GALFORM, the clustering of Extremely Red Objects and the colours of Lyman Break galaxies

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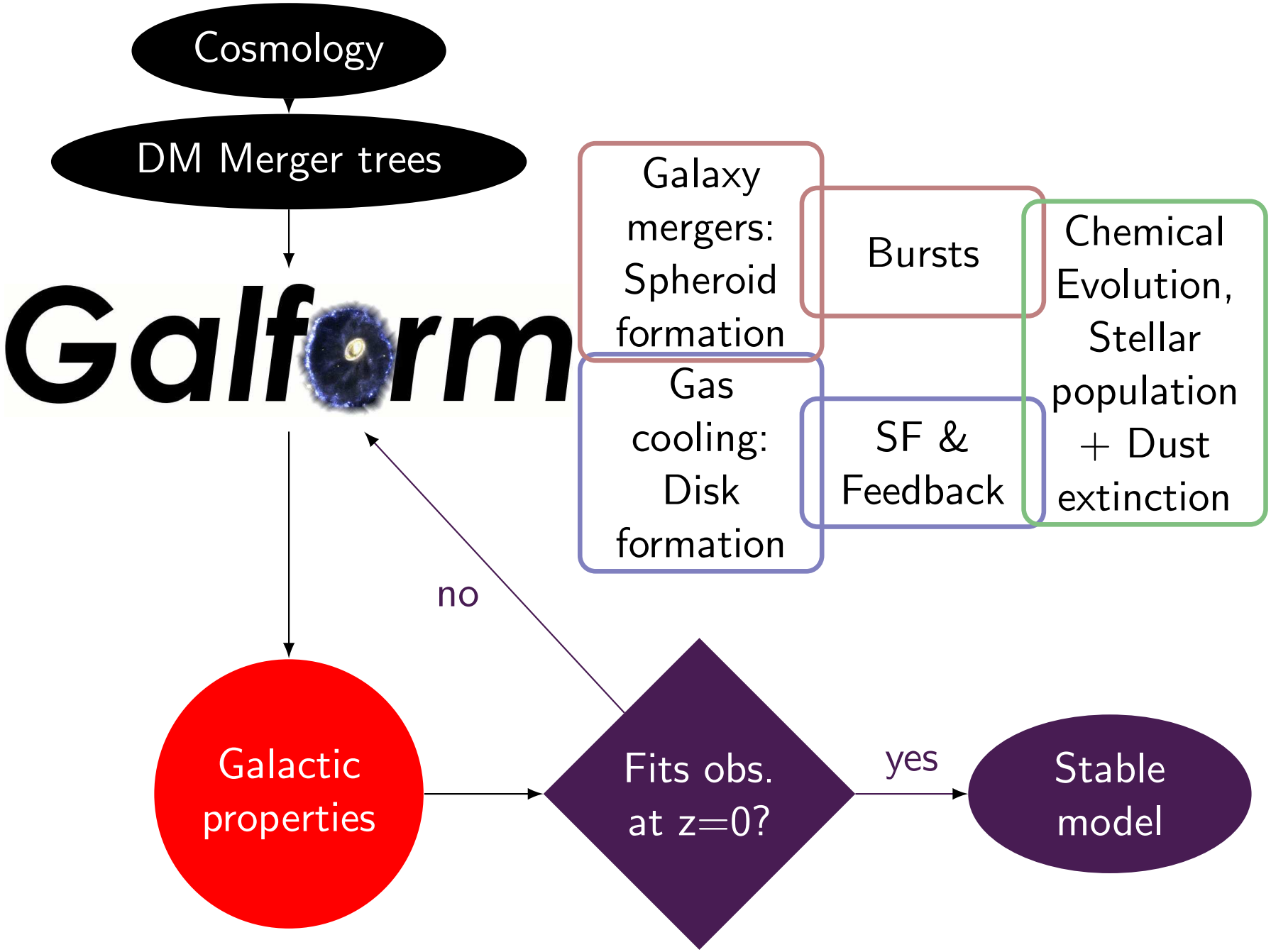
The semi-analytical approach: Because galaxies are not only shaped by gravity



	Baugh et al. 2005	**Bower et al. 2006**
Ω_0	0.3	0.25
Λ_0	0.7	0.75
Ω_b	0.04	0.045
σ_8	0.93	0.90
h	0.7	0.73
DM halo merger trees	Monte Carlo	N-body
Quenching of star formation	Superwind	AGN feedback
Dynamical scale for quiescent star formation	Independent of time	Dependent on time
Bursts triggered by	Mergers	Mergers and disk instabilities
Burst IMF	Top heavy	Kennicut 1998

Massive, red galaxies in a hierarchical universe-I Counts of Extremely Red Objects and basic properties

MNRAS, 2009

V. Gonzalez-Perez[1], C. M. Baugh[2], C.G.Lacey[2], C. Almeida[2].

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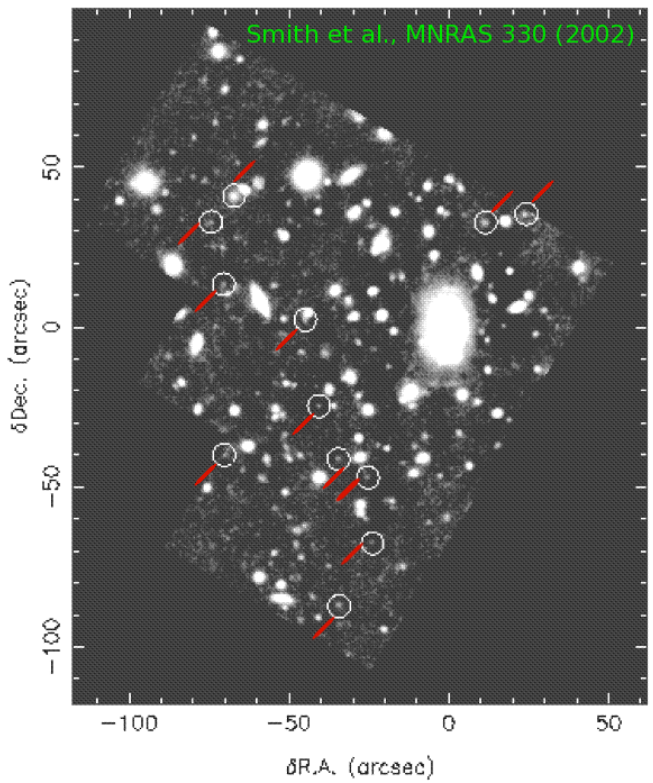
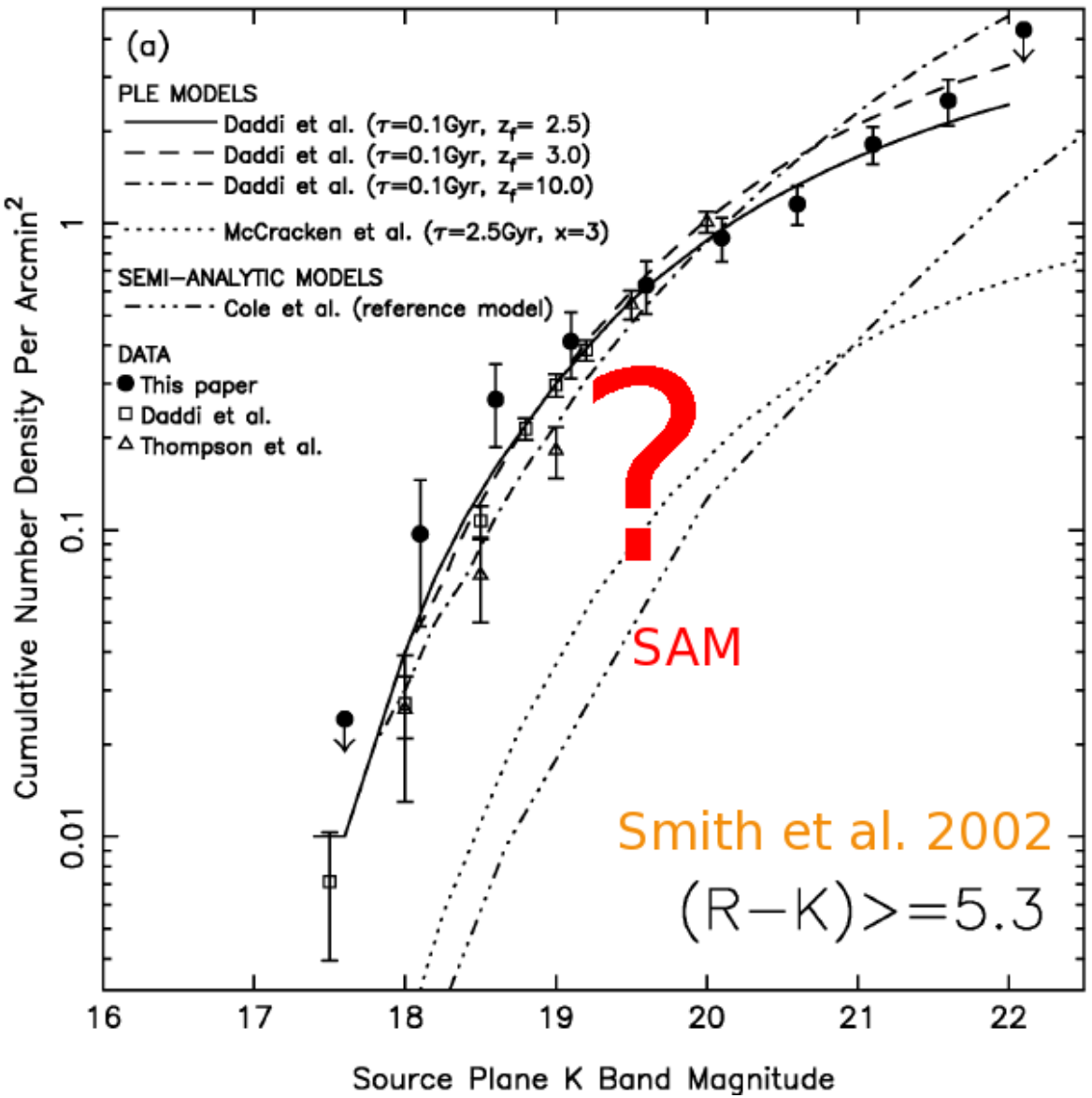
Observationally EROs are:

- Redder than e.g. $(R - K) = 5$
- They appear at $z \sim 1$
- Massive galaxies
- $\sim 50\%$ have an old stellar population
- Inhomogeneously distributed in the sky: highly clustered



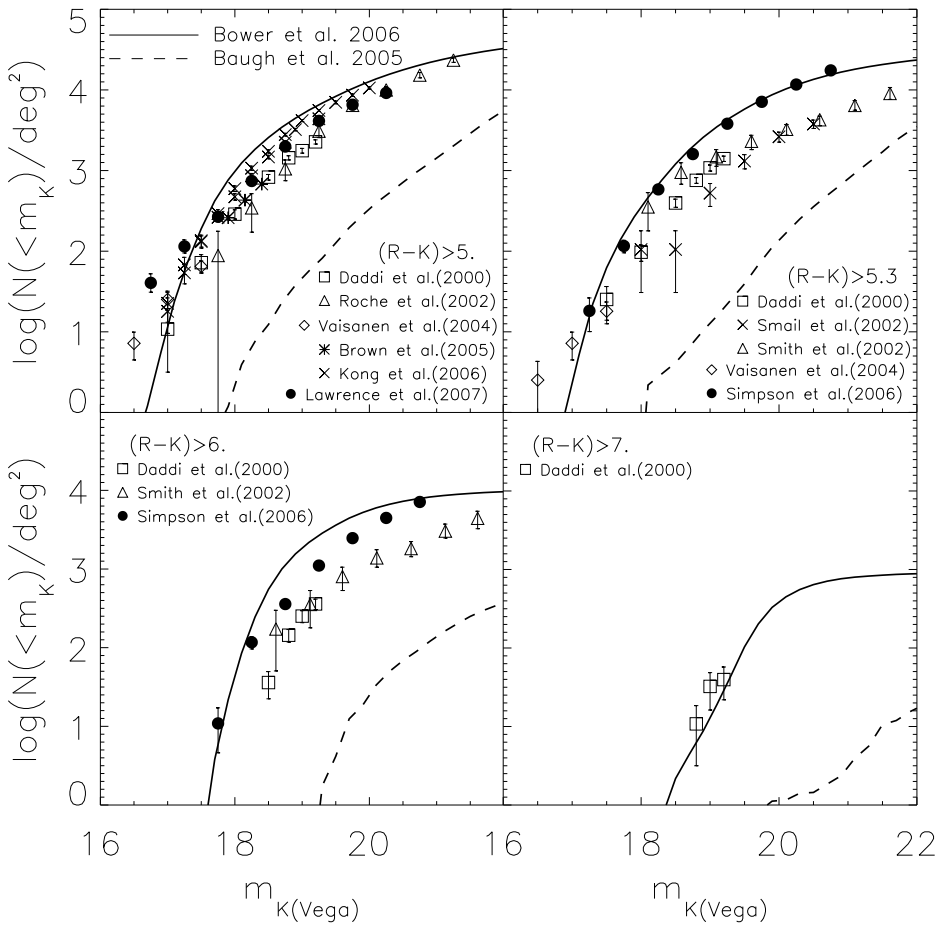
Counts of EROs and basic properties

Motivation of the study:



Counts of EROs and basic properties

The solution to a long standing problem:



- Baugh et al. (2005) underestimation $\times 10$ and lacks a turn over
- Bower et al. (2006) fits data well
- **AGN feedback** seems to be needed to understand massive galaxy evolution!!

The clustering of EROs

Massive, red galaxies in a hierarchical universe – II. Clustering of Extremely Red Objects

MNRAS, 2011

V. Gonzalez-Perez,* C. M. Baugh, C. G. Lacey and J.-W. Kim

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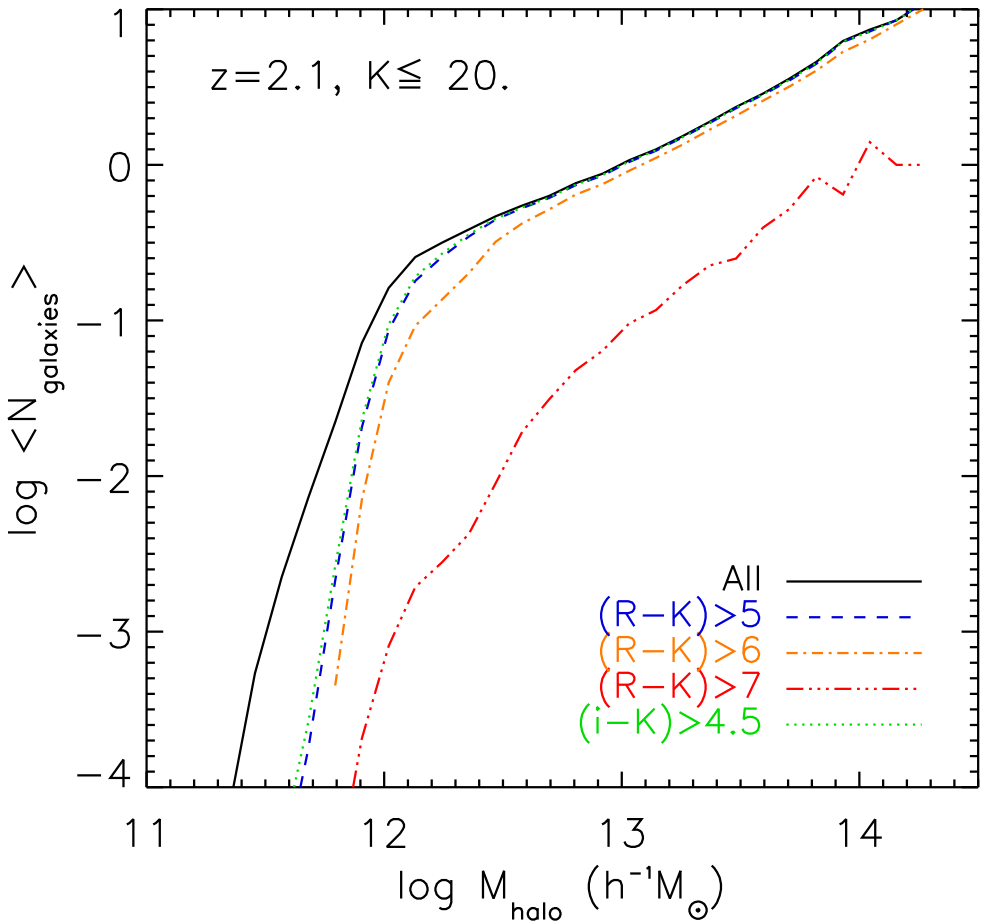
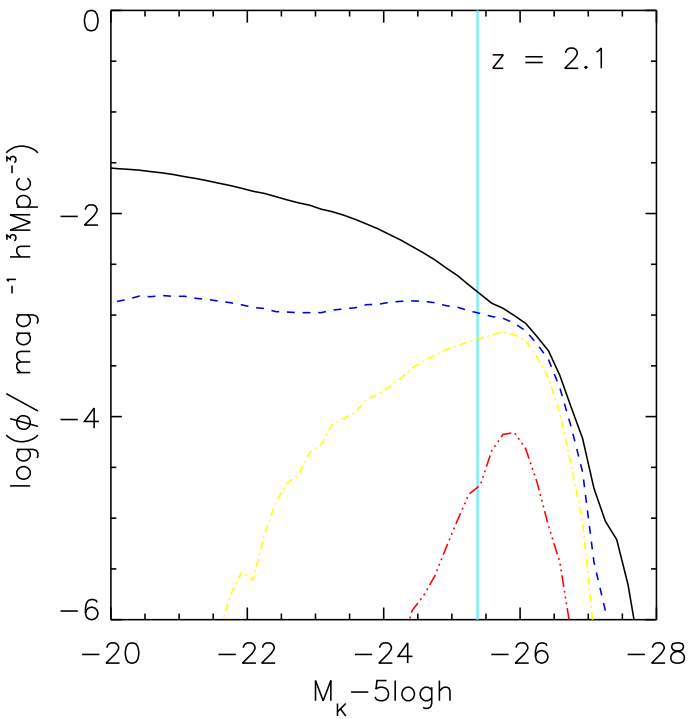
We predict the right number of EROs,
do they populate the correct haloes?

1. Study the predicted host haloes of EROs
2. Compare the predicted clustering of EROs with observations.

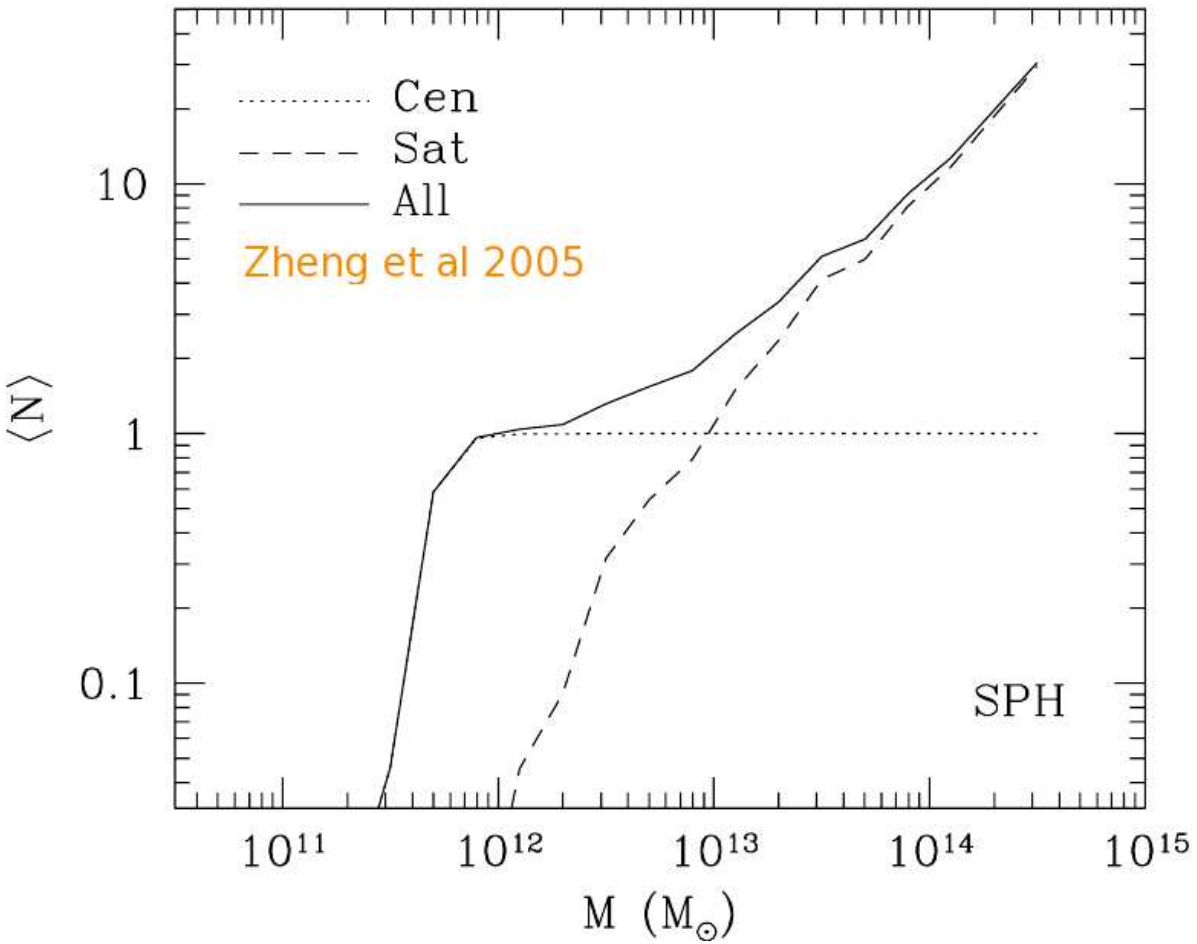
The predicted halo occupation distribution of EROs





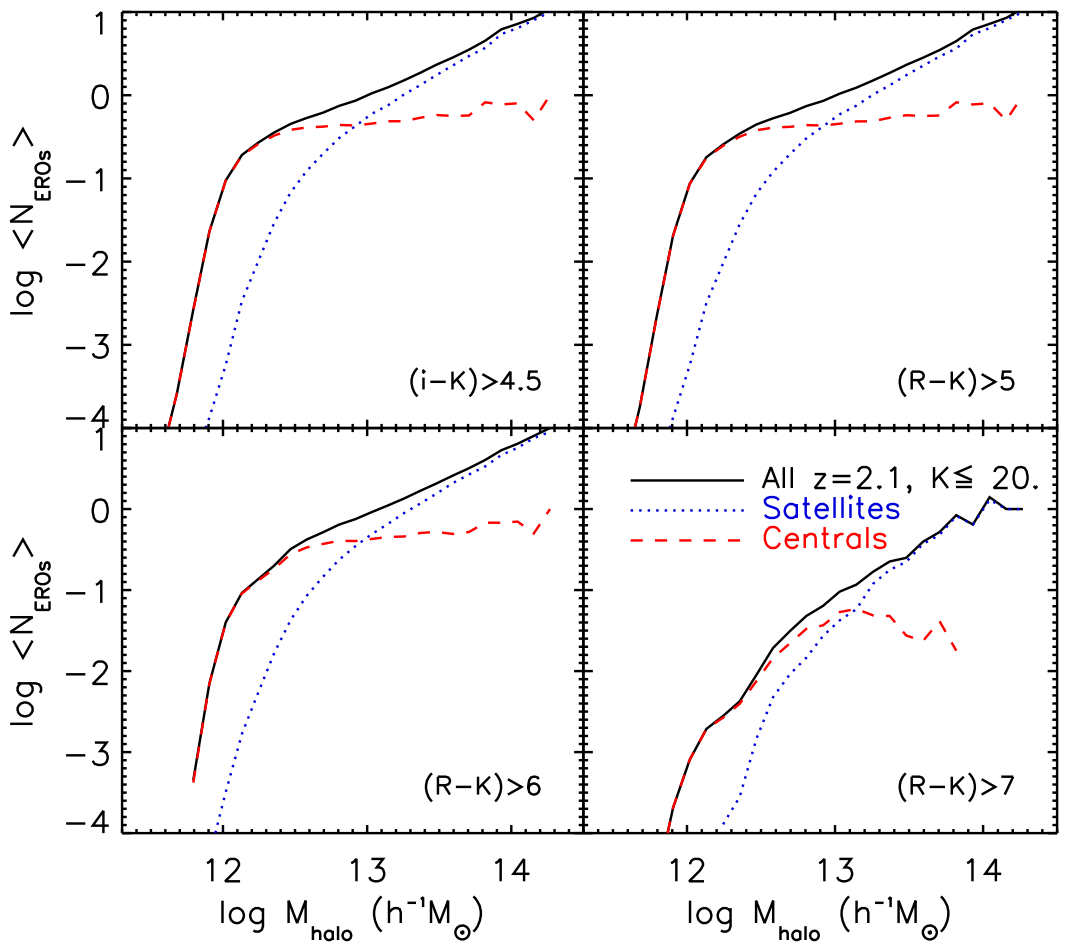
At $z = 2.1$ HOD EROs $\approx$ HOD K-selected galaxies.

The predicted halo occupation distribution of EROs



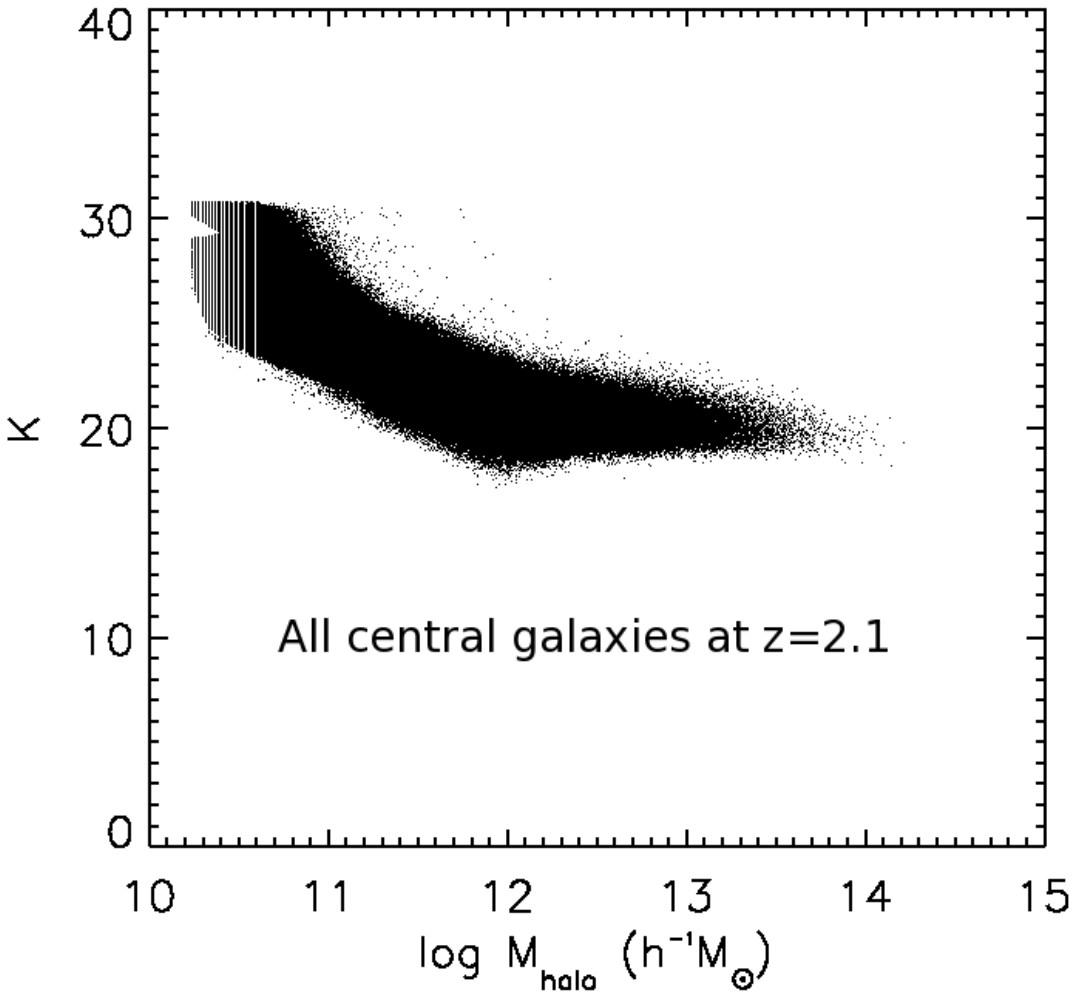
- The HOD is shaped by the relative fraction of satellite and central galaxies.

The predicted halo occupation distribution of EROs



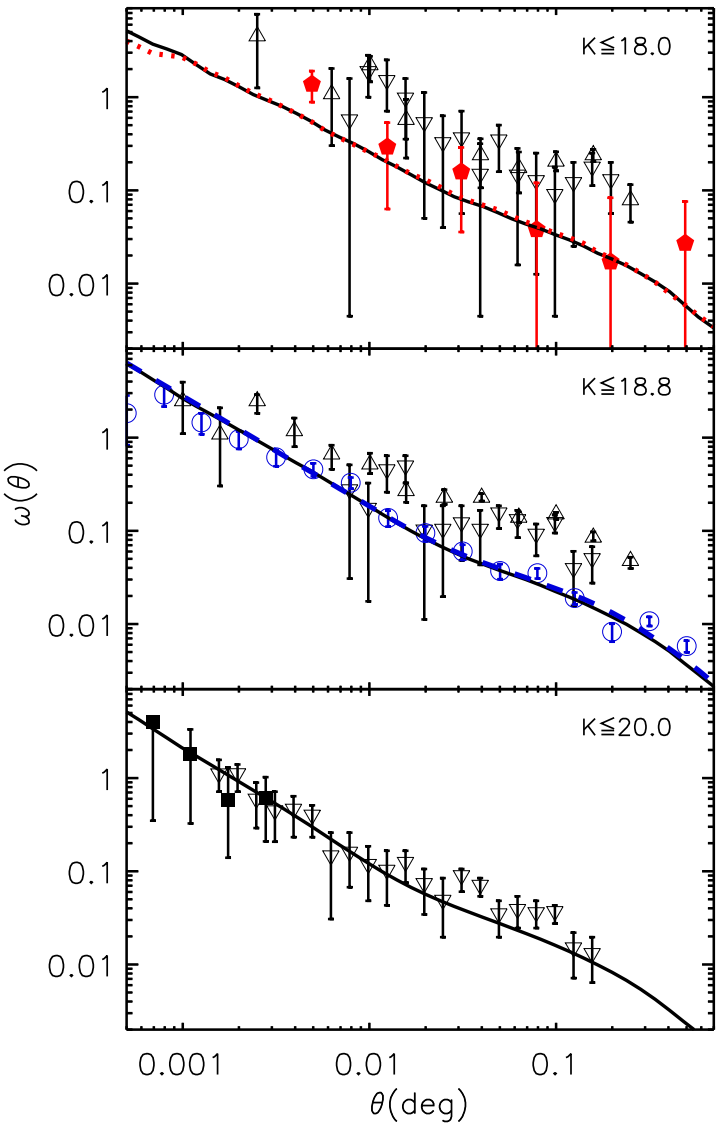
- The HOD is shaped by the relative fraction of satellite and central galaxies.
- The **predicted** HOD of central galaxies does not flatten at unity,

The predicted halo occupation distribution of EROs



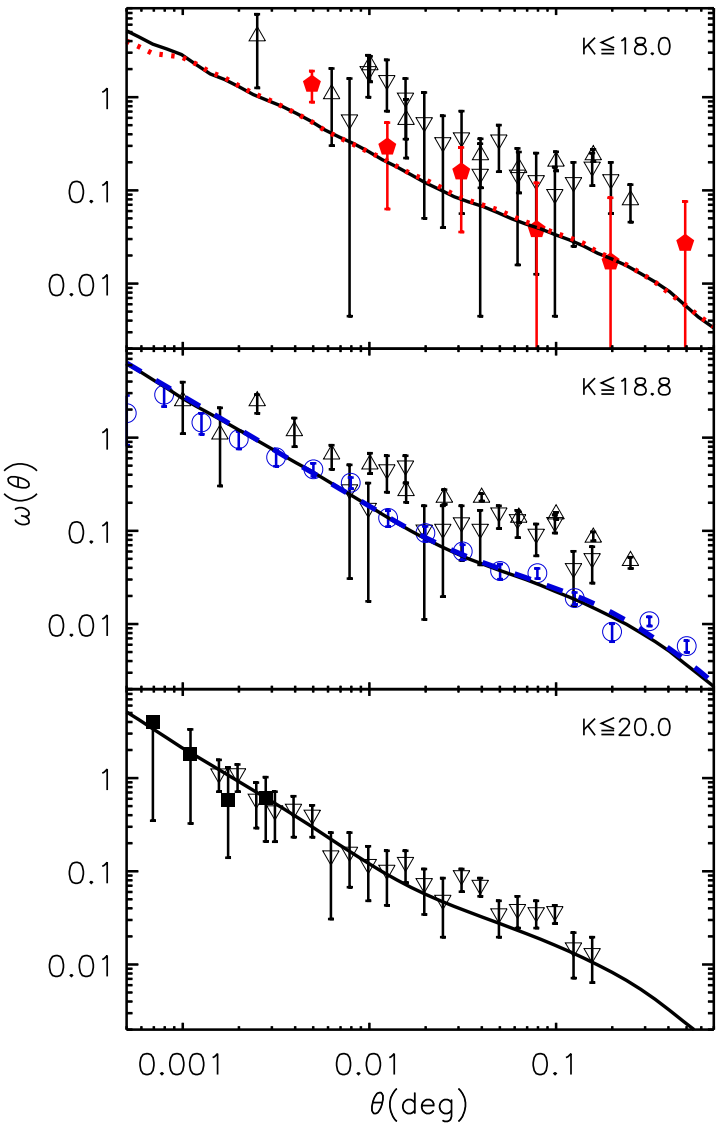
- The HOD is shaped by the relative fraction of satellite and central galaxies.
- The **predicted** HOD of central galaxies does not flatten at unity, due to the effect of the AGN feedback over the mass-luminosity relationship.

The clustering of EROS

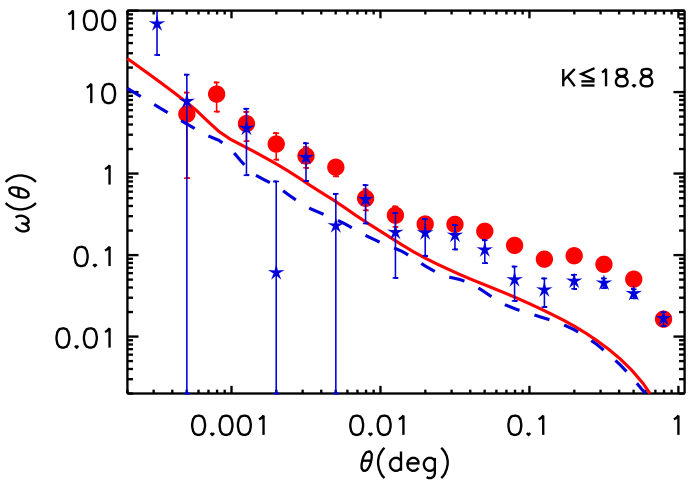


- Predictions for EROs with $(R-K)>5$ match the observed $\omega(\theta)$ in the range $0.0006 \leq \theta(\mathrm{deg}) \leq 0.6$, once cosmic variance is taken into account.

The clustering of EROS



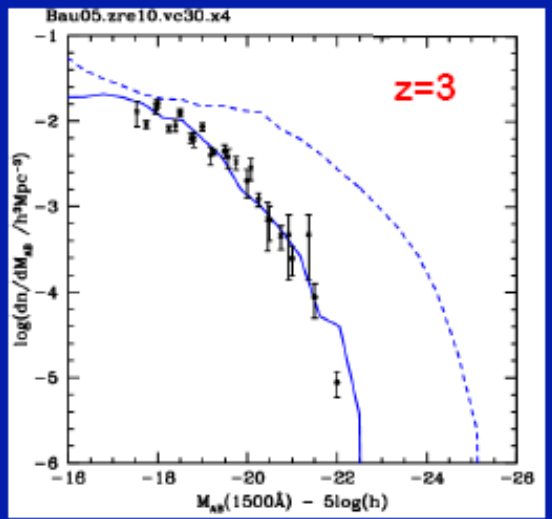
- Predictions for EROs with $(R-K)>5$ match the observed $\omega(\theta)$ in the range $0.0006 \leq \theta(\mathrm{deg}) \leq 0.6$, once cosmic variance is taken into account.
- However, the match is not so good when selecting EROs with $(i-K)>4.5$:

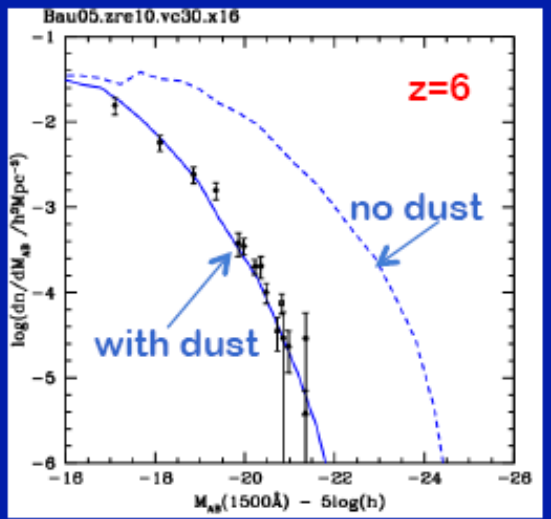


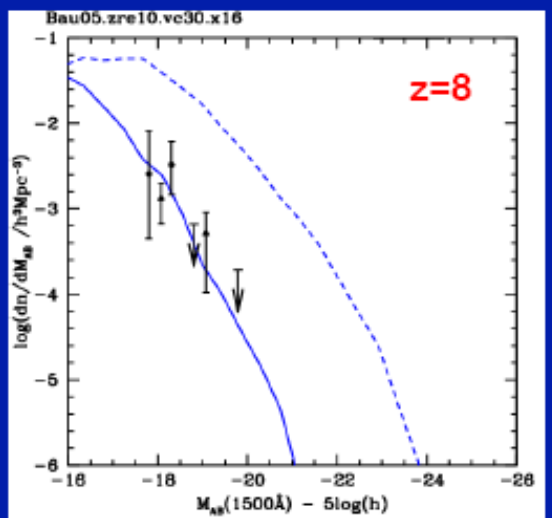
Ongoing work on this topic:

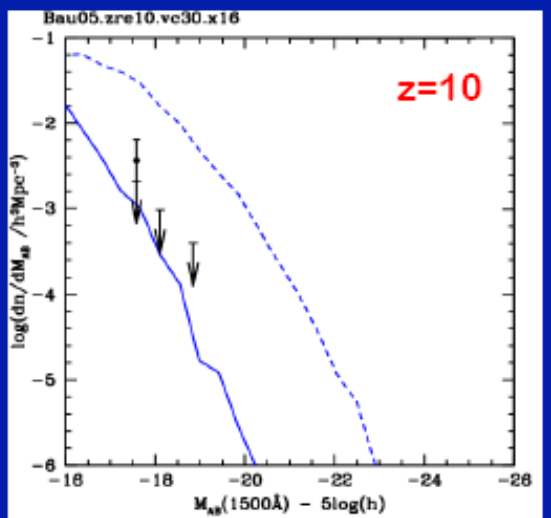
- Kim et al., ω_{EROs} in narrow z-bins.

Evolution of far-UV LF – comparison with LBGs





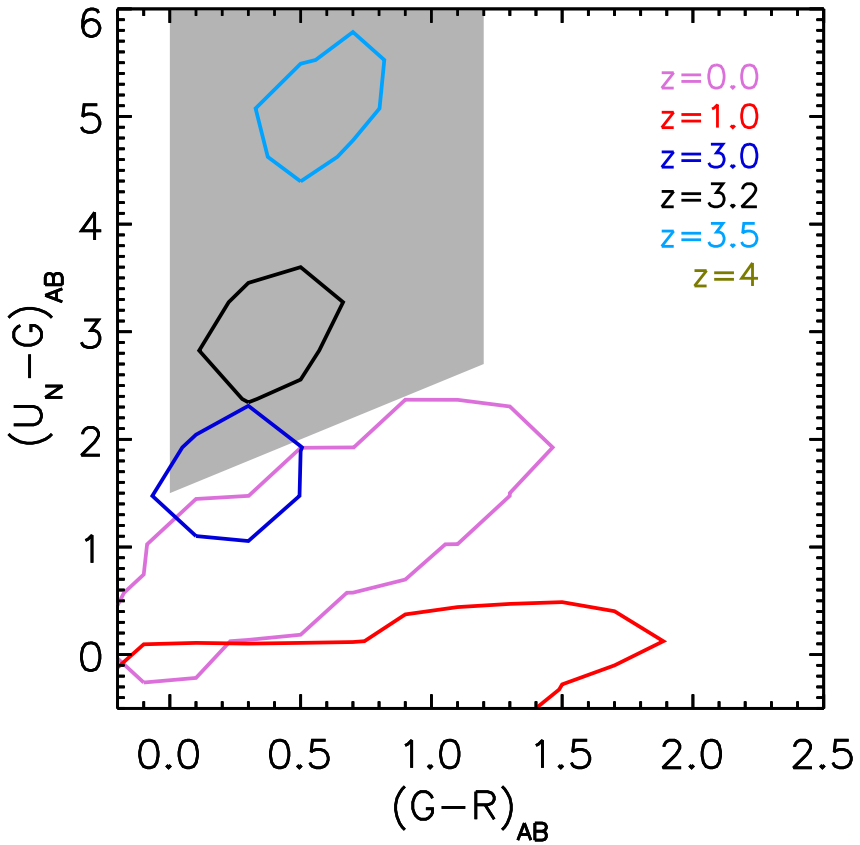




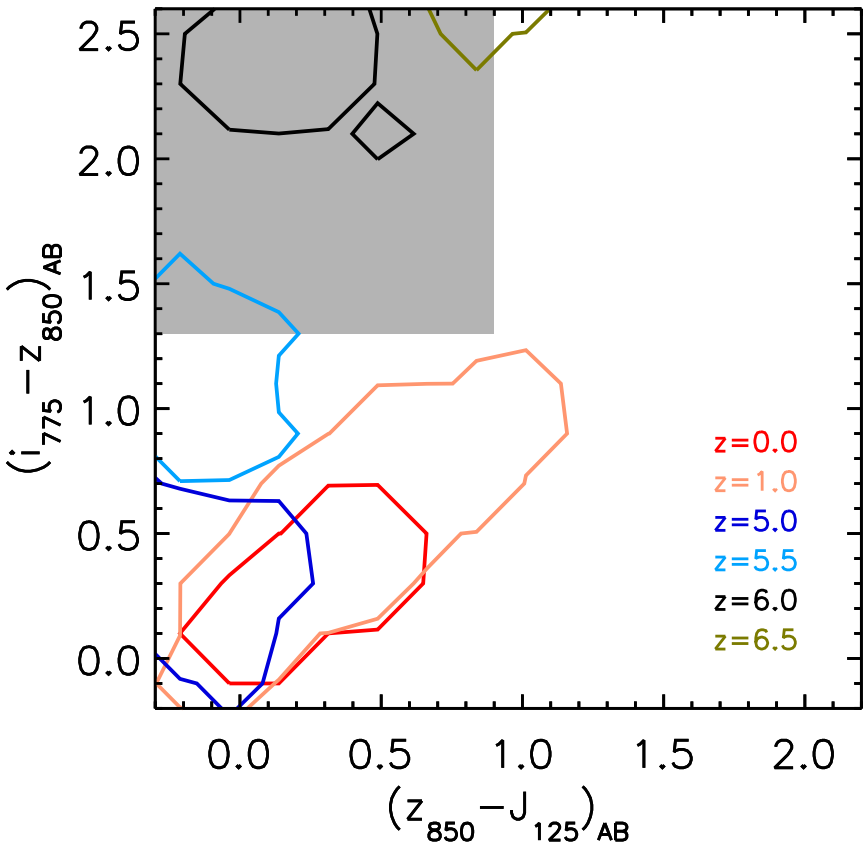
- Extends original agreement of model with LBG obs for z=3 (Baugh+05) up to z=10 (including new HST WFC3 data)
- predict large UV extinctions (~ 2 mag)

Lacey+11

The predicted UV colours of LBGs, galaxies at $z > 3$

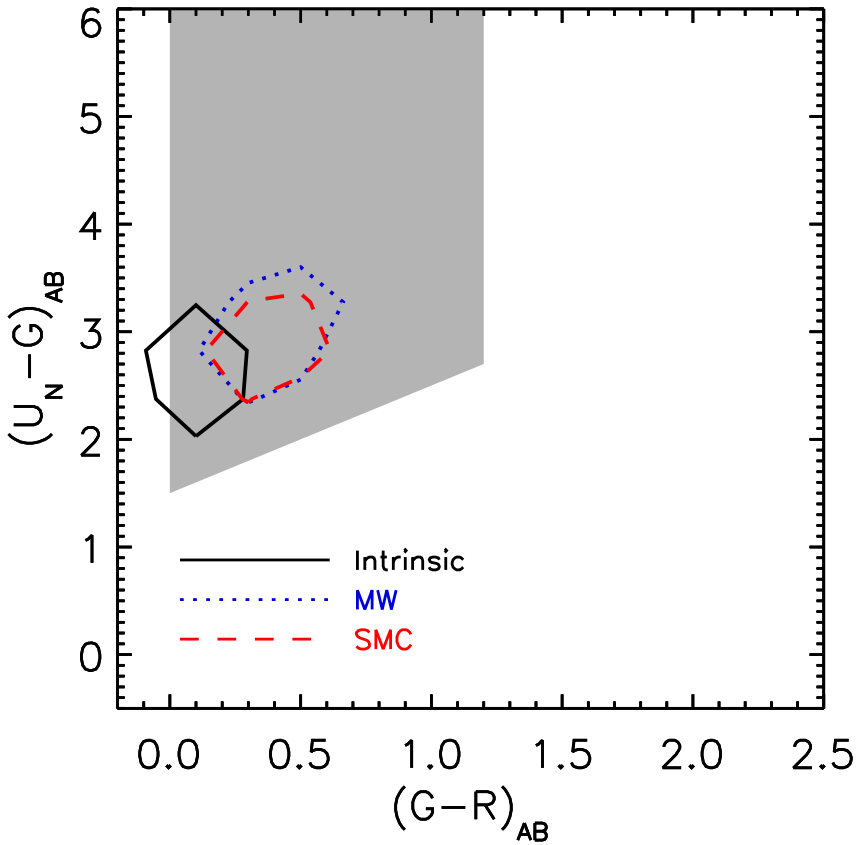


U-dropout selection from Steidel+95, $3 < z < 3.5$

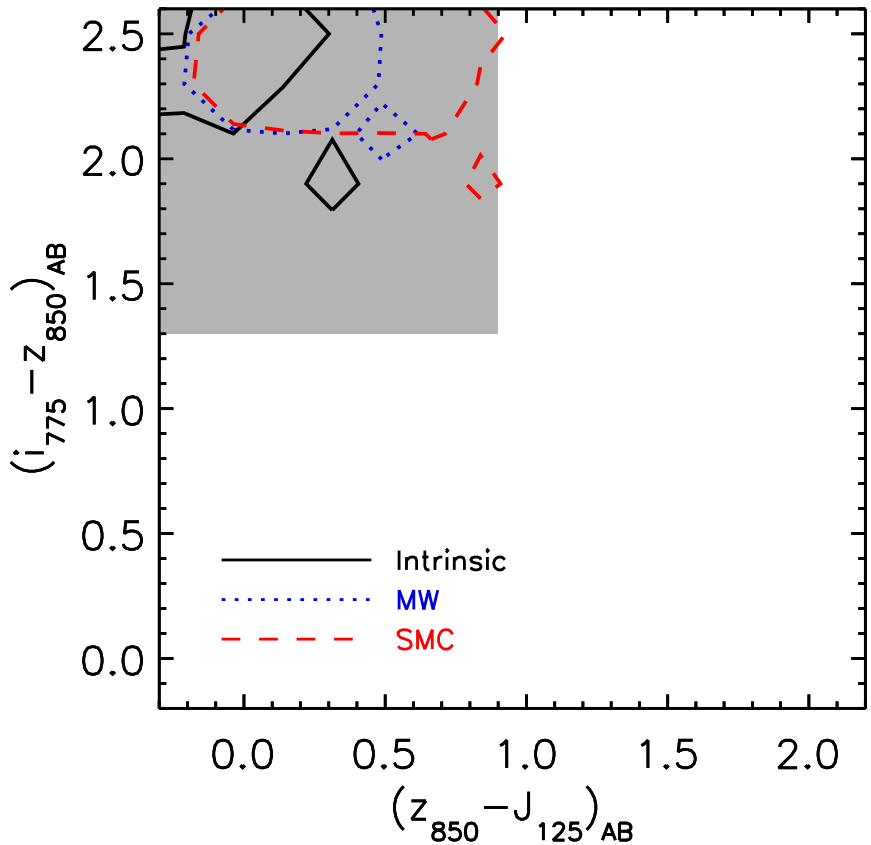


i-dropout selection from Bouwens+11, $z \sim 6$

The predicted UV colours of LBGs, galaxies at $z > 3$

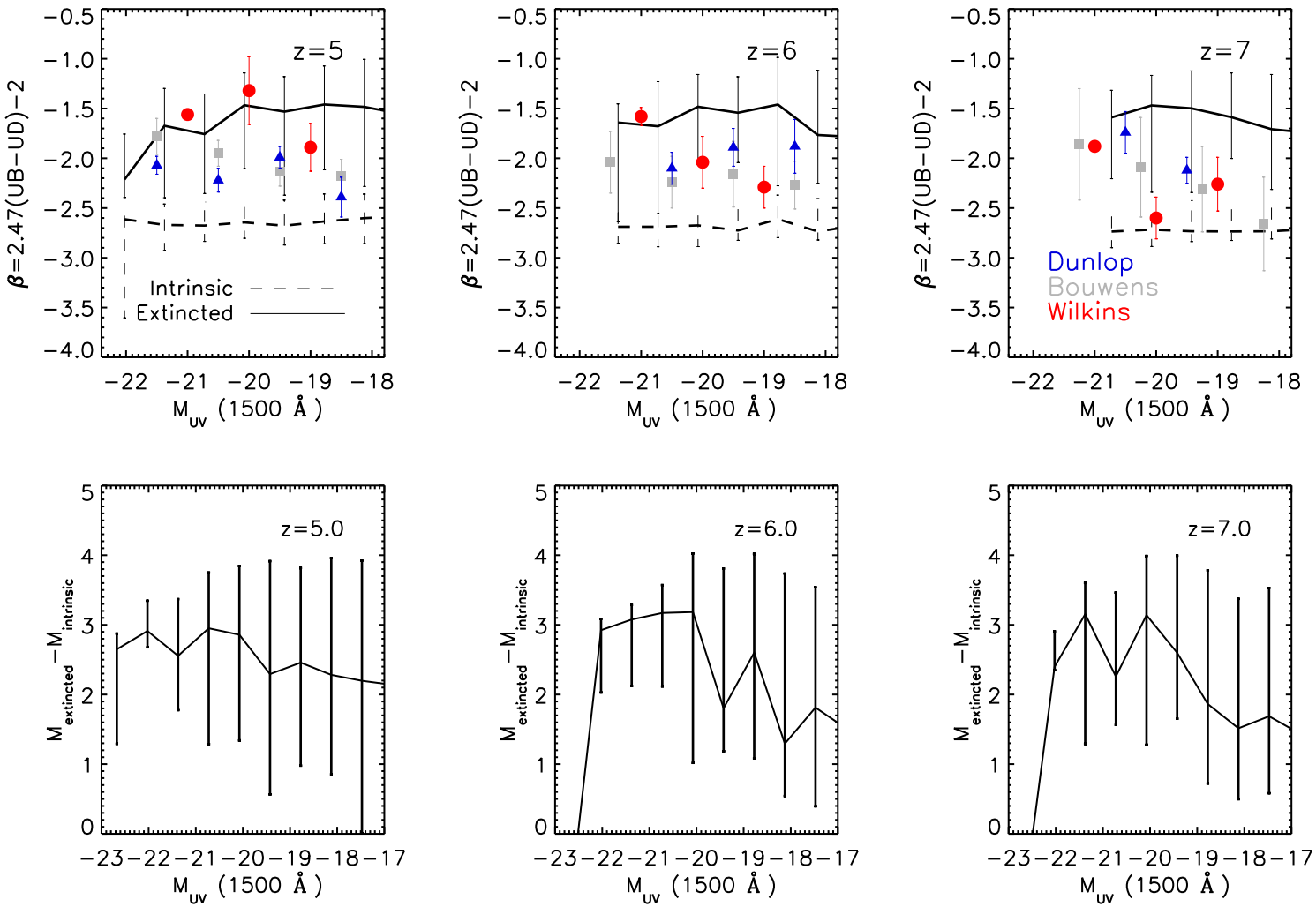


U-dropout selection from Steidel+95, $3 < z < 3.5$



i-dropout selection from Bouwens+11, $z \sim 6$

The predicted UV slope of LBGs



Concluding remarks

- Number counts can discriminate different theoretical models.
- AGN feedback is needed to understand the evolution of massive galaxies.
- The AGN feedback modifies the HOD of bright galaxies.
- GALFORM reproduces the angular clustering of EROs.

See Gonzalez-Perez et al., MNRAS, 2009 and 2011.

- The predicted galaxies have UV colours comparable to the observed ones.
- The predicted UV-continuum slope agrees with observations for the brightest galaxies.

Work in progress.

Semi-analytic models are useful tools to explore the physical processes that determine the evolution of galaxies!