Lensing by Galaxy Clusters

Pierre Astier
LPNHE / IN2P3 / CNRS , Universités Paris 6&7.

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Cosmology from clusters

- Cluster counts:
  - The linear theory (+ numerical simulations) predicts cluster density as a function of redshift and mass.
- Baryon fraction:
  - Assume that clusters are a fair sampling of the universe (not more or less baryons that elsewhere)
  - Measure the gas mass (X-rays, SZ) and the total mass (e.g. lensing) of a set of clusters.
  - Get $\Omega_b h^2$ from Big Bang Nucleosynthesis.
  - Divide.

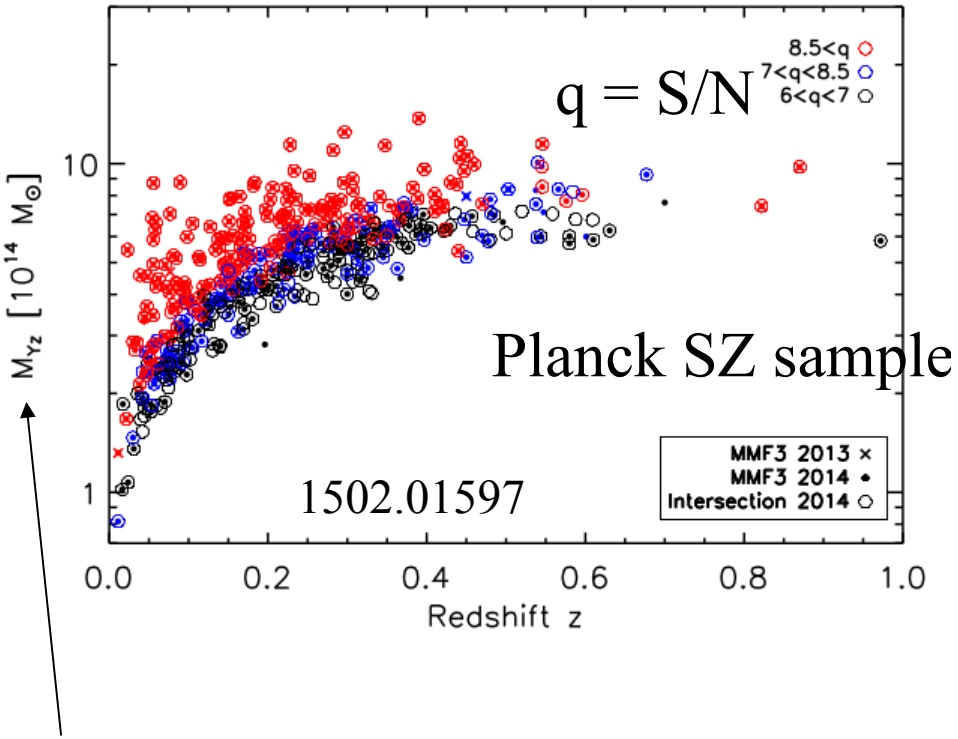
The importance of cluster masses

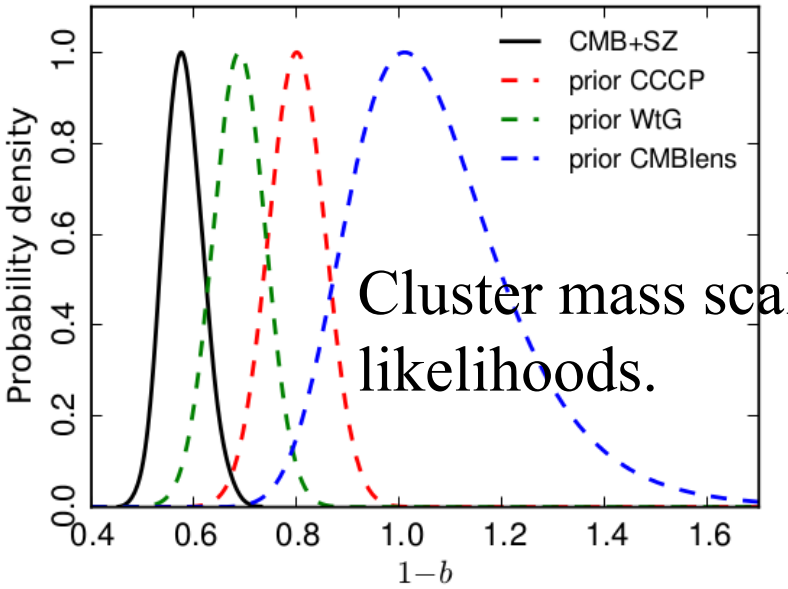
- Any comparison of a model to observations requires a mass estimate for each cluster.
- There are several good proxies of mass (called observables), but all require a calibration
  - X-ray profile/luminosity/temperature (+hydrostatics)
  - SZ decrement (+hydrostatics)
  - (Optical) galaxy count
  - Velocity dispersion.
- Beware: some mass estimates embed a distance.

Mass calibration

- Means “establishing the mass-observable relation”
- Can rely or on cluster physics ...
  - e.g. assume hydrostatic equilibrium of gas
- …. or not
  - (Weak) lensing of background galaxies.
- Today's consensus : one can rely on several methods, as long as one of them is lensing.

Plank clusters





Cluster mass scale likelihoods.

b=0: mass calibration from X-ray profile

Which mass : here, SZ decrement

- Use lensing-derived masses to set the scale

→ global scale uncertainty (10-20%)

Cluster lensing

- Seems the obvious thing to do, but limited in scope by the size of the enterprise:
  - More than 1 night/cluster on a 4-m
- Requires to gather two types of information:
  - Galaxy shapes
  - Galaxy colors for photo-z
  - Required FOV: 20' or more
- Requires a high density of galaxies because the measurement quality mostly depends on the number of measured background galaxies.

Weighing the Giants

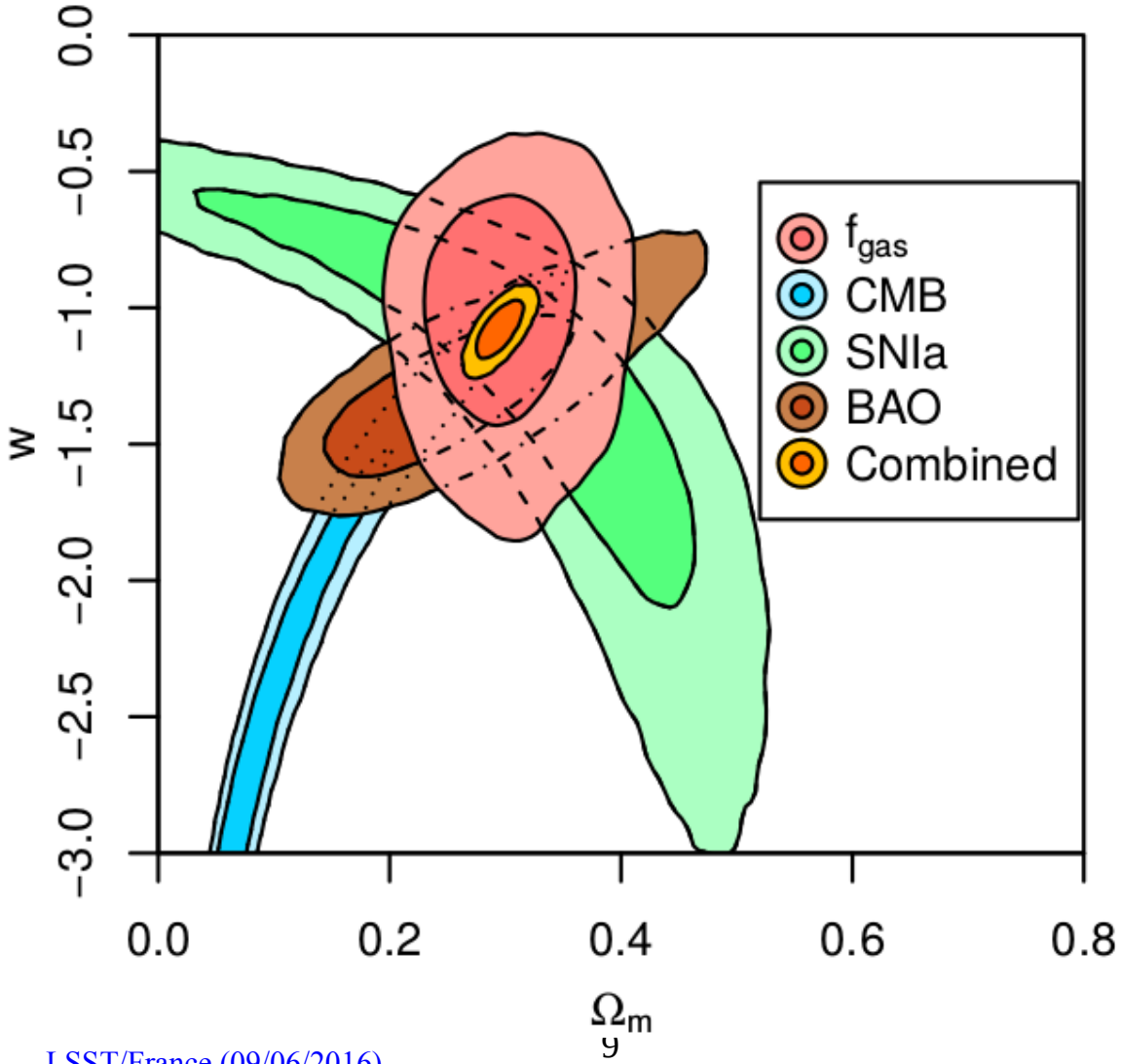
- "Large" enterprise aiming at carrying out cluster mass measurements
  - If possible only using sources with photo-z
  - ...with 5-band measurements
  - … plus some deep r or i band for shapes.
- Its past publications (e.g. von der Linden et al) are used in the Planck cluster cosmology paper.
- Typical observational setup:
  - 2-h exposures per band at CFHT for photo-z
  - 1-h exposure at Subaru (e.g. i-band) for shapes

WtG : people

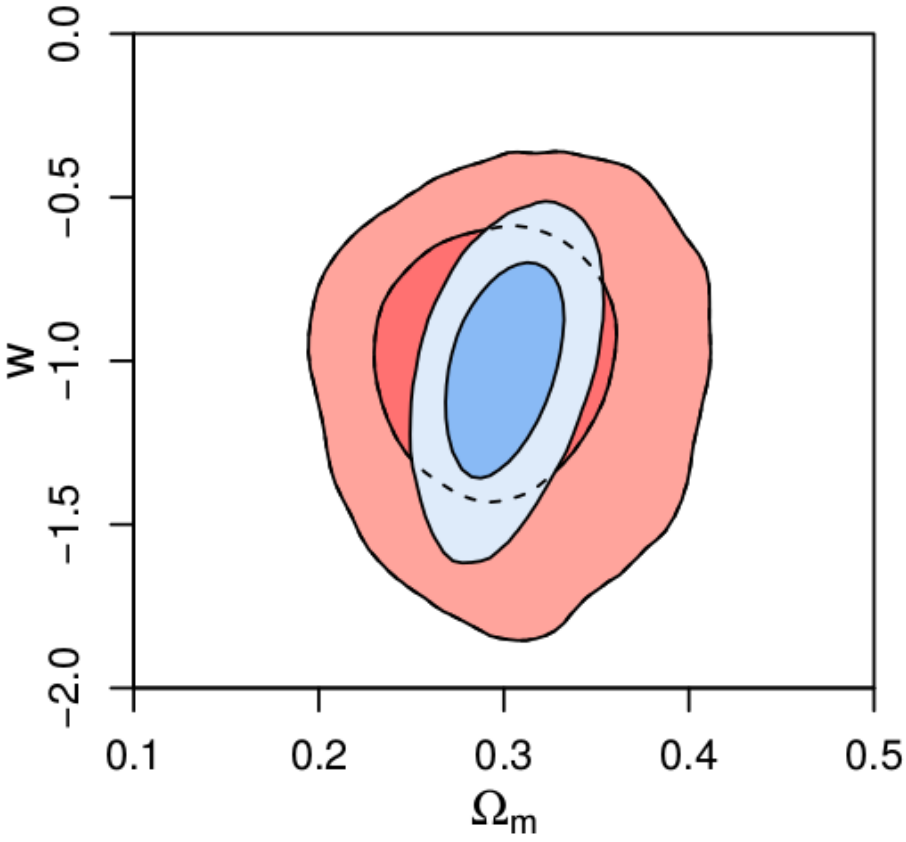
- Core team : Stanford (Steve Allen, Anja von der Linden, Pat Burchat, Burke….), Bonn (Erben)
- New people (CFHT proposals):
  - Ludovic van Waerbeke (Vancouver)
  - Frenchies : P.Astier, D. Boutigny, A Guyonnet, …
- Scientific argument: gas fraction
  - A small number of extra clusters pays off.
  - Drawback : no way to team up with Planck cluster follow-up.

The gas fraction promise

Now



Goal



Proposals/observations

- Lensing observations : Subaru
  - Red sensitivity, collecting power.
  - SC (>2008) and HSC are equipped with deep-depleted CCDs → brighter-fatter effect
  - In the south: DECam on the Blanco (won't get VLT time for this kind of program....)
- Photo-z: CFHT/Megacam
  - Proposals get submitted (and approved, today) since 3 semesters on both Canadian and French agencies. This is our (key?) contribution so far, 10 to 20 hours. Last proposal poorly ranked (12/24).

WtG reduction (legacy) tools

- Basics for each camera used: flafielding, illumination correction, calibration....
  - Under control for CFHT (provided by the observatory), less for DECam, and Subaru. HSC is a new territory.
- Relative astrometry: Scamp is the current solution
- Stacking: Swarp
- PSF and Shear: PSFex and KSB+
- No hope to use CFHTLens toolkit.

Obvious contribution avenue: reduction improvements

- Contributions about flat-fielding: gather HSC and DECam recipes.
- Astrometry: jointcal.
- Stacking: stacking is a dead end for shape measurements. Stacking is only meaningful to define the galaxy sample (and perhaps photo-z).
- PSF : ? test algorithms, e.g. DM's approach (which ?)
- Shear: think about methods that can be used for cosmic shear.

Discussion:

- WtG telecon next week(s).
- Should we target a contribution in tools/methods in this science topic?
- How to do something rapidly, or CFHT time is over.
- A minimal team is required to assemble a contribution in terms to tools/methods. Do we have it ?
- Are there any people interested in understanding/improving shear measurements ?