Galaxy and Mass Assembly (GAMA): The Galaxy LF

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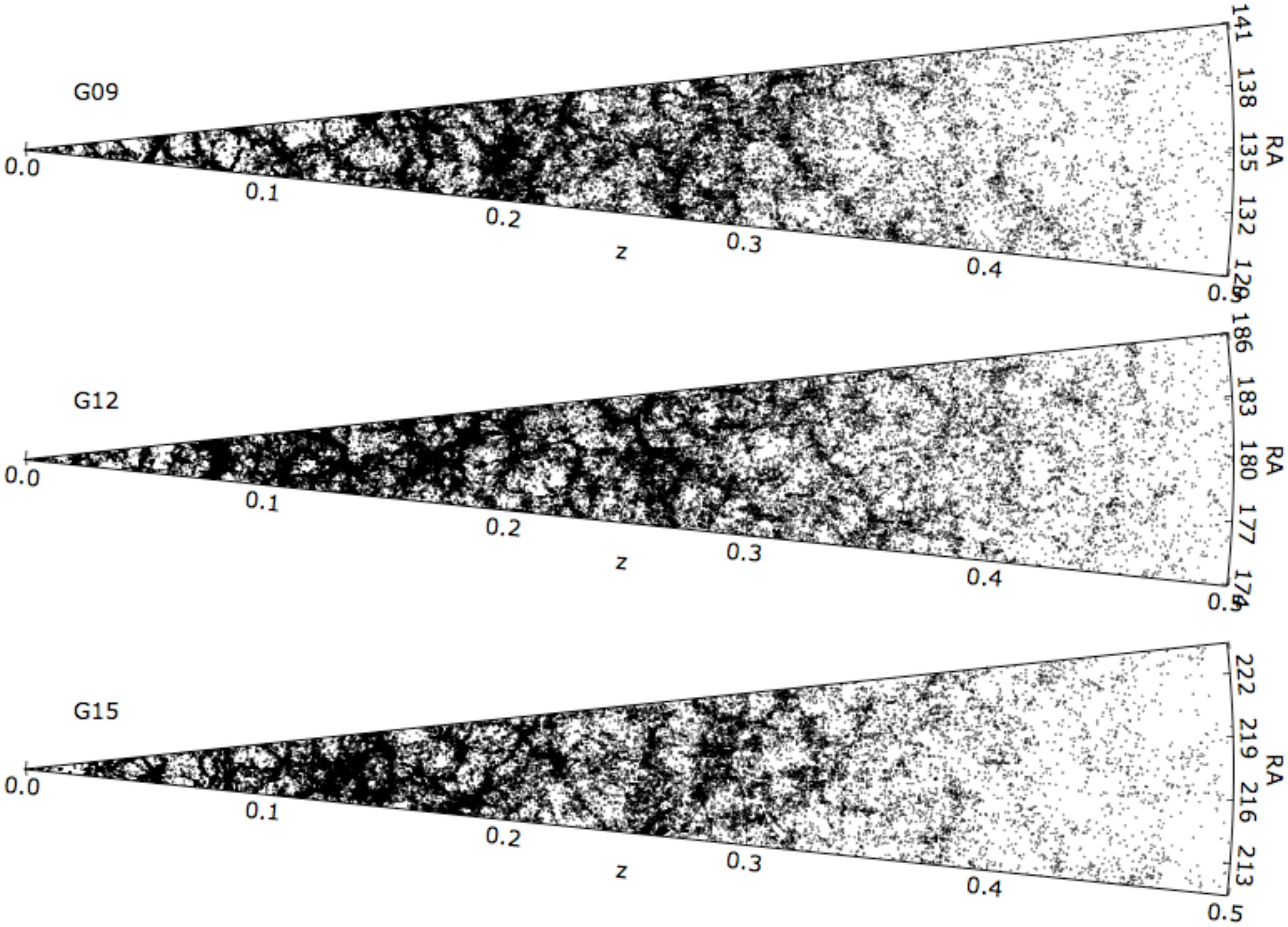
Outline

- GAMA field galaxy LFs (Loveday et al in prep.)
  - Low-redshift faint-end
  - Evolution $z = 0 - 0.5$
- LF dependence on group properties (preliminary: not yet tested with mocks; see also Vazquez Mata poster)

GAMA Phase 1
Redshift Statistics

- Redshift success rate (Q > 2) 98%
- 114,531 unique redshifts
- 94,851 GAMA-measured (most others from SDSS)

GAMA Phase I



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ugriz luminosity functions

- Luminosity function φ(*L*) tells us the number density of galaxies per unit luminosity *L*
- Basic prediction that galaxy formation models must get right
- ugriz bands probe different parts of the spectrum from near-UV to near-IR
- *u* band dominated by massive, young stars
- *z* band dominated by low-mass stars

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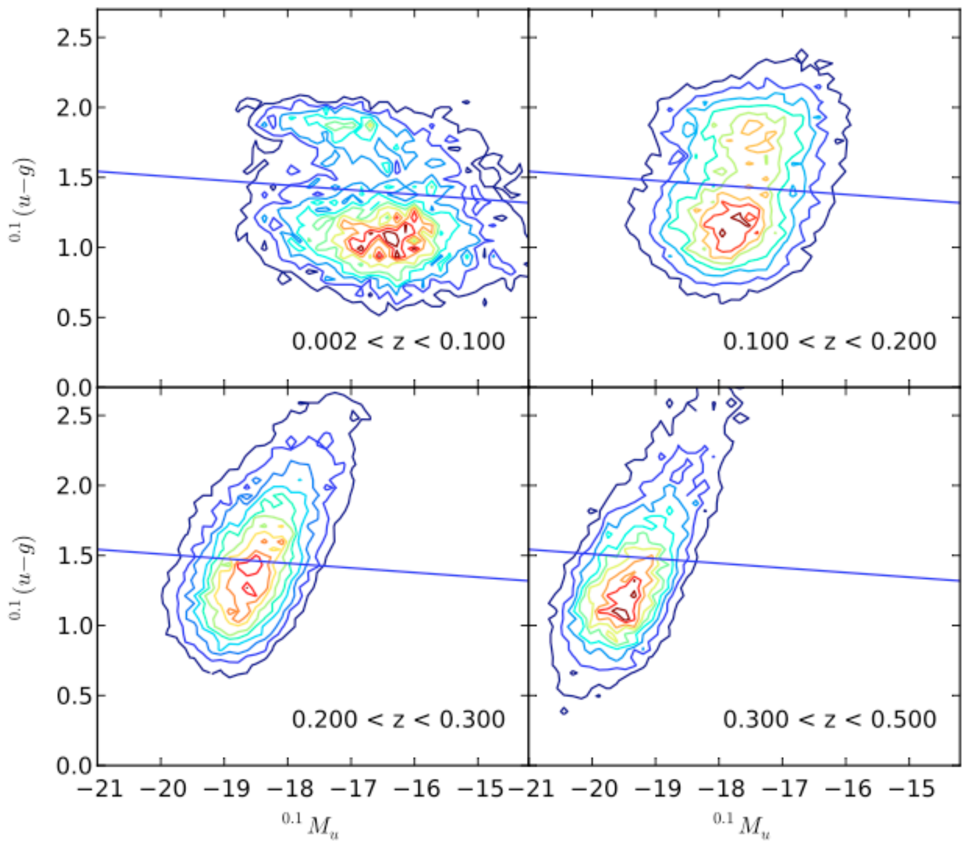
Colour selection



$$u - g = 0.85 - 0.033M_u$$

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LF Estimators

- $1/V_{max}$ and stepwise maximum-likelihood (SWML) in redshift slices
- Parametric fit of Schechter function with optional 2nd power-law

$$\phi(L) = \phi^* \left(\frac{L}{L^*}\right)^{\alpha} \exp\left(\frac{-L}{L^*}\right) \left[1 + \left(\frac{L}{L_t}\right)^{\beta}\right]$$

or evolving M^*, φ^* (Lin et al 1999)

$$\alpha(z) = \alpha(z_0),$$
$$M^*(z) = M^*(z_0) - Q(z - z_0)$$
$$\phi^*(z) = \phi^*(0) 10^{0.4Pz}$$

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Incompleteness Corrections

- LF estimator needs to allow for any incompleteness in the survey
- Weight galaxies by inverse completeness
- Sources of incompleteness:
  - Imaging (magnitude, surface brightness; neglected here)
  - Targeting (magnitude)
  - Spectroscopy (fibre mag)

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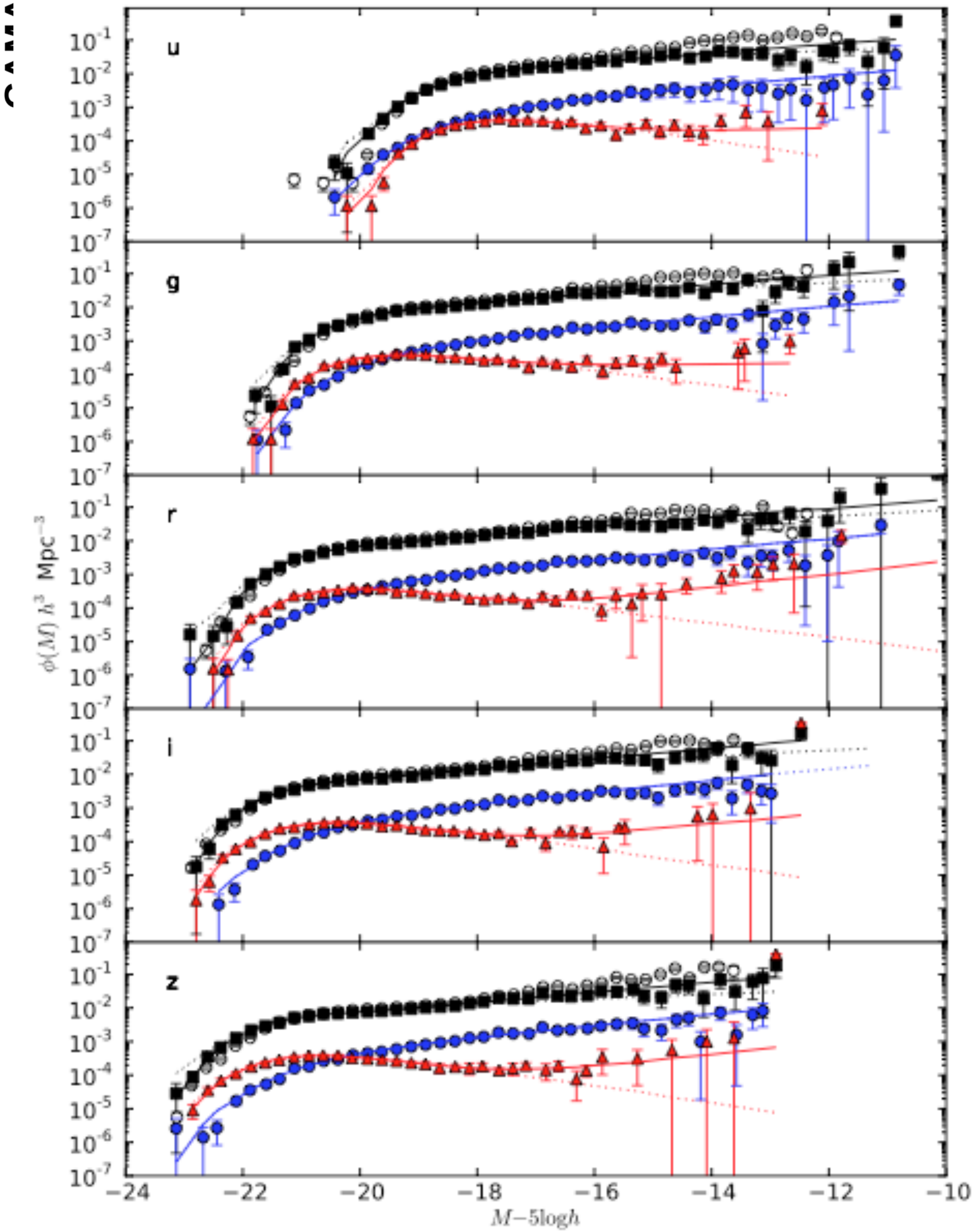

z < 0.1 DP fit

- Blue and red LFs scaled by 0.1
- Blue galaxy LFs well-fit by standard Schechter function over 10 mag
- Red galaxies need double power-law (Peng et al 2010 quenching model, HOD models)

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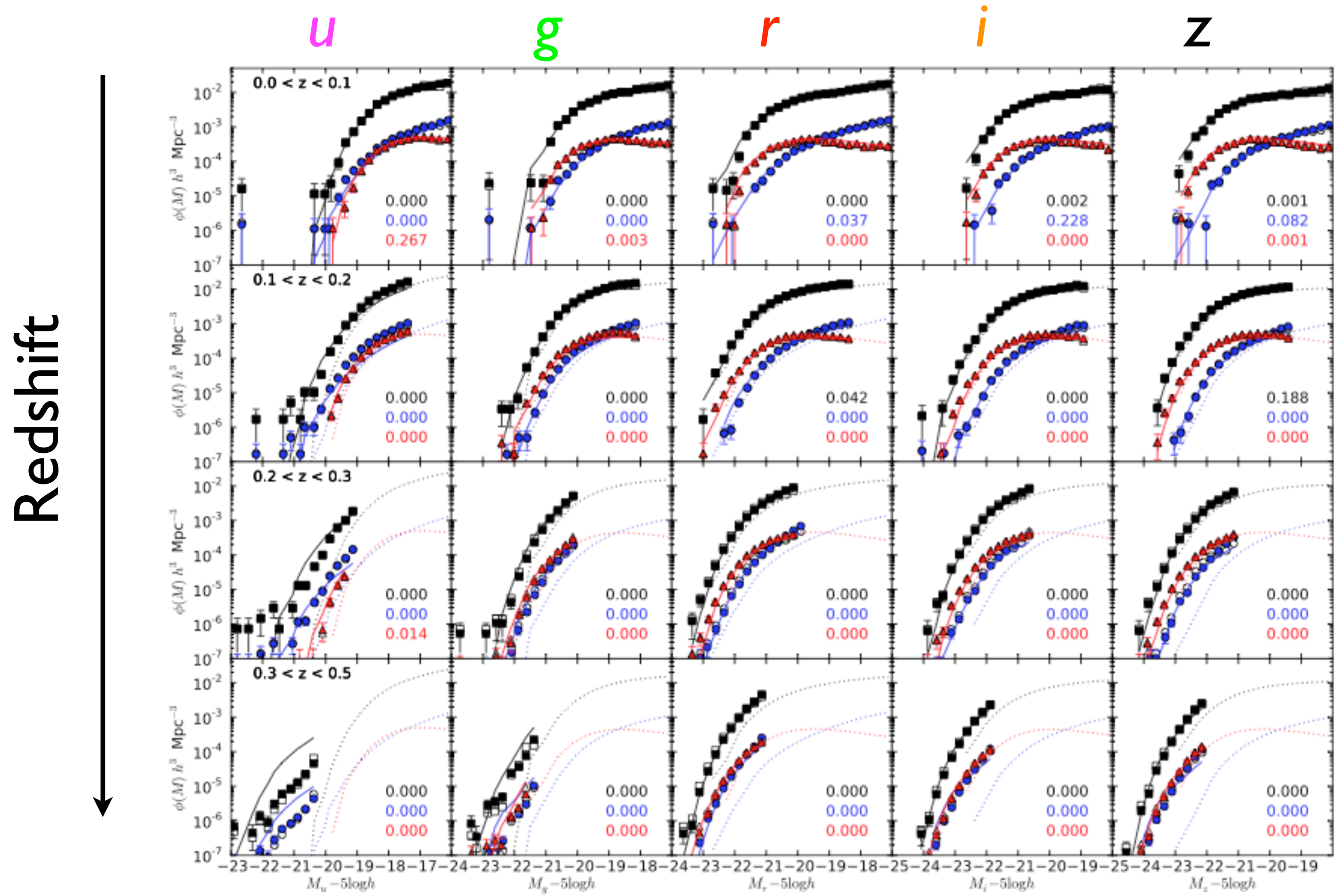
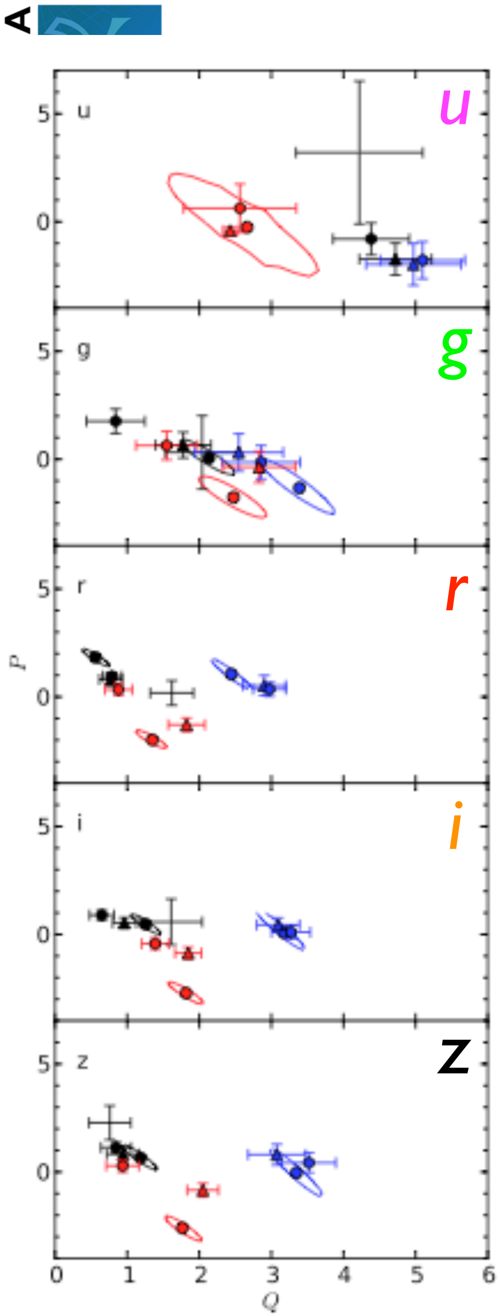
LF Evolution





LF Evolution

- u and g bands very poorly fit by parametric model (contours): bright ends way over-predicted at high redshift
- Also fit Schechter functions by least squares to SWML in 4 or 8 redshift slices (α fixed)
- Good agreement for blue galaxies ($Q \approx 3, P \approx 0$), poor for red

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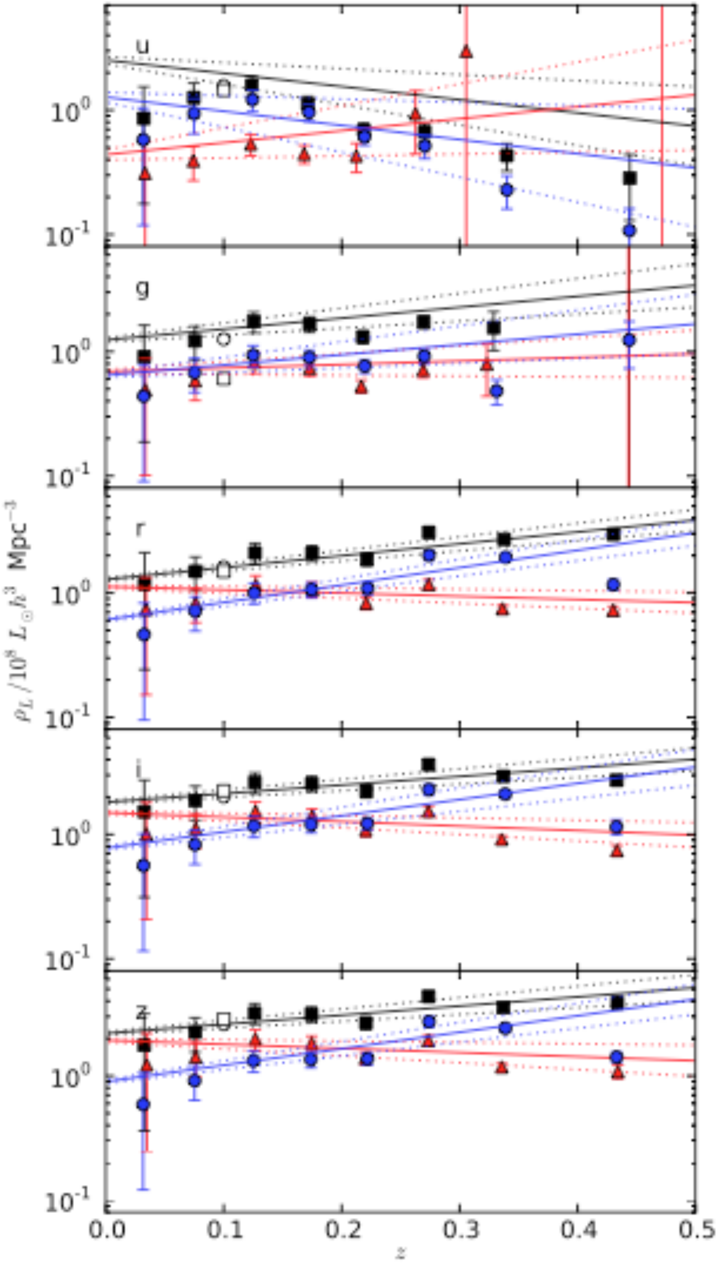

Lum density evolution

- *riz* bands
  - red galaxy light dominates at $z \lesssim 0.2$, blue galaxy light at higher redshifts
- *g* band
  - red and blue galaxy light comparable at low *z*
- *u* band
  - v uncertain due to poor fit

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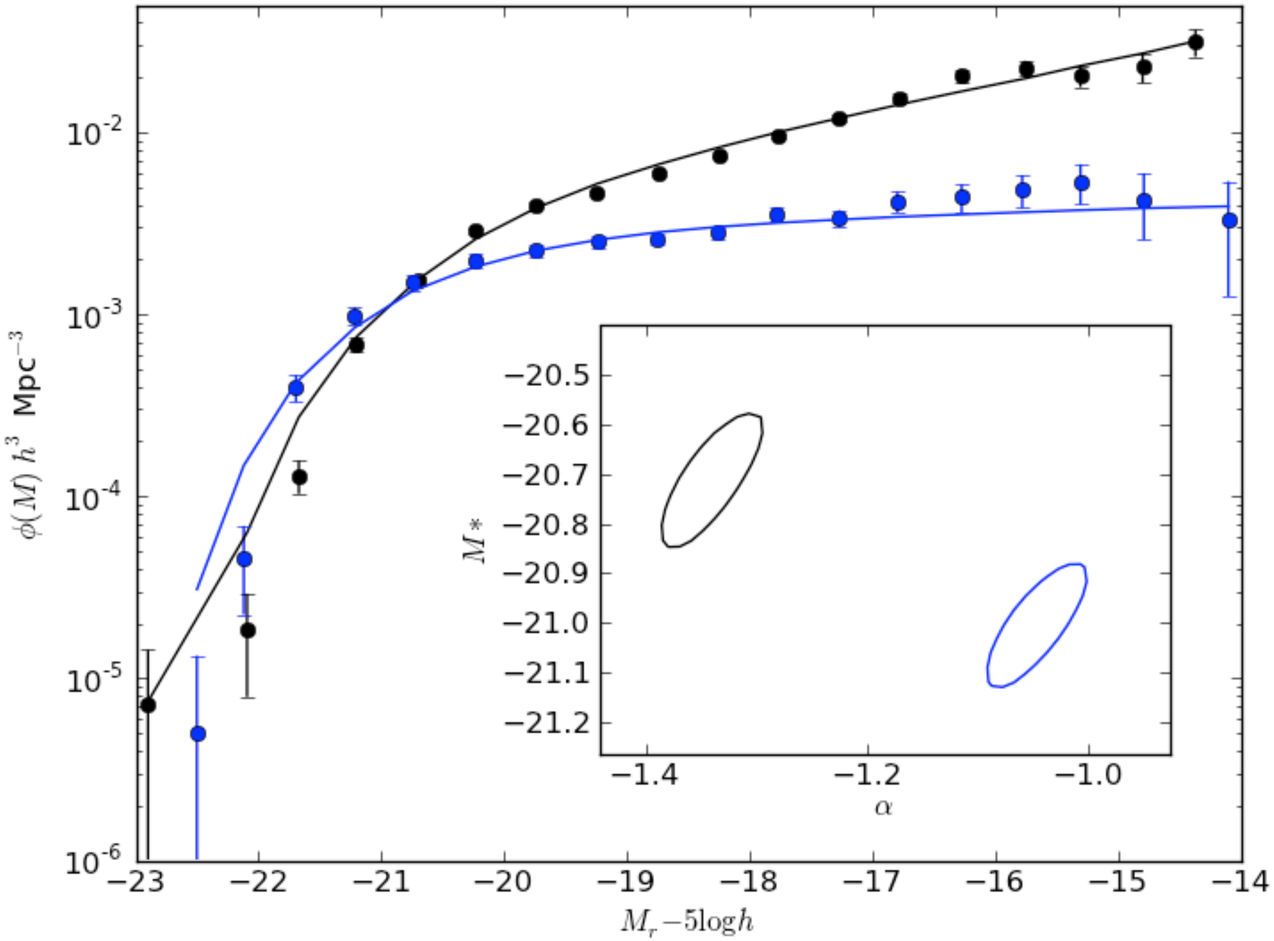
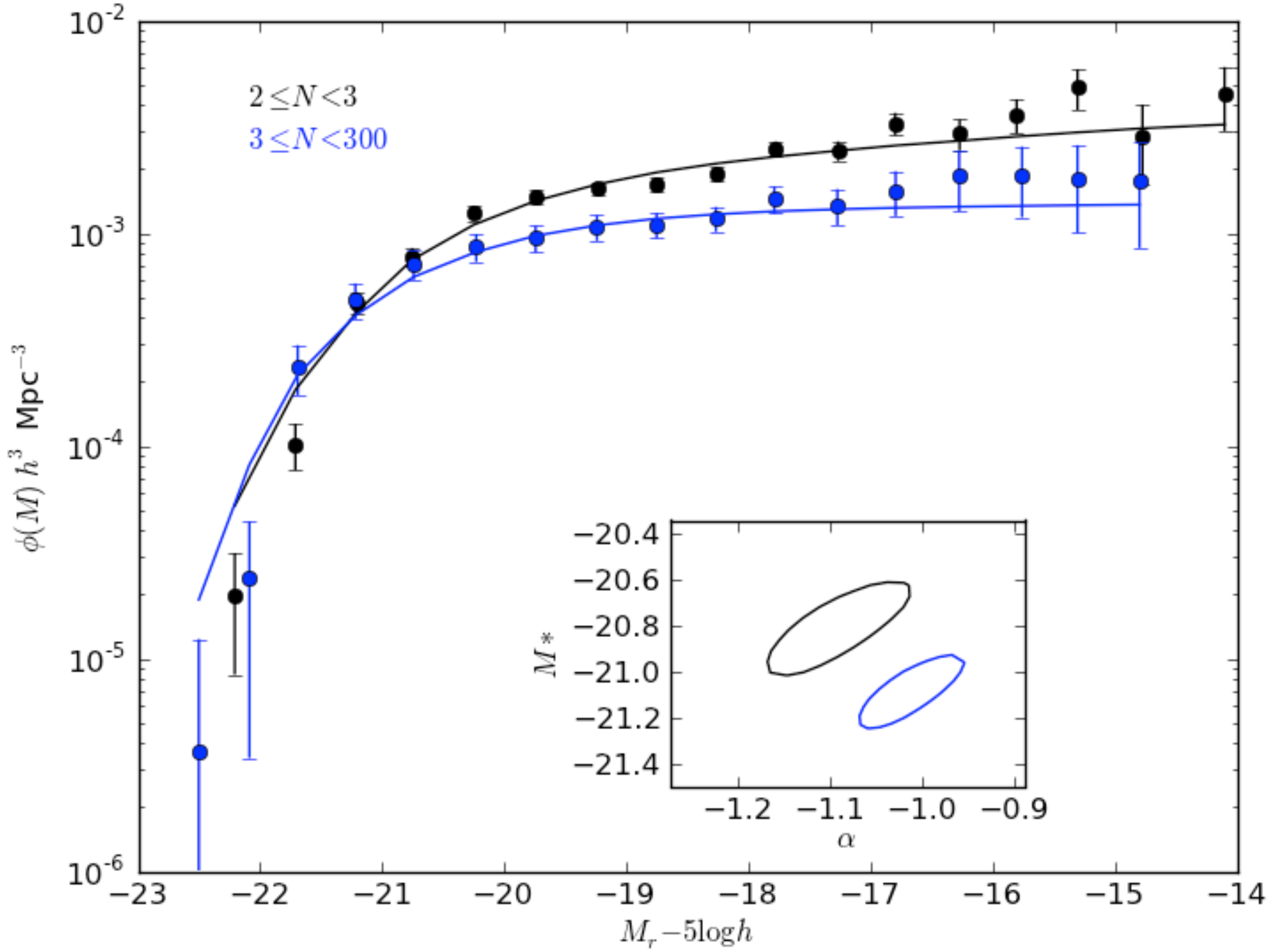
LF dependence on group properties

- r-band, combined, blue and red samples
- Low redshift sample ($0.012 < z < 0.1$) with standard, non-evolving Schechter function fits
- Compare LFs by ungrouped/grouped, richness, mass and velocity dispersion (normalised to same $\sum \varphi V$)

Grouped/Ungrouped



Richness - All



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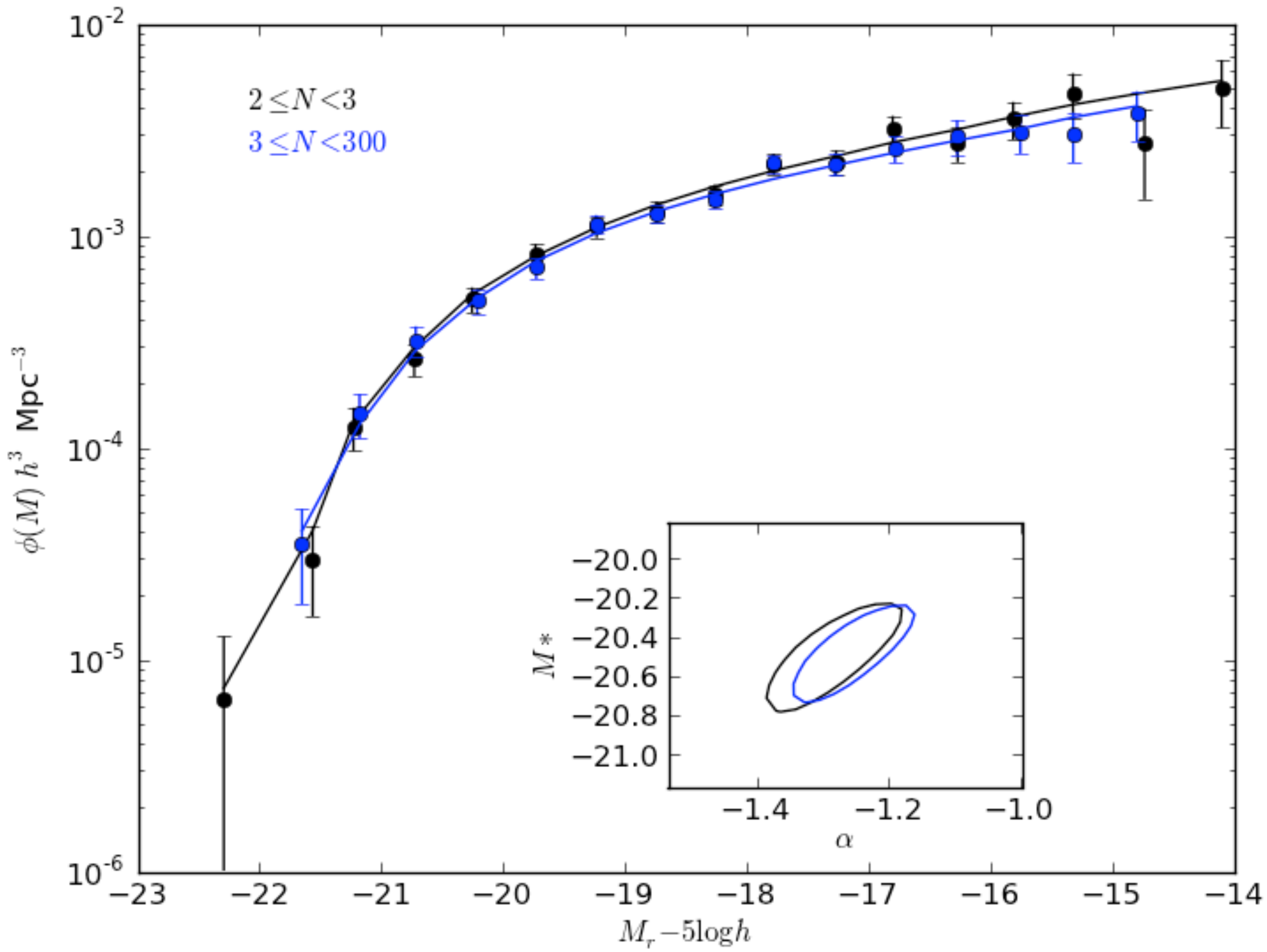
Richness - Blue



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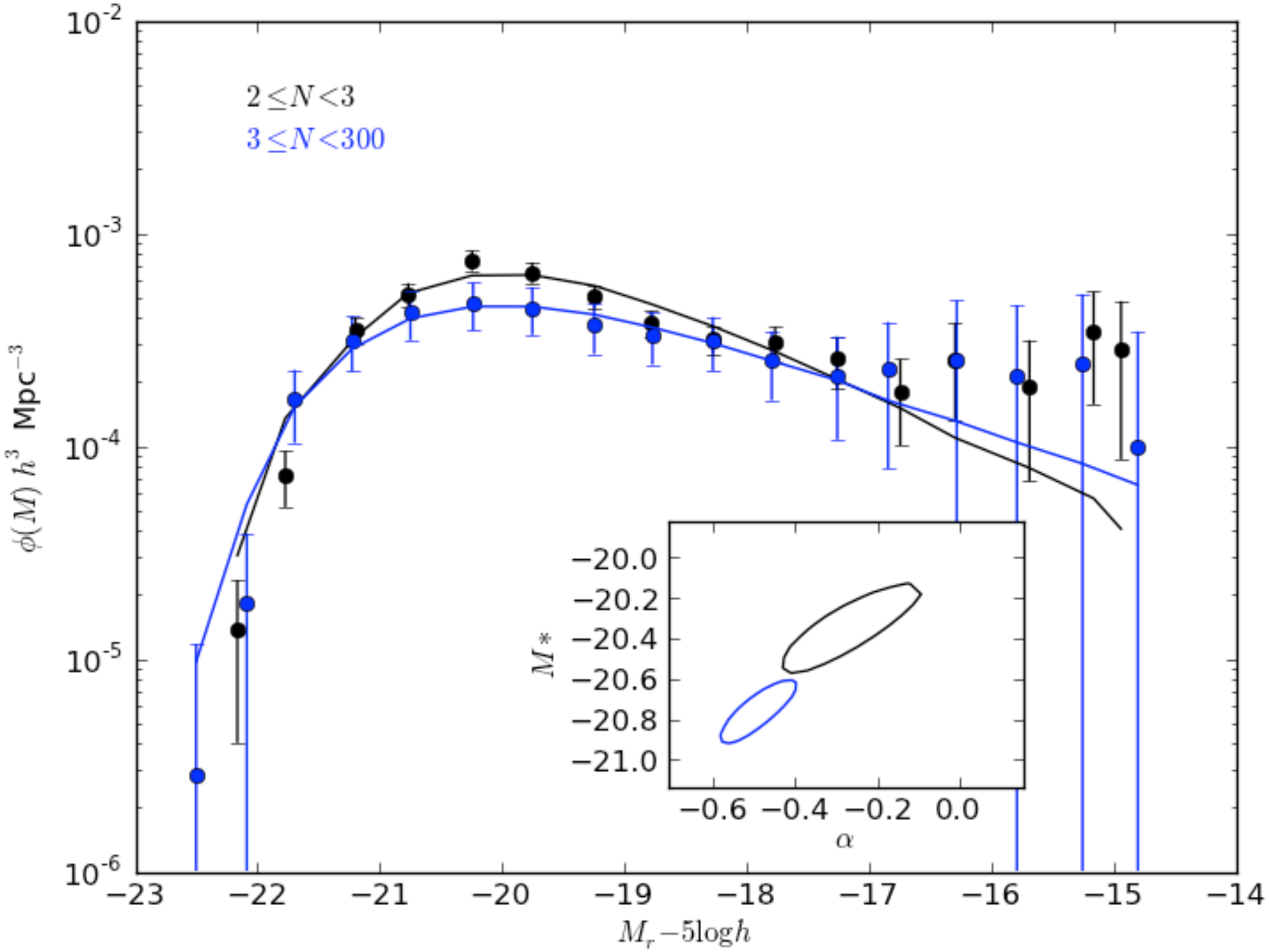
Richness - Red



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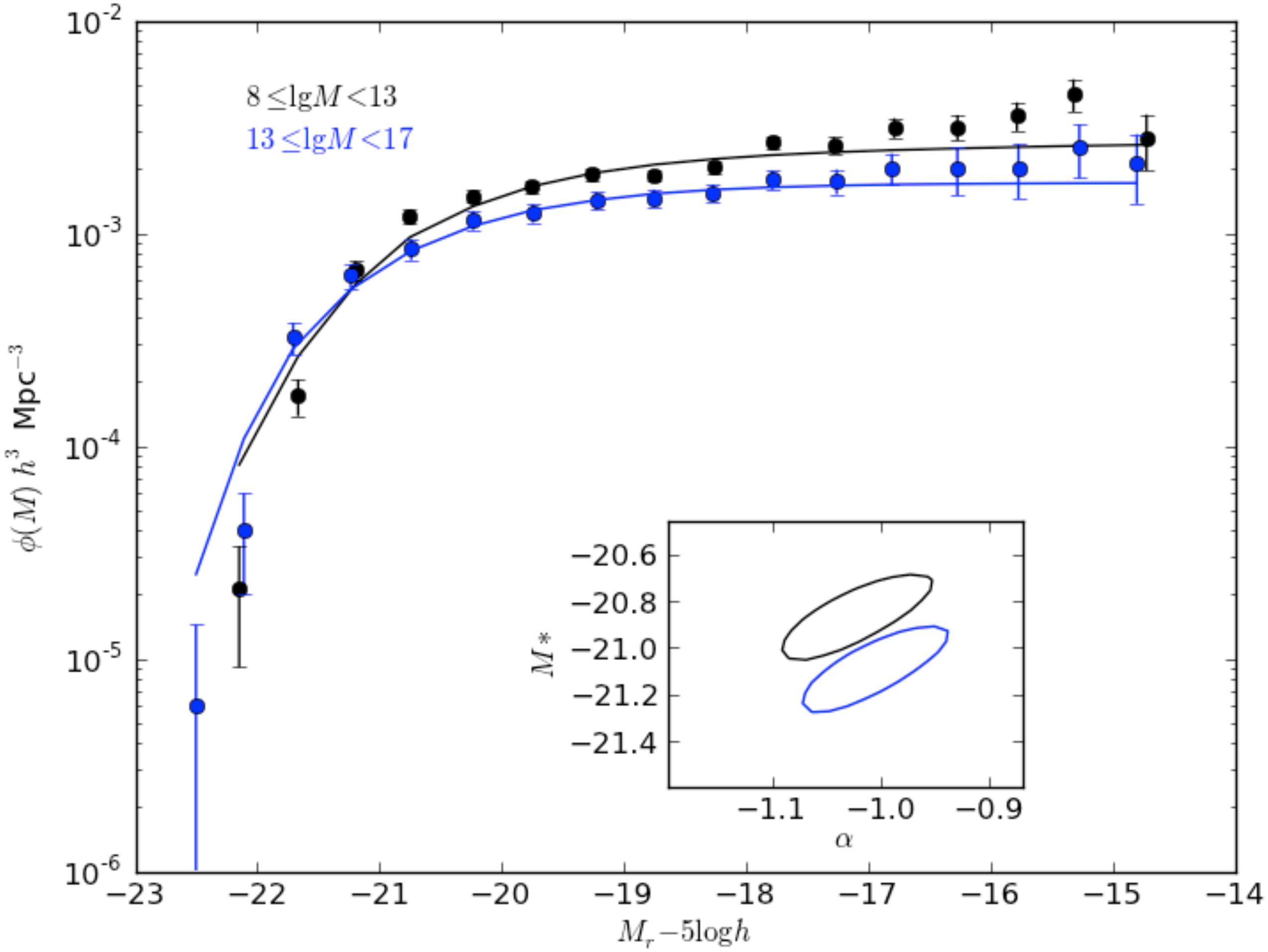
Mass - All



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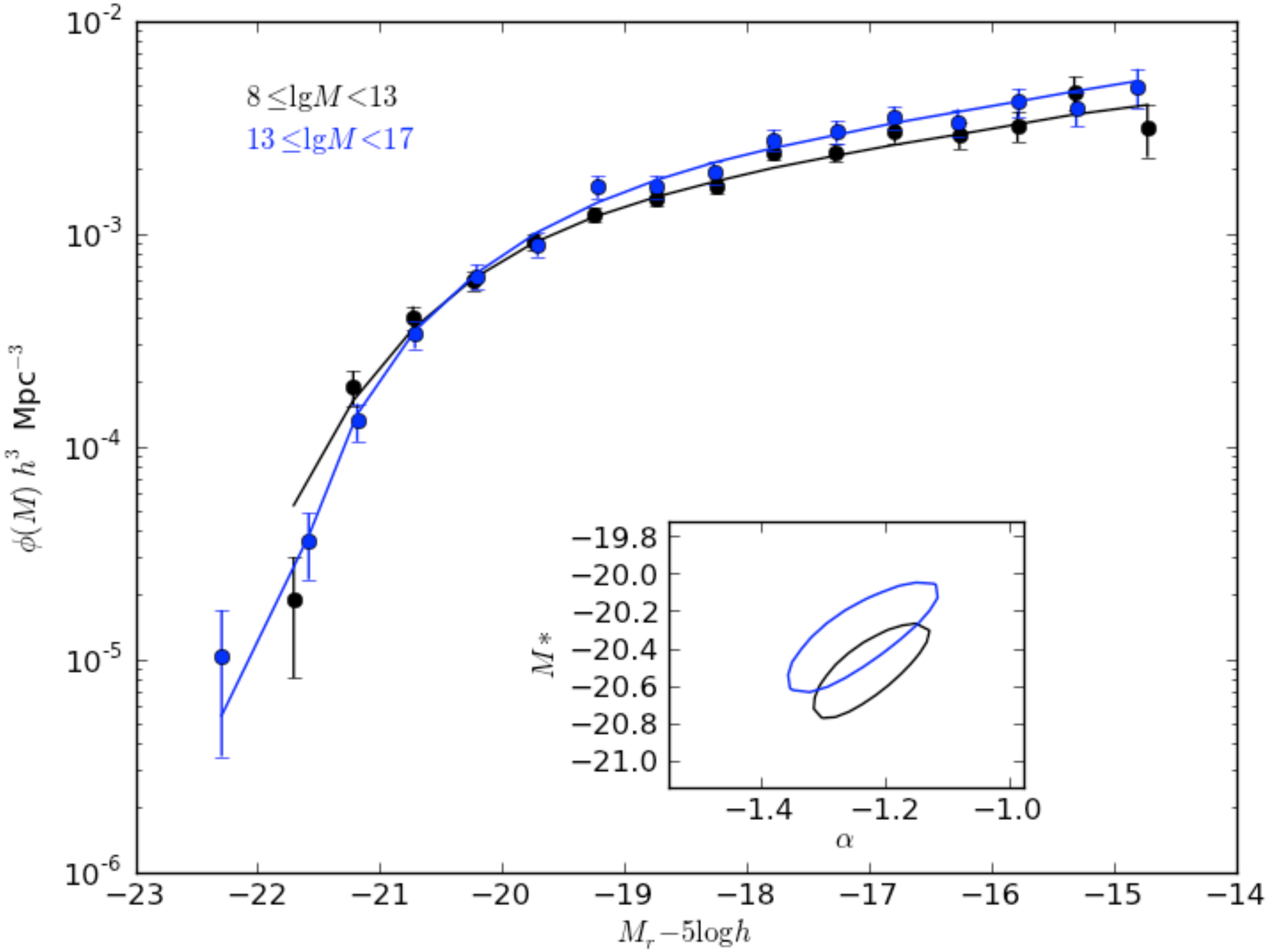
Mass - Blue



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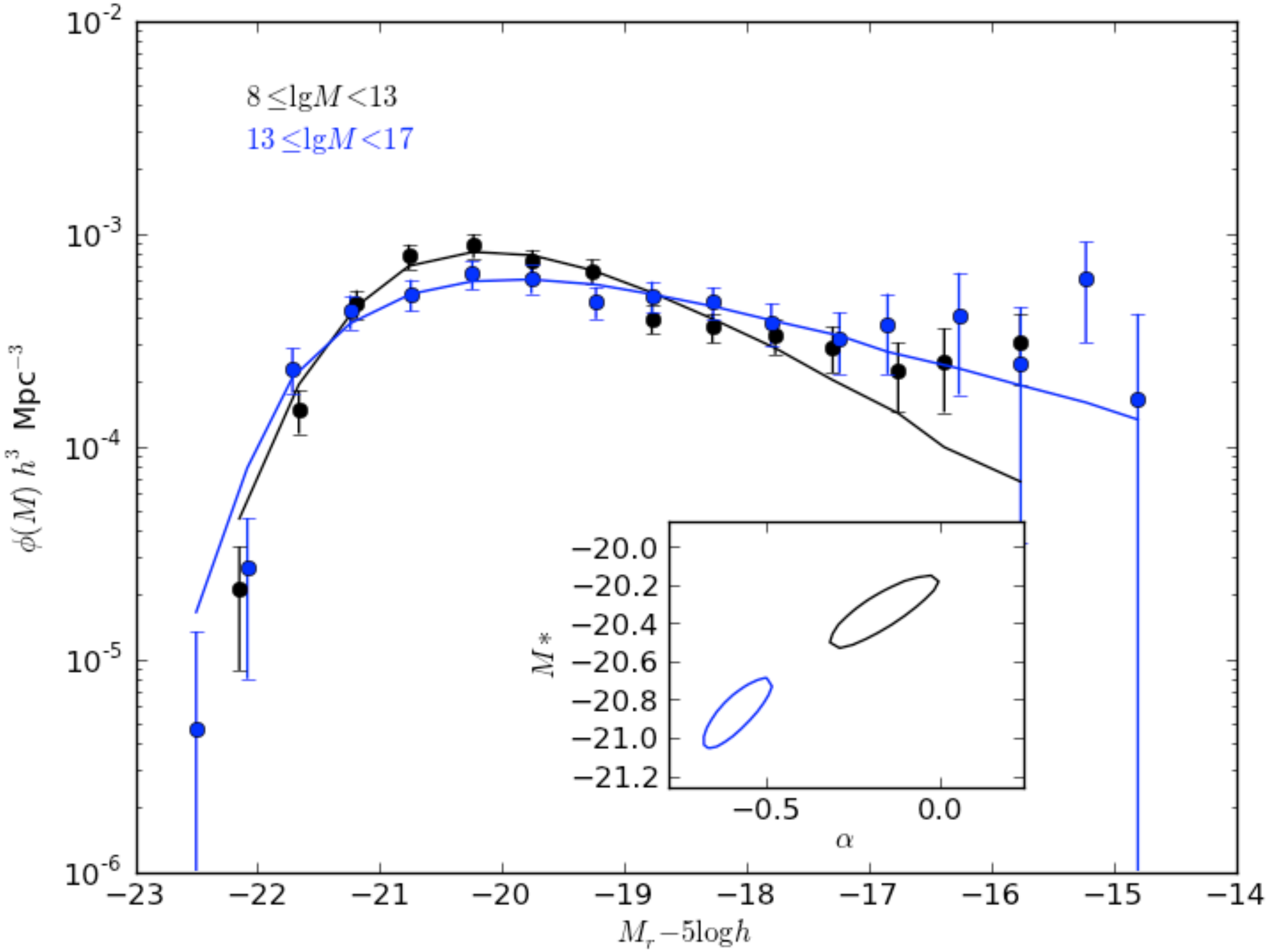
Mass - Red



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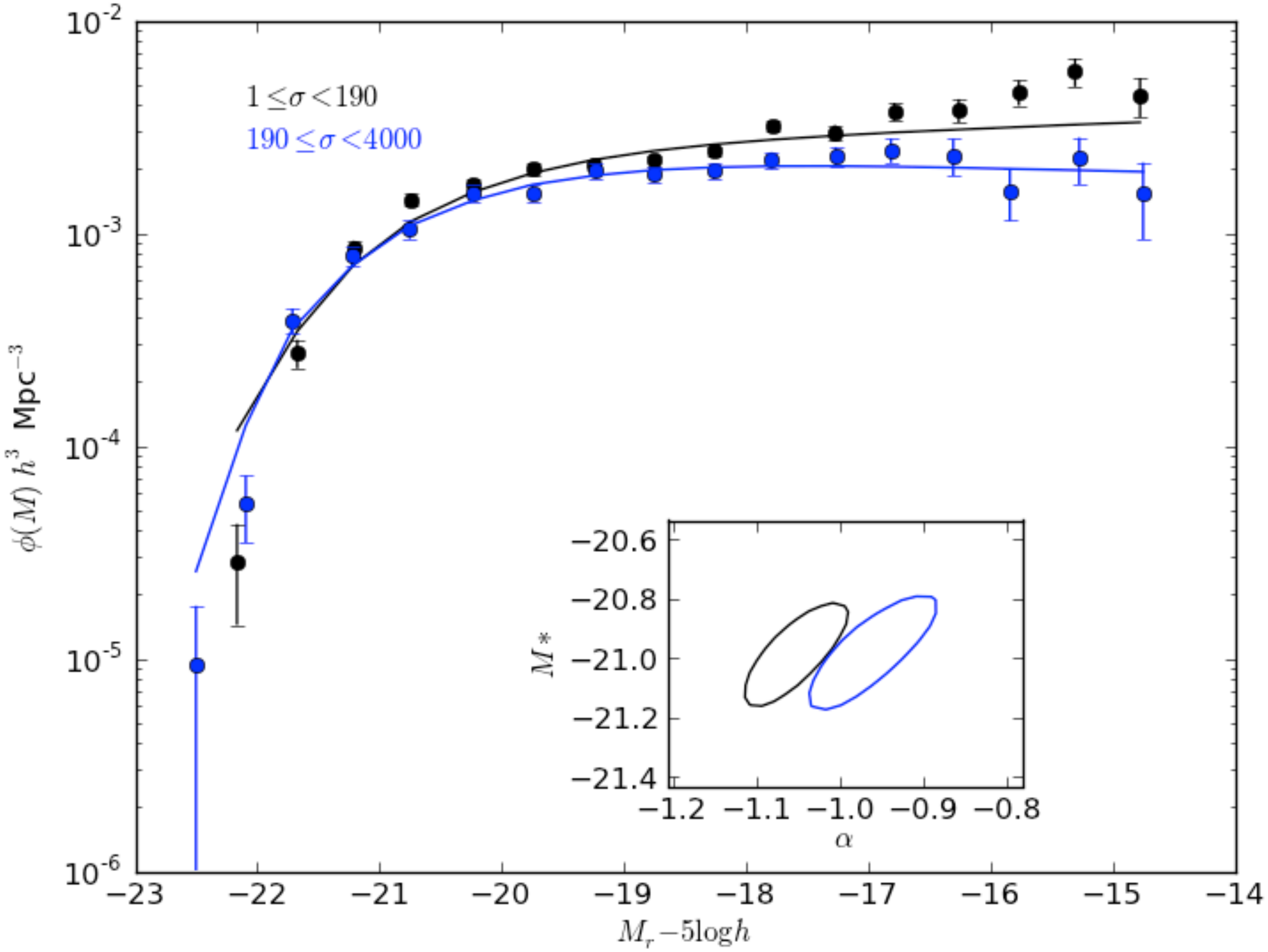
Vel Dispersion - All



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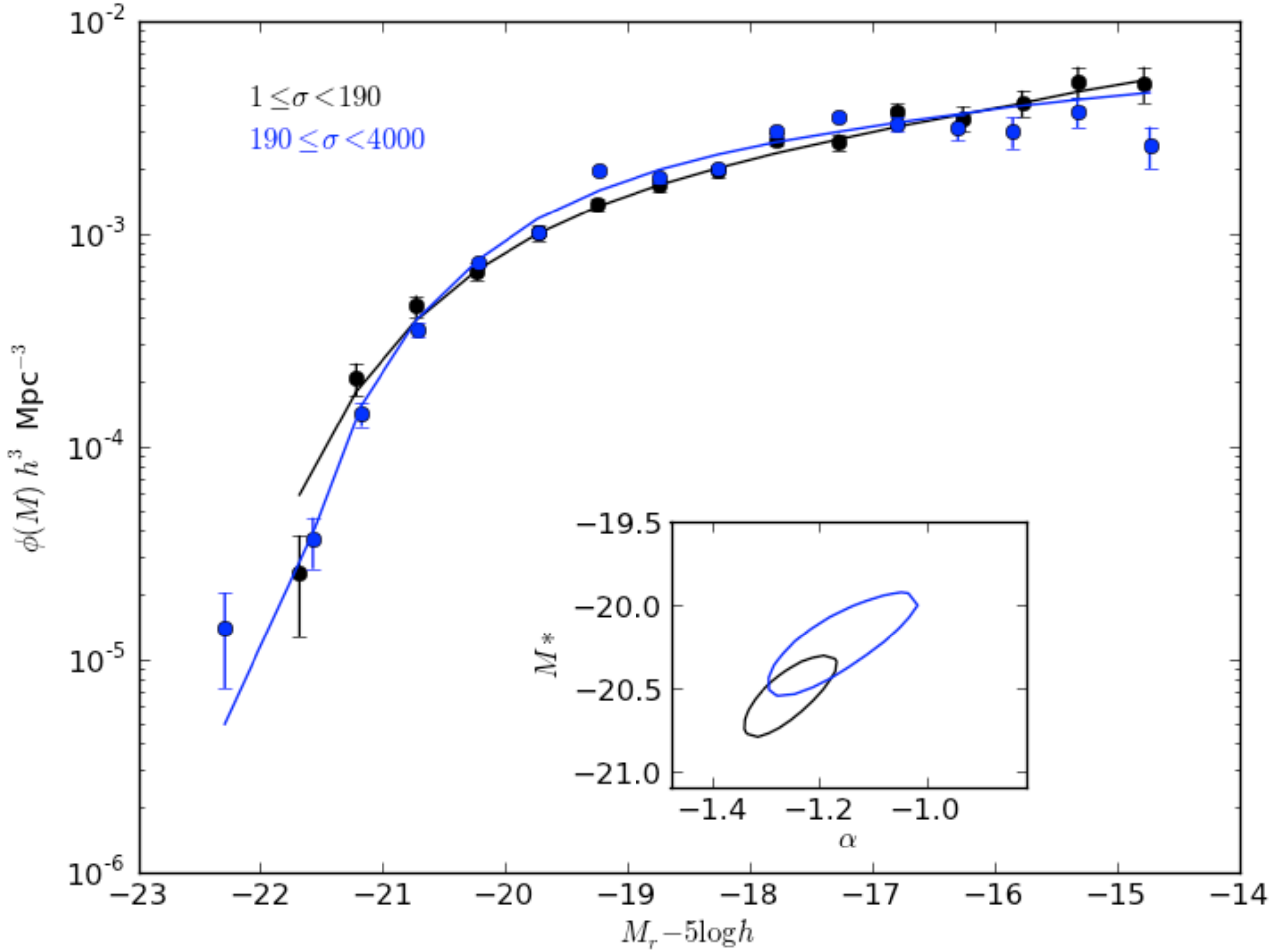
Vel Dispersion - Blue



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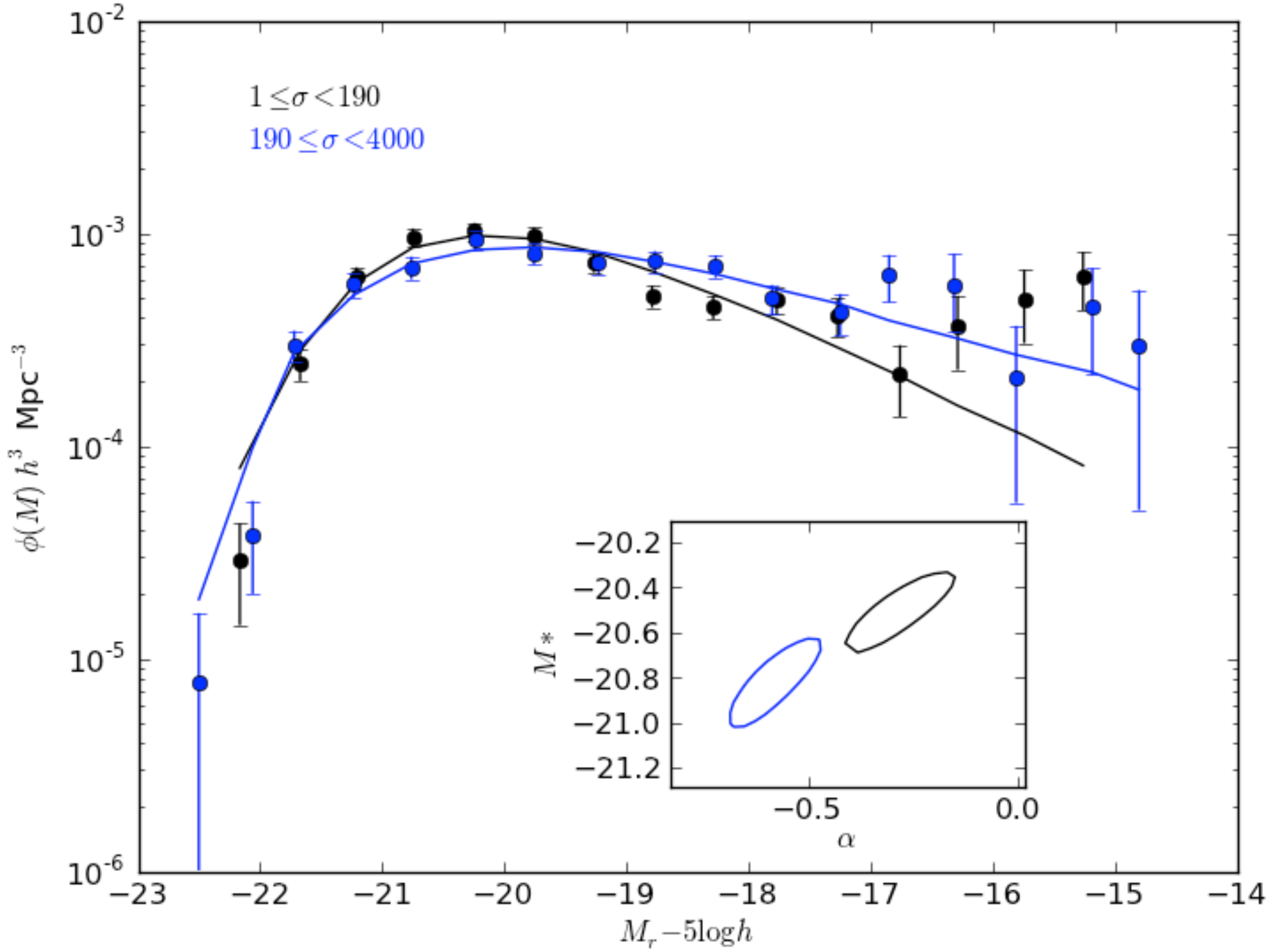
Vel Dispersion - Red



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Group LF Summary

- Grouped galaxies are systematically more luminous than ungrouped (caveat: selection)
- Rich (N > 2) groups systematically brighter than pairs (caveat: selection)
- Mass: main difference at bright end
  - Galaxies in massive groups ~ 0.2 mags brighter than those in less massive groups
- Velocity dispersion: main difference at faint end
  - Fewer faint galaxies in large-σ groups

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Summary

- At low redshifts, red galaxies require a double power-law Schechter function to fit faint-end
- *riz* bands well fit by simple evolutionary model ($Q \approx 1-3$, $P \approx 0$)
- *ug* bands: model over-predicts luminous galaxies at high redshift, wacky *Q*, *P* values
- Group LFs:
  - Group mass most affects bright end
  - Group vel disp most affects faint end
  - Red galaxy LFs much more sensitive to group properties than blue