Magnification & dust reddening by galaxies and large-scale structures

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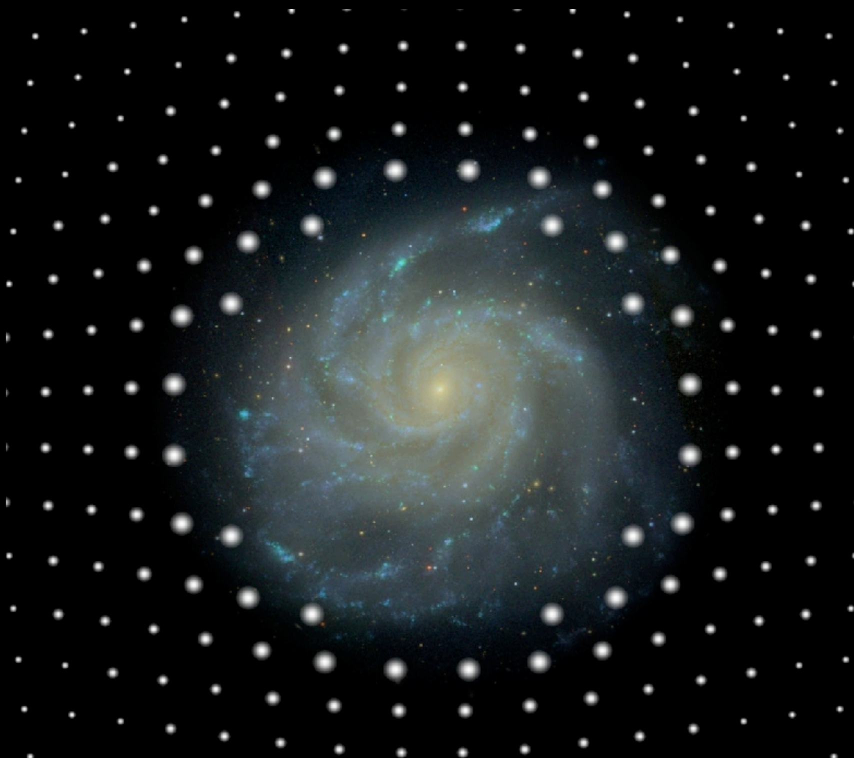
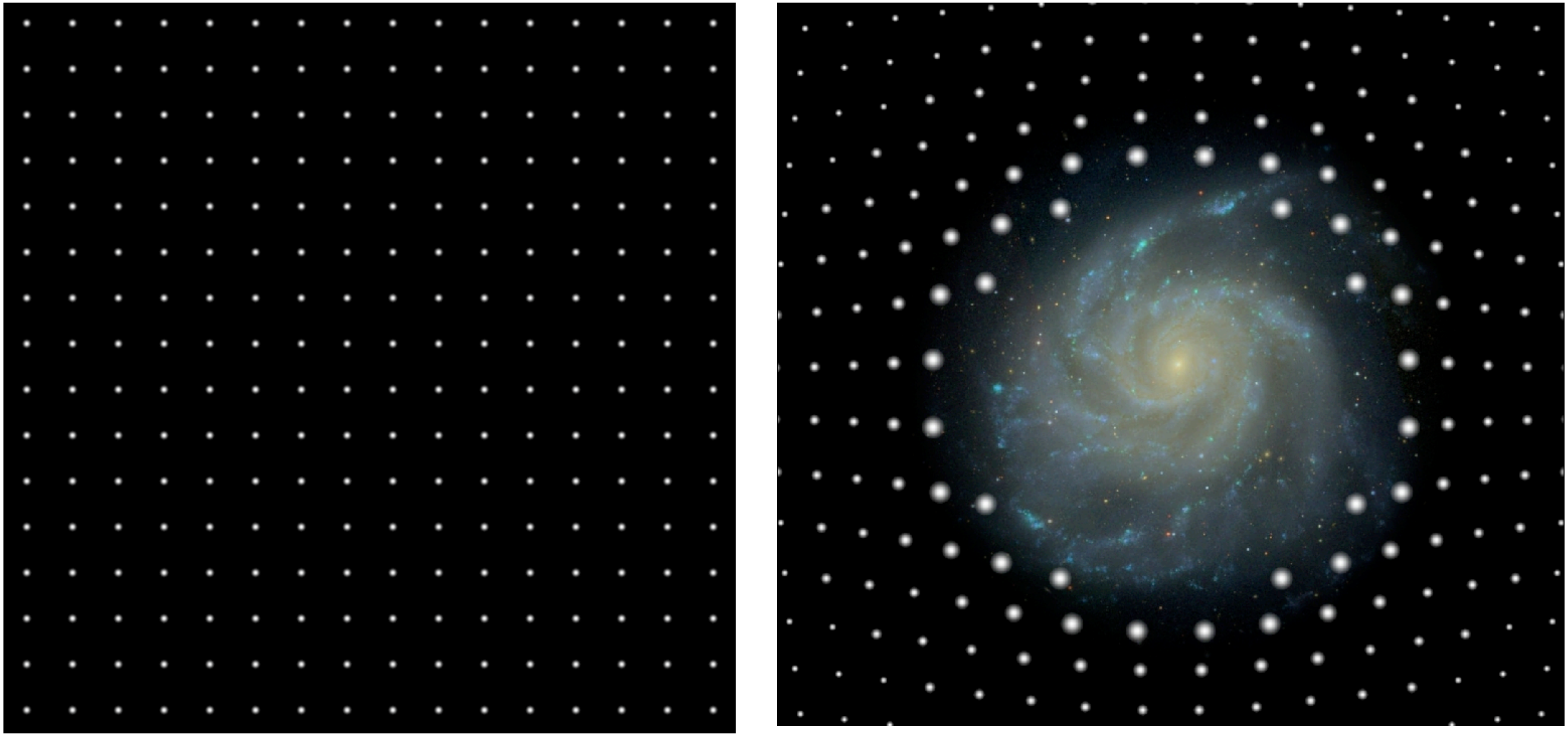


in collaboration with

Ryan Scranton
Masataka Fukugita
Gordon Richards

Gravitational magnification of point sources



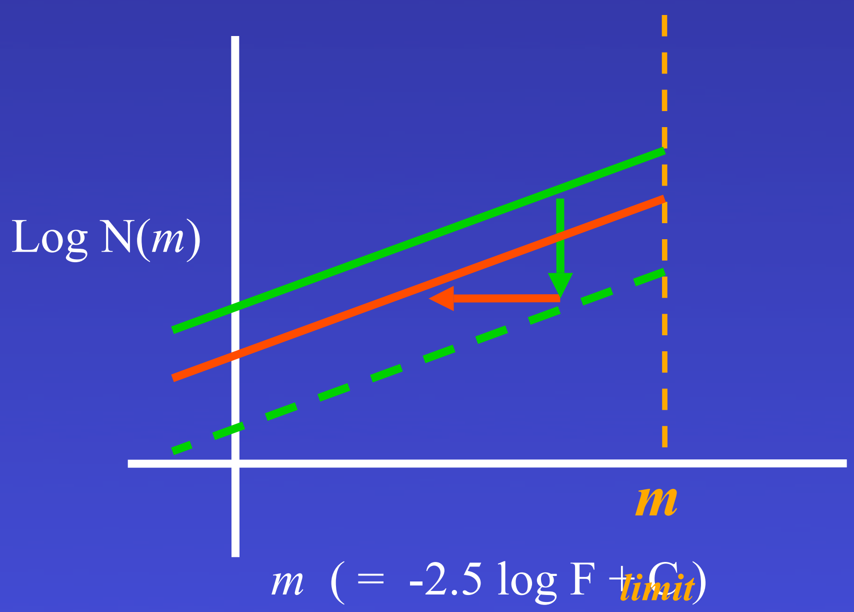
Measuring magnification effects

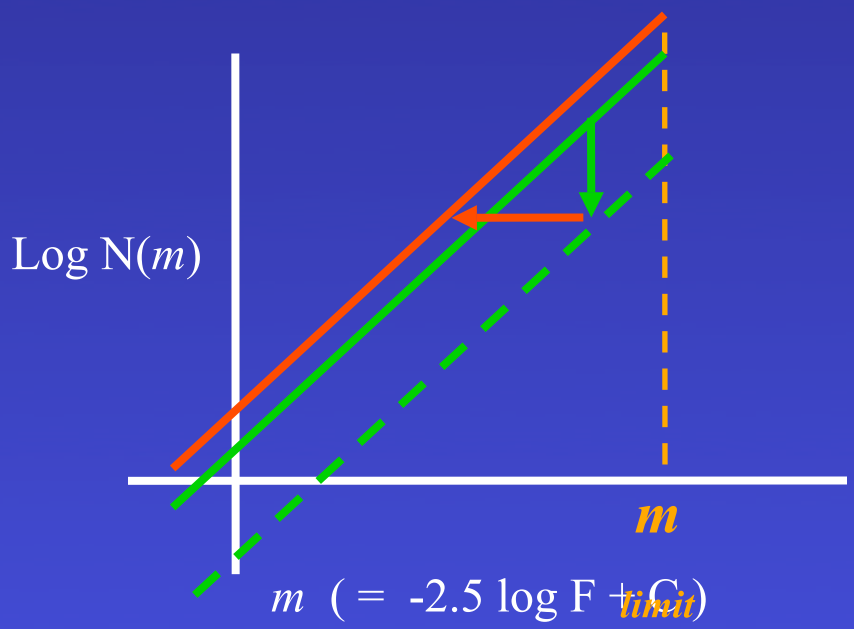
- <u>for an isolated source</u>: $L_{obs} = \mu\, L_0$

Dilatation of the sky solid angle

- <u>for an ensemble of sources</u>: $n_{obs}(>L) \;=\; 1/\mu \;\; n_0(>L/\mu)$

Fainter objects become detectable





Measuring magnification effects

Dilatation of the sky solid angle

- for an isolated source: $L_{obs} = \mu \, L_0$
- for an ensemble of sources: $n_{obs}(>L) \;=\; 1/\mu \;\; n_0(>L/\mu)$

Fainter objects become detectable

if $n_0(>L)$ / $L^{-2.5\alpha}$ then

$$n_{obs}(<m) = \mu^{\alpha-1} \, . \, n_0(<m)$$

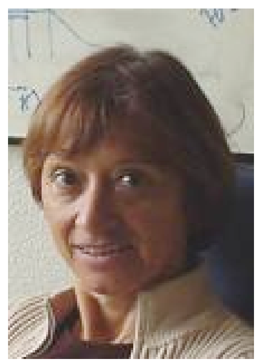
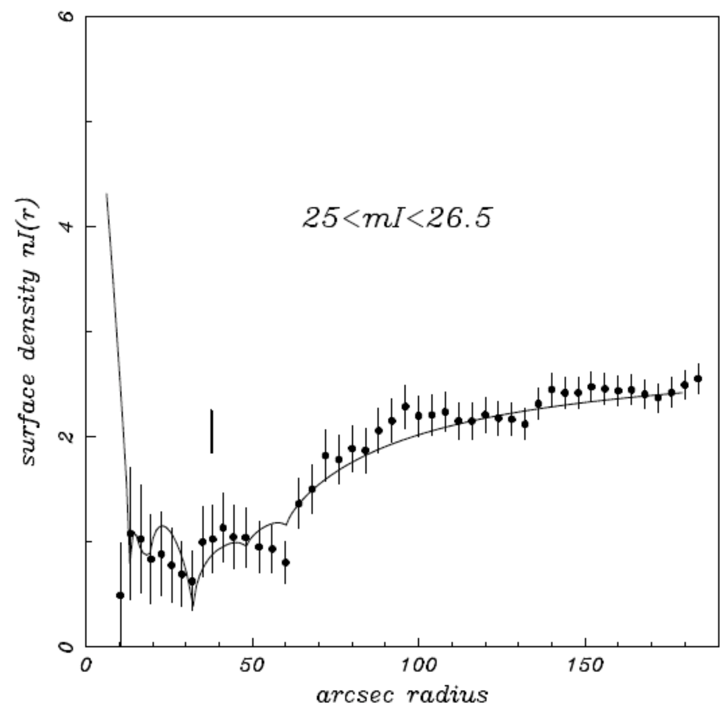
if $\mu = 1 + \delta\mu$ then

$$n_{obs}(<m) = (\alpha-1) \, . \, \delta\mu \, . \, n_0(<m)$$

The magnification bias

- Webster et al. (1988) — excess of QSOs around foreground galaxies
- Narayan (1989)
  Schneider (1989) — Lensing => QSO-galaxy correlations
- Broadhurst (1995) — Magnification bias detected from A1689
- Fort, Mellier & Dantel-Fort (1996) — Magnification bias detected in Cl 0024+1654



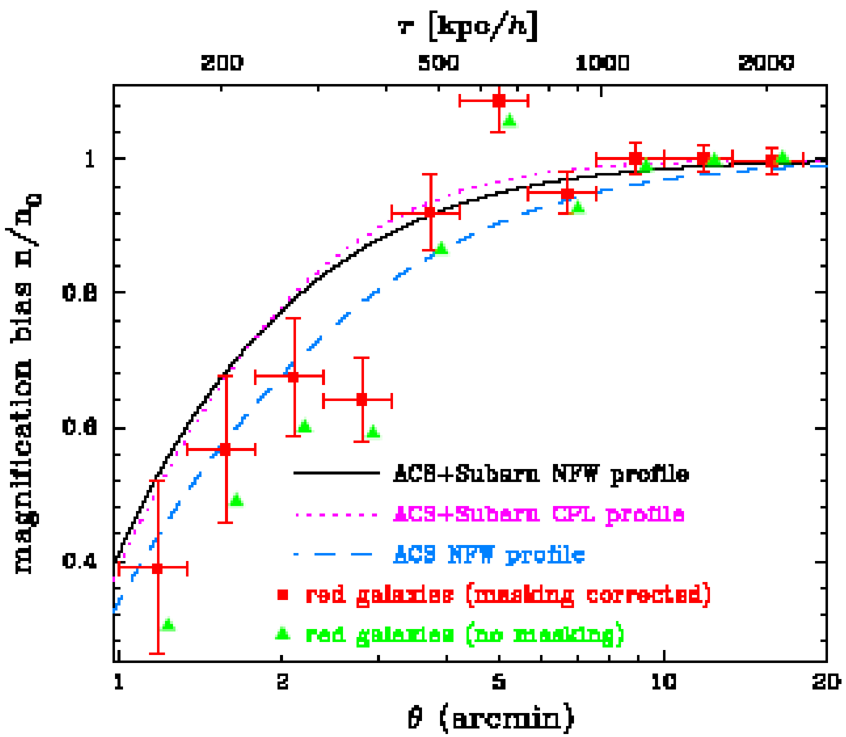



Magnification bias around clusters

- Webster et al. (1988) — excess of QSOs around foreground galaxies
- Narayan (1989), Schneider (1989) — Lensing => QSO-galaxy correlations
- Broadhurst (1995) — Magnification bias detected from A 1689
- Fort, Mellier & Dantel-Fort (1996) — Magnification bias detected in Cl 0024+1654

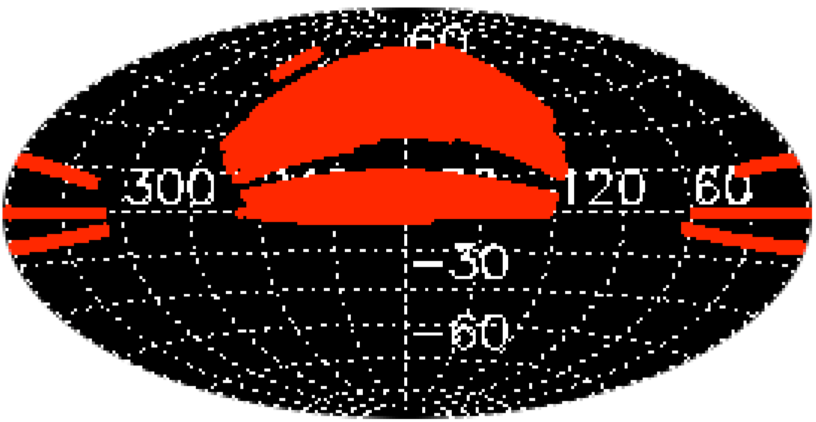
...

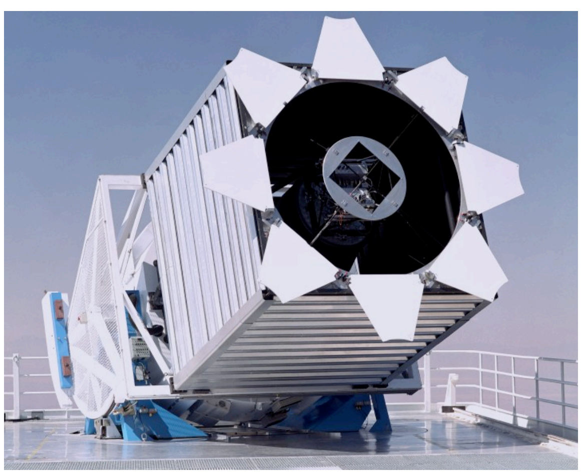
- Broadhurst et al. (2004)



The magnification bias with the SDSS

Scranton, Ménard et al., 2005





- 5000 deg^2
- 225,000 photometric quasars with photoZ > 1
- 13.5 million galaxies

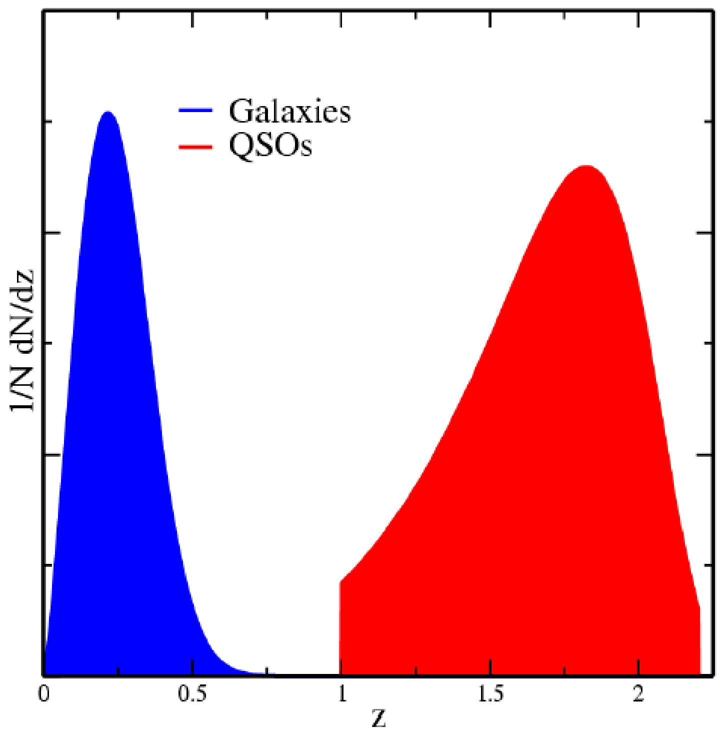
Both quasars and galaxies come from the same photometric survey

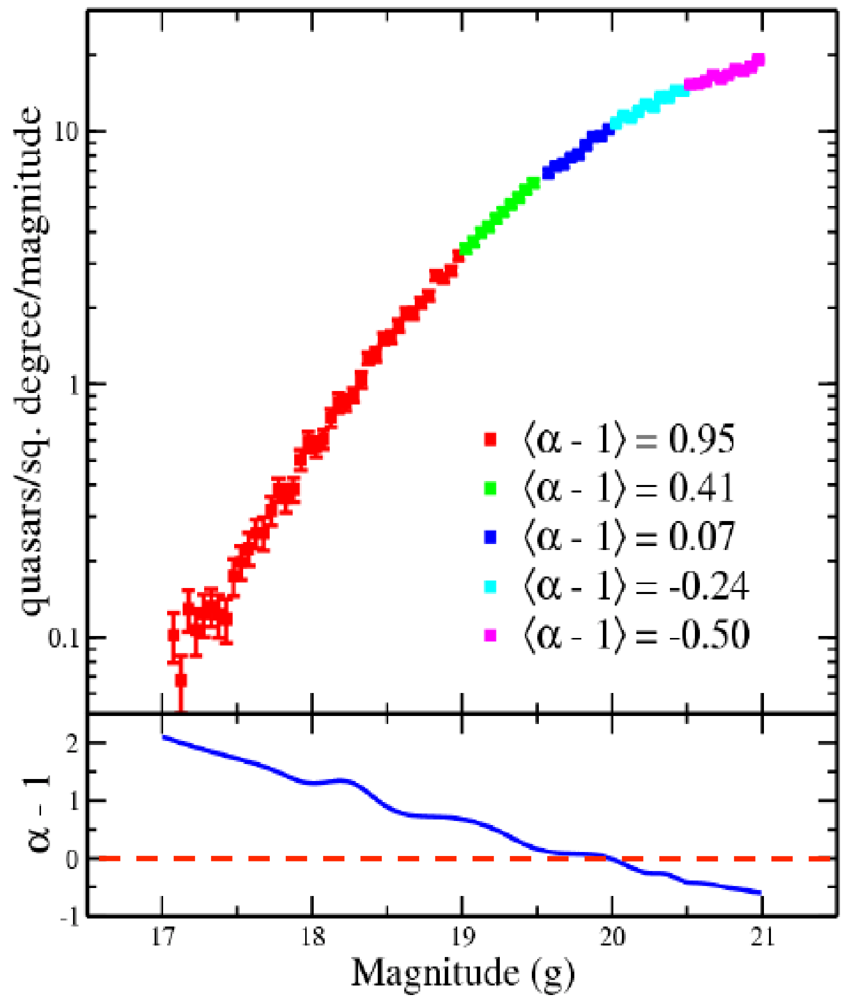
- masks applied around bright objects
  and bad seeing regions

Analysis with the Sloan Digital Sky Survey

Scranton, Ménard et al., 2005

redshift distributions

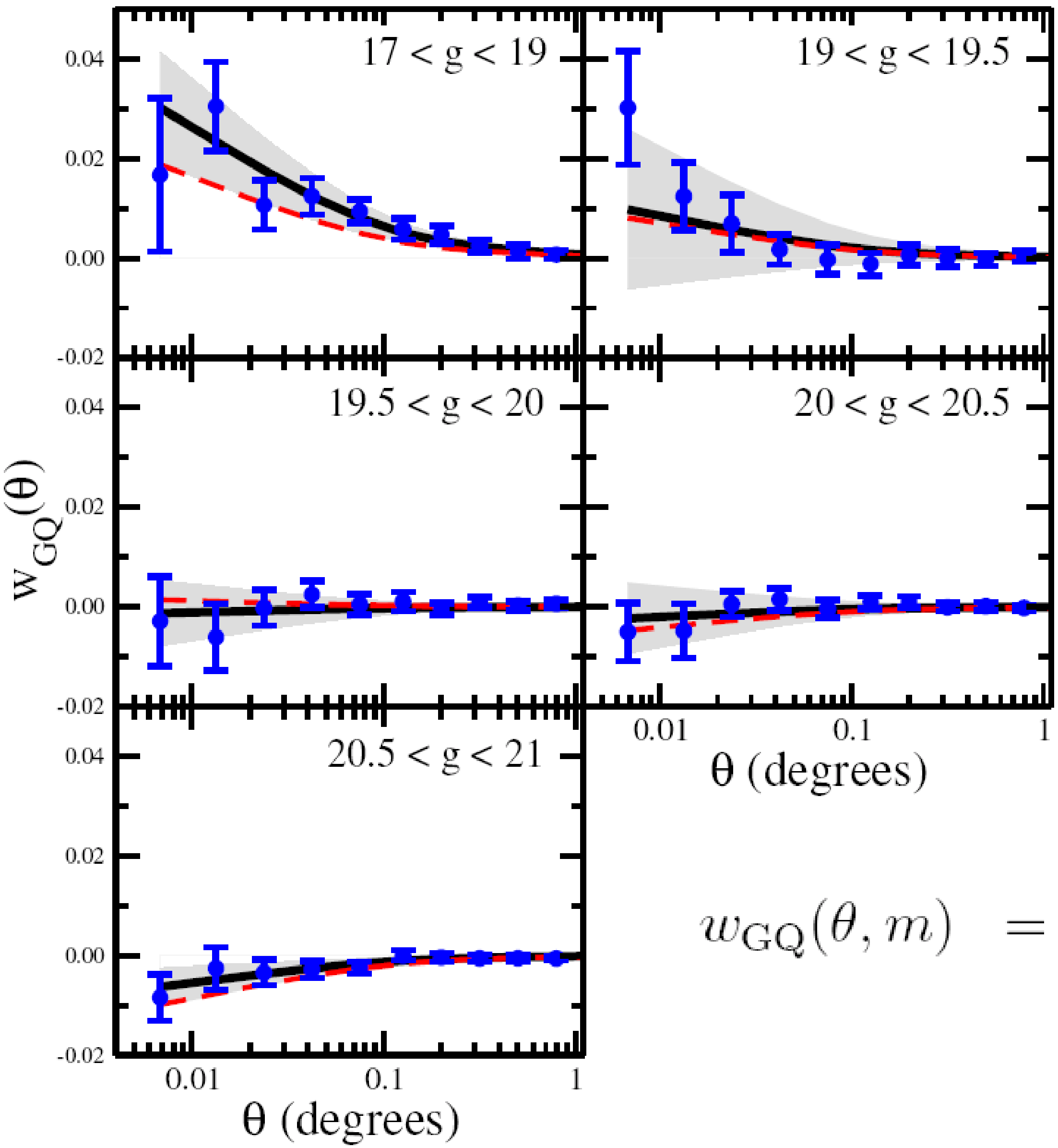




GOAL: to demonstrate that the signal is due to lensing

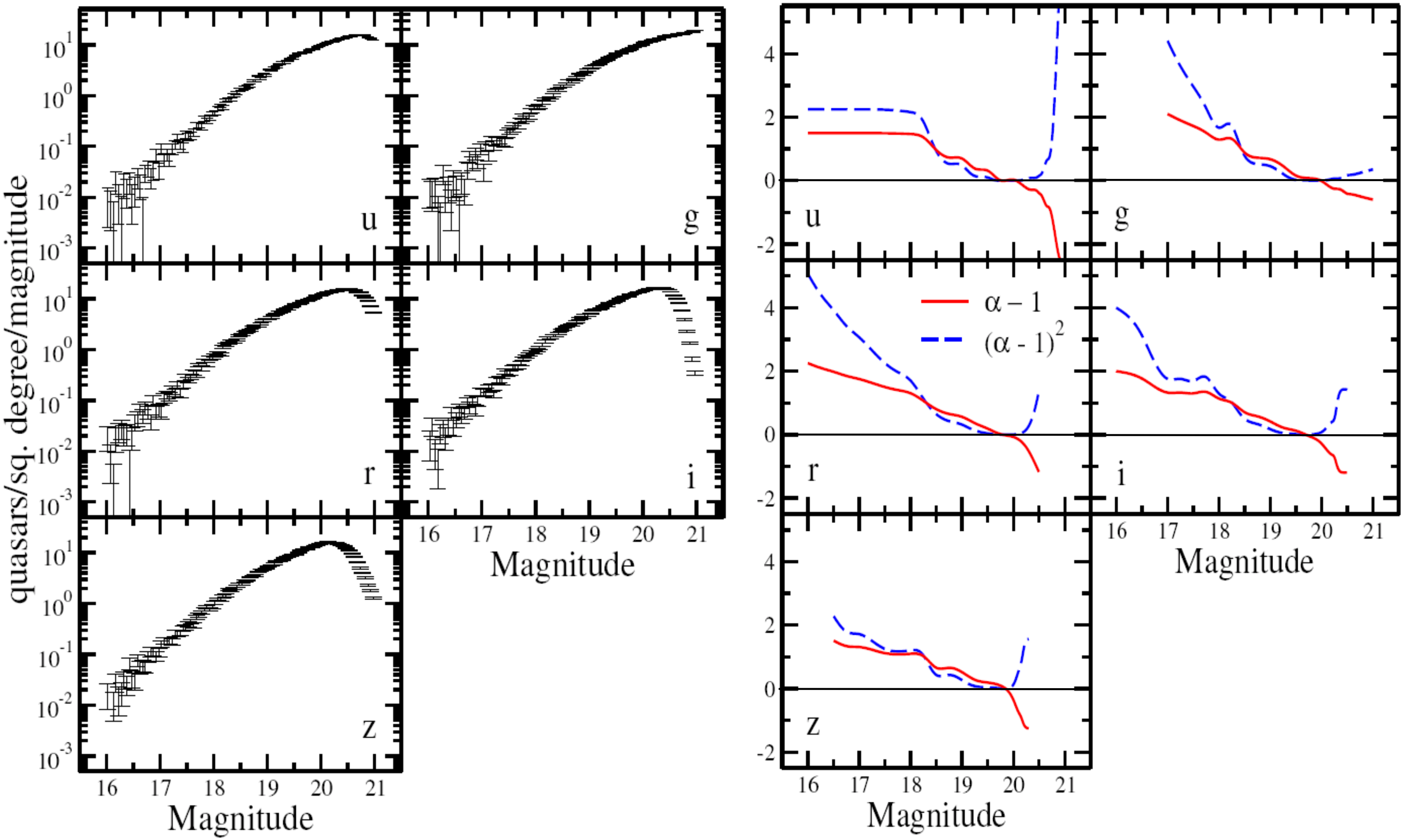
$$W_{QG}(\theta) = 2 \left[\alpha(\mathbf{m}) - 1 \right] < \kappa \, \delta_g >$$

Detection of Cosmic Magnification with the SDSS

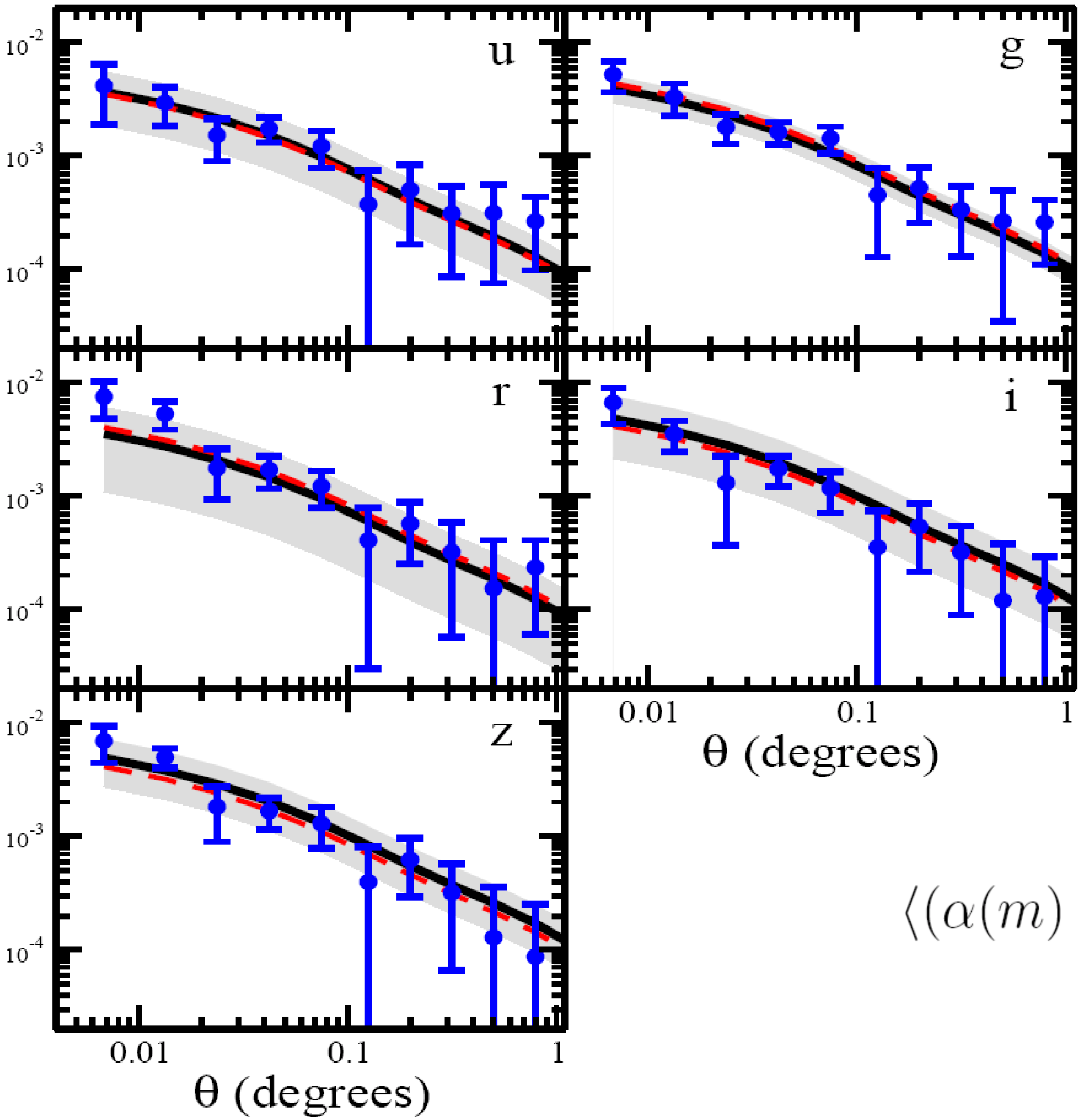


$$w_{GQ}(\theta, m) = (\alpha(m) - 1) \times w_0(\theta)$$

Quasar number counts

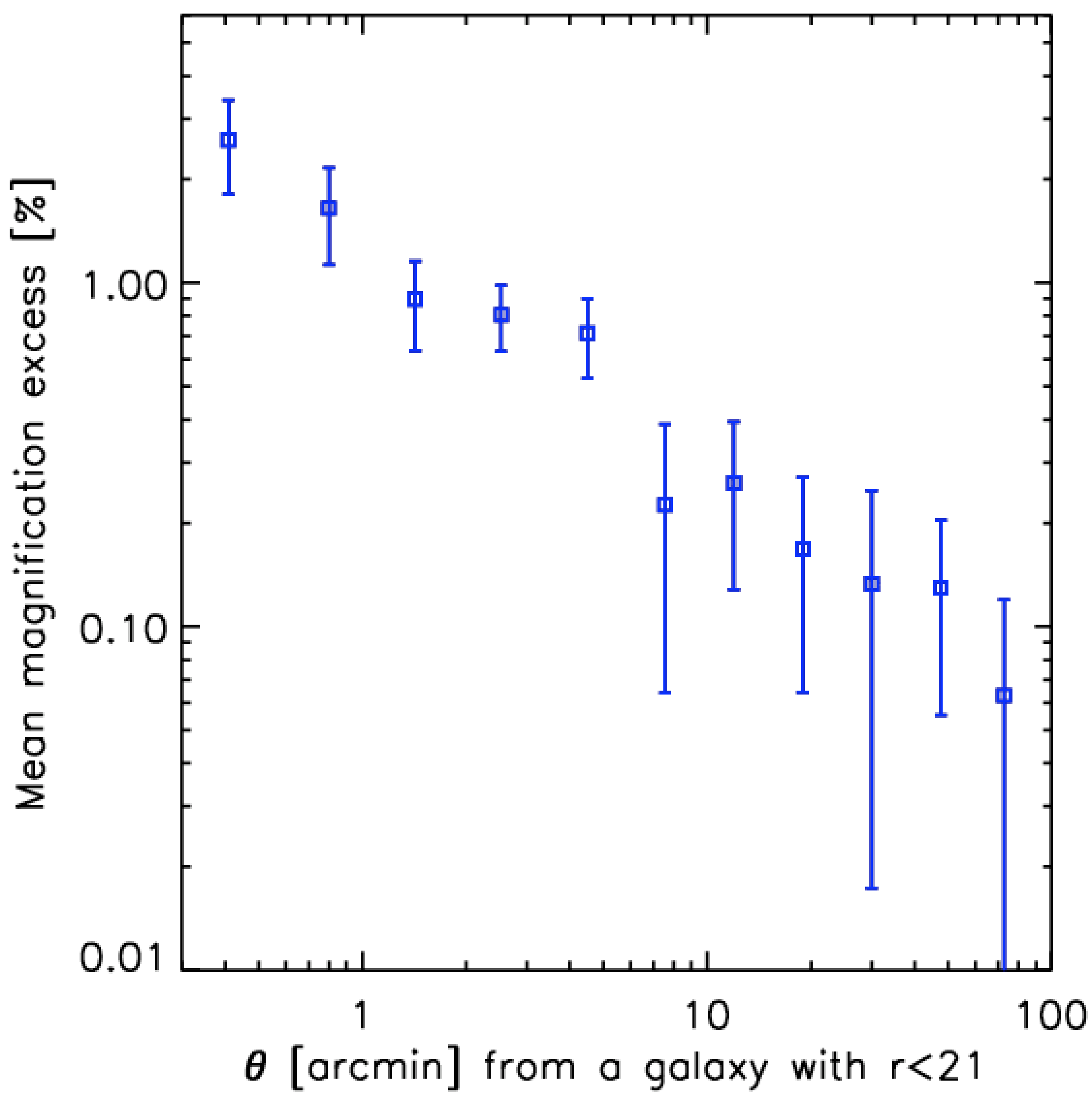


Correlation: Second moment (m)

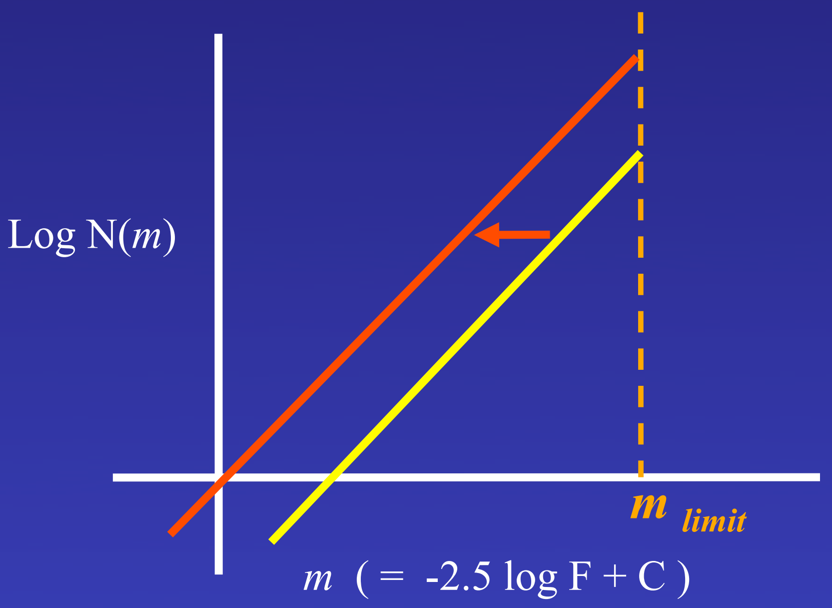


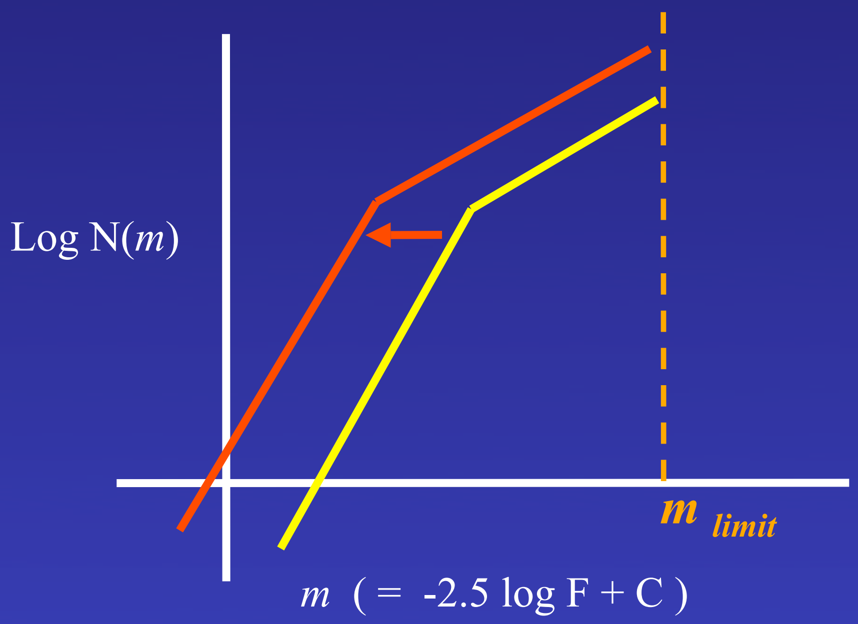
$$\langle(\alpha(m)-1)^2\rangle \times w_0(\theta)$$

Magnification as a function of scale



Measuring magnitude shifts



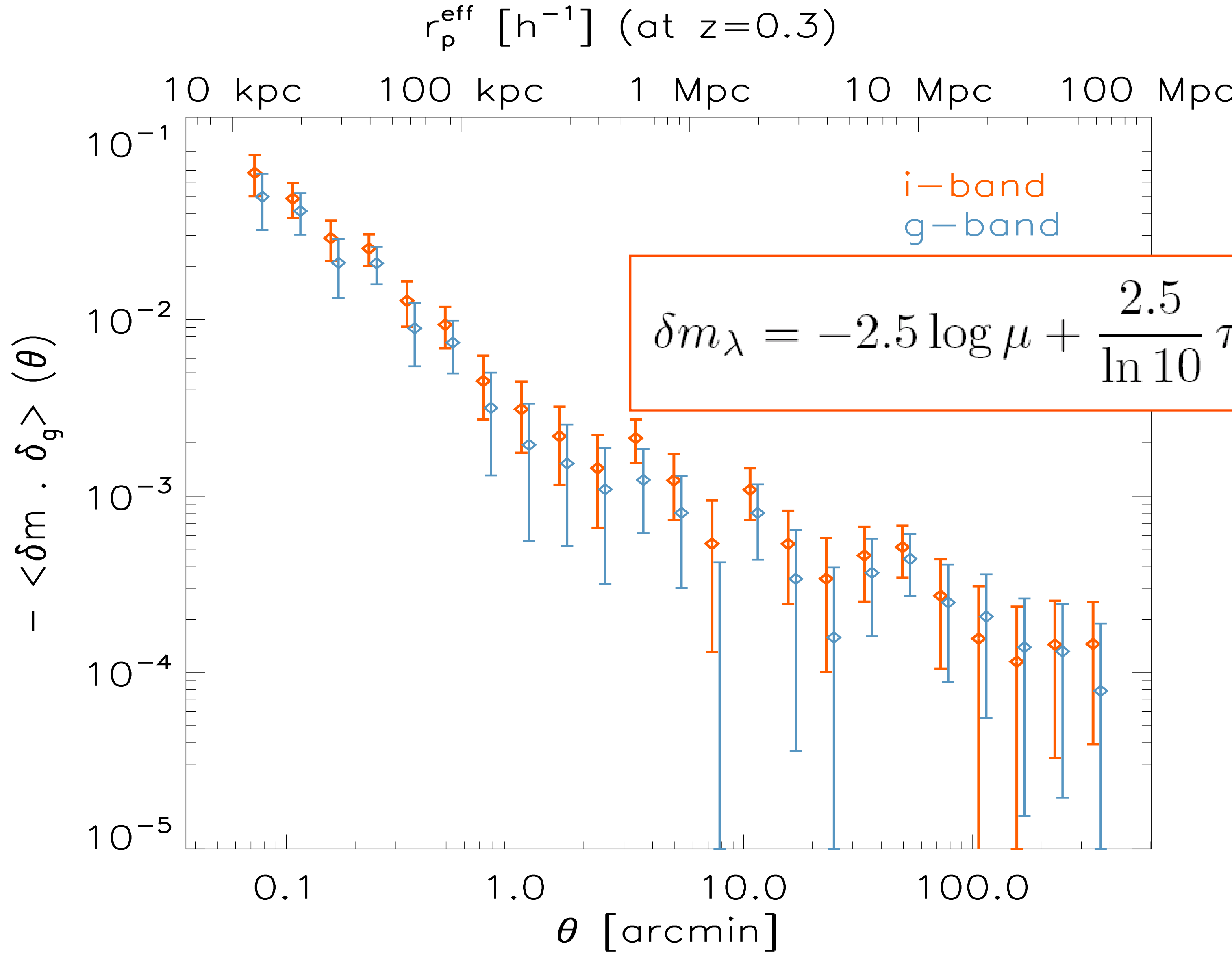


Lensing effects *cannot* be observed

→ Observable effects

Magnitude change: < m_{QSO} . $N_{galaxies}$ > (theta)

Reddening by LSS



$$\delta m_\lambda = -2.5 \log \mu + \frac{2.5}{\ln 10} \tau \left(\frac{\lambda}{1+z} \right)$$

Estimators for the signal

Number count change:
$< N_{QSO} \,.\, N_{galaxies} > (\text{theta})$

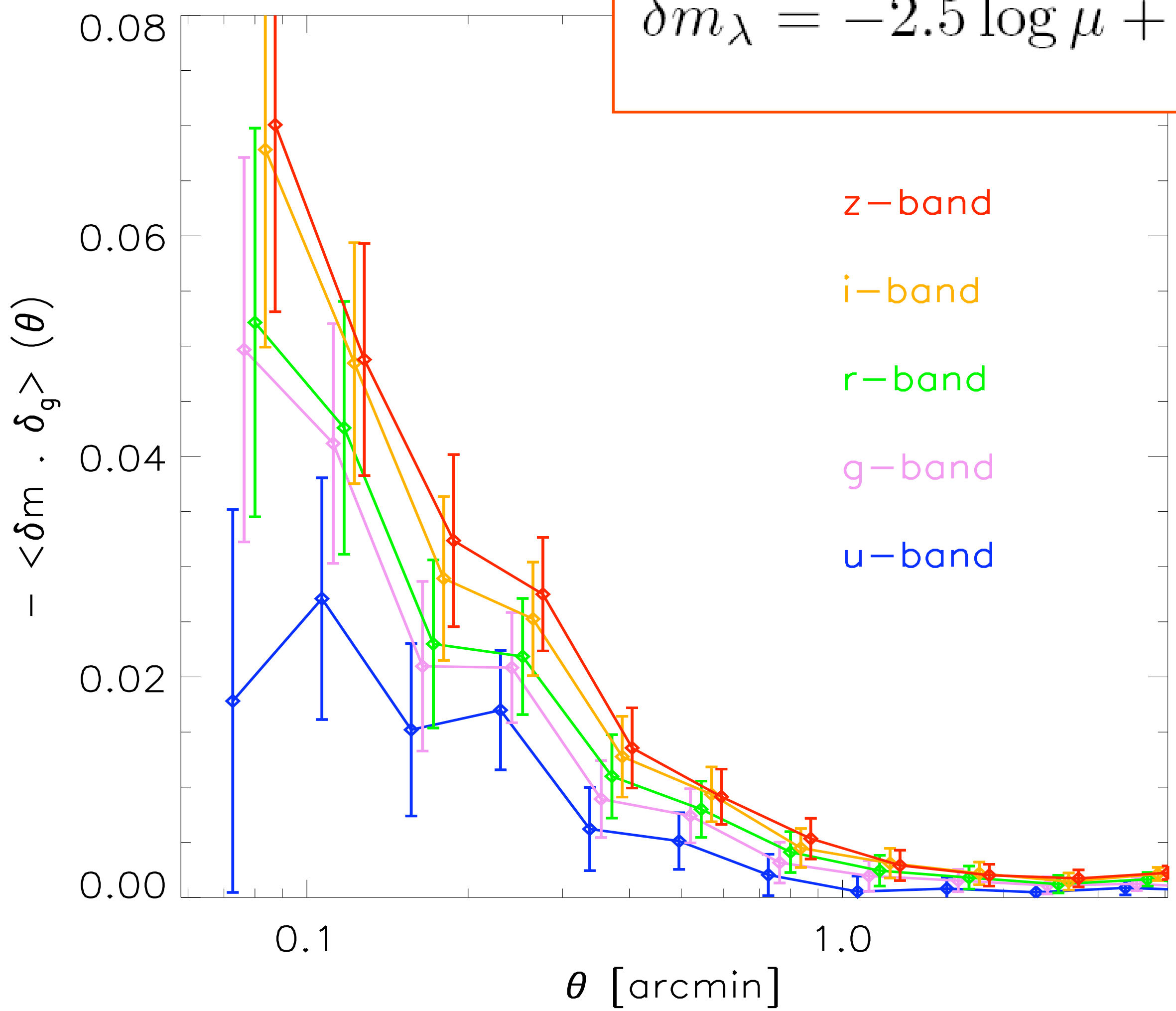
Magnitude change:
$< m_{QSO} \,.\, N_{galaxies} > (\text{theta})$

expected change: $$\delta m_\lambda = -2.5 \log \mu + \frac{2.5}{\ln 10} \tau \left(\frac{\lambda}{1+z} \right)$$

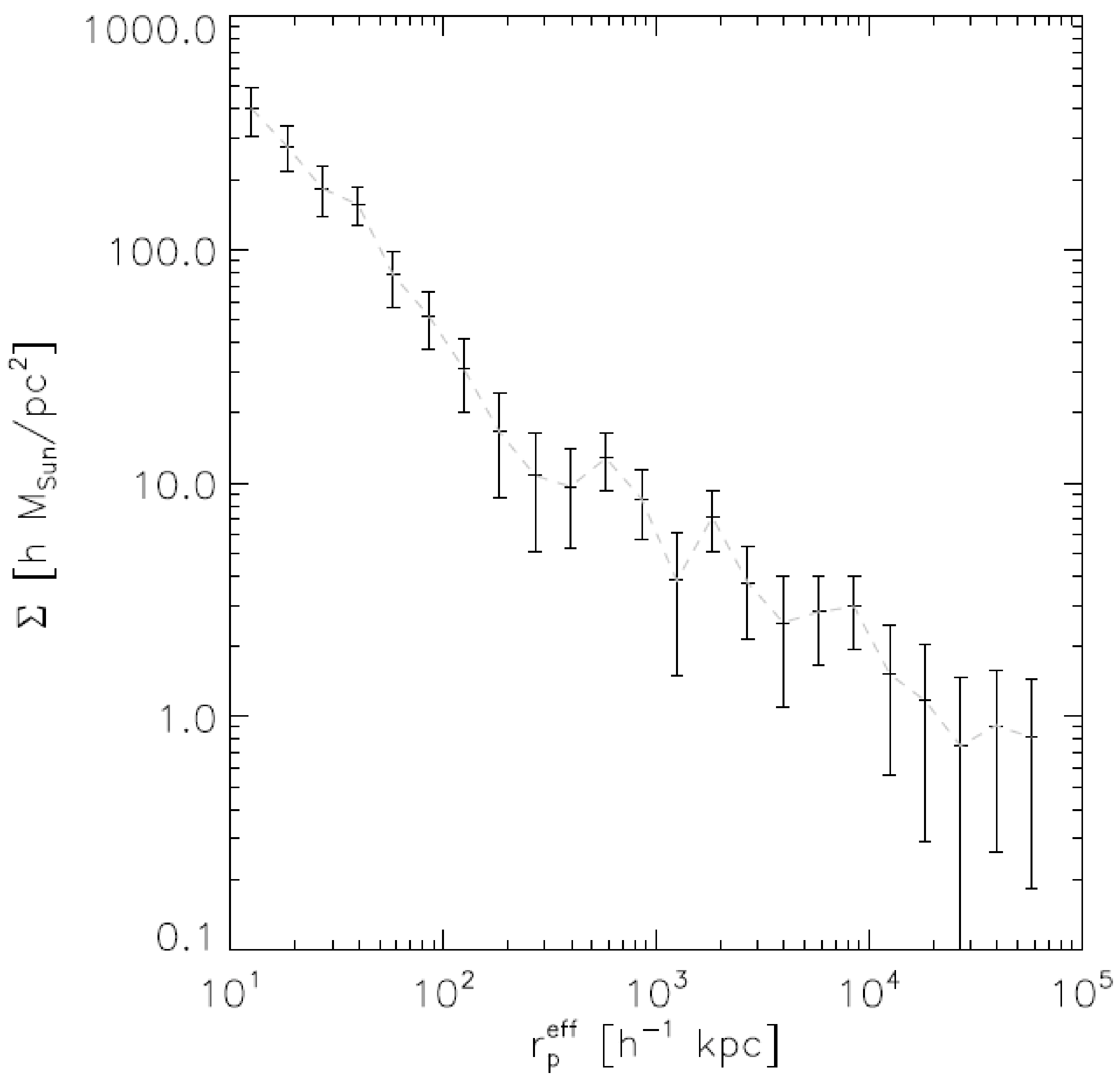
Color change:
$< (m_{QSO} - m_{QSO}') \,.\, N_{galaxies} > (\text{theta})$

Reddening by LSS

$$\delta m_\lambda = -2.5 \log \mu + \frac{2.5}{\ln 10} \tau \left(\frac{\lambda}{1+z} \right)$$

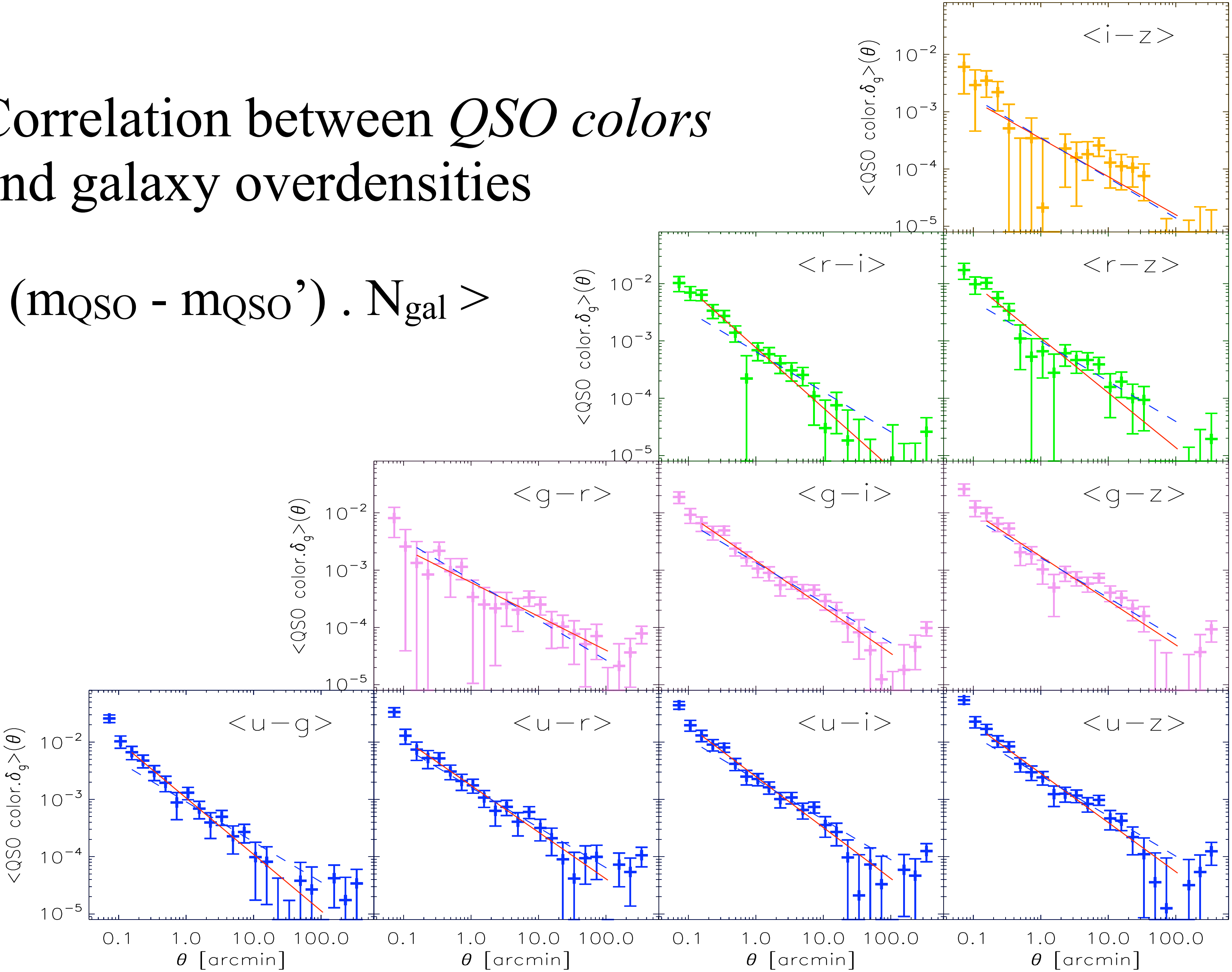


Mass profile from magnification



Correlation between *QSO colors* and galaxy overdensities

$< (m_{QSO} - m_{QSO}') . N_{gal} >$



Menard et al. 2007

Extinction curve

Zaritsky (1994)
“Preliminary evidence for dust in galactic halos”

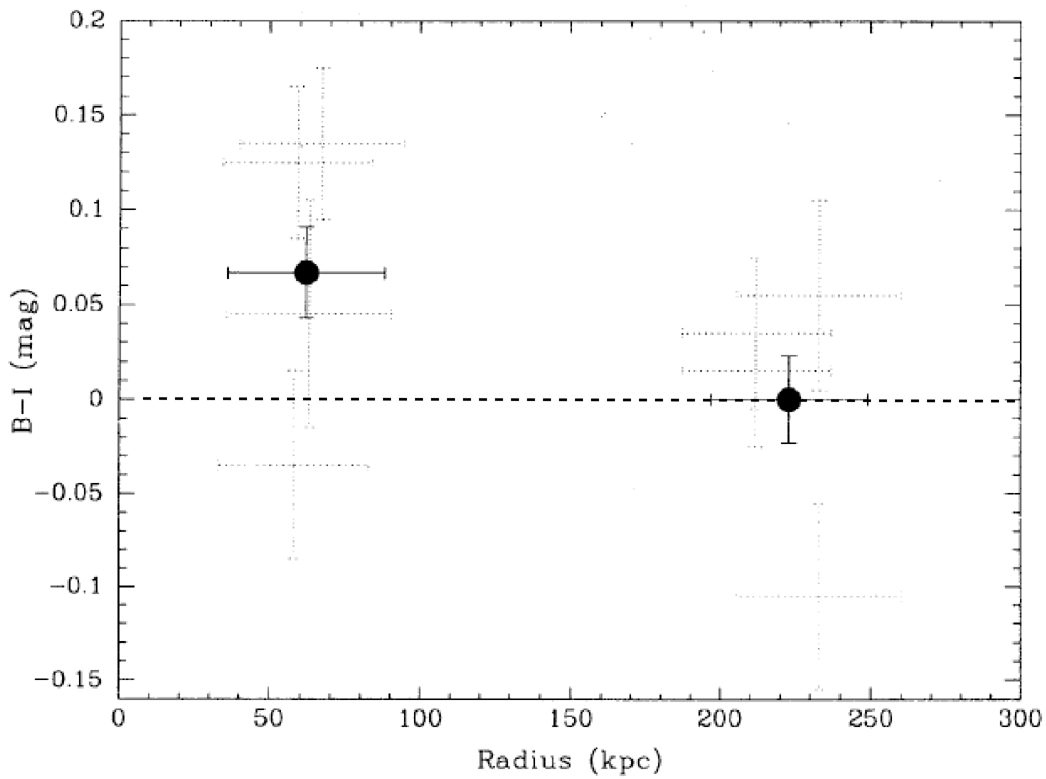
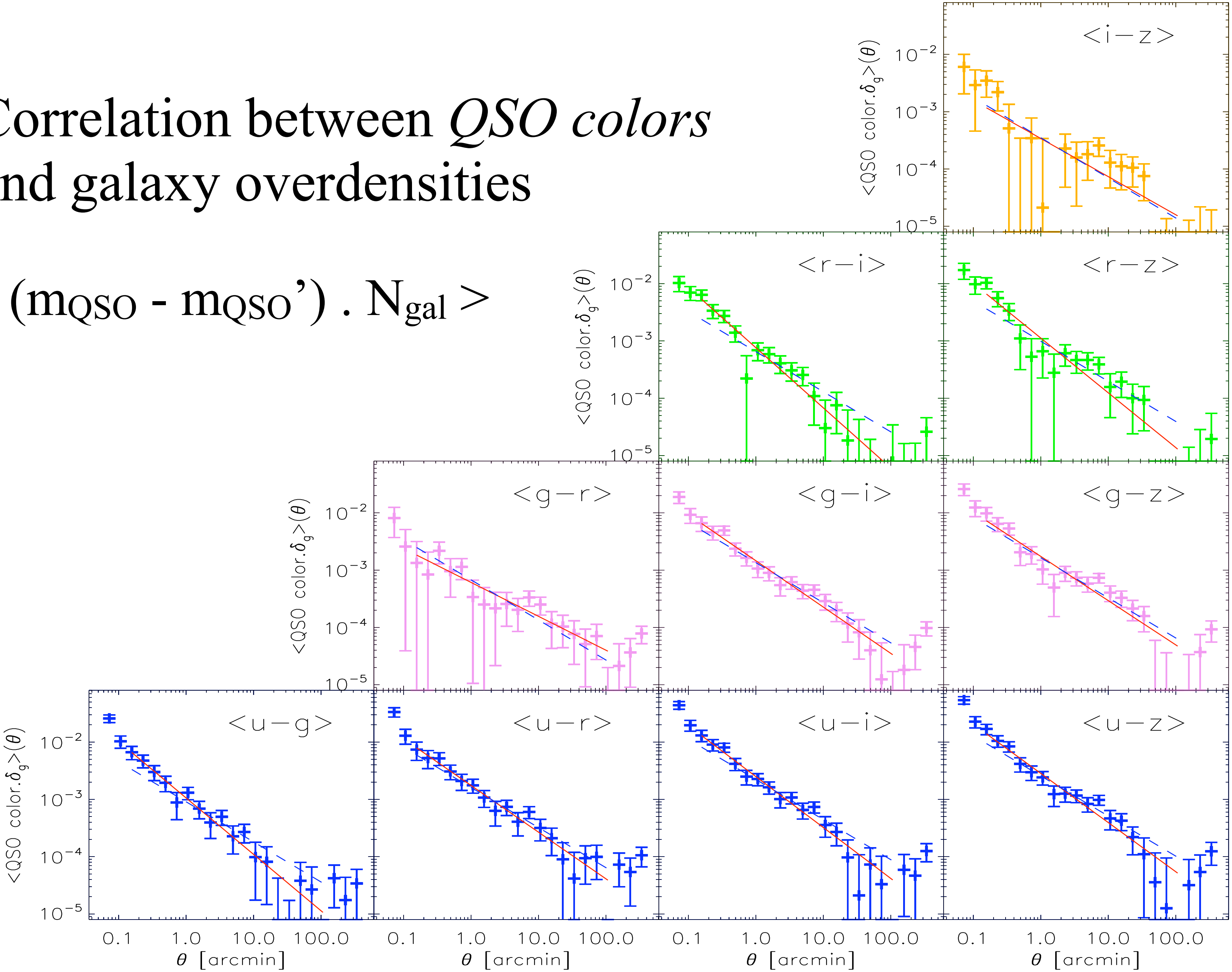


FIG. 5. Color differences for the eight fields are plotted. The colors are normalized to produce zero mean $B-I$ color in the outer fields. Dotted error bar crosses represent results from the individual eight fields, with the height representing the 1σ uncertainty in the color differences and the width rep-

Correlation between *QSO colors* and galaxy overdensities

$< (m_{QSO} - m_{QSO'}) . N_{gal} >$



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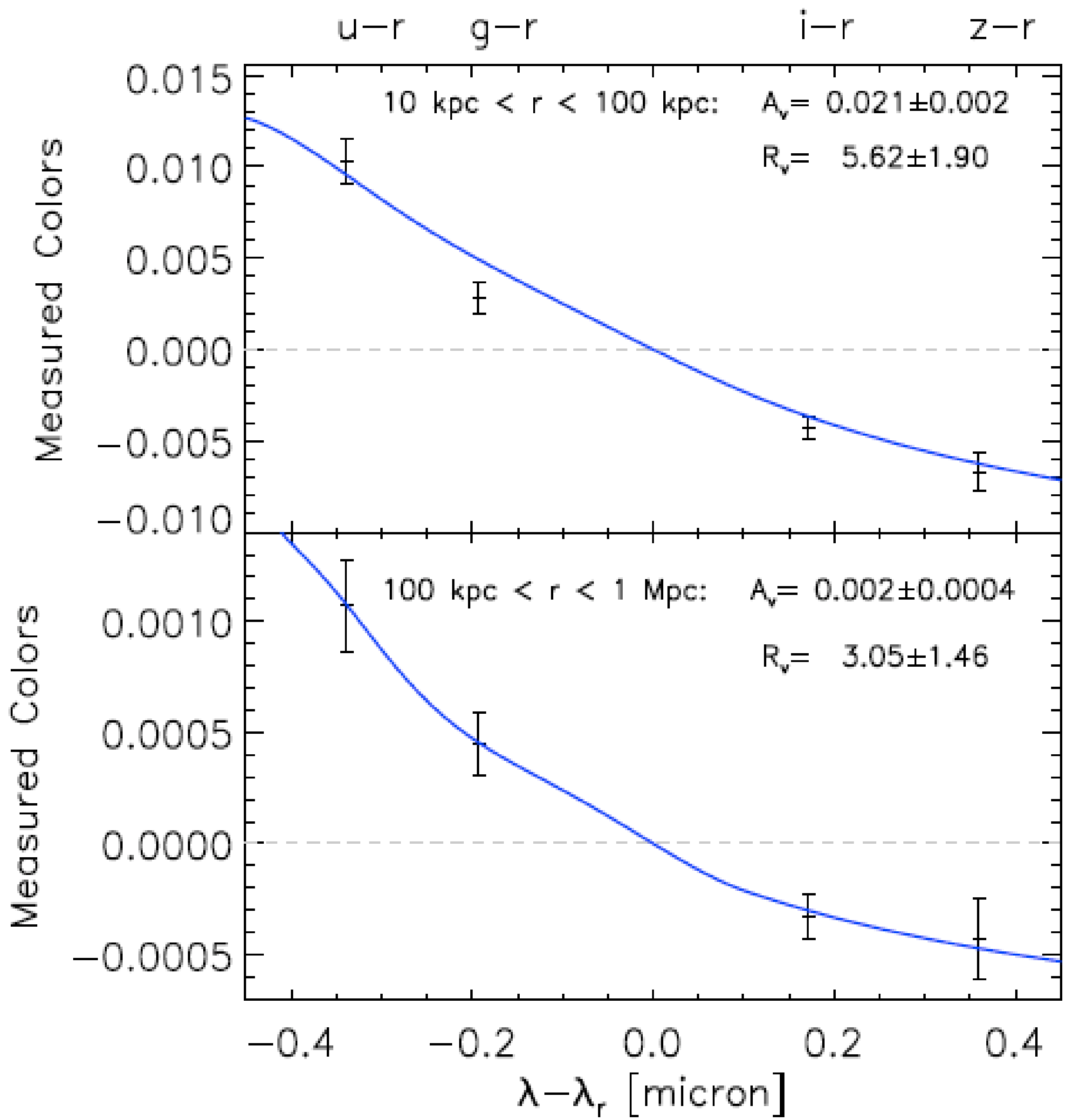
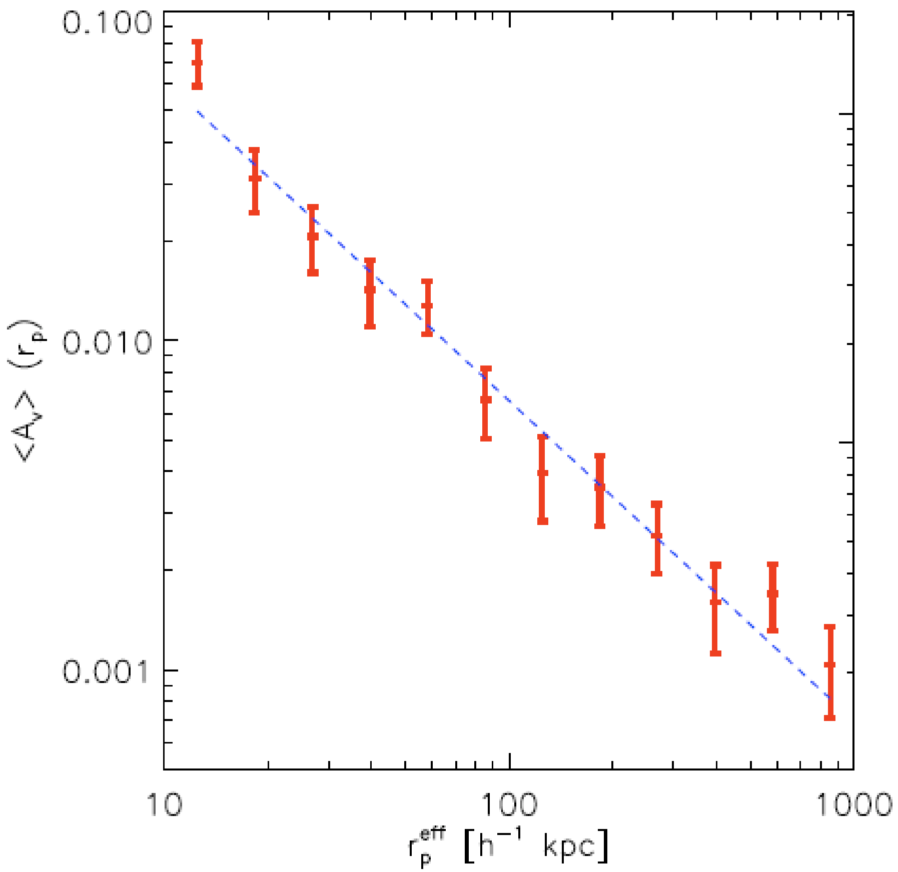


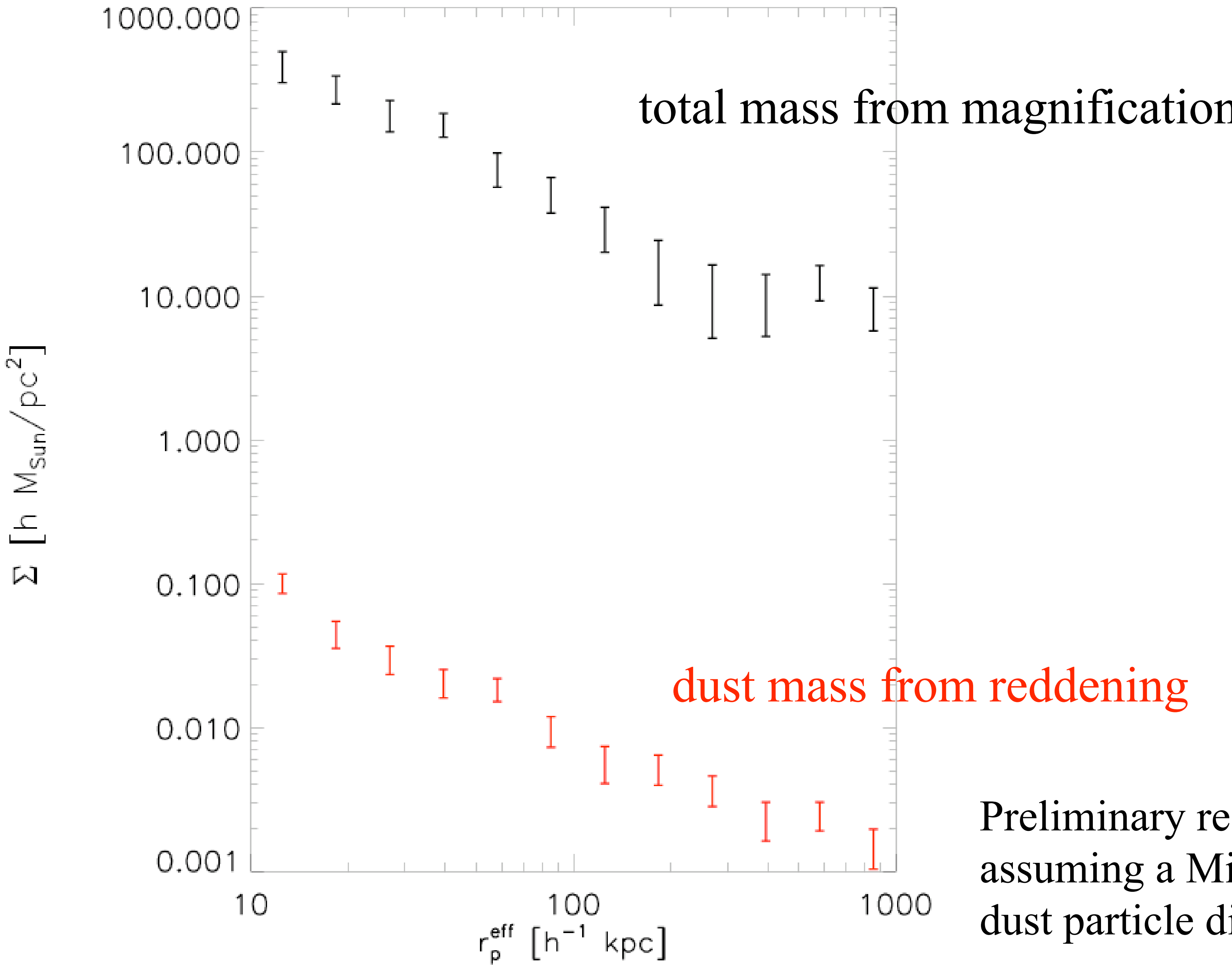
Extinction profile



$$M_{dust} = \frac{2\pi}{K_{abs}(\lambda_V)} \int_0^{r_{vir}} \mathrm{A_V}(r_p)\, r_p\, \mathrm{d}r_p$$

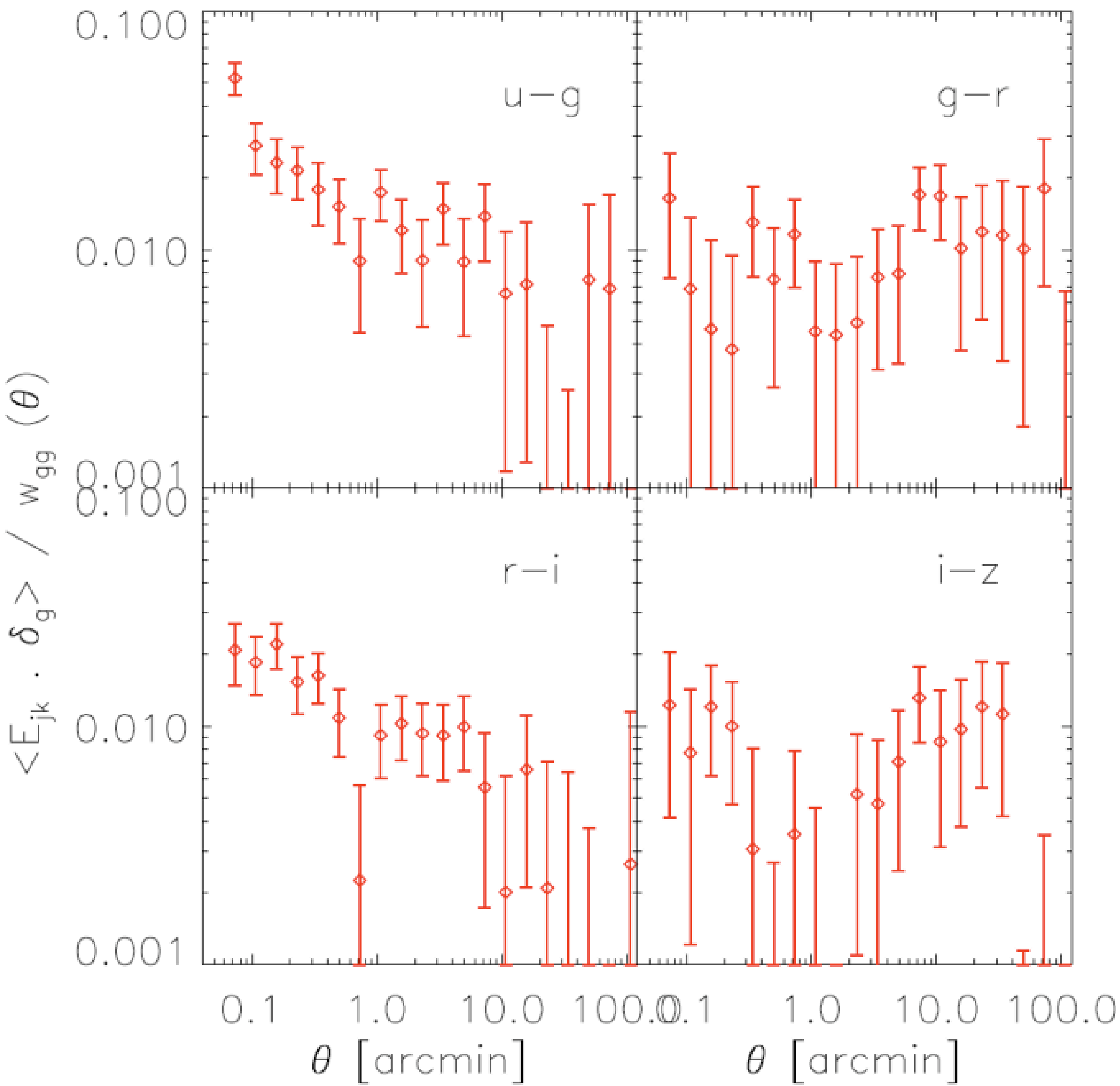
$$M_{dust}(15\,\mathrm{kpc} < r < r_v) \simeq 5 \times 10^7\, M_\odot$$

Mass profiles



Preliminary results assuming a Milky way dust particle distribution

Dust bias



u−g
g−r
r−i
i−z
0.100
0.010
0.001
0.1
1.0
10.0
100.0
θ [arcmin]
<E_{jk} · δ_g> / w_{gg} (θ)

Summary

The magnification bias due to galaxies is detected on scales ranging from ~20 kpc to 50 Mpc.

We are now able to detect the effects of dust reddening due to galaxies on the same scales.

We are now measuring the signal for blue/red galaxies, groups and clusters.

Upcoming surveys will allow us to measure these signals as a function of redshift and investigate the properties of dust around galaxies.