Weak lensing introduction

Mass bends light

$\Rightarrow$ Coherent distortion in ellipticities of distant galaxies by foreground "cosmic web"

$\Rightarrow$ Measure dark matter directly, independently of galaxy bias

– Typical shear distortion is ~1%

– Need to measure with accuracy ~0.1%

– But shear distortions from systematic effects e.g. seeing ~10%

Control of psf is most serious limitation for ground–based weak lensing surveys

Requirements for weak lensing surveys

– Very high image quality
(high–quality and stable psf)
for accurate shape measurement

– High surface density
(10 – 100 $arcmin^{-2}$)
to reduce statistical noise

– Wide survey area
(few deg^2)
to reduce cosmic variance

Performance on science depends on trade–off between these variables

Science experiment (1): "cosmic shear power spectrum"

– Measure the correlation of galaxy shears as a function of angular scale

First application:

– Measurement of amplitude of matter power spectrum (σ_8)

[shear depends on amount of clustered matter in the way]

The next step:

– Cosmic parameters such as dark energy

[shear depends on cosmic distances]

But we need:

– Accurate knowledge of power spectrum and survey redshift distribution

– Survey of 100s deg^2

The competition

– Current state–of–the–art:

~ 10 deg^2 in optical wavebands

[Techique proven; measurement of σ_8 to ~10%]

– In 5 years:

~ 100 deg^2 (CFHT Legacy; Subaru)

[better statistics]

– In 10 years:

~ 10,000 deg^2 (VISTA, LSST)
~ 300 deg^2 from space (SNAP)

[Accurate measurement of dark energy parameters; use of bispectrum; divide into redshift slices]

– Although:

With increasingly accurate shear measurements, control of systematics is increasingly important

Science experiment (2): "Dark matter profiles of clusters"

– Measure shear pattern around specific clusters (selected by e.g. X–rays)

Re–construct gravitational potential from shear

– Compare with CDM theories
– Compare light and mass distributions

Currently, this has been done for 10s of clusters, and also from space (HST)

Need wider–field niche:

– Look at outskirts of clusters to discriminate dark matter profiles

– Target known superclusters to probe filamentary structure/cosmic web

Best observing waveband?

K−band? (Need to reach K~23)

Advantages:

– Get out to high redshift more easily
– Galaxy shapes "smoother"

Disadvantages:

– Higher sky background
– More expensive detectors

R−band? (Need to reach R~23)

Advantages:

– Sharper images (diffraction limit)
– Know redshift distribution pretty well

Disadvantages:

– Smaller (AO−corrected) field−of−view