Cosmic shear results from CFHTLS

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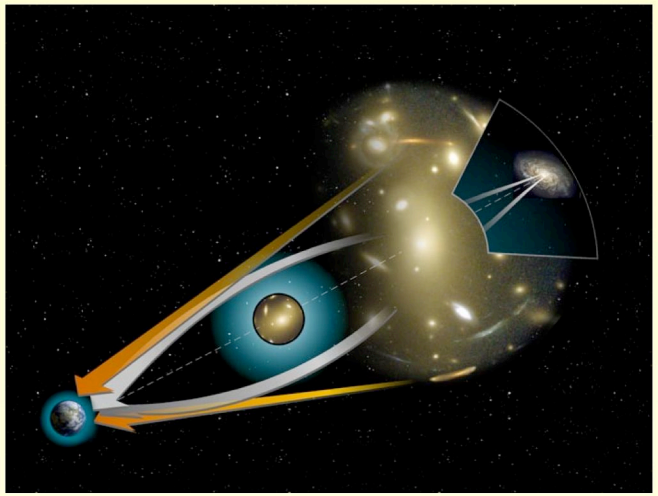
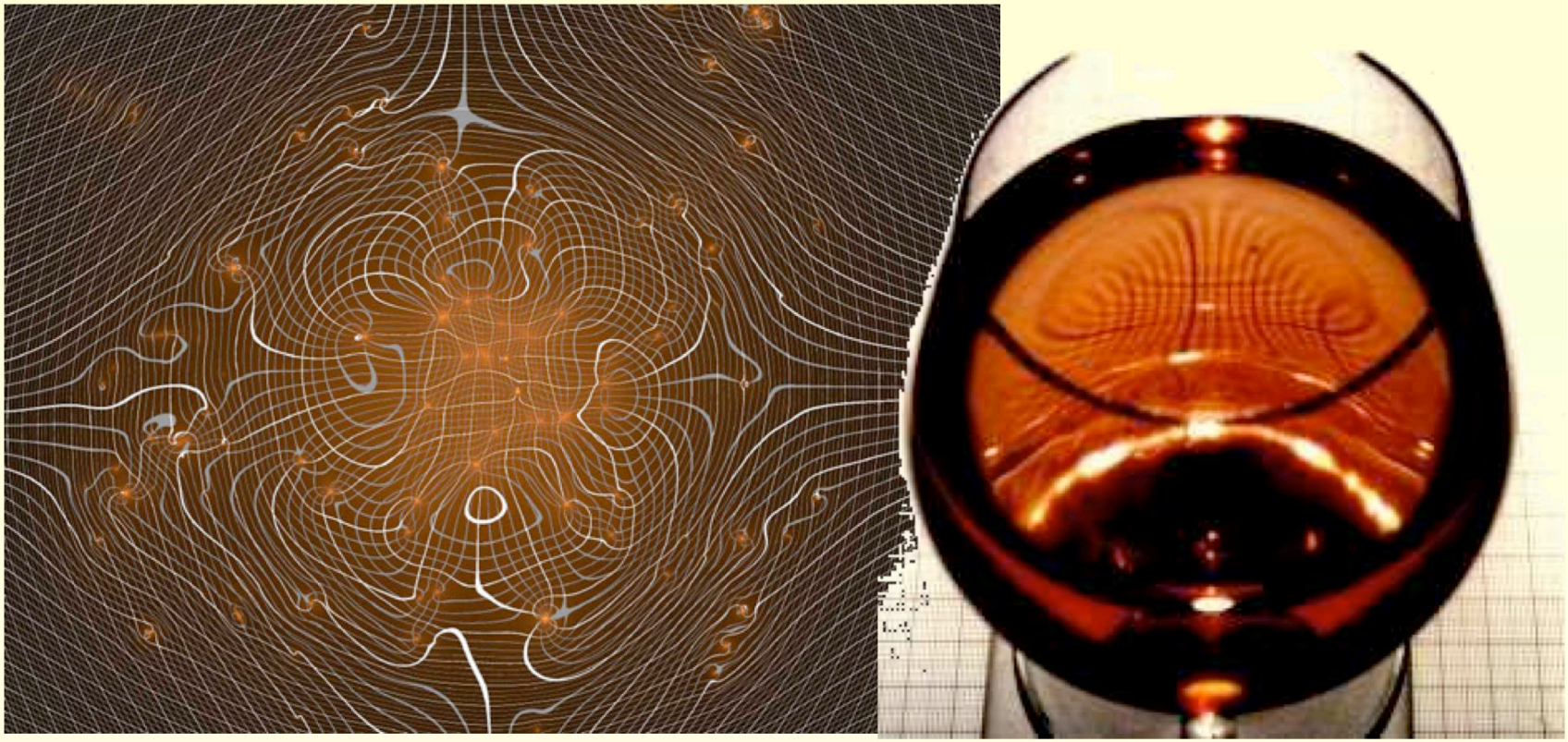
Gravitational lensing



Observations of the (weak) gravitational lensing signal provide a powerful way to study the dark matter distribution in the universe.

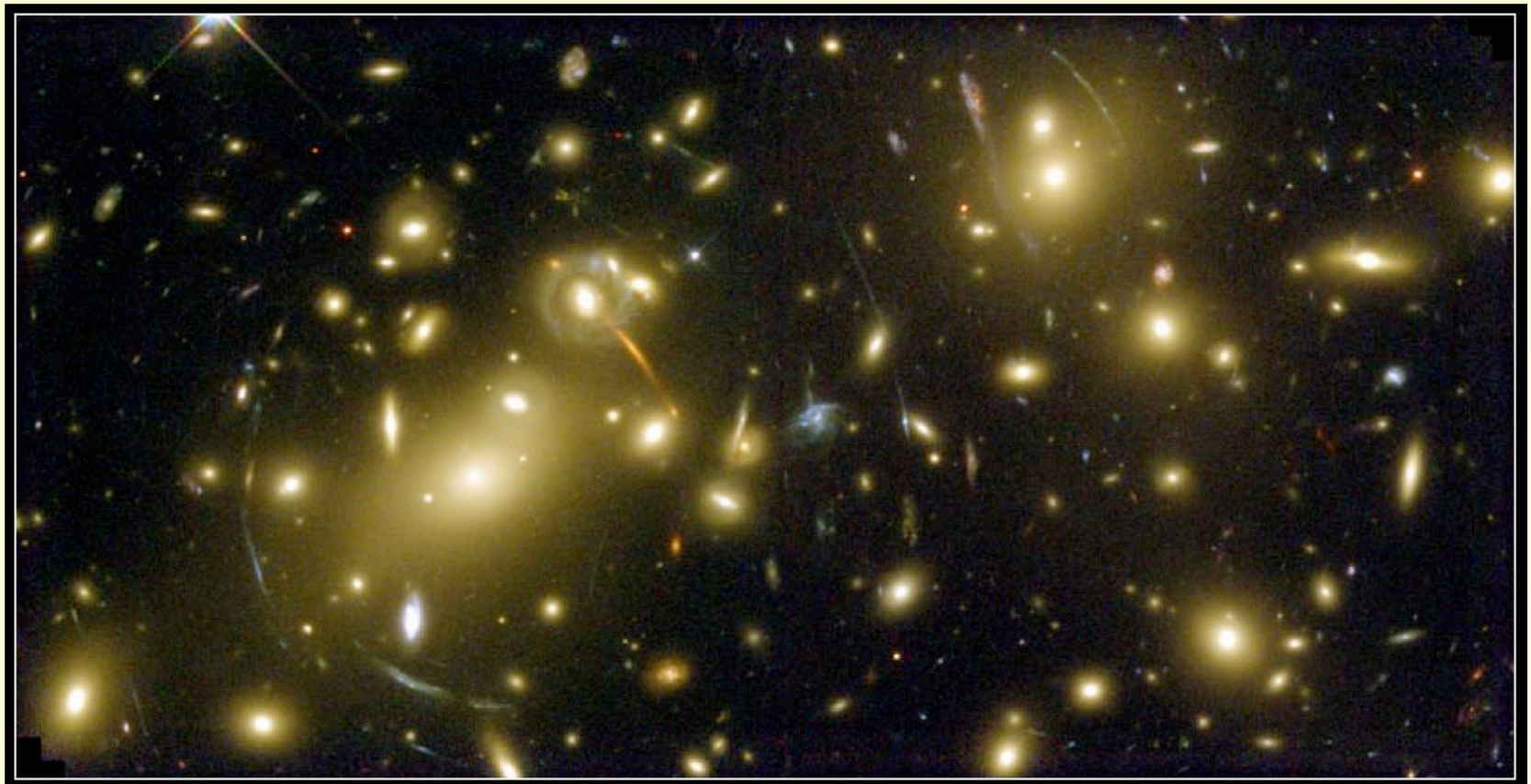
- It does not require assumptions about the dynamical state of the system under investigation.
- It can probe the dark matter on scales where other methods fail, as it does not require visible tracers of the gravitational potential.

Gravitational lensing



The large scale mass distribution causes a distortion in the shapes of background galaxies. This can lead to spectacular lensing examples…

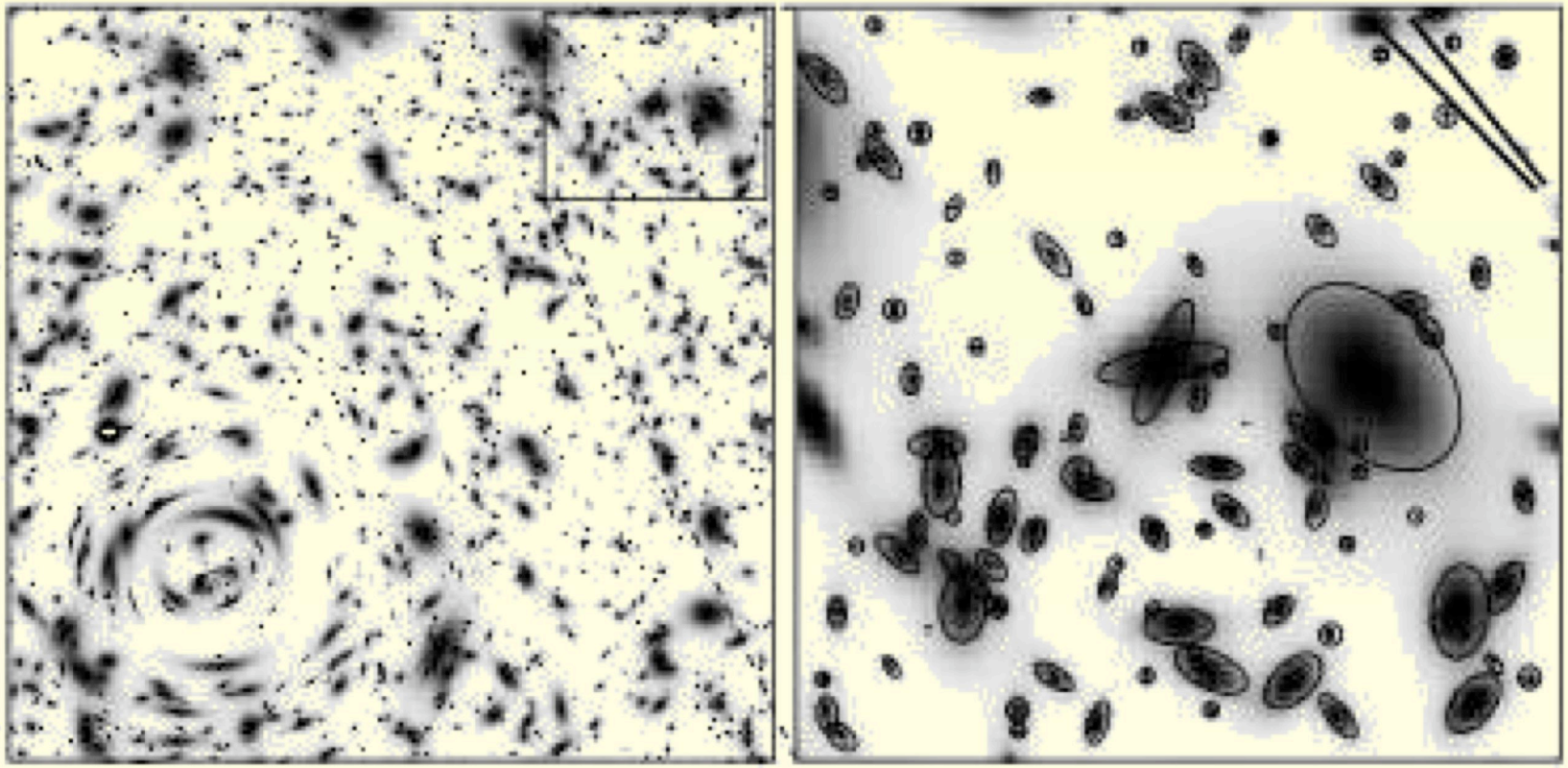
Gravitational lensing



Galaxy Cluster Abell 2218 **HST • WFPC2**

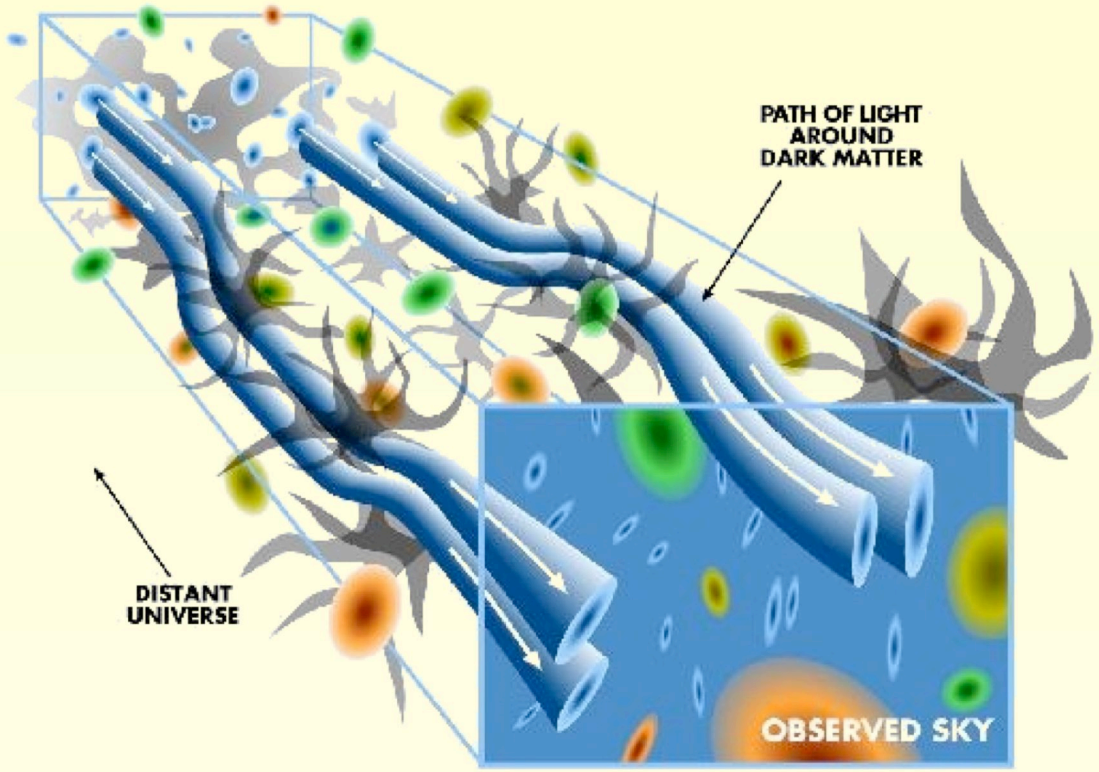
NASA, A. Fruchter and the ERO Team (STScI, ST-ECF) • STScI-PRC00-08

What is weak lensing?



A measurement of the ellipticity of a galaxy provides an unbiased but noisy measurement of the gravitational lensing shear

What is cosmic shear?



Cosmic shear is the lensing of distant galaxies by the overall distribution of matter in the universe: it is the most “common” lensing phenomenon.

What do we measure?

Underlying assumption: the galaxy position angles are uncorrelated in the absence of lensing

1. Measure the galaxy shapes from the images
2. Correct for observational distortions
3. Select a sample of background galaxies

Lensing signal

The conversion of the lensing signal into a mass requires knowledge of the source redshift distribution

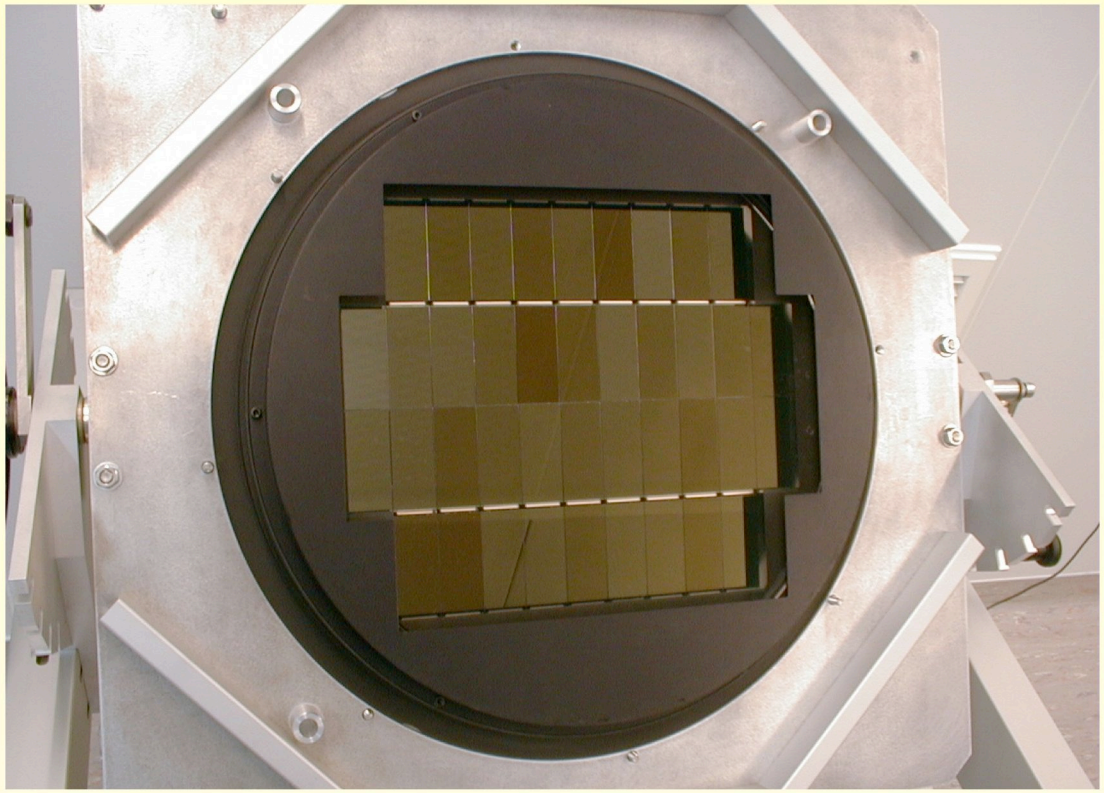
What do we need?

The weak lensing signal is small:

- We need to measure the shapes of many galaxies.
- We need to remove systematic signals at a high level of accuracy.

Only recently we have been able to overcome both obstacles, although we still need various improvements to deal with the next generation of surveys

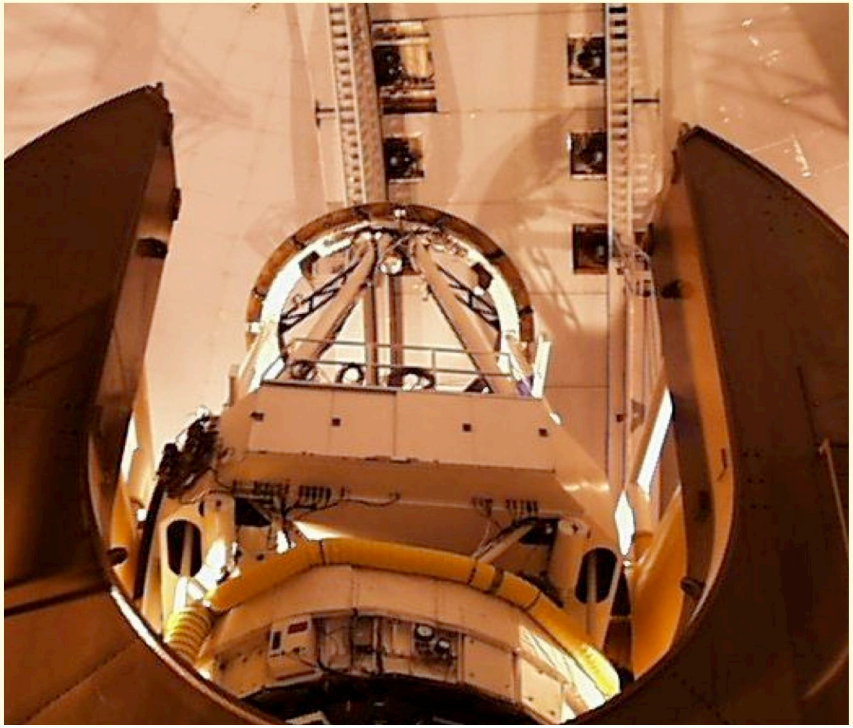
Build a big camera…



Megacam:

- 1 square degree field of view
- ~350 megapixels

Put it on a good telescope…



Such as the CFHT

or VST, LSST, SNAP, etc

… and take a lot of data!

CFHTLS
RCS2
KIDS

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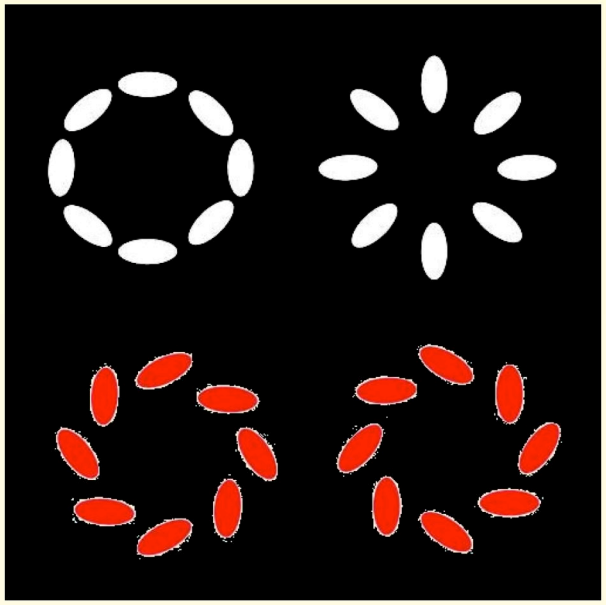
Dealing with systematics: the PSF

Weak lensing is rather unique in the sense that we can study (PSF-related) systematics very well.

Several diagnostic tools can be used. However, knowing systematics are present doesn't mean we know how to deal with them…

E-mode (curl-free)

B-mode (curl)



Dealing with systematics: tests

It is relatively easy to create simulated data to test the measurement techniques.

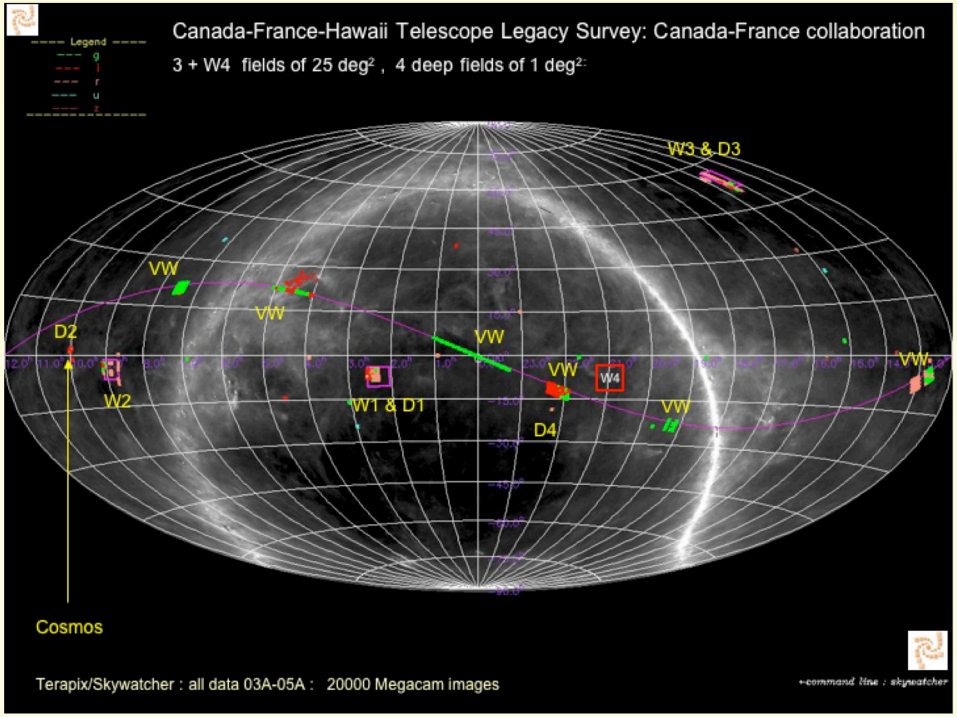
The Shear TEsting Programme is an international collaboration to provide a means to benchmark the various methods.

So far two papers have been published (Heymans et al., 2006 and Massey et al., 2007). These results provide a snapshot of the current accuracy that can be reached (~1-2%).

CFHT Legacy Survey

The Canada-France-Hawaii Telescope Legacy Survey is a five year project, with three major components. The Wide Survey's focus is weak lensing.

- ~140 square degrees
- 4 fields
- 5 filters (u,g,r,i,z')
- i<24.5



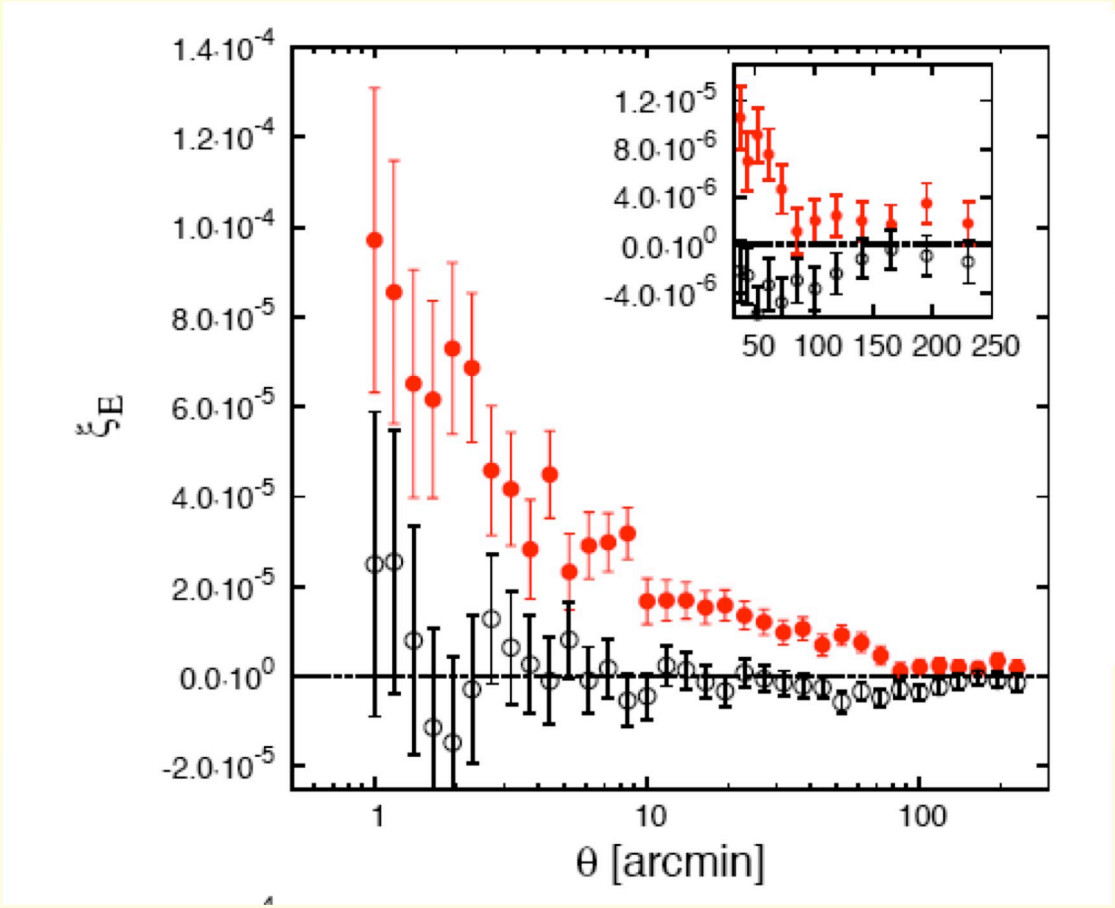
CFHTLS: current status

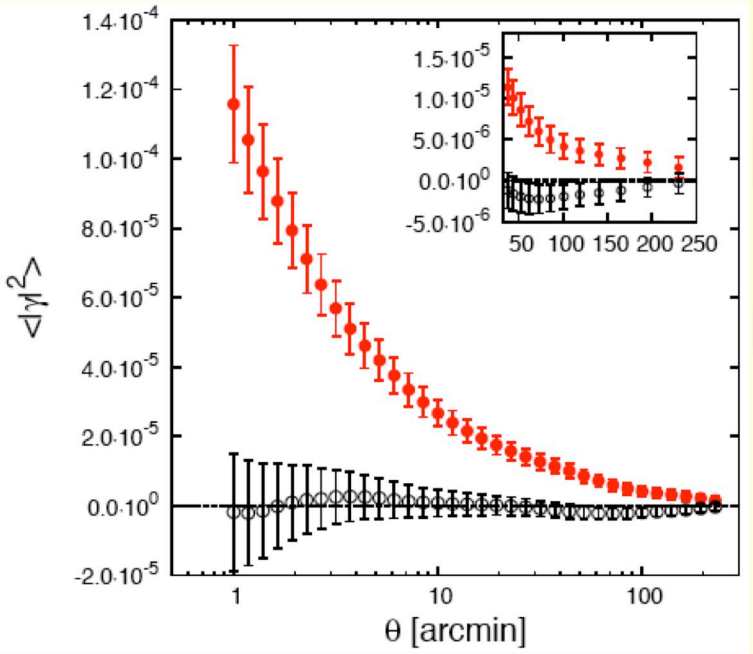
Since the publication of the first results (Hoekstra et al. 2006) a number of things have improved:

- ✓ Reduced systematics
- ✓ Larger area observed (we can probe larger scales)
- ✓ Improve estimates of cosmological parameters using photo-z's

The latest results, based on the analysis of 57 sq. deg. spread over 3 fields will be published in Fu et al. (2007)

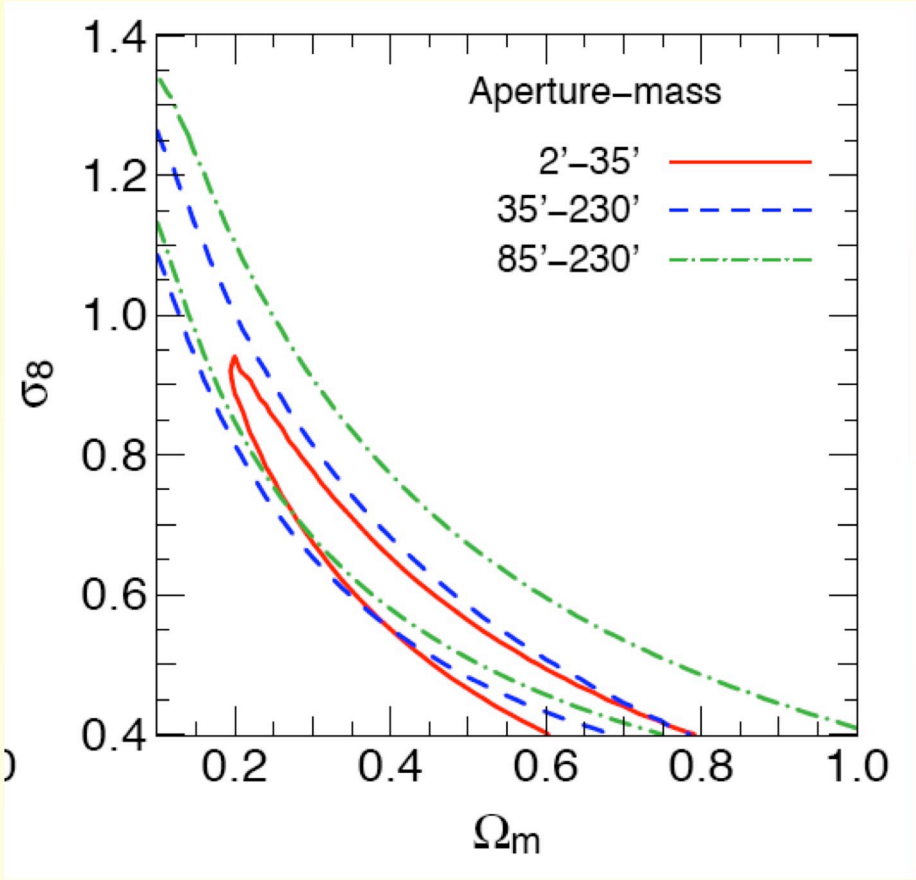
CFHTLS: the measurement





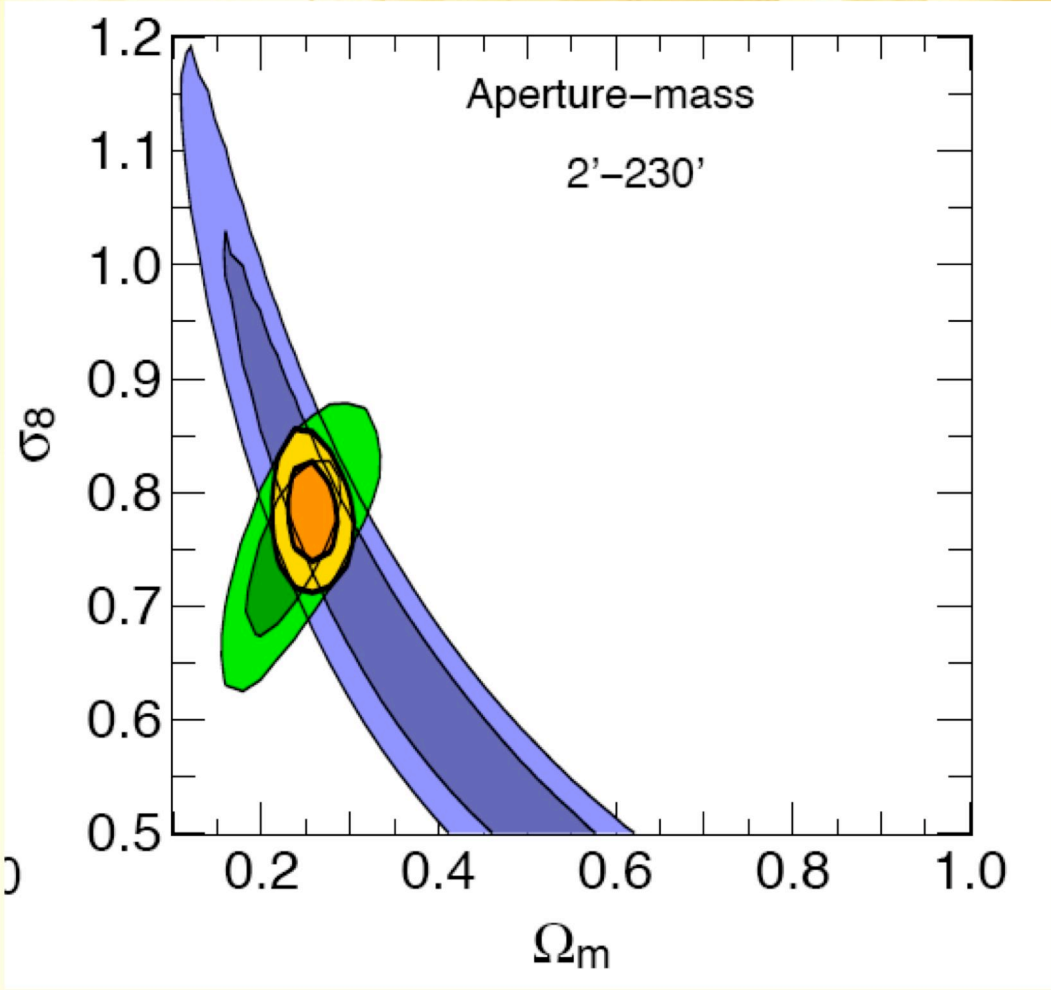
Measurements out to
4 degree scales!

CFHTLS: recent results



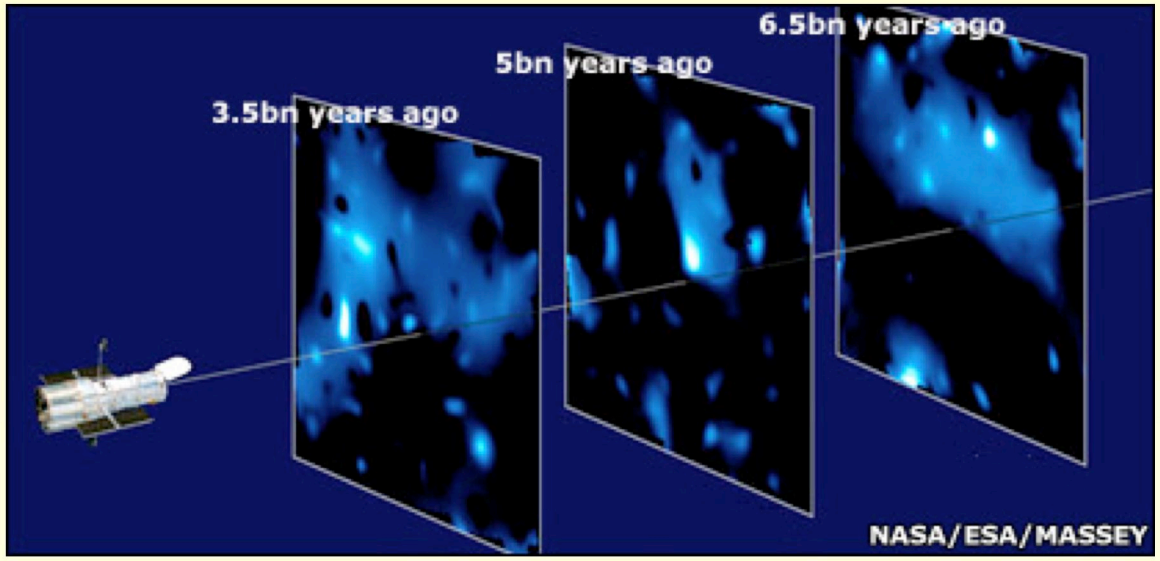
Cosmology is “scale independent”: non-linear corrections sufficient so far.

CFHTLS: recent results



Results agree well with WMAP3!

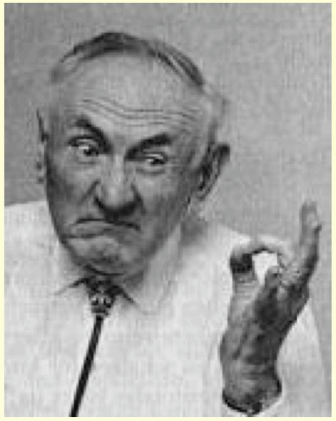
What to do next?



Currently ~35 sq. deg. of data have the full *ugriz* coverage and photometric redshift are being determined.

With photometric redshift information for the sources we can study the growth of structure, which significantly improves the sensitivity to cosmological parameters.

Conclusions



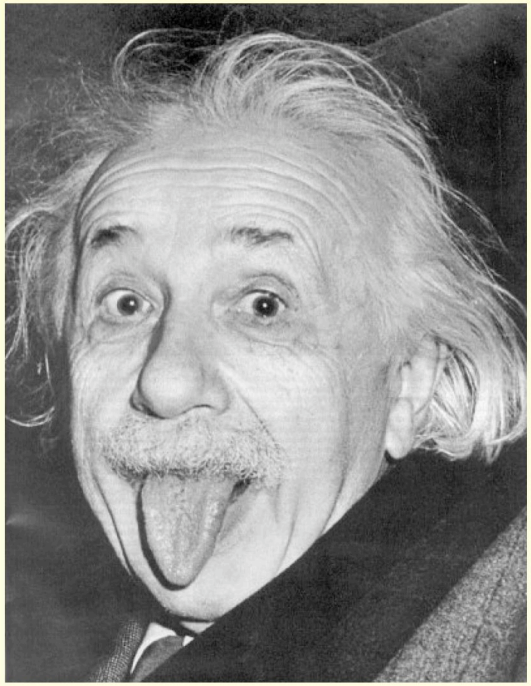
The measurement of the cosmic shear signal using CFHTLS data is progressing well.

The use of photometric redshifts for the sources should lead to a dramatic improvement in the determination of cosmological parameters.

BUT…

There is some(?) work left…

We need to improve our knowledge of:



Source redshift distribution
- ❑ photometric redshift from the survey data
- ❑ deep (photometric) redshift surveys

Non-linear power spectrum
- ❑ large numerical simulations
- ❑ good initial conditions

Intrinsic alignments of galaxies
- ❑ can be measured using photometric redshifts

Observational systematic effects
- ❑ Improved correction schemes
- ❑ Detailed simulations