Constraining Dark Energy from the Abundance of Weak Gravitational Lenses (astro-ph/0210134)

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Dark energy: cosmological constant or quintessence?

- Goal: determine dark energy equation of state $w = p/\rho$
- Cosmological constant $\Rightarrow w = -1$
  Quintessence $\Rightarrow w > -1$
- Different w yield different:
  - distance-redshift relation $[D(z)]$
  - power spectrum amplitude $[\sigma_8]$
  - rate of structure growth $[g(z), \delta_{\rm c}, \Delta_{\rm vir}]$

$\Rightarrow$ predicted abundance of weak lenses changes with w

Method:

→ find minimum overdensity, $\Delta_{\rm min}$, for detectable weak lensing signal

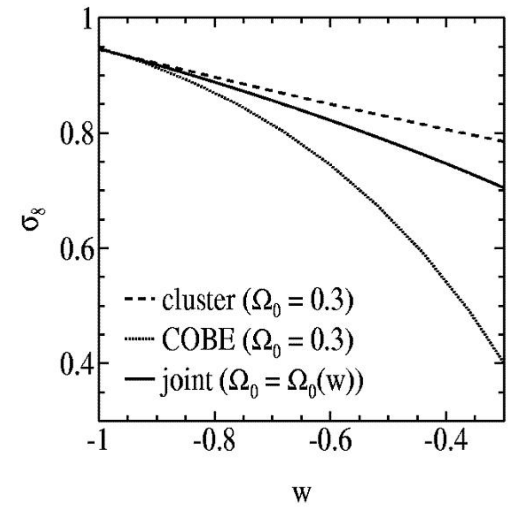
→ solve spherical-top-hat-collapse with dark energy ⇒ combining with PS mass function get differential abundance of weak lenses

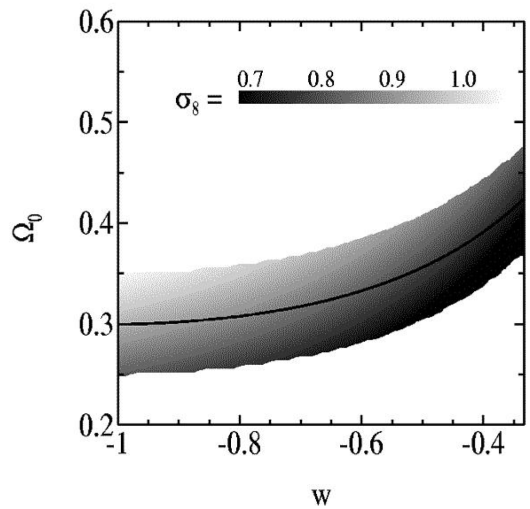
→ 3 possible methods of constraining w using weak lens abundances:

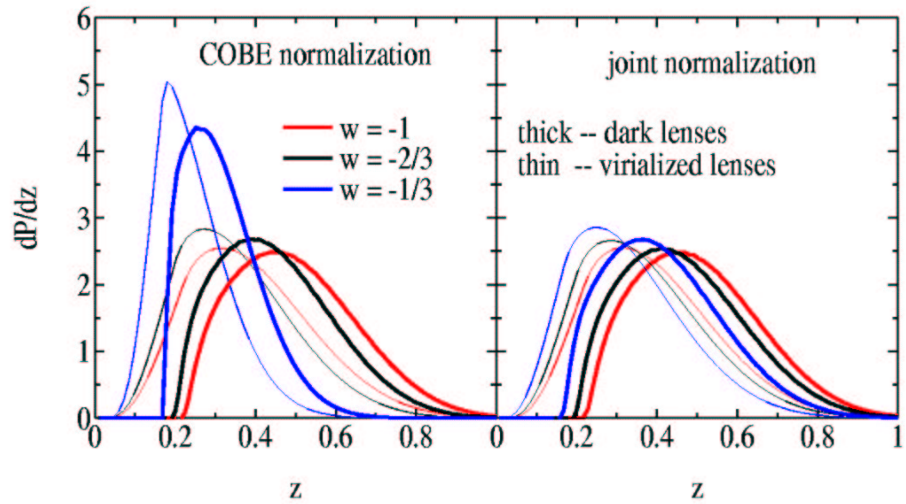
- redshift distribution
- number count
- fraction of lenses that are dark

Footnotes:

1. can have $\Delta_{\rm min} < \Delta_{\rm vir}$ ⇒ X-ray underluminous (i.e., dark) lenses (observed? Miralles et al. 2002, Erben et al. 2000...)
2. for $w \neq -1$ space curvature inside evolving overdensity time dependent

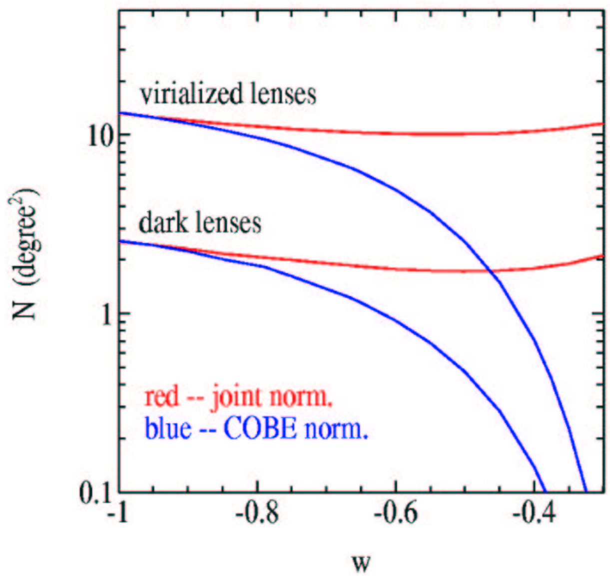






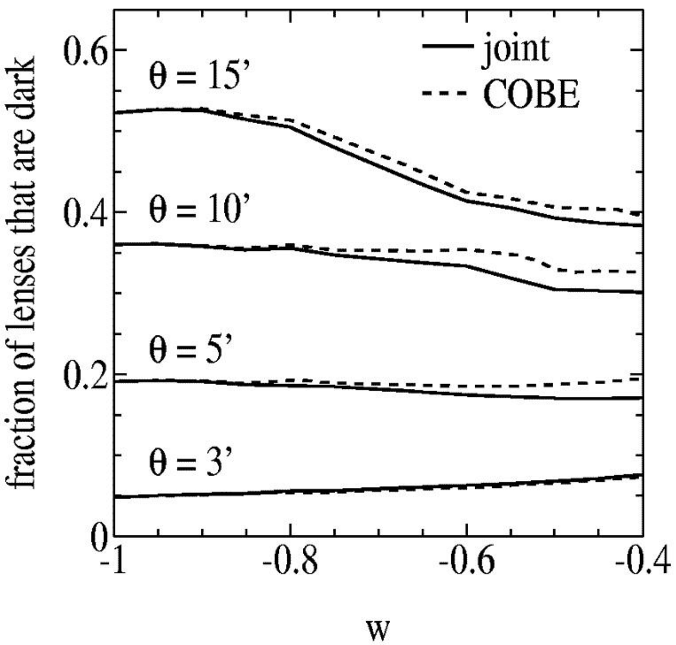
K-S test ⇒

- 200 lenses (~ 15 deg^2) to differentiate $w = -1$ from $w = -0.6$ to 3σ
- 2000 lenses (~ 150 deg^2) to differentiate $w = -1$ from $w = -0.9$ to 3σ



- for a fixed cosmological model ⇒ ~ 40 deg^2 to differentiate $w = -1$ from $w = -0.9$ to 3σ
- given current uncertainties in Ω_m ⇒ ~ 90 deg^2 to differentiate $w = -1$ from $w = -0.9$ to 3σ

→ but fairly big systematic uncertainties (noise in lensing map, density profile. . .)



- not very sensitive to noise in weak lensing maps or uncertainties in cosmological parameters
- ~ 50 deg^2 to differentiate $w = -1$ from $w = -0.6$ to 3σ