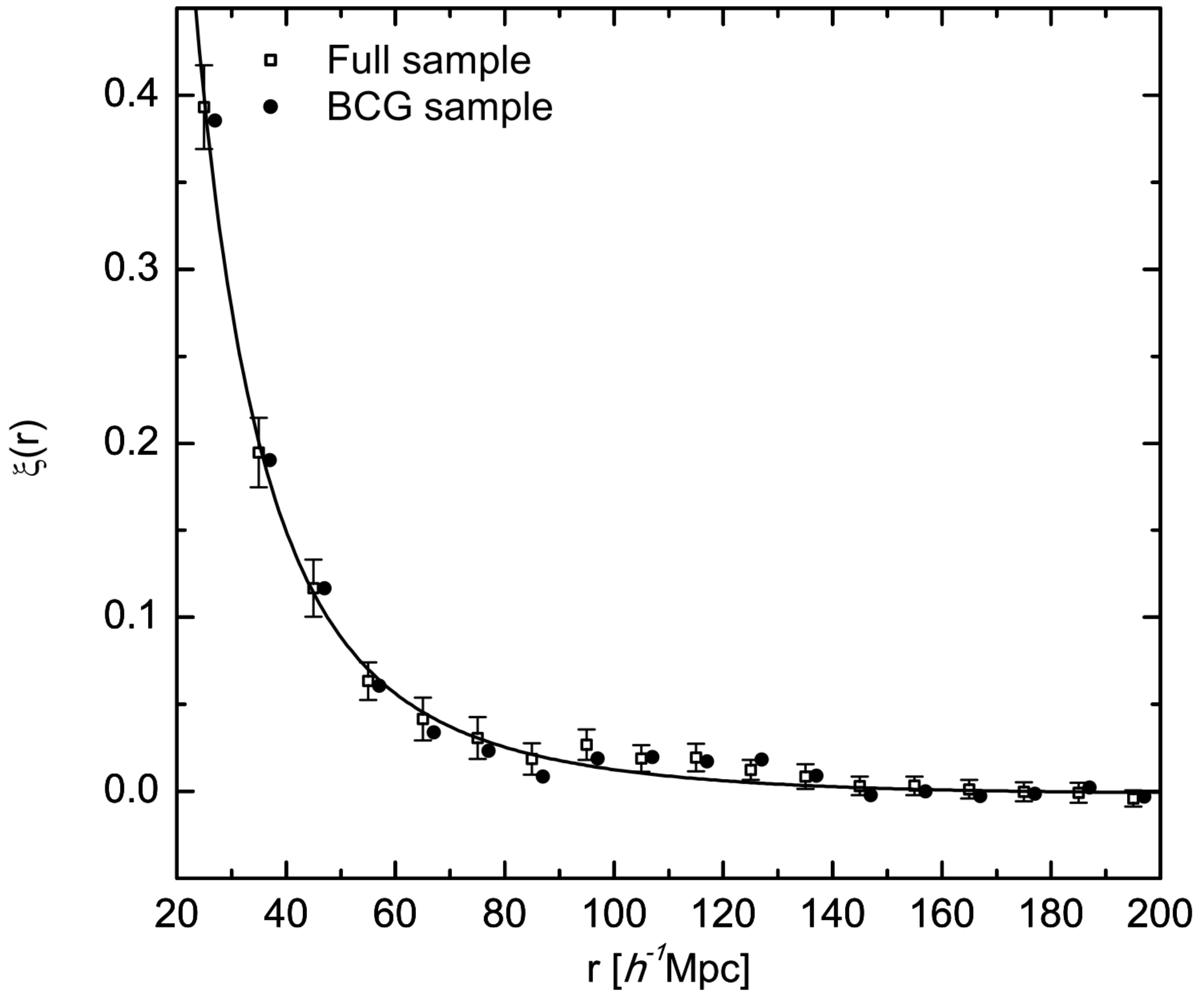
Difficulty with redshifts:
- Purity of the galaxy sample
- Limited sample
- Limited number of bands
- Calibration



Clustering

$$\xi_{\pm}(\theta) = \frac{DD - 2DR + RR}{RR}$$



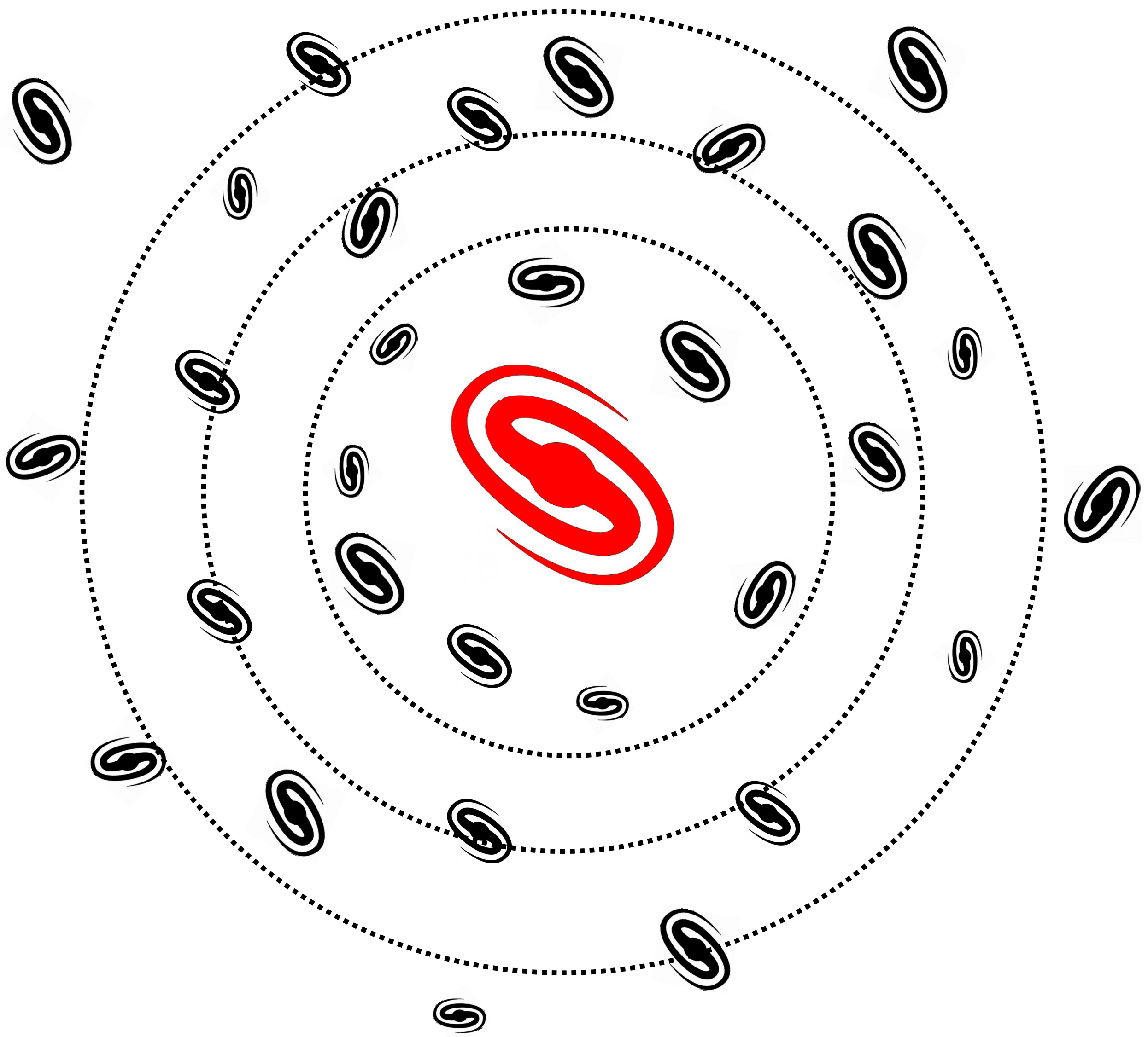


(Ref : Hong 2012)

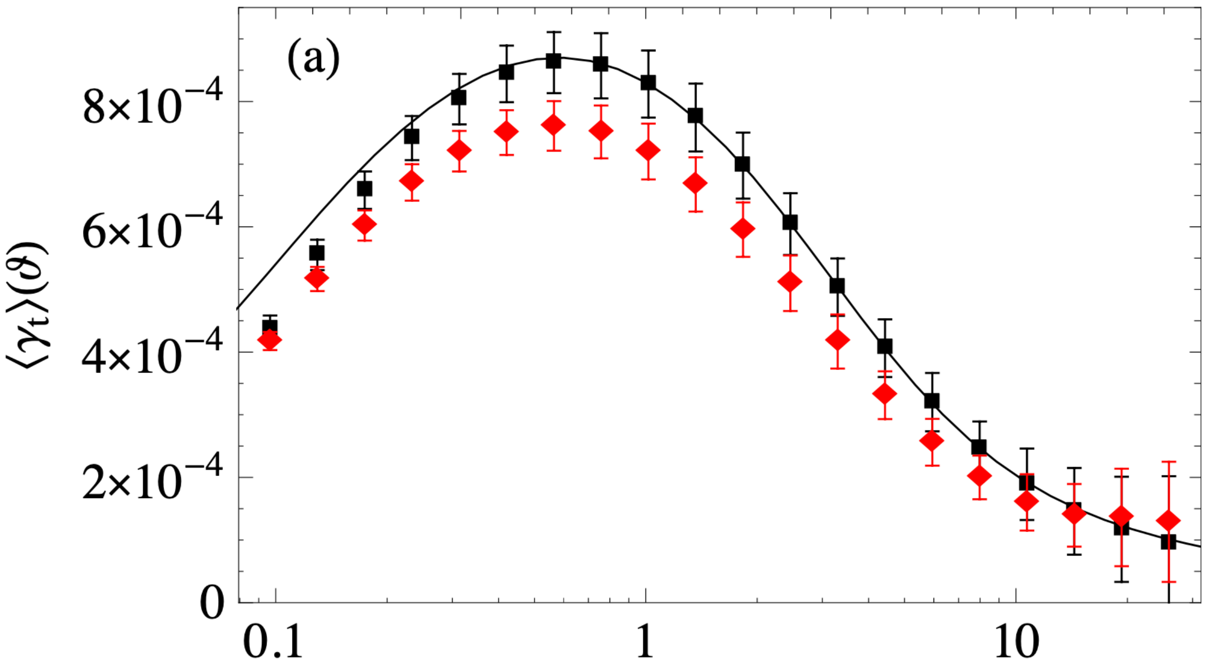
Galaxy-Galaxy lensing

(Ref : Hubble)

Galaxy-Galaxy lensing



$$\gamma_t(\theta) = \frac{\sum_j w_j \gamma_{+,j}}{\sum_j w_j}$$



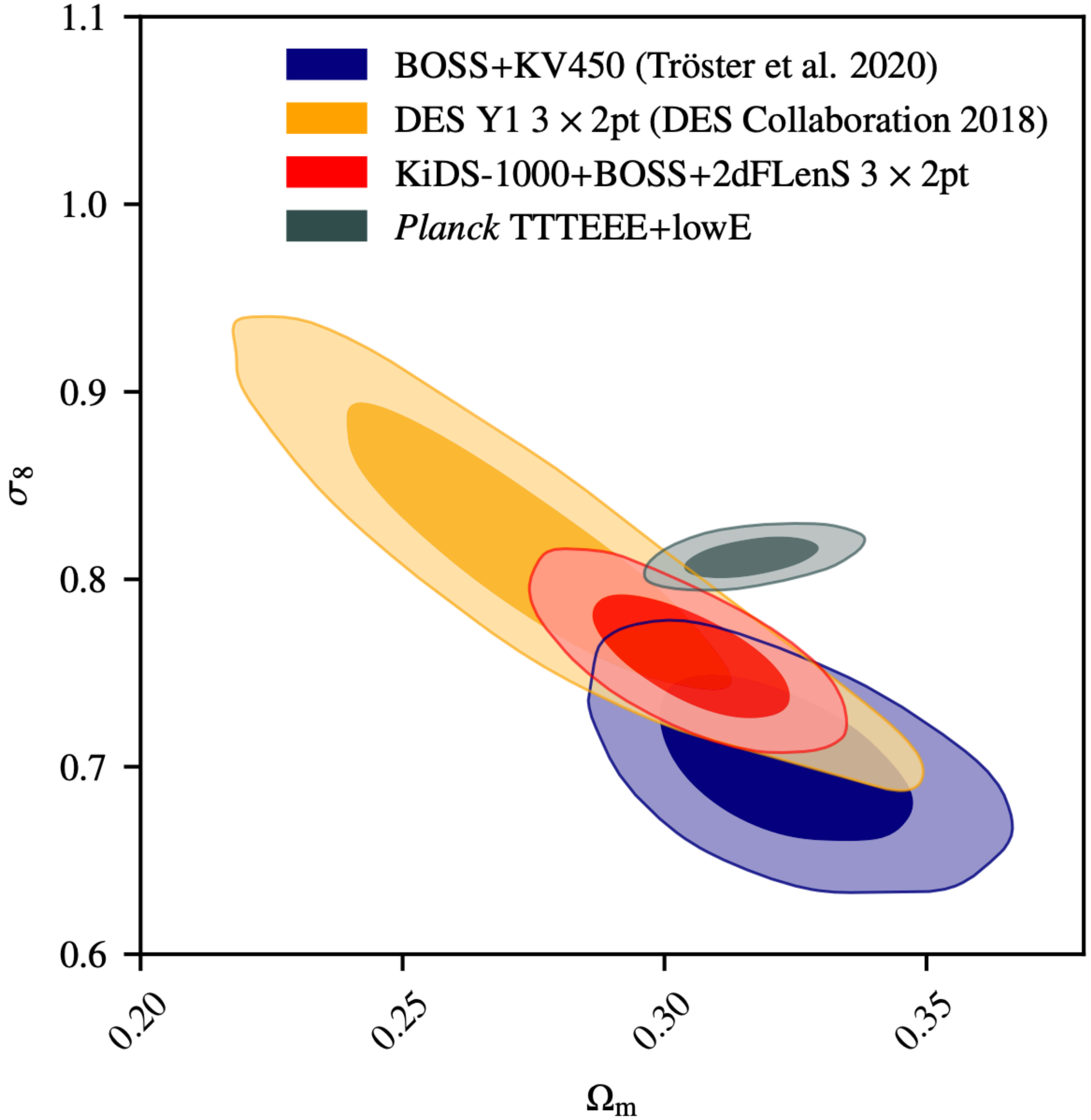
(Ref : Hilbert 2009)

Current surveys

Current surveys

KiDS-1000

ΛCDM



Sources: KiDS

- Area: 777 deg^2
- Galaxy density: 6.17 $gal.arcmin^{-2}$
- Redshift range: $0.1 < z < 1.2$

Lens: BOSS

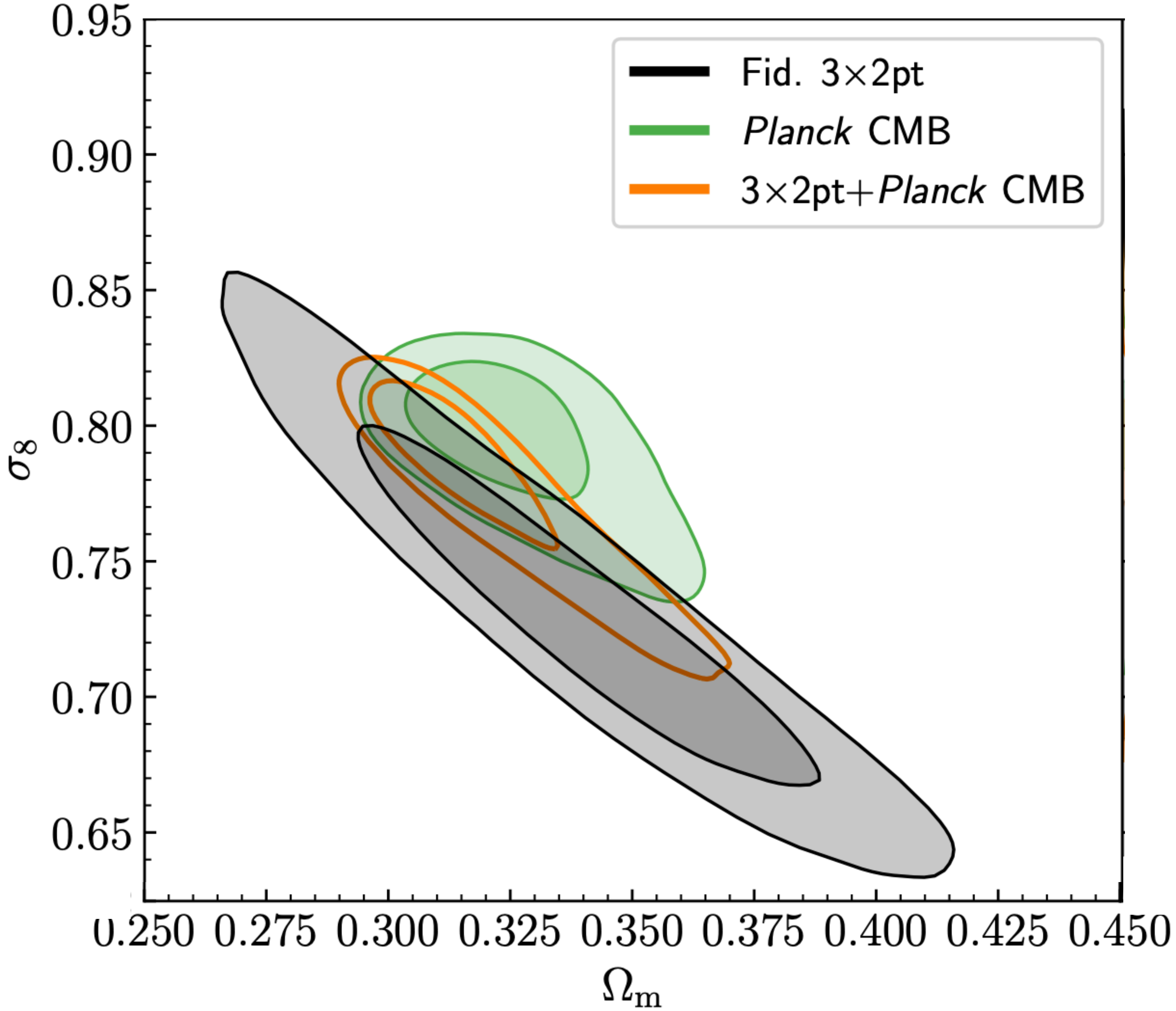
- Area: 409 deg^2
- Galaxy density: 0.031 $gal.arcmin^{-2}$
- Redshift range: $0.2 < z < 0.9$

(Ref : Heymans 2020)

Current surveys

DES Y3

ΛCDM



Sources: DES-Y3

- Area: 4143 deg^2
- Galaxy density: 5.59 $gal.arcmin^{-2}$
- Redshift range: $0 < z < 2$

Lens: MagLim (DES-Y3)

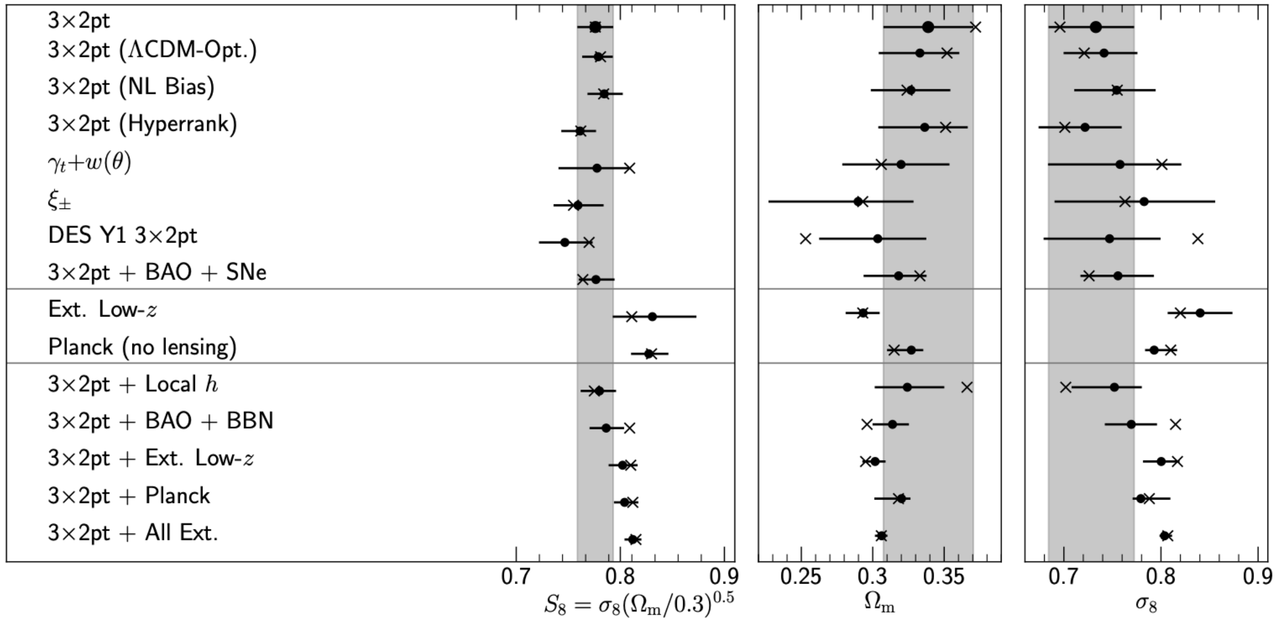
- Area: 4143 deg^2
- Galaxy density: 0.7 $gal.arcmin^{-2}$
- Redshift range: $0.2 < z < 1.05$

(Ref : Abbott 2020)

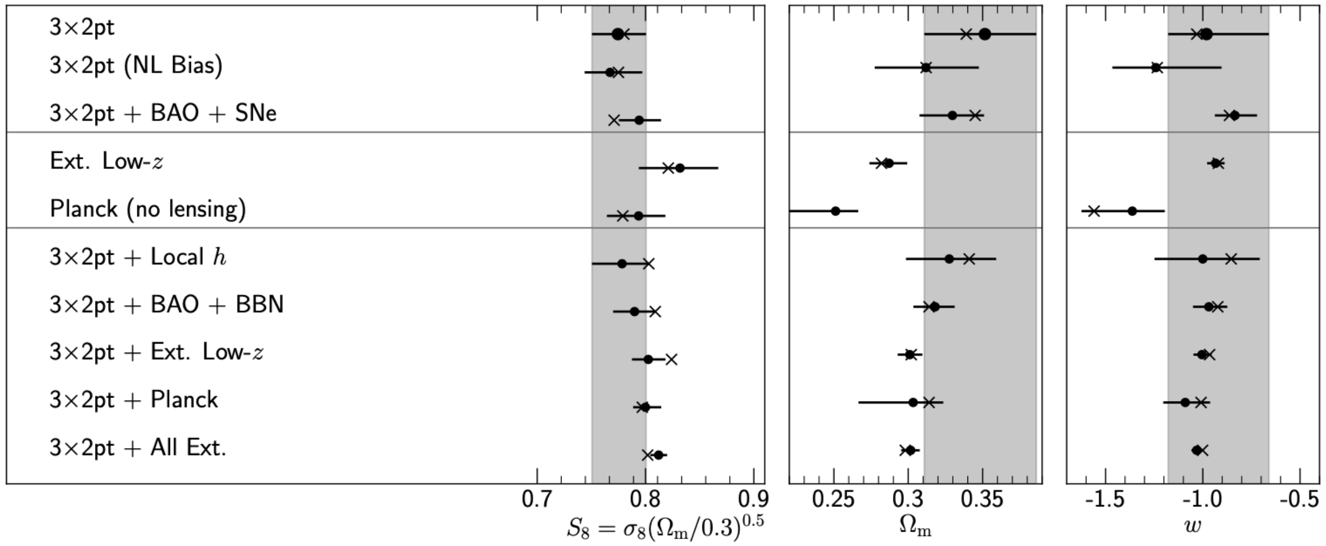
Current surveys

DES Y3

ΛCDM



***w*CDM**



Conclusion

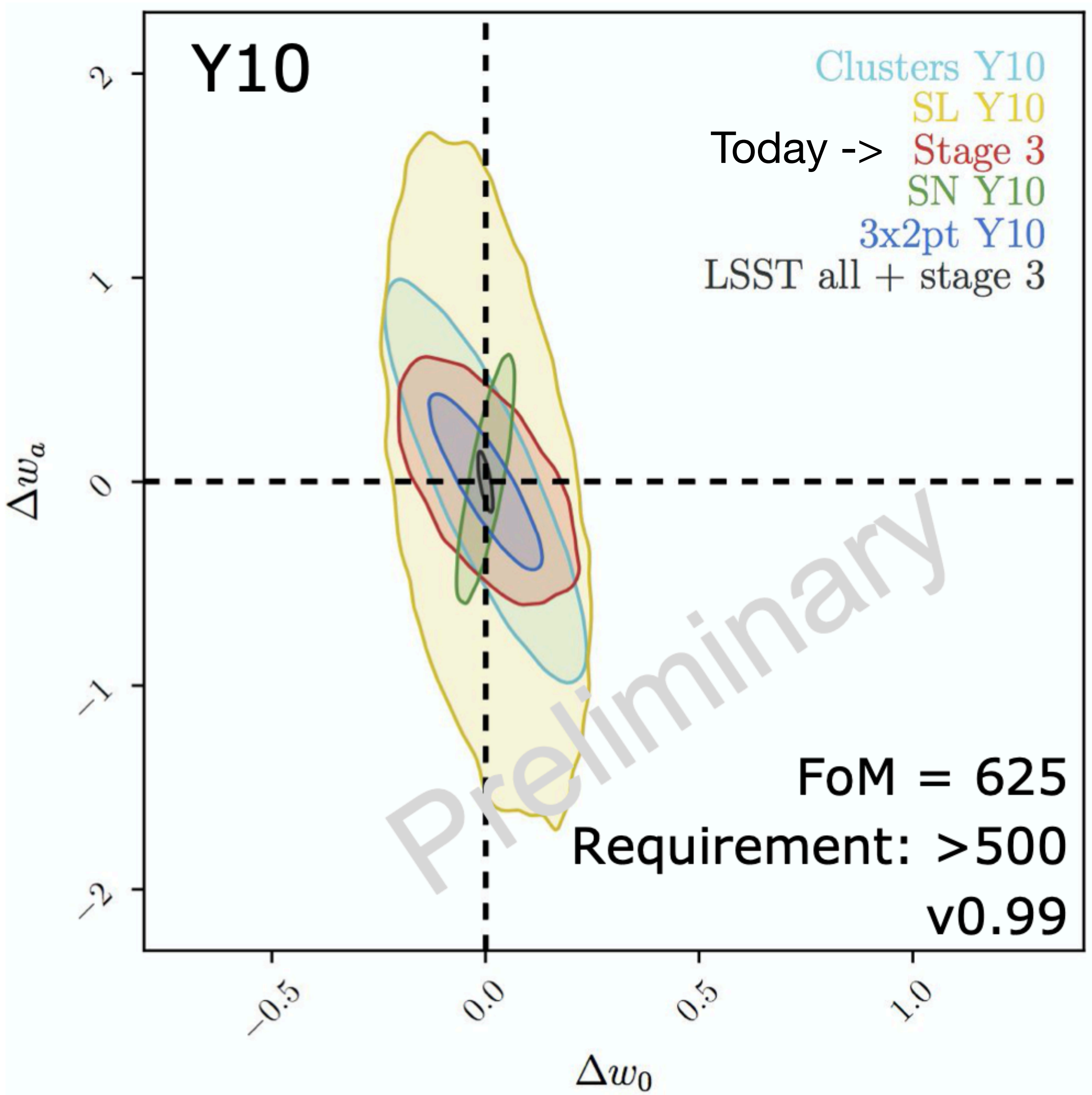
Up coming missions

Euclid

- Area: 15 000 deg^2
- Galaxy density: 30 gal.arcmin^{-2}
- Redshift range: $0 < z < 2$

LSST

- Area: 18 000 deg^2
- Galaxy density: 40 gal.arcmin^{-2}
- Redshift range: $0 < z < 2$



(Ref : Collet, DESC)

Main challenges

- Blending:
  - Looking deeper increase chances of having overlaps
- Shear calibration:
  - Simulations becomes harder with new survey
  - Metacalibration (data driven) ?
  - “New” bias redshift dependent
- Photo-z calibrations:
  - Training sample
  - Cluster-z ?
- Tension between Planck and photometric surveys