Mass growth and mergers:

Direct observations of the luminosity function of LRG satellites out to z=0.7

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BOSS collaboration

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The mass growth of massive galaxies

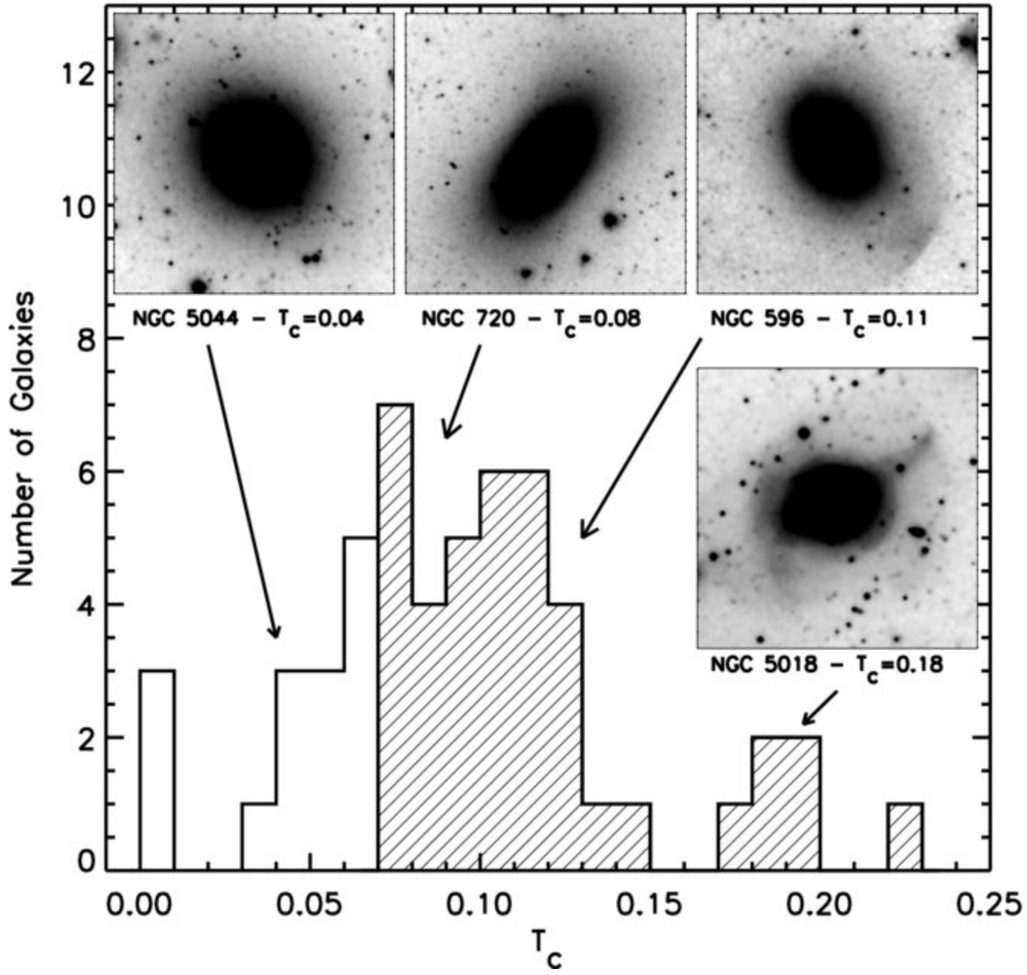
- Star formation rates are low at 0<z<1

  (e.g., Faber 73, Balogh+04, Worthey+92, Peletier 98, Jørgensen+99, Trager+00, , Kauffmann+03, Hogg+04, Thomas+05)

- At least some growth due to minor mergers

  (e.g., Kormendy+89, Schweizer+92, van Dokkum05, Naab+07,09, Bournaud+07, Stewart+08, Bezanson+09, Tal+09)

- Difficult to quantify frequency and mass ratio



Tal et al. 2009

Environment

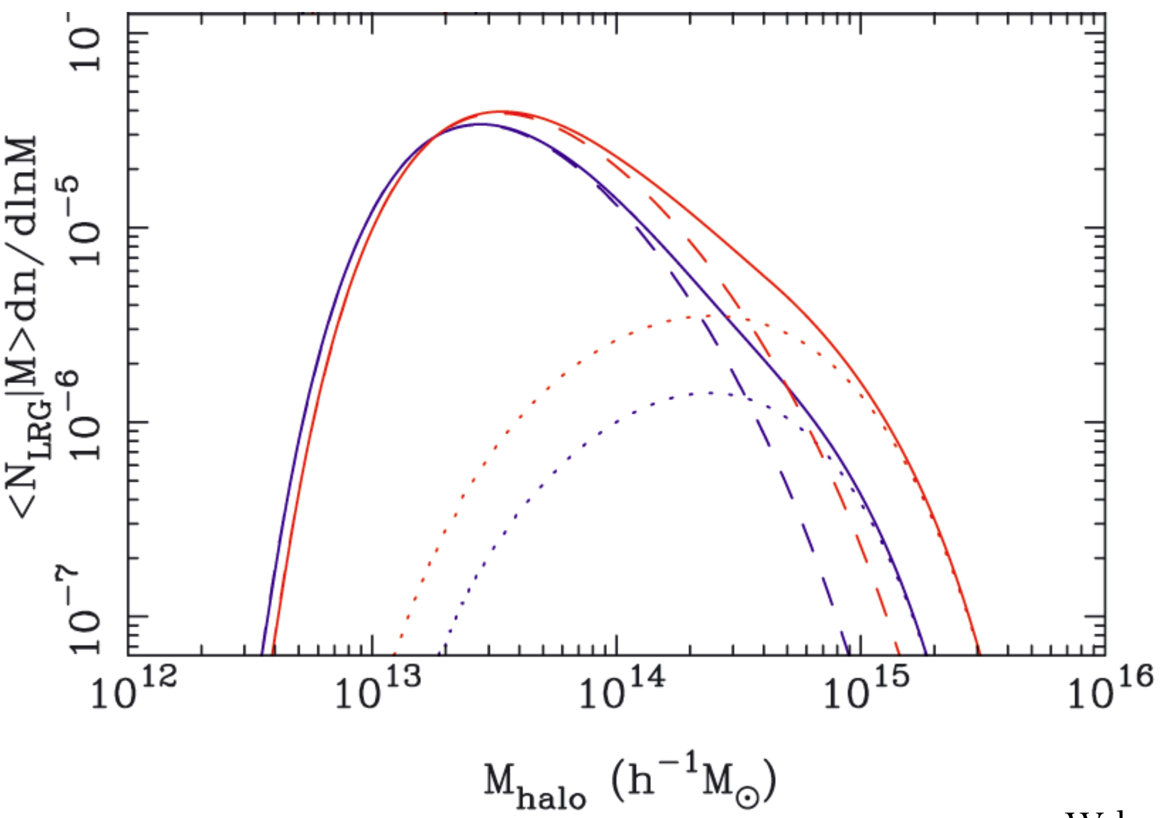
- Which galaxies do massive galaxies merge with?
  - What is a typical mass ratio?

- Difficult to identify satellite galaxies of individual environments

- Alternative - observe the average luminosity function of satellite galaxies around massive galaxies

Statistical study of the environment

- Well defined sample → LRGs
- Large statistical sample → SDSS+BOSS
- Contamination → Important



Wake et al. 2008

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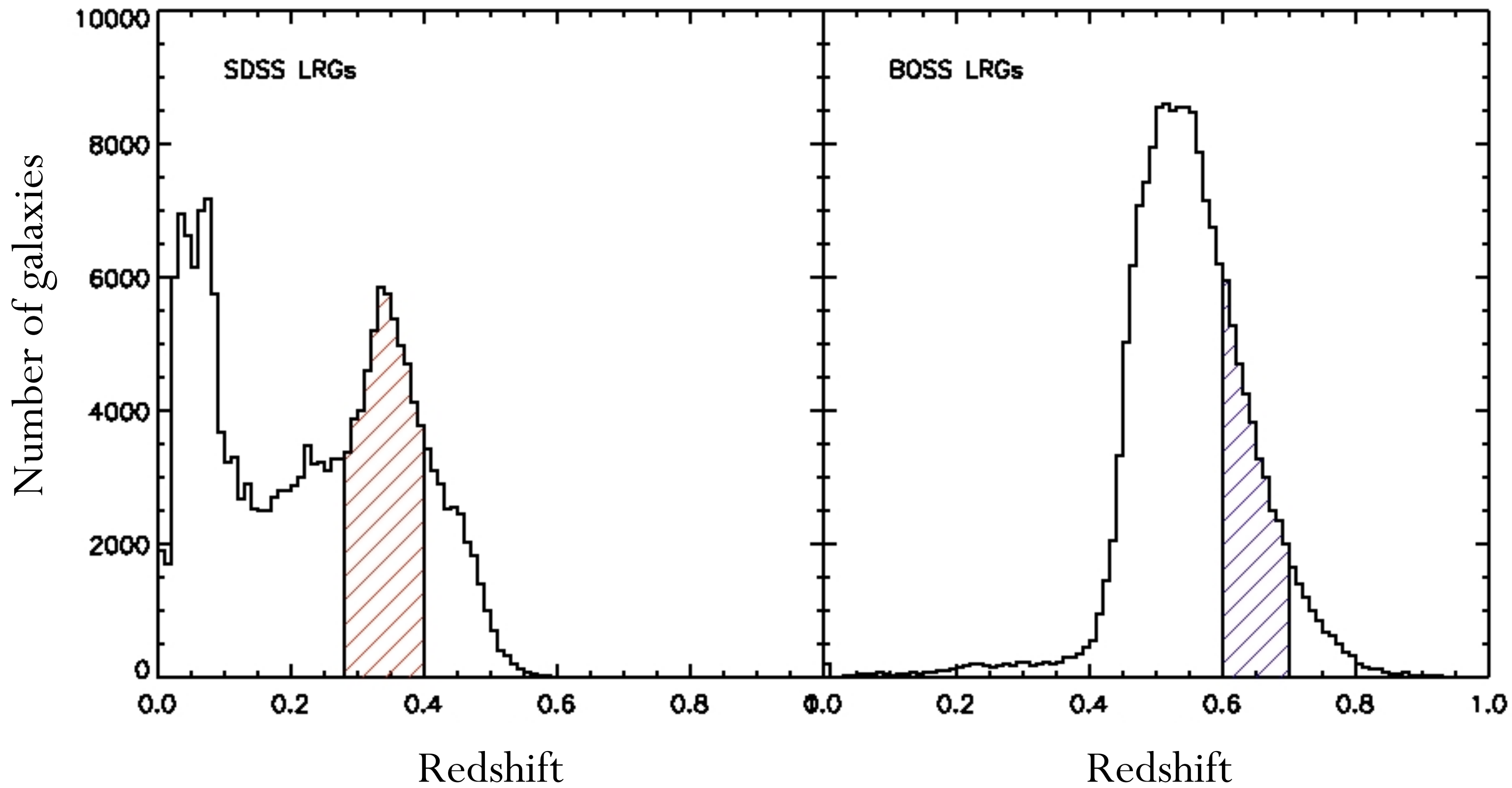
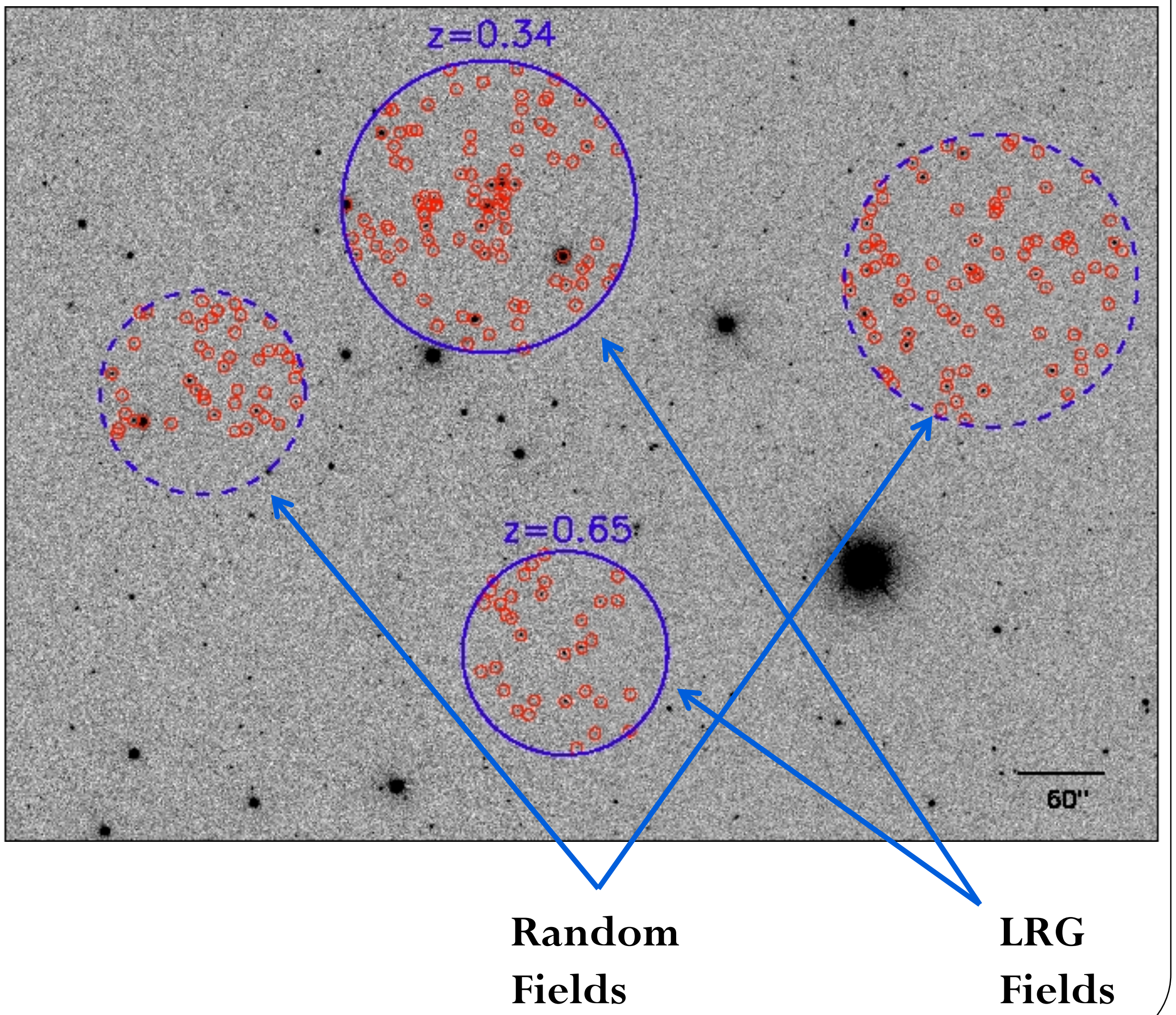


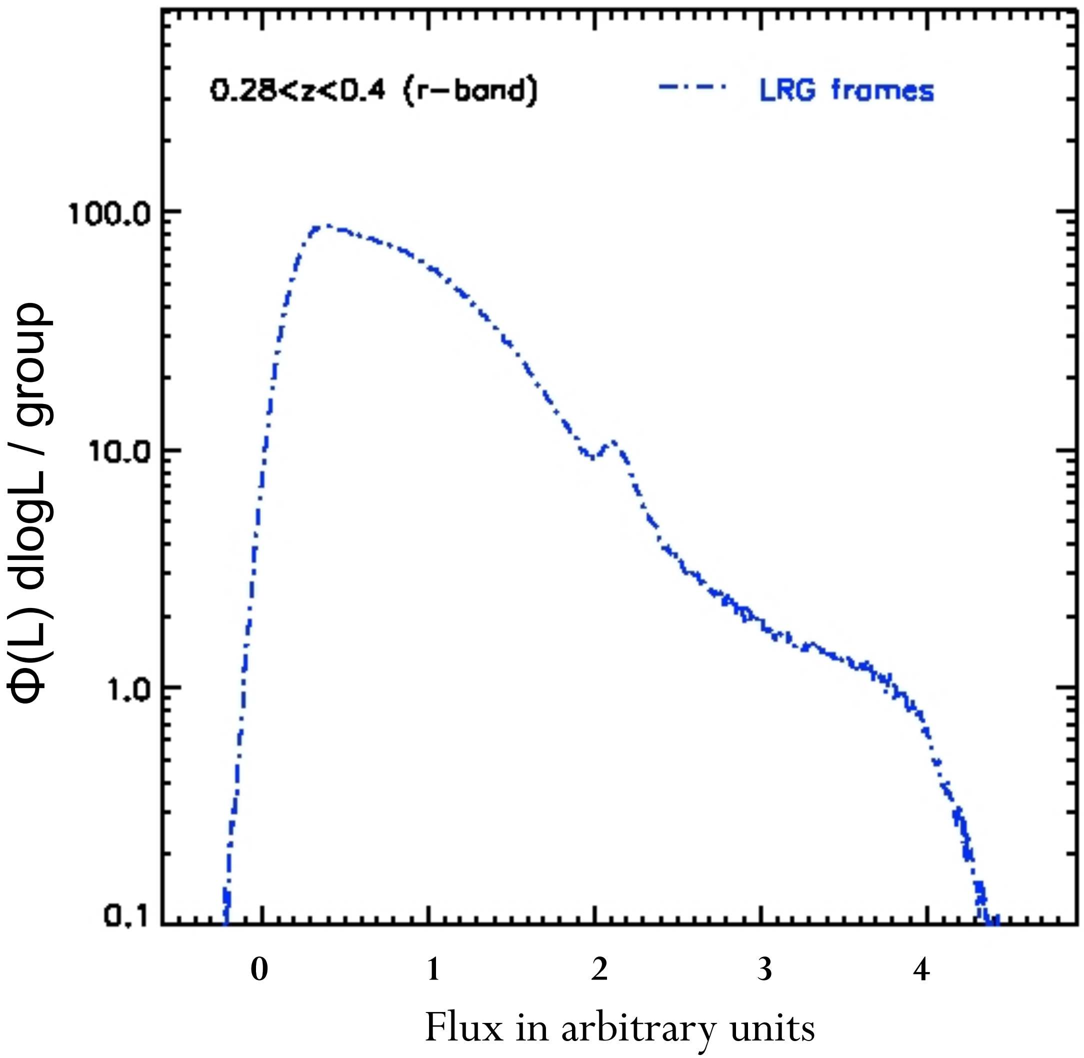
Photometry

- Detect all objects in 500 kpc apertures around each LRG
- Low detection threshold
- Repeat in randomly selected positions within the same SDSS imaging fields



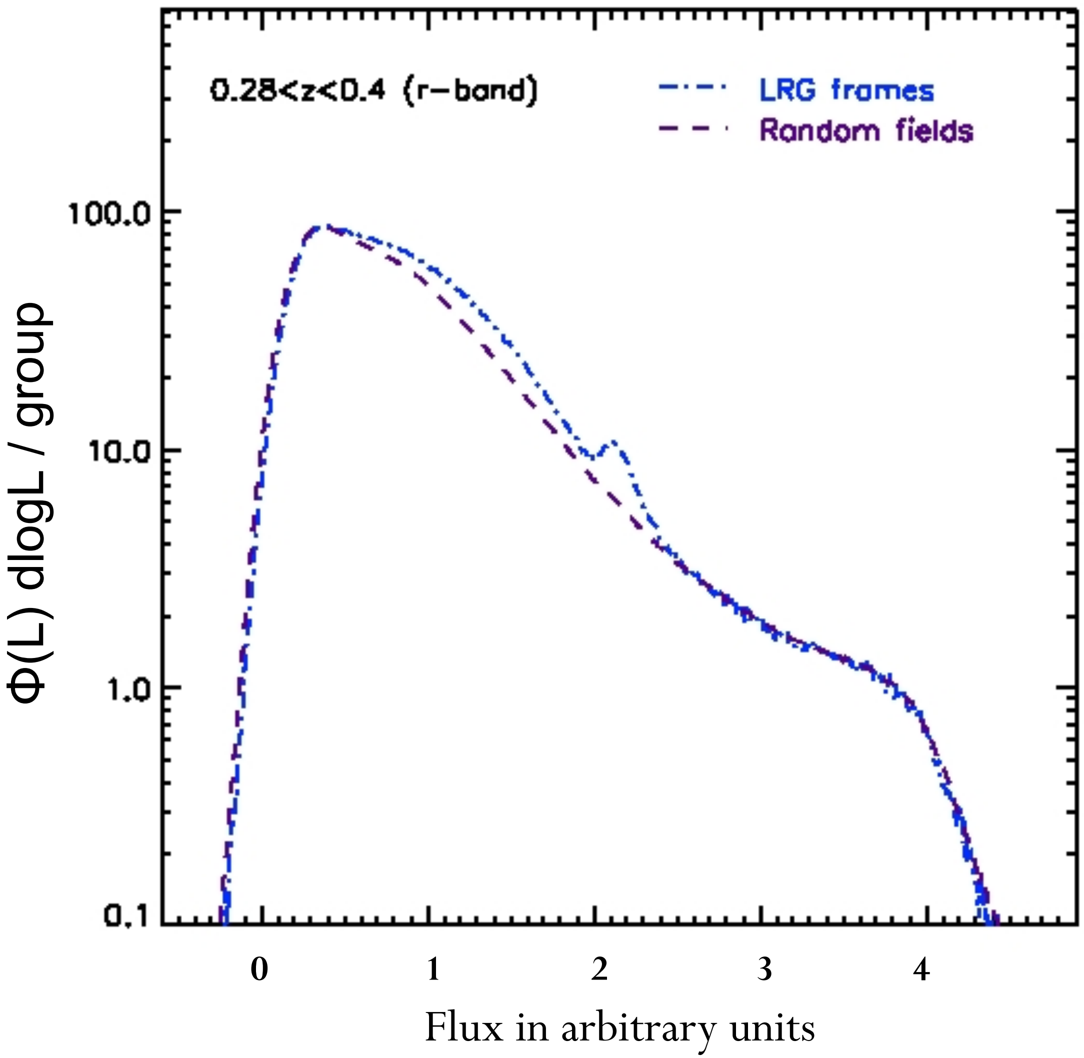
The luminosity function of satellite galaxies

- Measure luminosity distribution in LRG fields



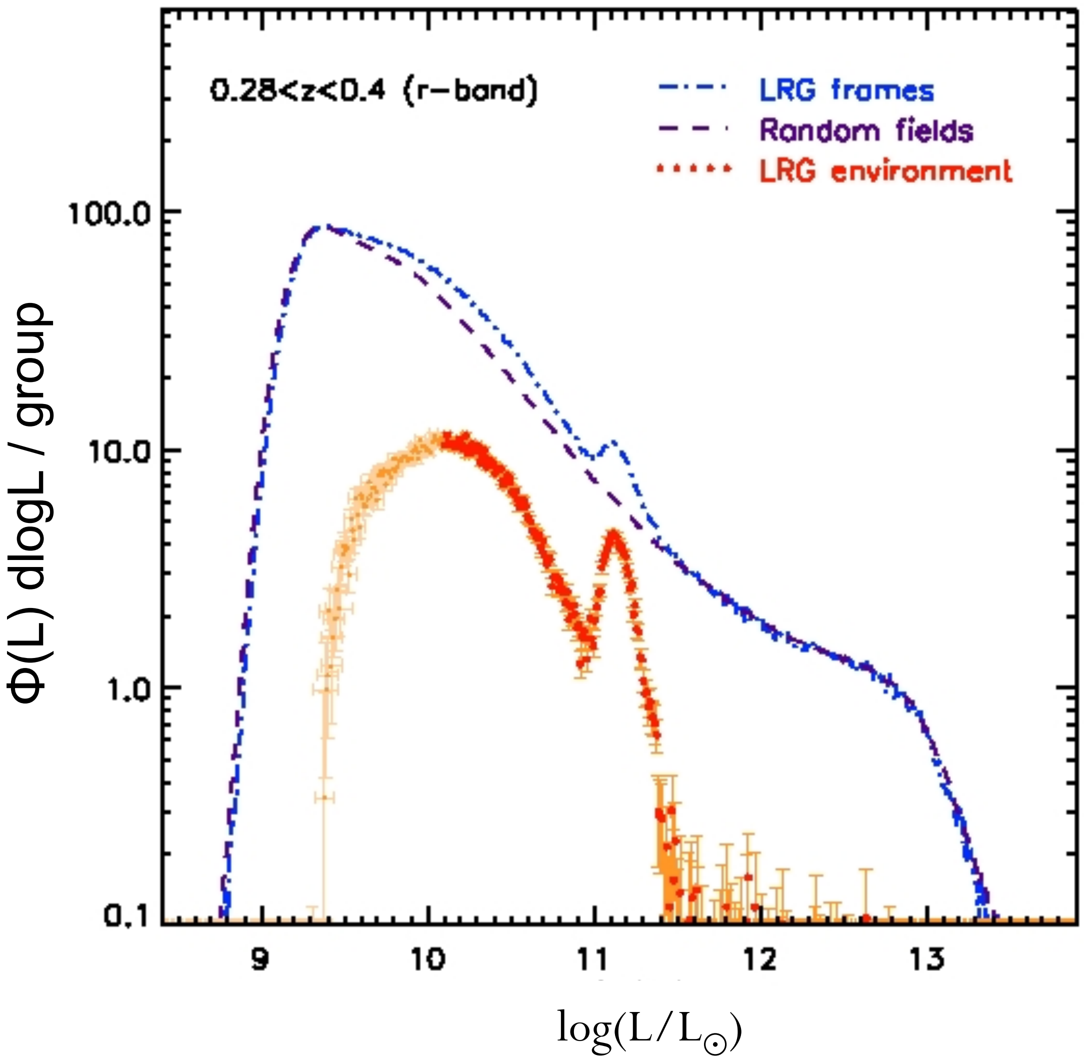
The luminosity function of satellite galaxies

- Measure luminosity distribution in LRG fields
- Also in random fields



The luminosity function of satellite galaxies

- Measure luminosity distribution in LRG fields
- Also in random fields
- Subtract one from the other



The luminosity function of satellite galaxies

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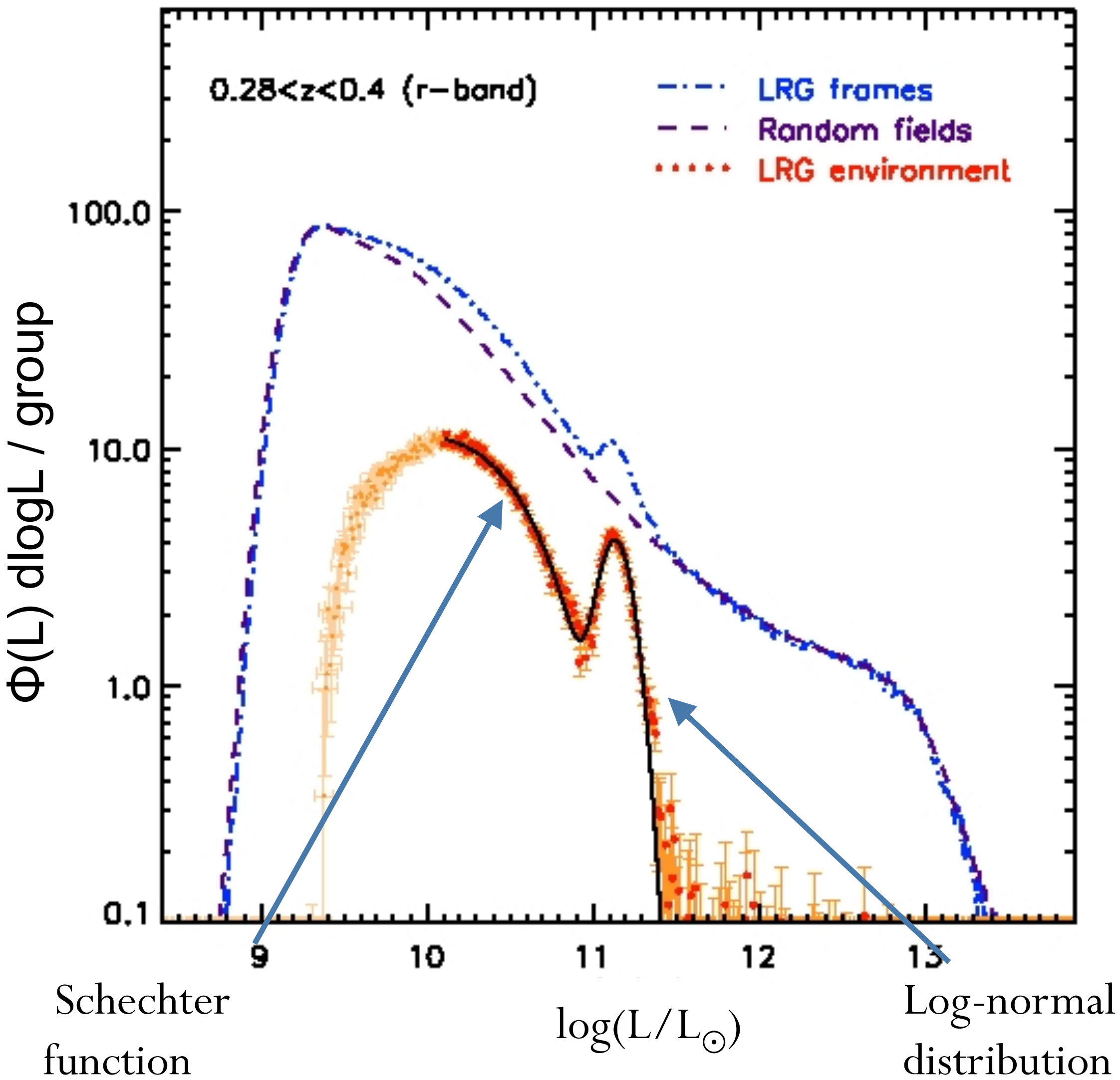
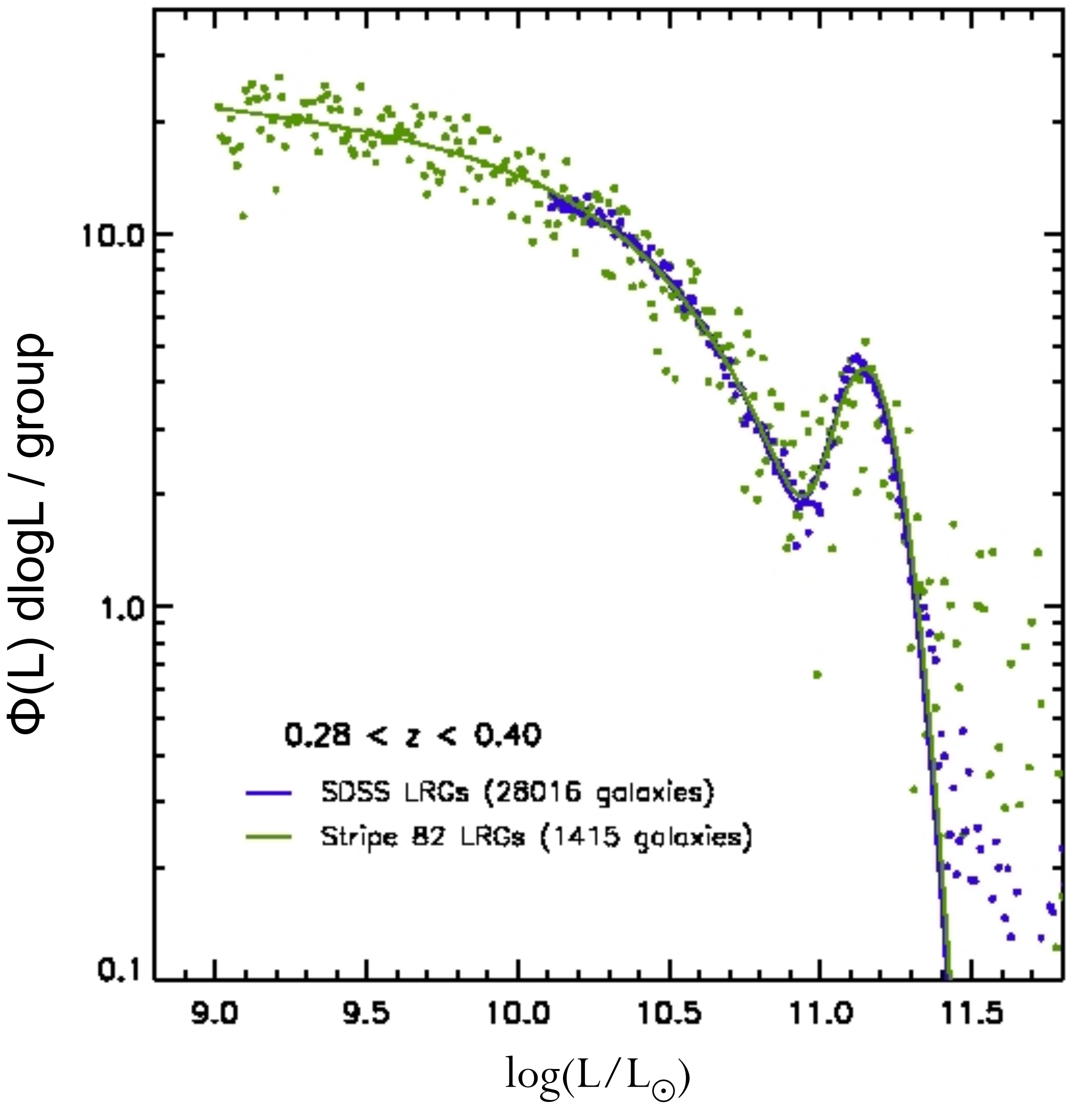
- Also in random fields
- Subtract one from the other

- **Poor fit by just a Schechter function – use two-parameter fits**



Deep stripe 82 images

- Using deep Stripe 82 data we constrained Schechter slope, detection threshold



Gap properties

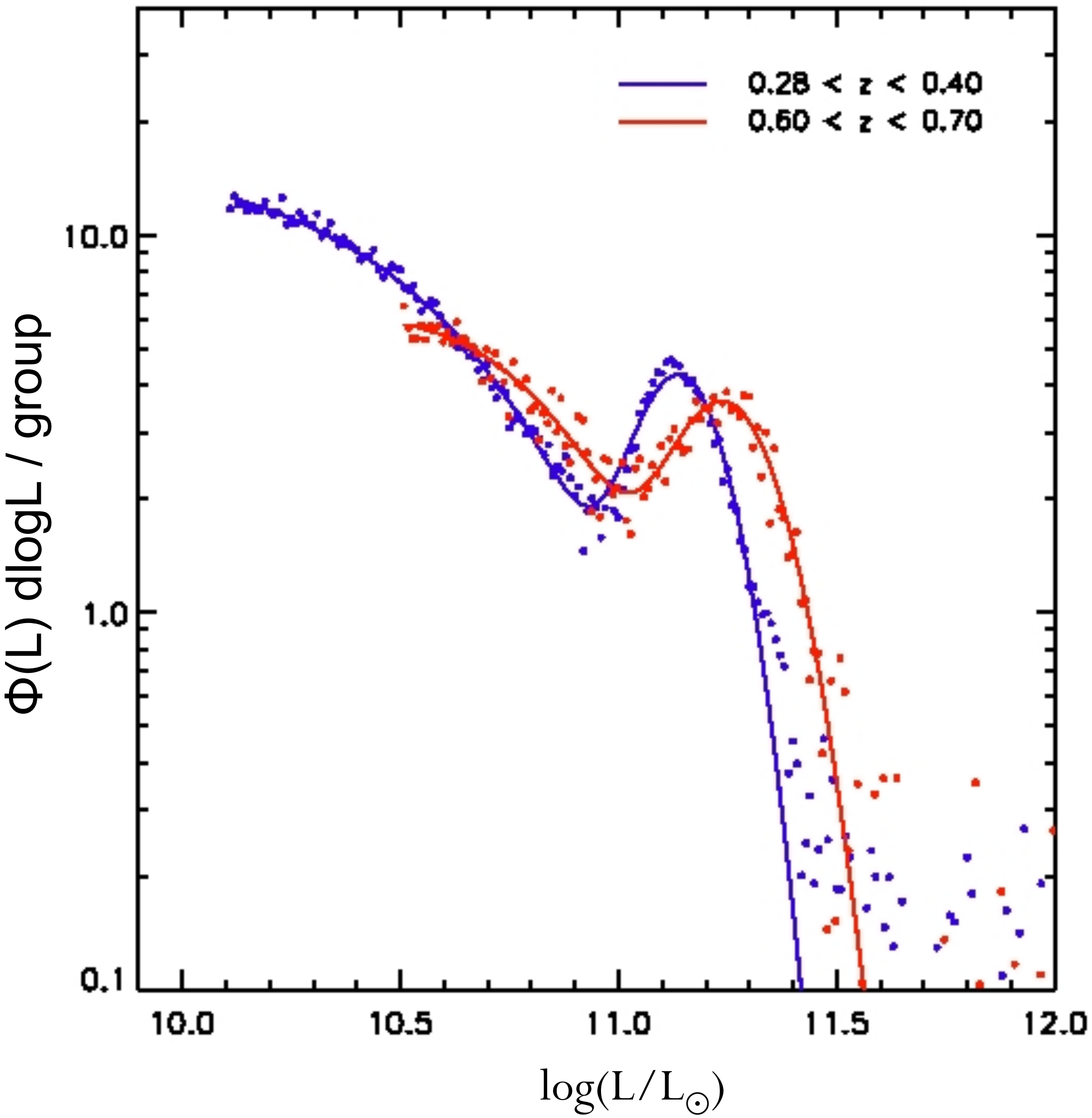
- Width measurement:

$$\int_{L_2}^{\infty} \Phi(L) d \log L = 1$$

$$\Delta M = 2.5 \log(L_2 / L_{cen}) \approx 1.3 mag$$

at both redshifts

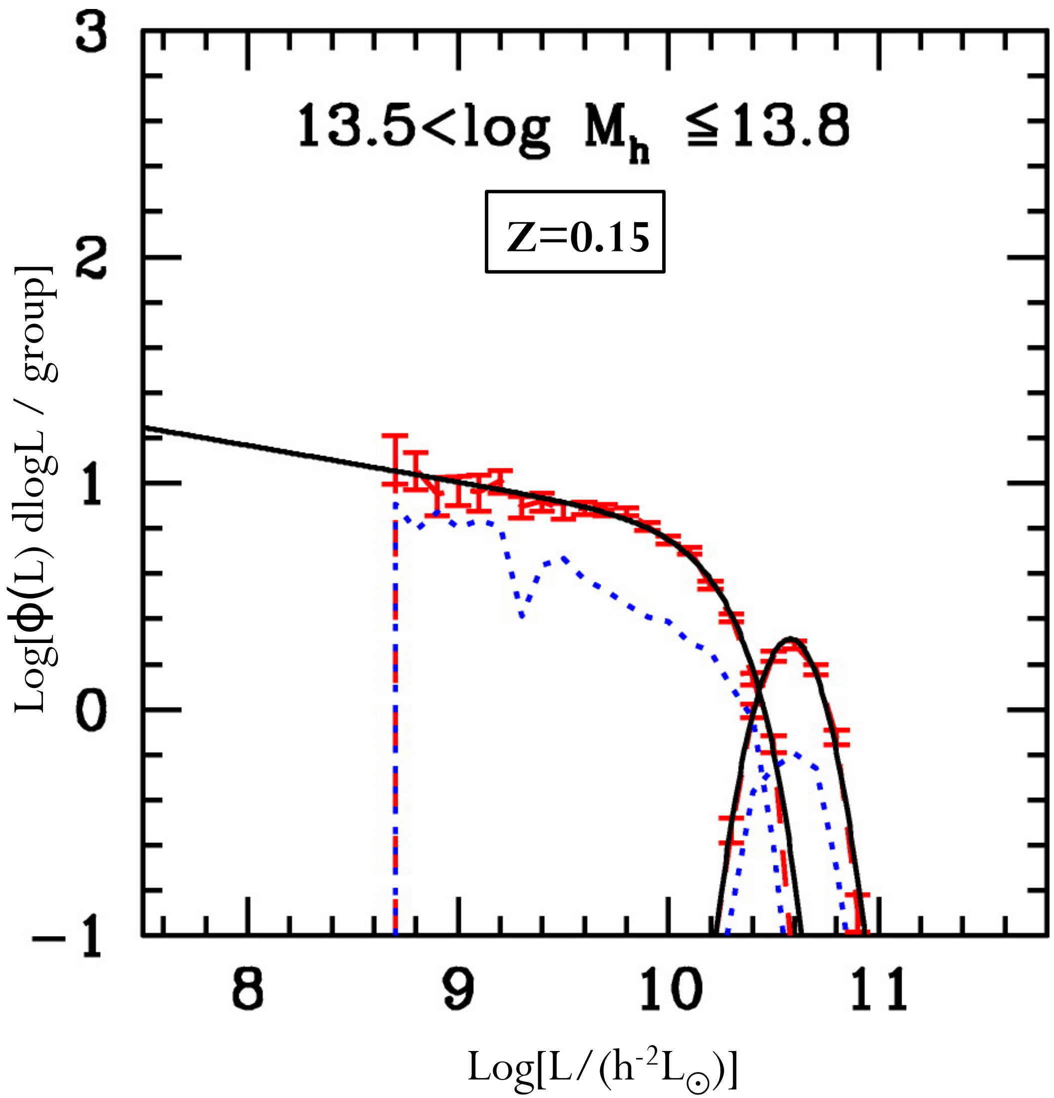
- LRG peak consistent with passive luminosity evolution



Sample selection and the gap

- Gap was noticed in halo mass selected groups
- Steep high luminosity end suggests that pairs are unlikely
- Can similarly reproduce this by randomly sampling the Schechter distribution

- **Our selection picks environments with a pronounced magnitude gap**



Yang et al. 2008

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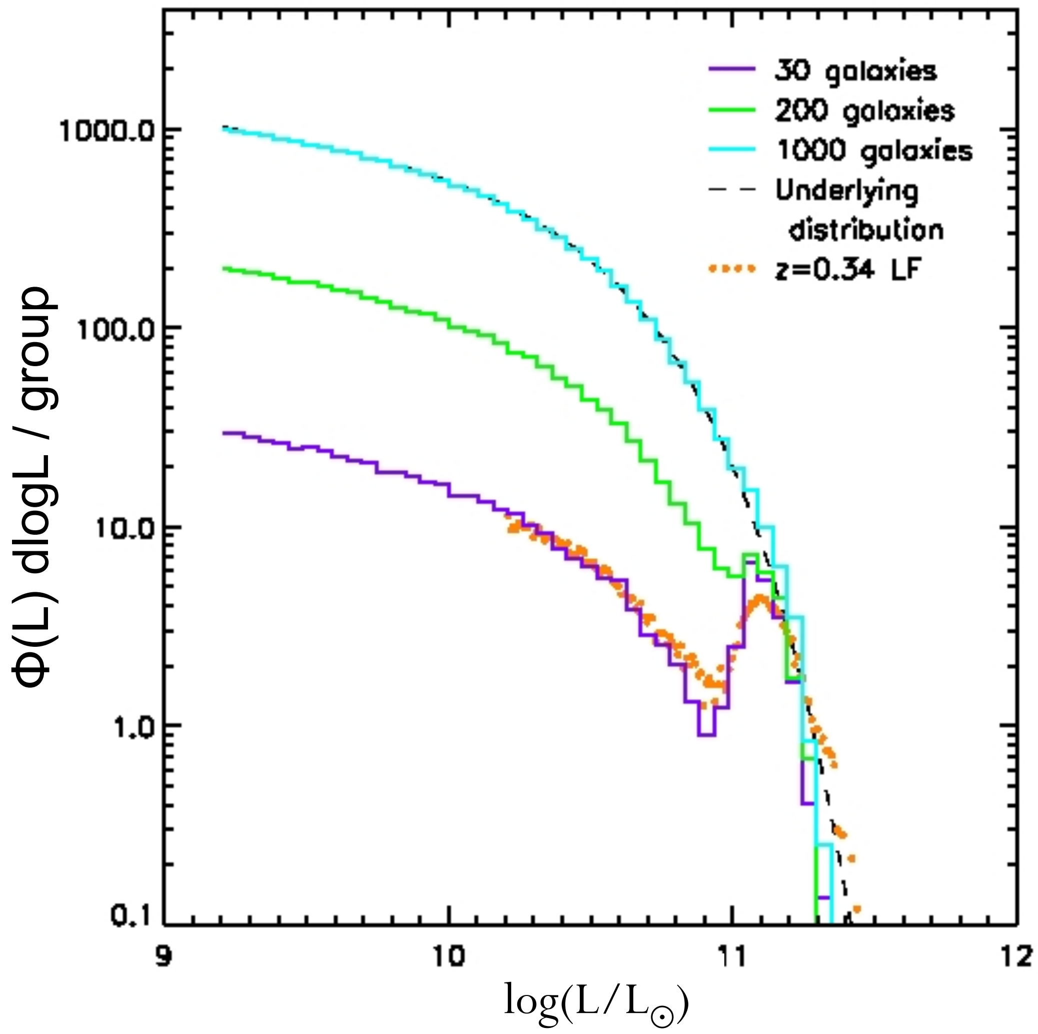
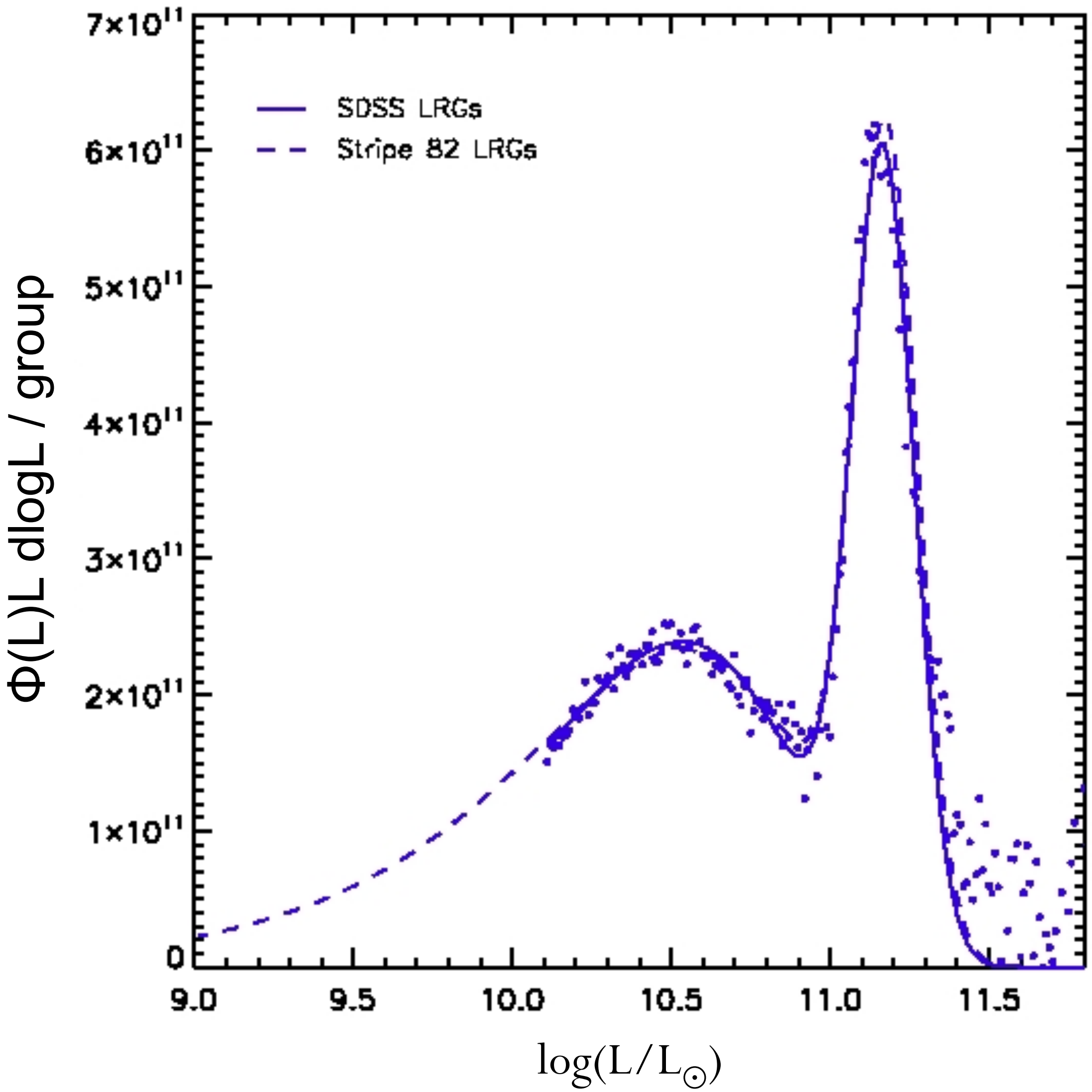


The mass growth of LRGs through mergers

- The gap width implies a typical mass ratio of 1:4 between the central galaxy and its most massive satellite
- **Mergers of higher mass ratio within the environment unlikely**



Summary

- Statistical study of the luminosity function of satellite galaxies in LRG environments

- Luminosity gap between the central galaxy and its most luminous satellite
  - Implies that growth through major mergers is unlikely
  - Significant growth (doubling the LRG mass) requires at least 3-4 minor mergers ($M_1/M_2>4$)