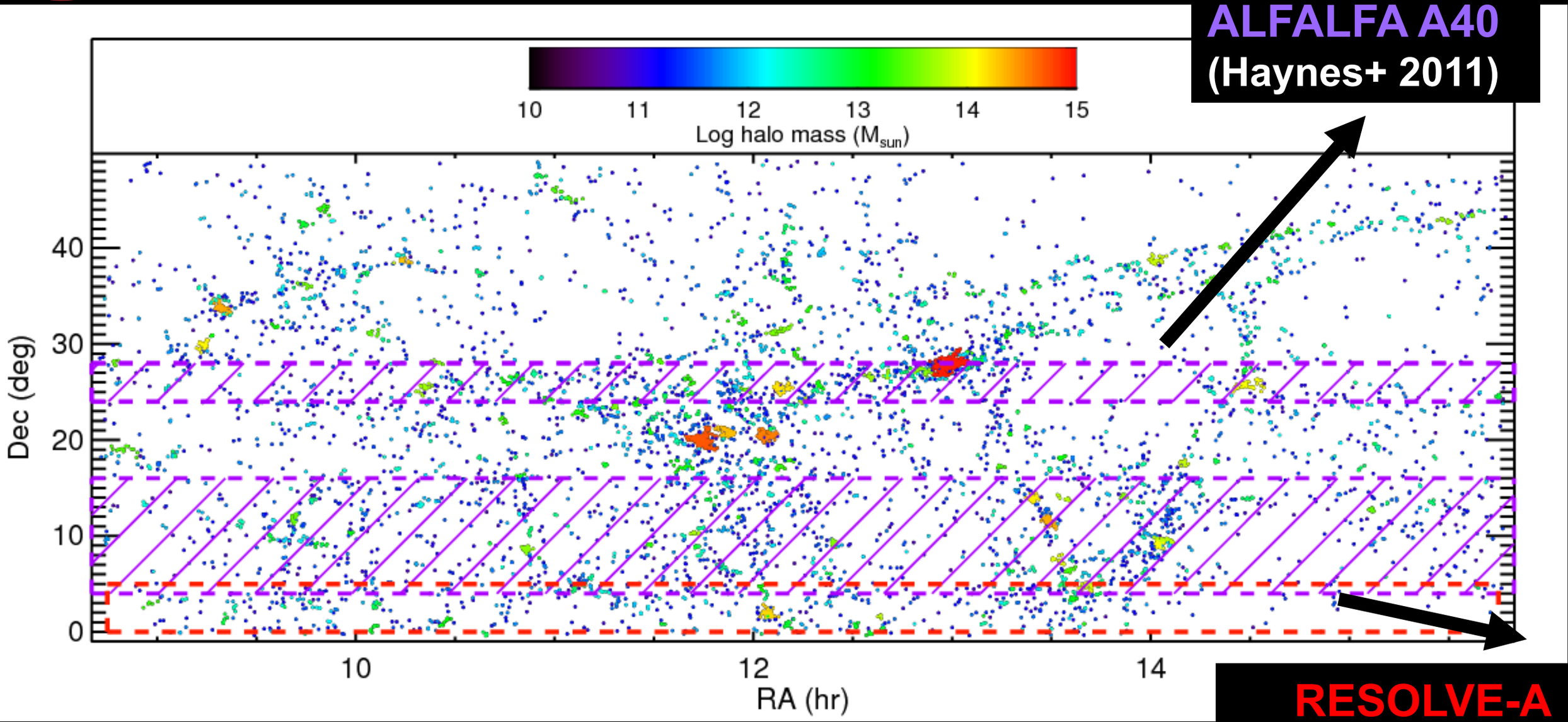
ECO and RESOLVE: Morphology and Disk Growth in Environmental Context

Amanda Moffett
(ICRAR, U. of Western Australia)

Sheila Kannappan, Andreas Berlind, Kathleen Eckert, David Stark, David Hendel, Mark Norris, Norman Grogin, and the RESOLVE team

ECO Catalog Coverage



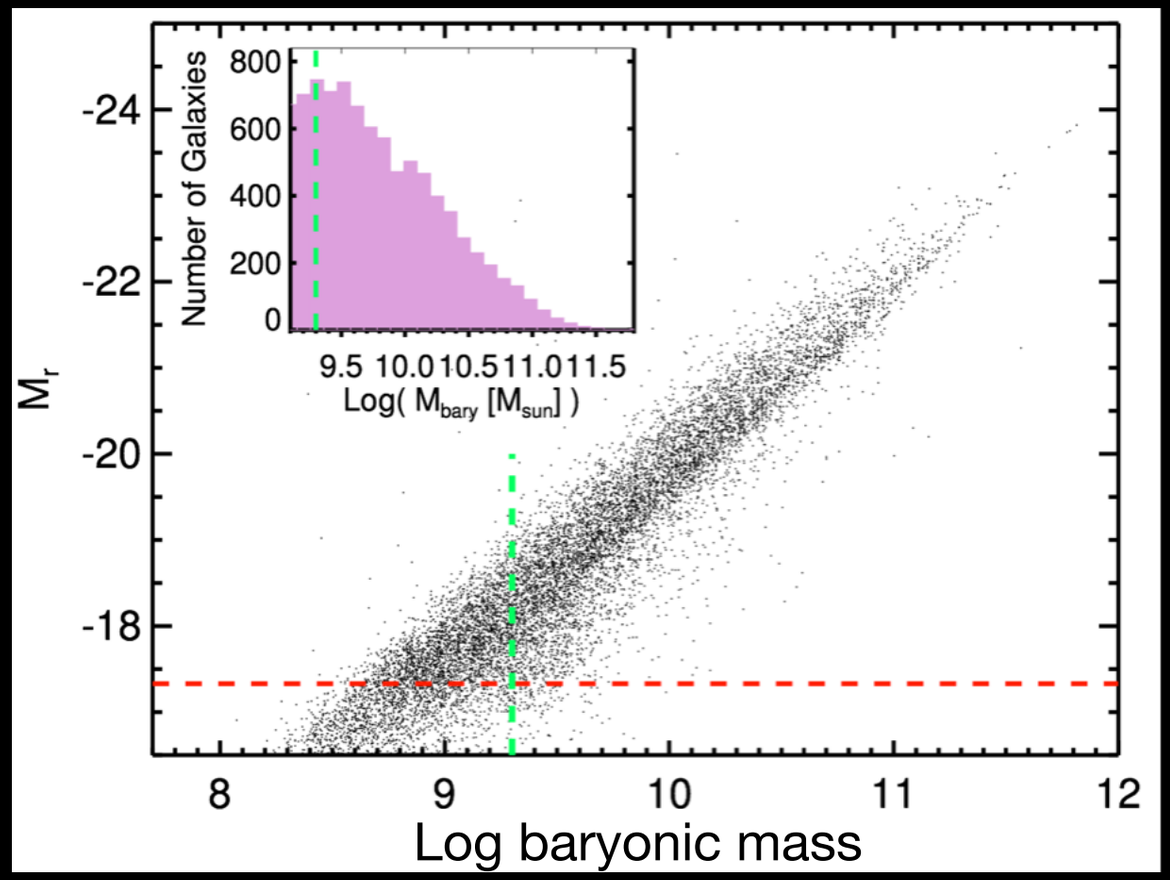
- Defined by overlap of UZC and SDSS
- Also contains RESOLVE, HyperLEDA, GAMA, 2dF, and 6dF spec z
- M_r < -17.33 and cz ~2500 - 7500 km/s
- ~13,000 galaxies in a >500,000 cubic Mpc volume

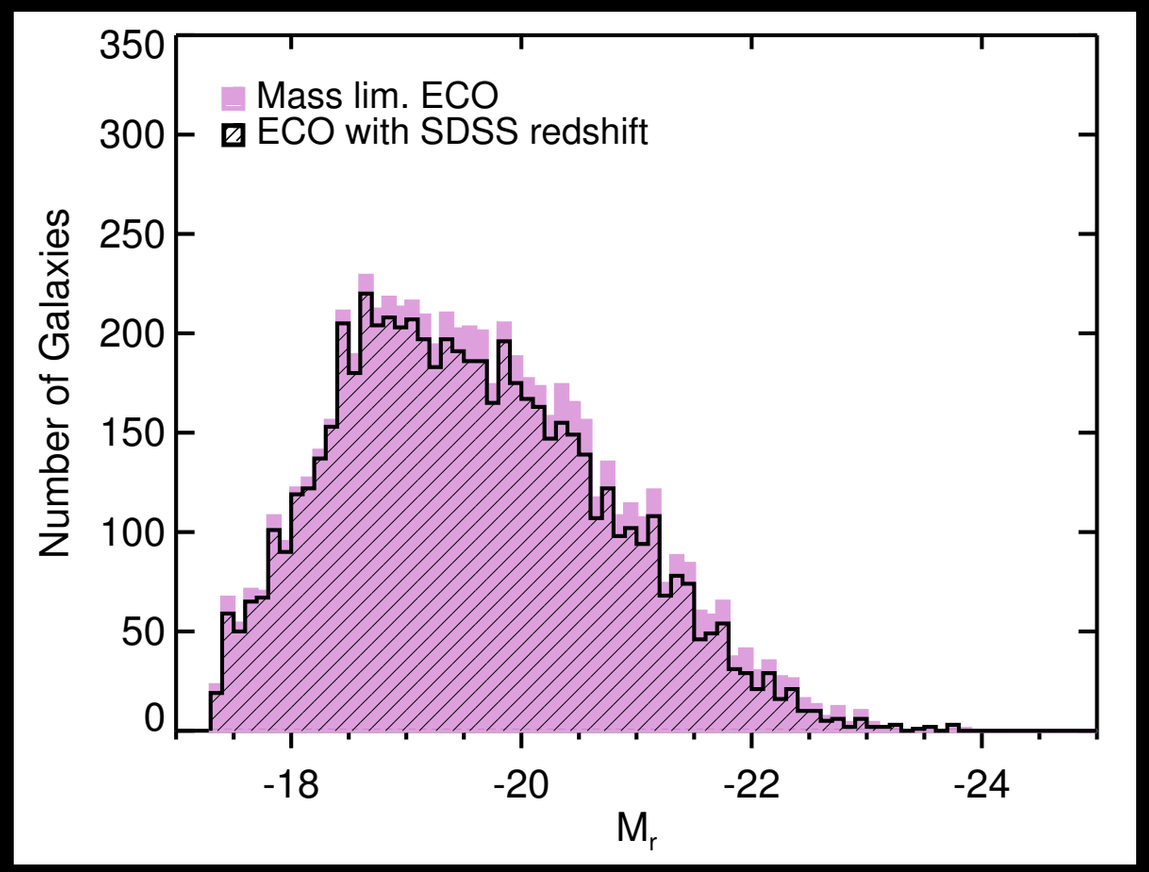
ECO Data Products

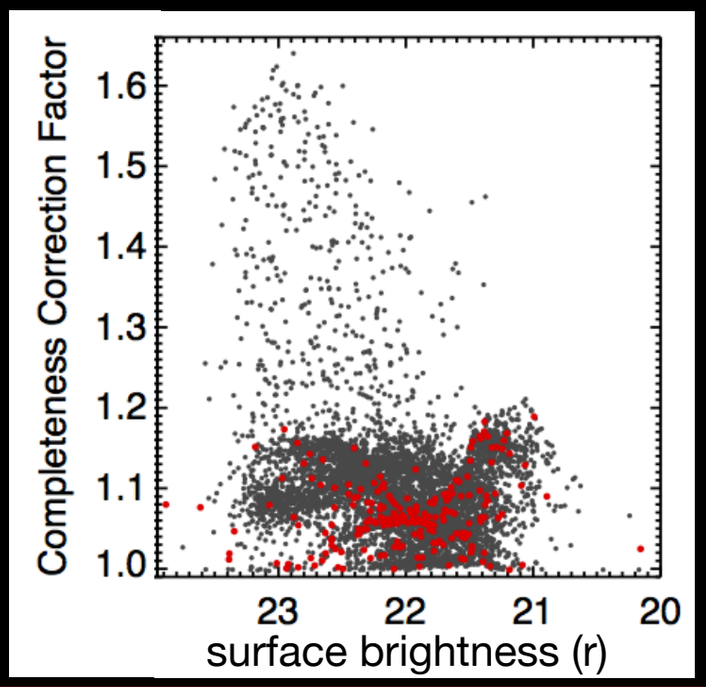
- High completeness compilation
- Reprocessed SDSS, 2MASS, and GALEX photometry (based on methods of Eckert+ 2015 for RESOLVE)
- Stellar mass estimates using methods of Kannappan+ 2013 (also e.g., extinction-corrected colors, SFRs)
- Atomic gas masses (ALFALFA A40) and photometric gas fraction estimates (e.g., Kannappan+ 2013, Eckert+ 2015)
- Morphology information (quantitative, based on RESOLVE visual classifications)
- Environment metrics: group finding with halo abundance matching (Berlind+ 2006), number density fields, and large-scale structure IDs in development (e.g., J. Florez, D. Stark)

DR1 now available: Moffett+ 2015 & http://resolve.astro.unc.edu/

ECO Mass Limited Sample Completeness

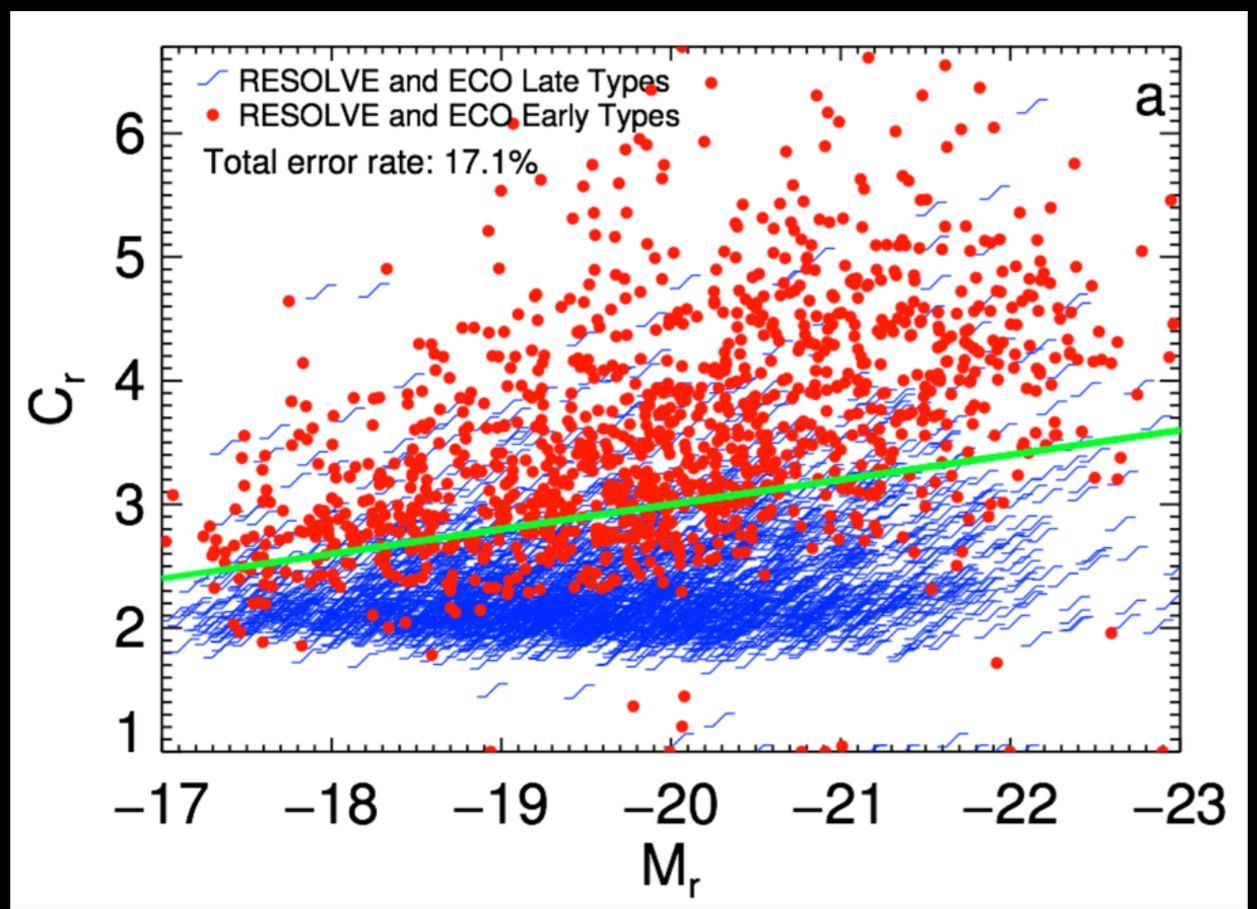


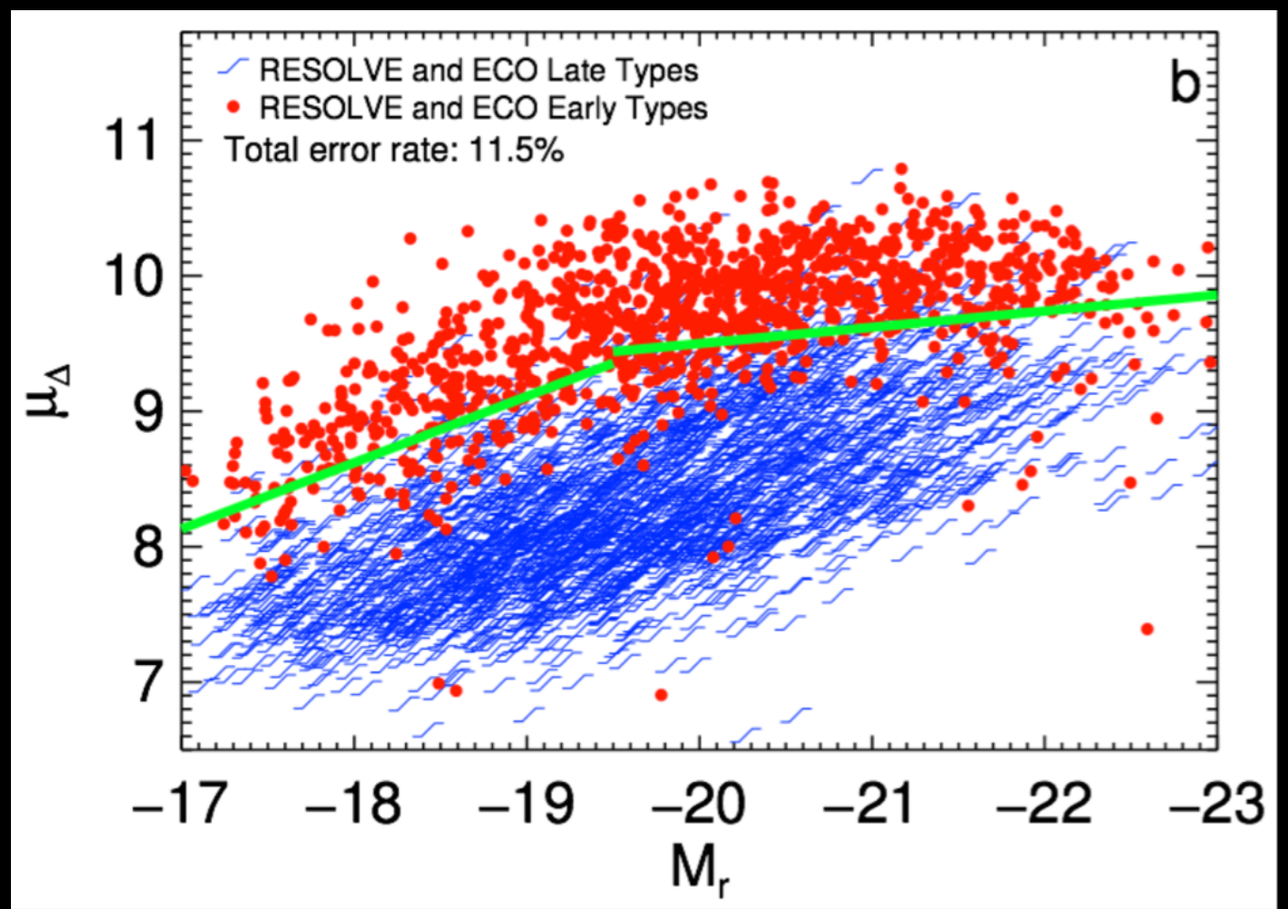




- ECO contains additional objects at ~all mags
- Comparison to RESOLVE-B gives further corrections

Improved Quantitative Morphology Cut





$$\mu_\Delta = \mu_{90} + 1.7\Delta\mu$$

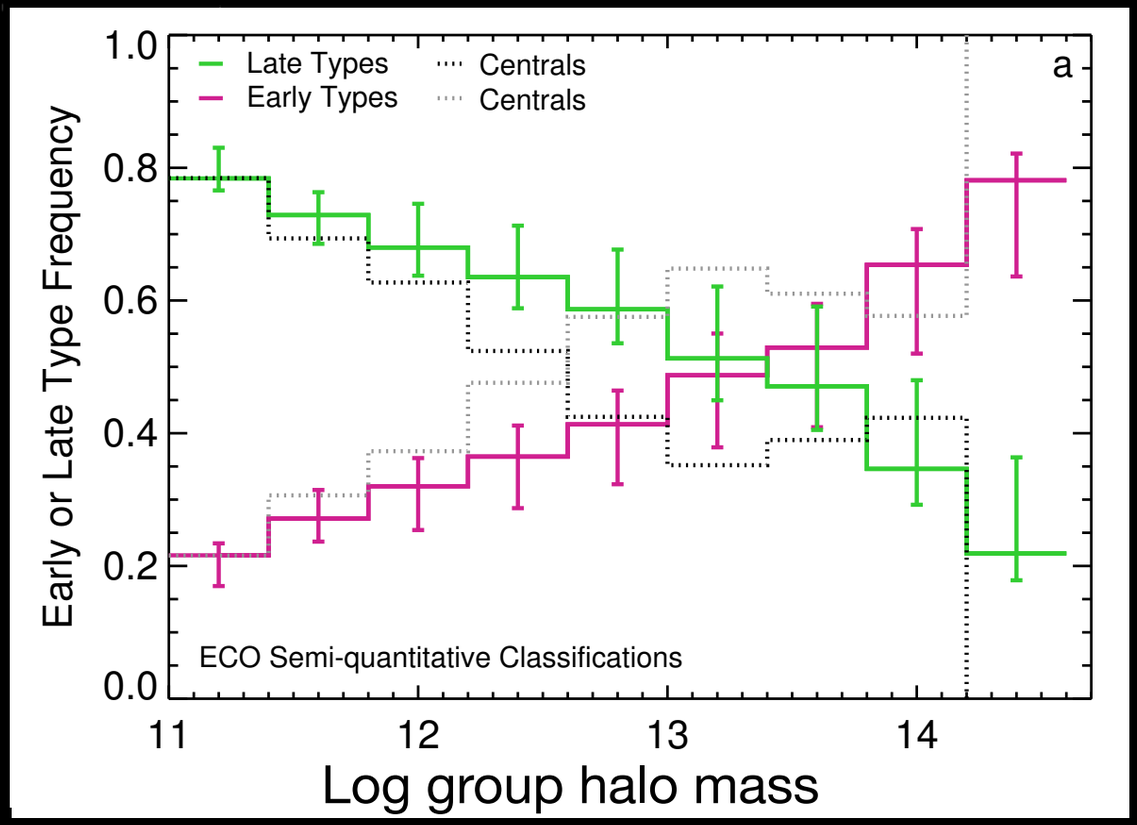
$$\mu_{90} = \log \frac{0.9M_*}{\pi r_{90,r}^2}$$

$$\Delta\mu = \log \frac{0.5M_*}{\pi r_{50,r}^2} - \log \frac{0.4M_*}{\pi r_{90,r}^2 - \pi r_{50,r}^2}$$

Kannappan+ 2013

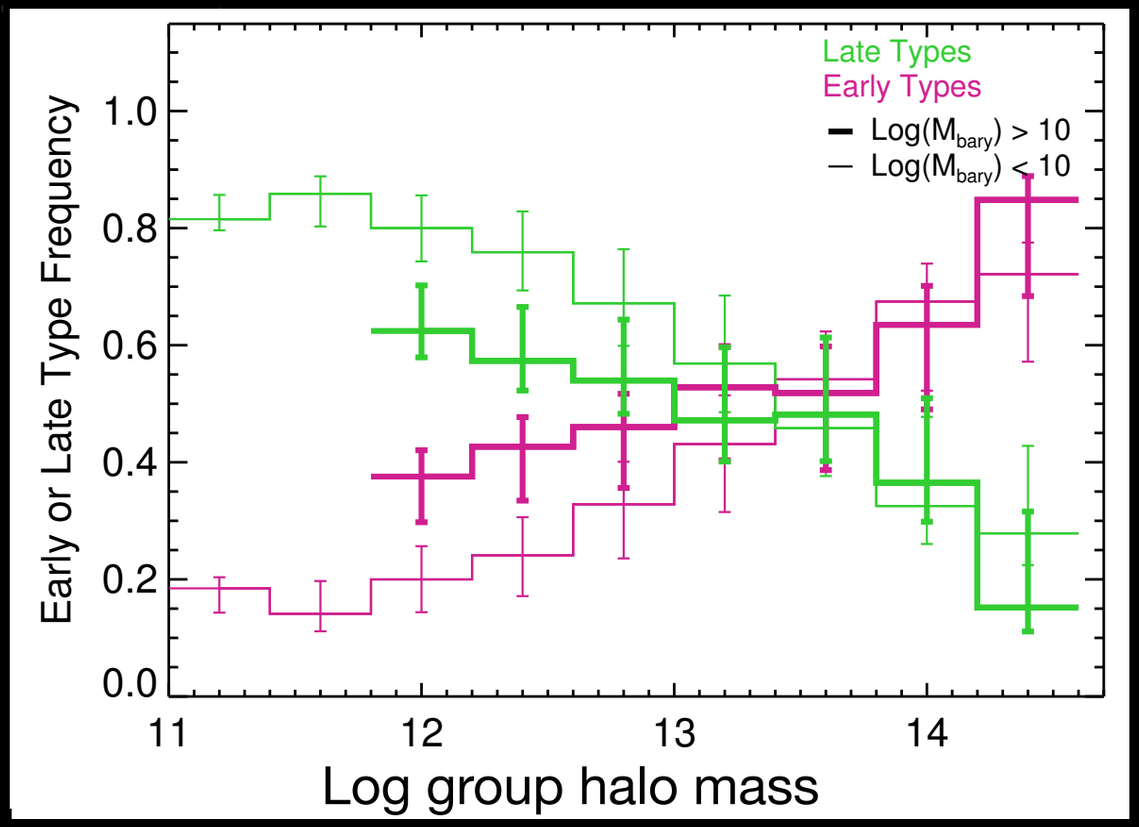
μ_Δ improves on $C_r = r_{90}/r_{50}$ discriminant

Morphology-Environment Relations



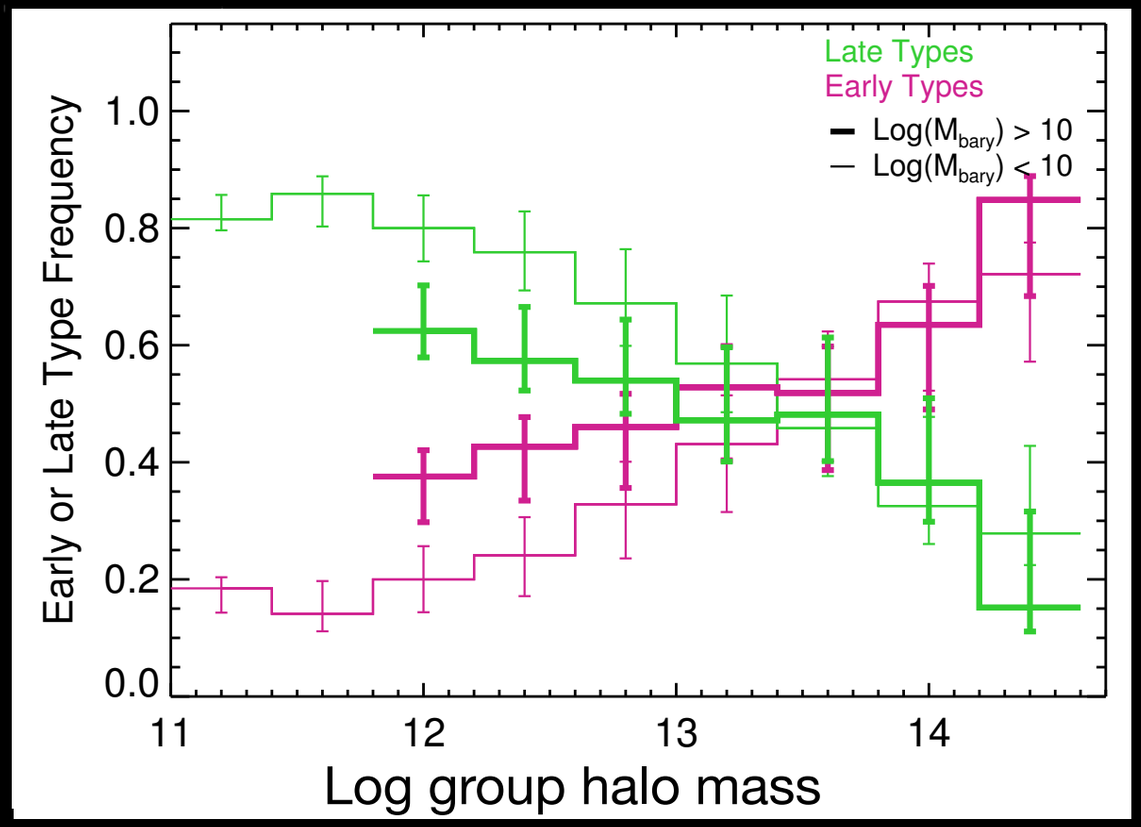
- Traditional relation: P(M|E)

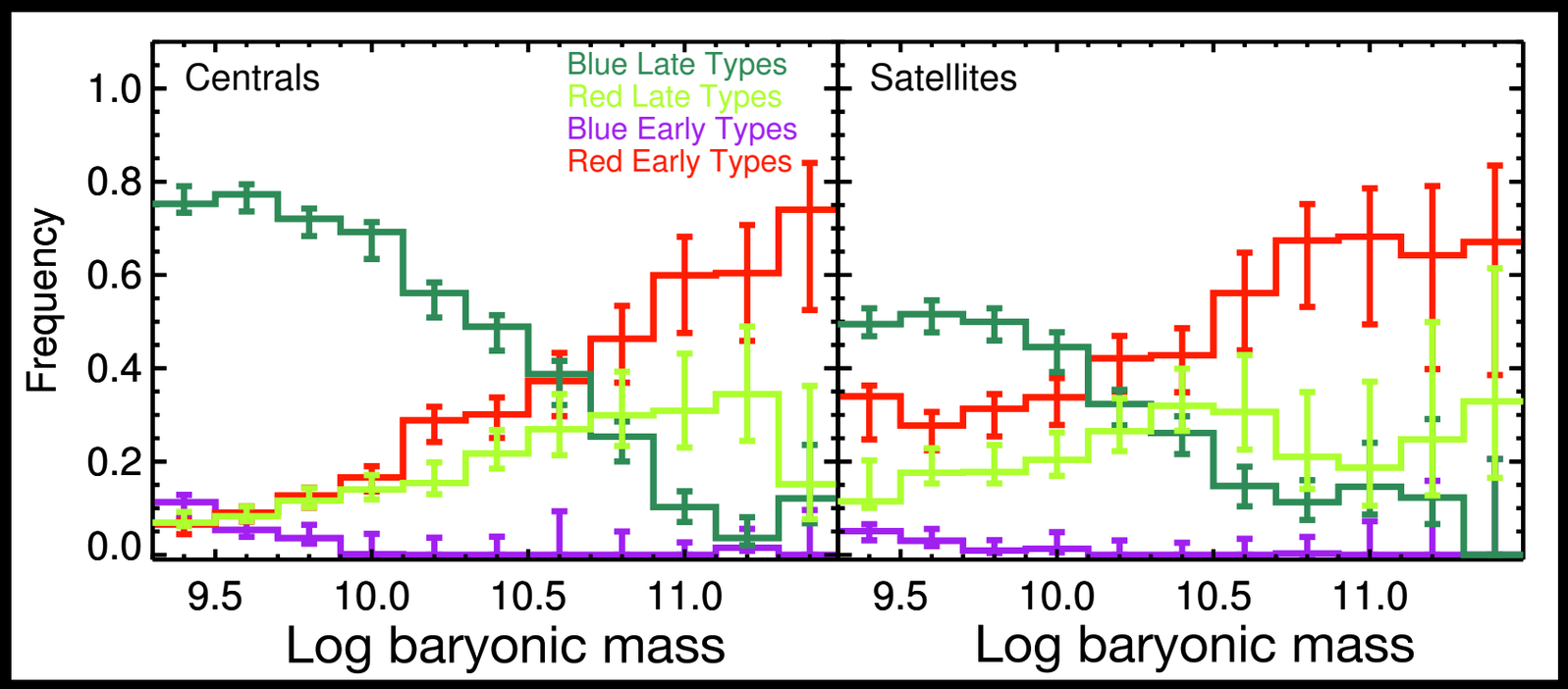
Morphology-Environment Relations



- Traditional relation: P(M|E)
- High baryonic mass relations shallower and offset towards higher ET frequency

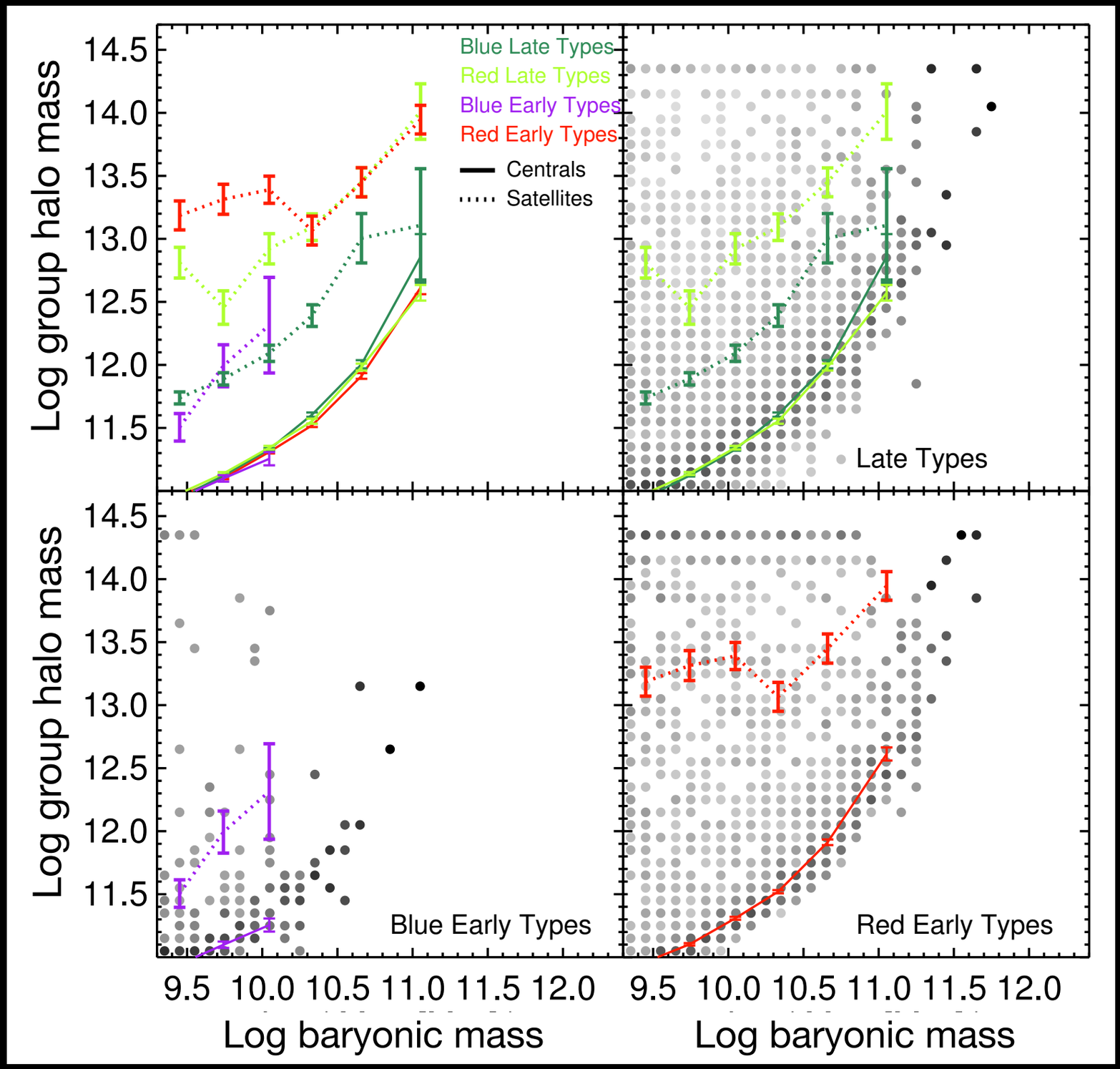
Morphology-Environment Relations





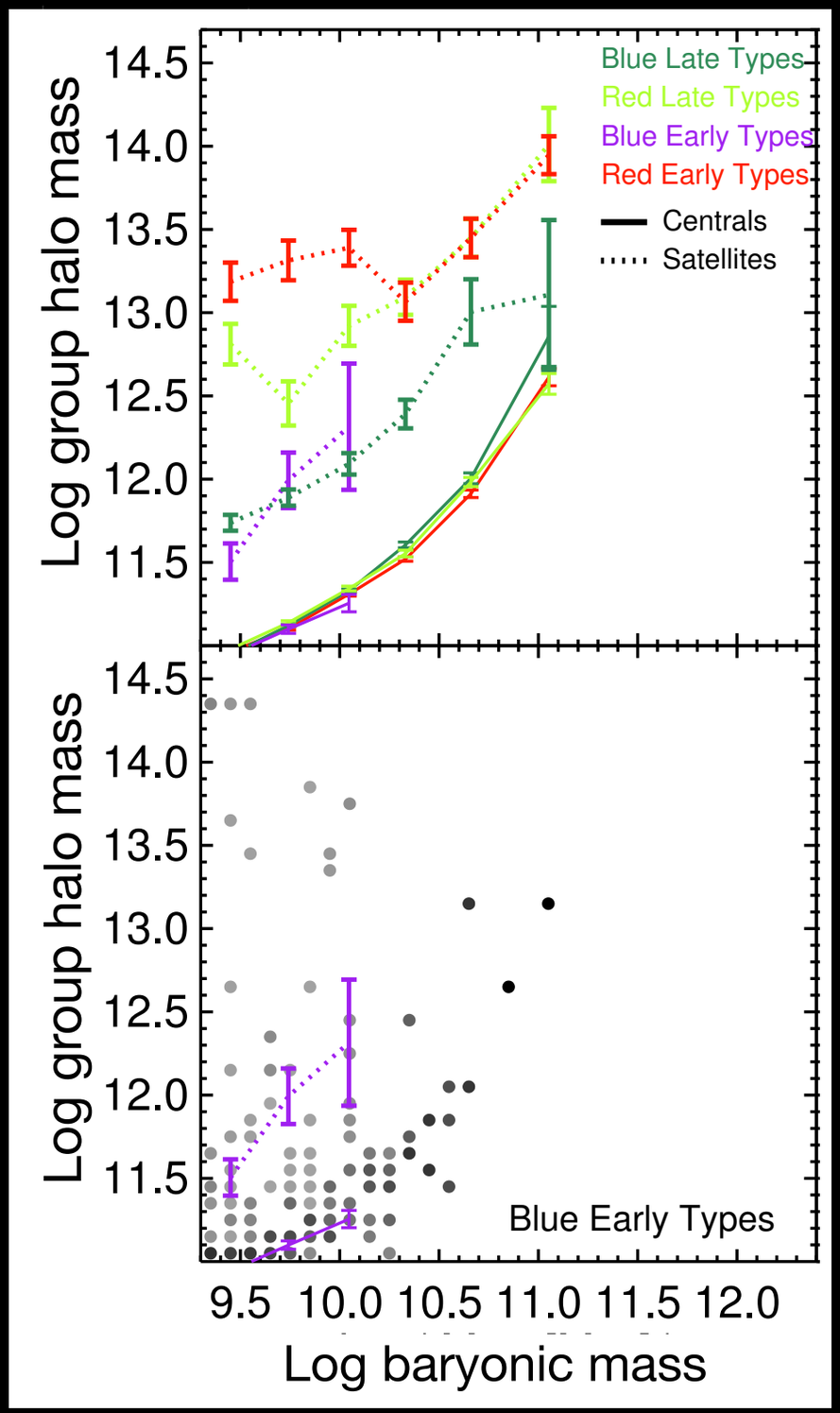
- Traditional relation: P(M|E)
- High baryonic mass relations shallower and offset towards higher ET frequency
- Offset between low and high mass relations driven partially by change in blue and red galaxy frequency with galaxy mass

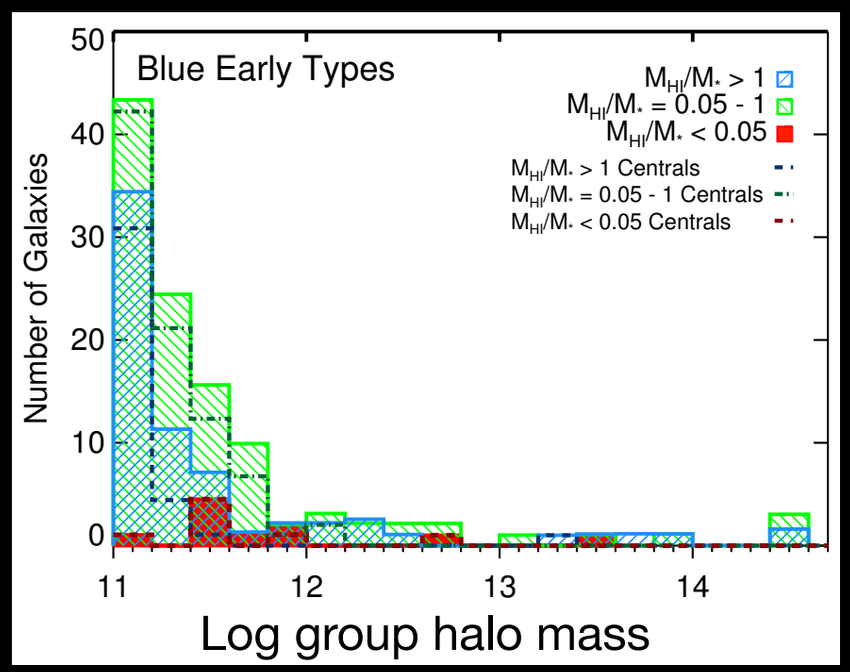
Morphology-Environment Relations



- Alternative relation: P(E|M)
- At fixed baryonic mass, main difference in typical environment is between red and blue satellites
- Traditional relation mixes morphology-galaxy mass relation for centrals and color-environment relation for satellites

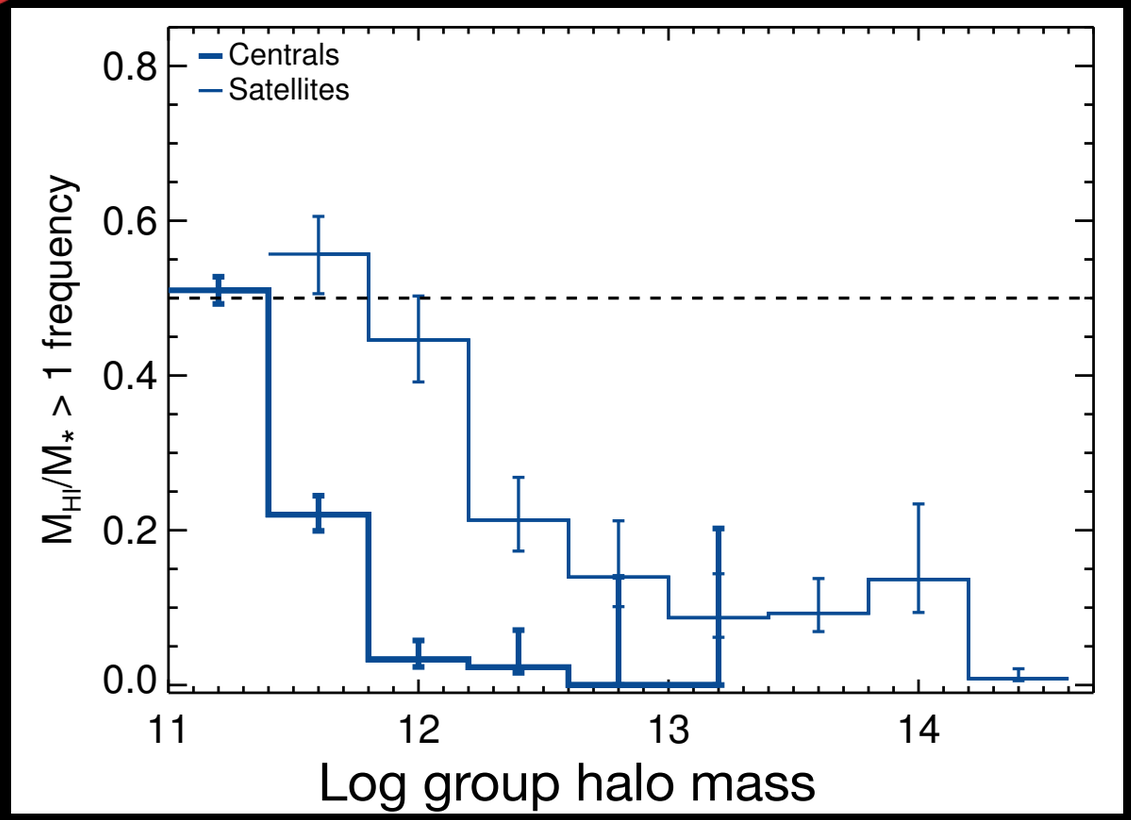
Blue Early Types and Disk Regrowth

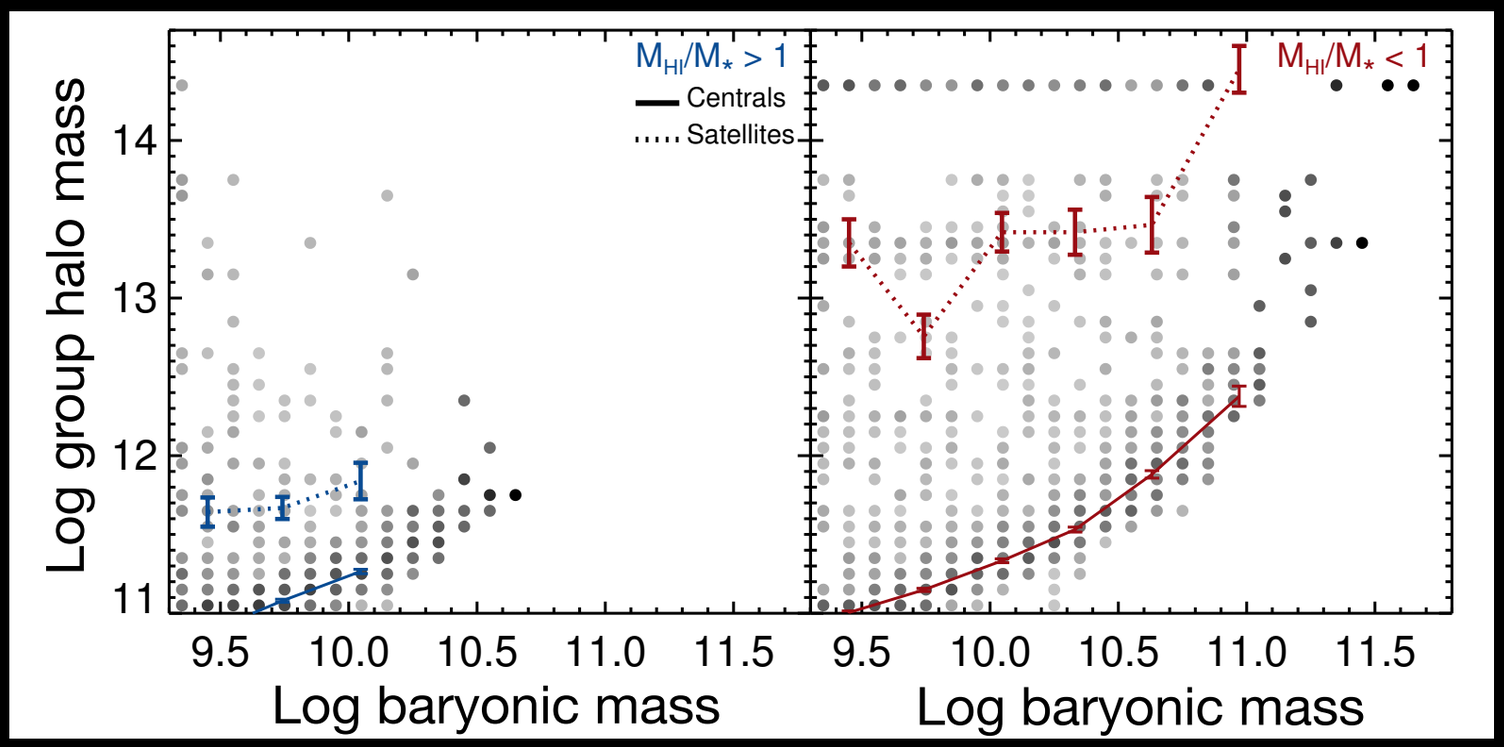




- Blue ETs are a low mass and low group halo mass population
- Show similar environment distribution to blue LTs at fixed mass, consistent with LT disk regrowth
- Sufficient gas and star formation to grow new disks (see Kannappan+ 2009; Wei+ 2010; Moffett+ 2012; Stark+ 2013)

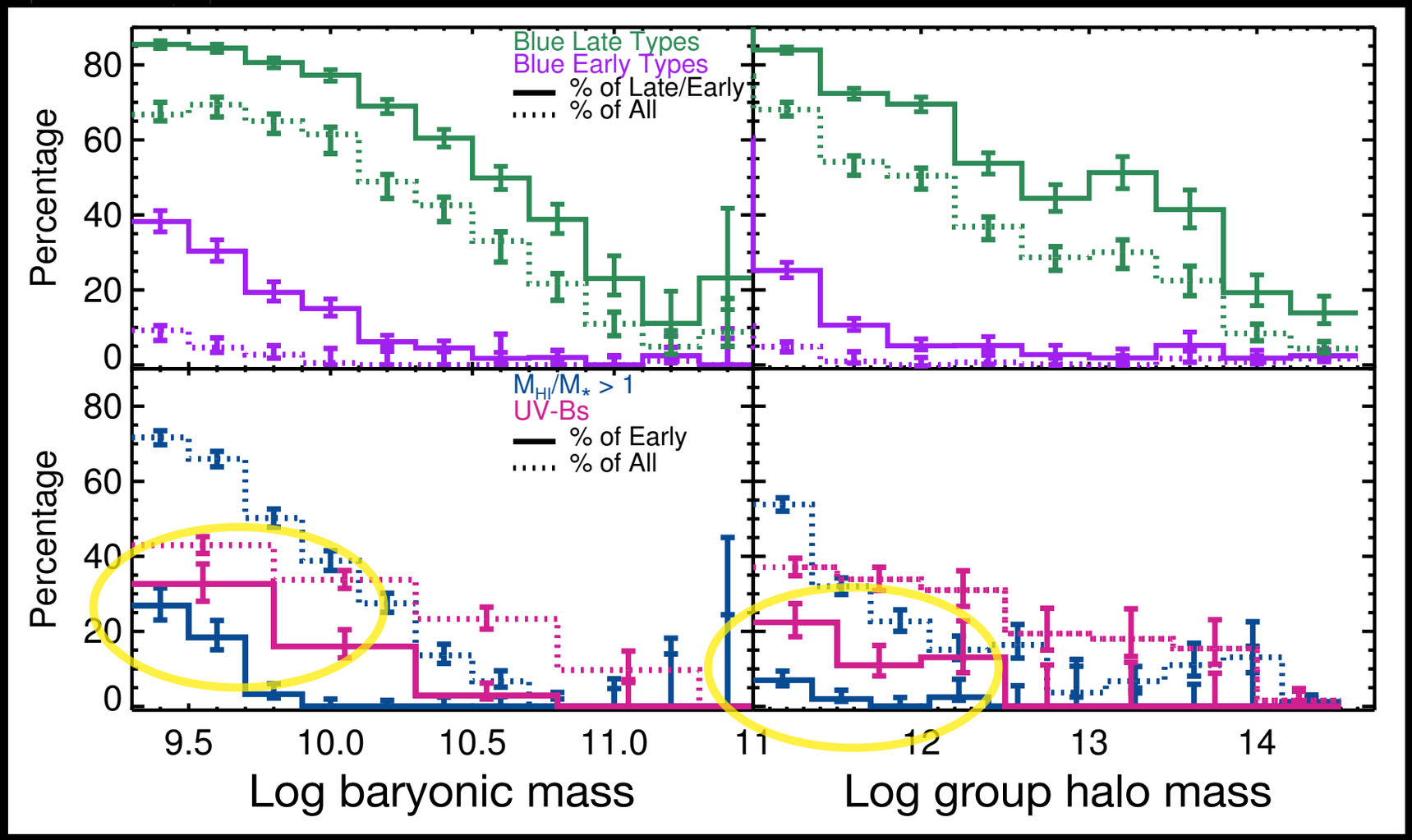
Gas Richness and Environment



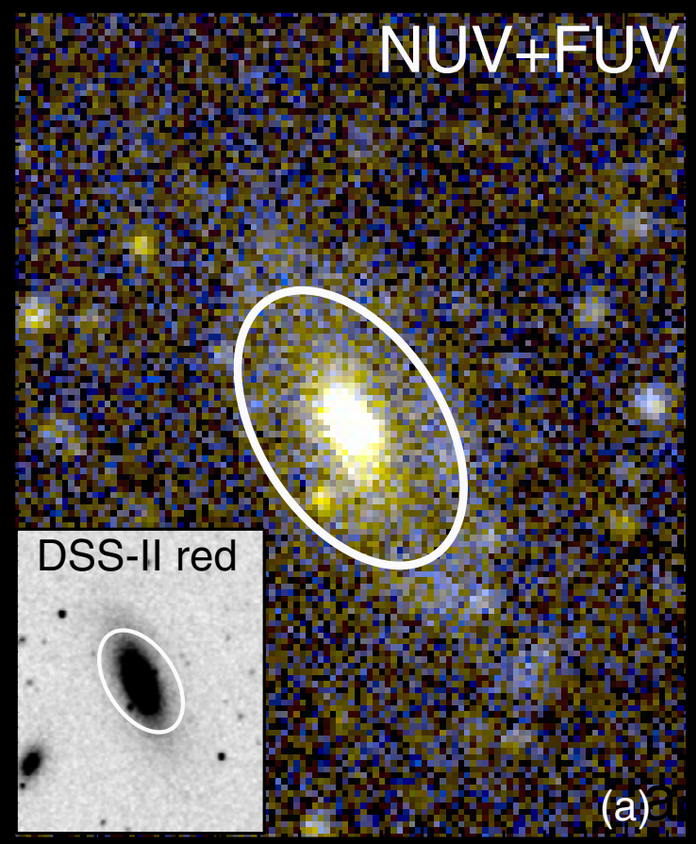


- Fraction of gas-dominated galaxies ($M_{HI}/M_* > 1$) is a strong function of group halo mass
- Large gas reservoirs are particularly common below $M_{halo} \sim 10^{11.5} M_{sun}$
- Not solely due to galaxy mass: gas-dominated satellites inhabit lower mass groups *at fixed galaxy mass*

Growing Disks at Low Mass

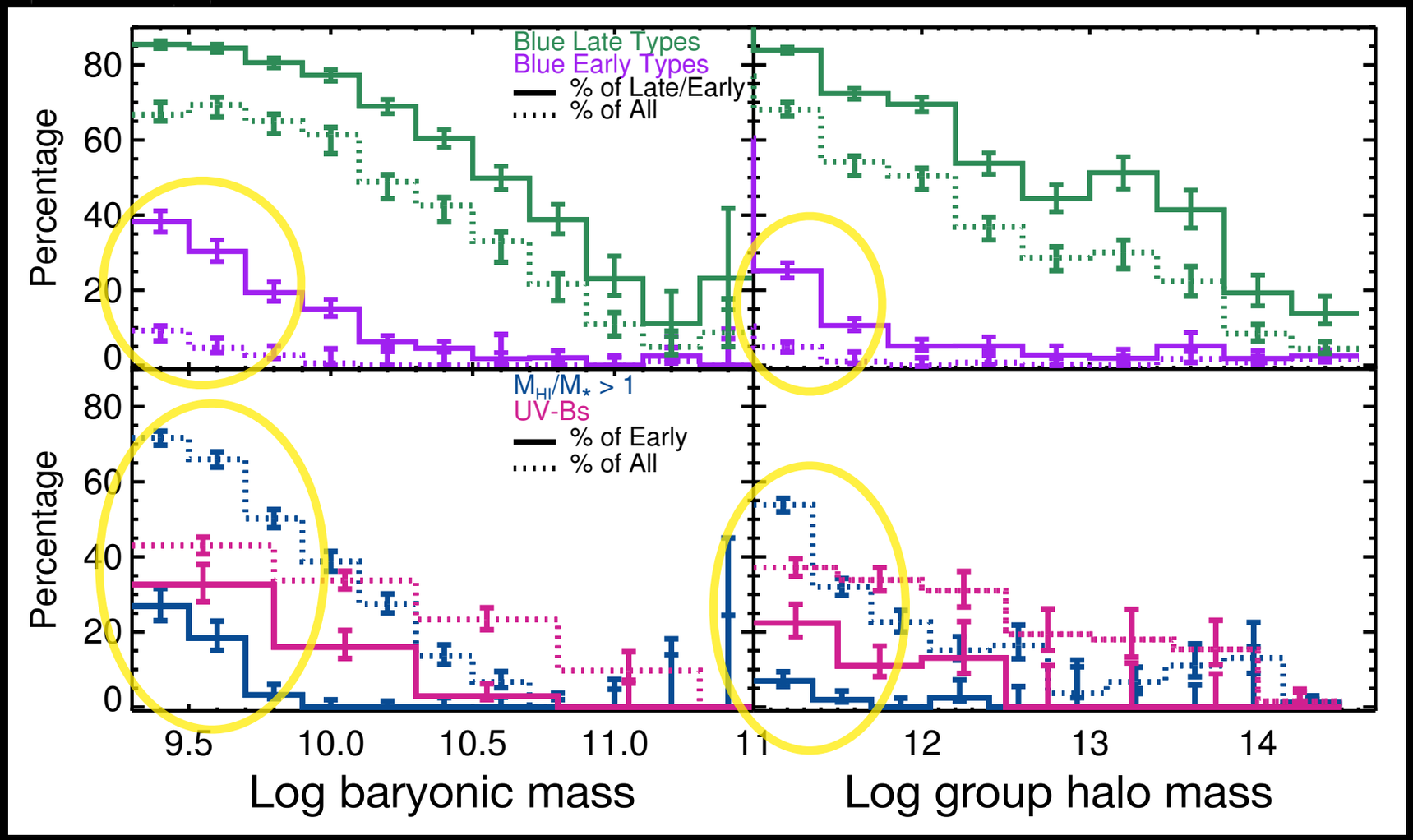


Frequency of UV-Bright disks in ETs greatest at low galaxy mass and group mass



Moffett+ 2012

Growing Disks at Low Mass



Frequency of UV-Bright disks in ETs greatest at low galaxy mass and group mass

Blue ETs, gas-dominated galaxies, and ET UV-B disks are preferentially found at **group halo mass < $10^{11.5}$ M_{sun}** & **galaxy baryonic mass < $10^{10}M_{sun}$** (~ "gas-richness threshold" mass)

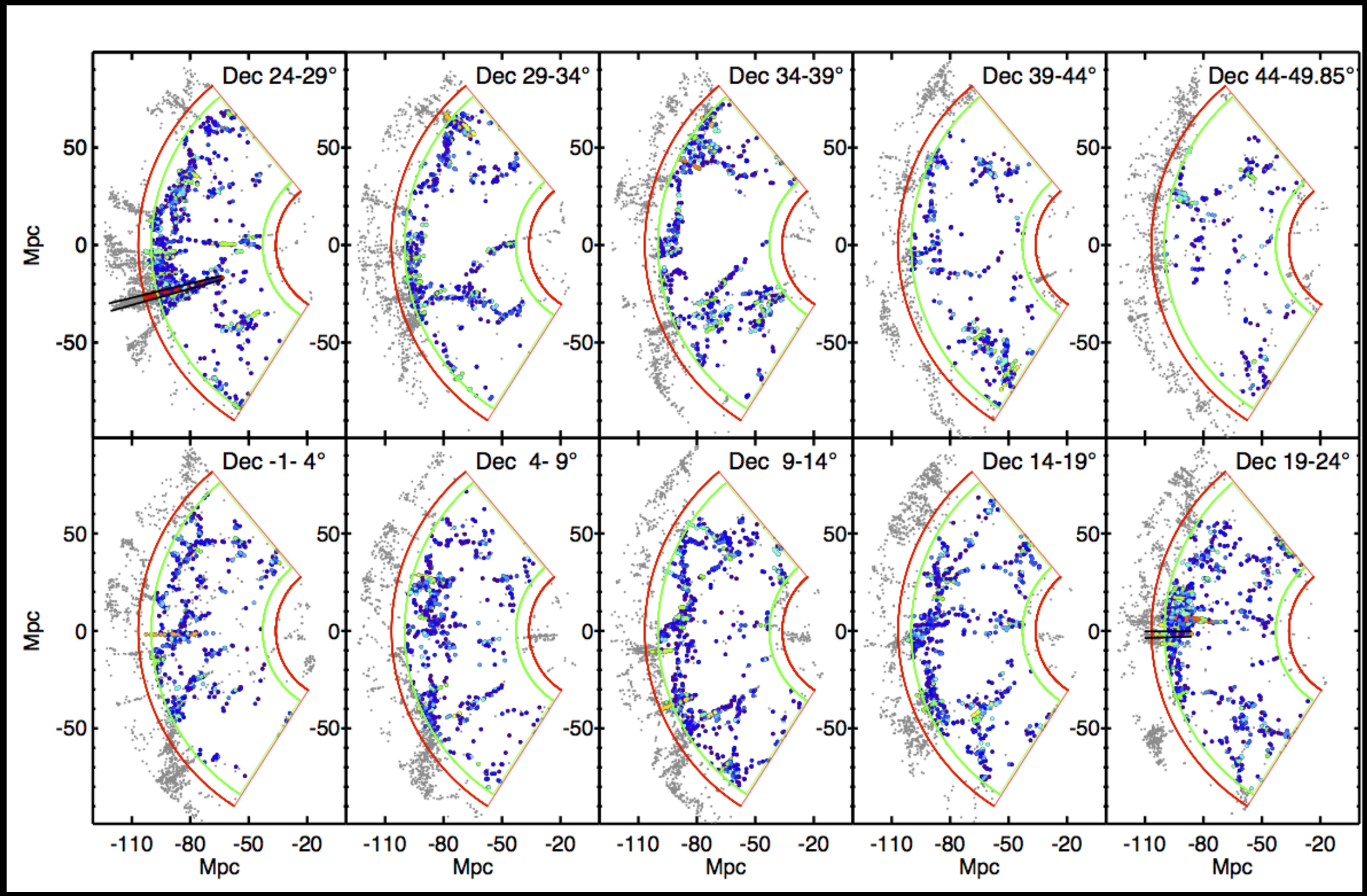
→ **disk growth regime**

Summary of ECO First Results

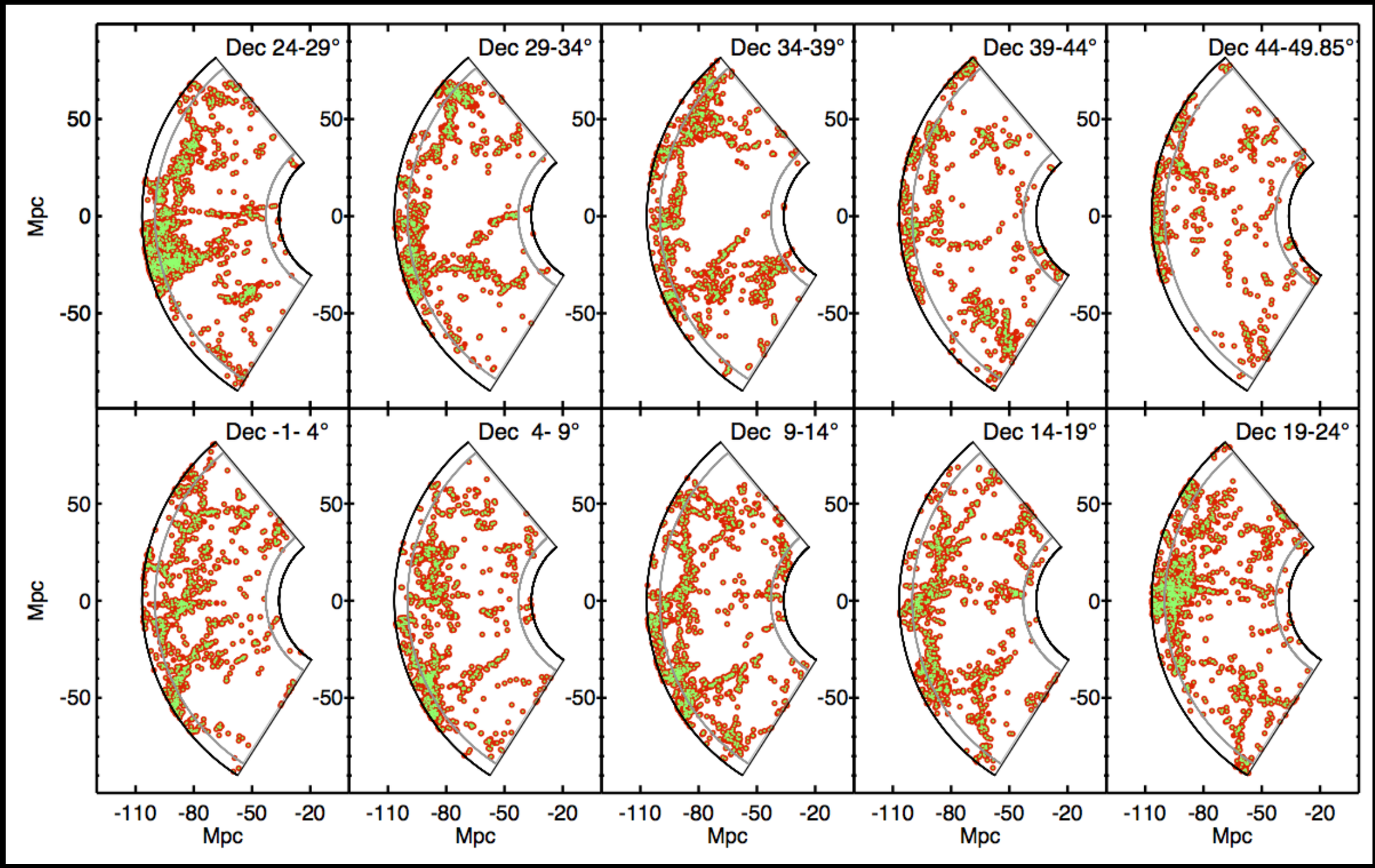
- **ECO DR1 now available (see Moffett+ 2015 & http://resolve.astro.unc.edu/)**
- At fixed *galaxy* baryonic mass, the only significant difference in *group* mass with galaxy type is for satellite galaxies with different colors (i.e., red early/late types vs. blue early/late types)
- Traditional morphology-environment relation = morphology-galaxy mass relation for centrals + color-environment relation for satellites
- Low group halo mass ($<10^{11.5}$ M_{sun}) and low galaxy mass regime - emergence of blue-sequence ETs, gas-dominated galaxies, and ET UV-Bright disk hosts → preferred for ongoing disk growth

Also see me discuss the mass budget of galaxy spheroids and disks in GAMA on Friday (408.01)!

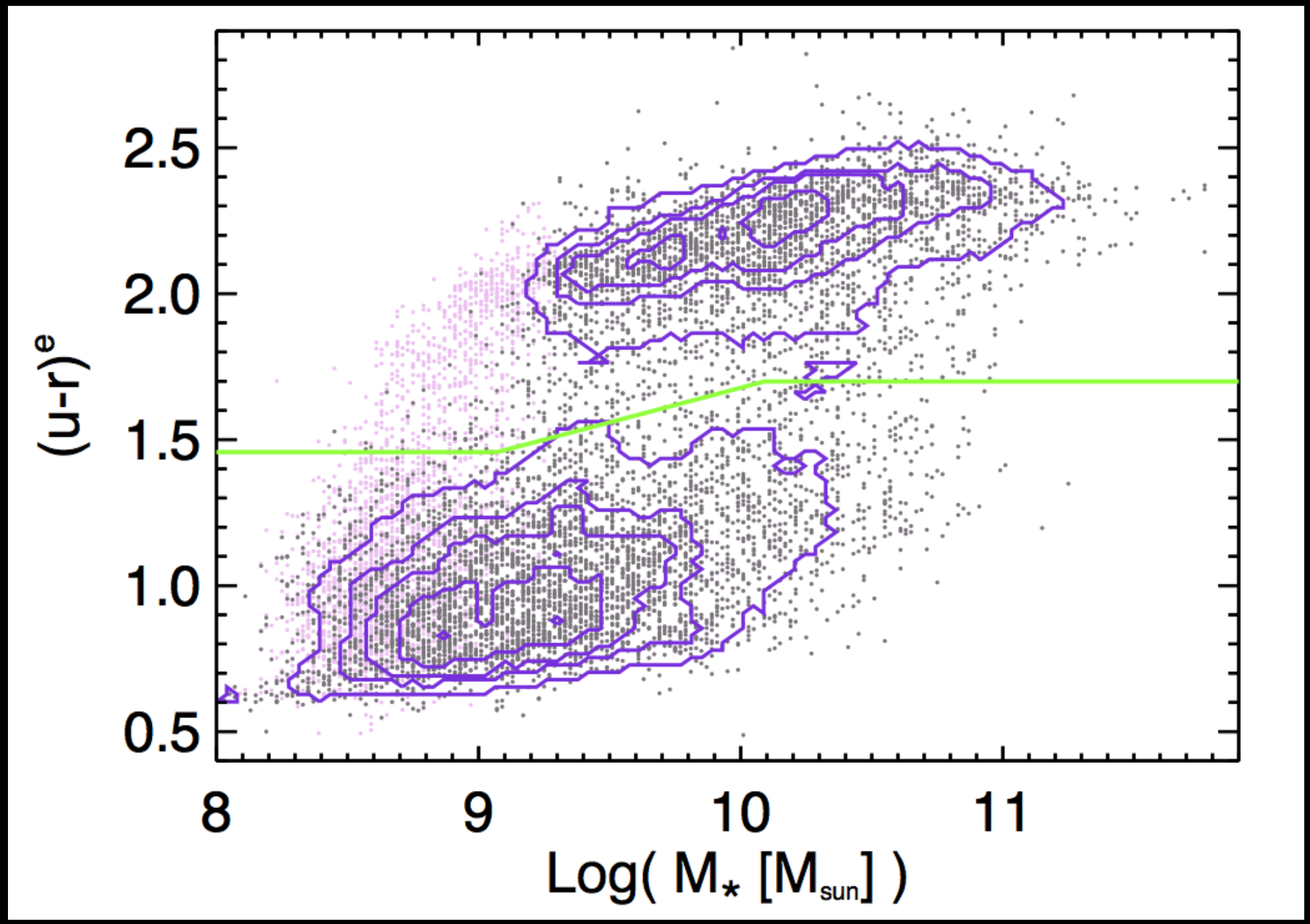
Slices through ECO



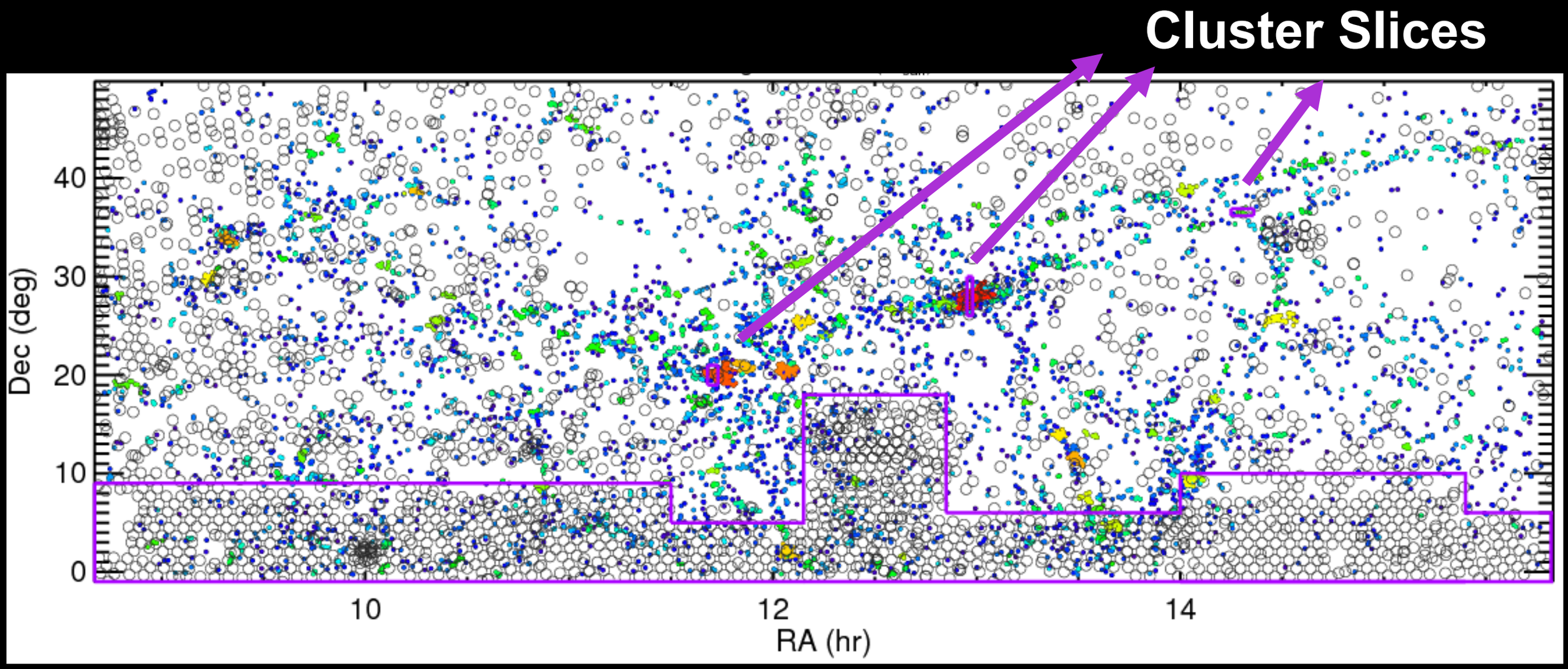
Small-scale Density Fields: Group Collapse



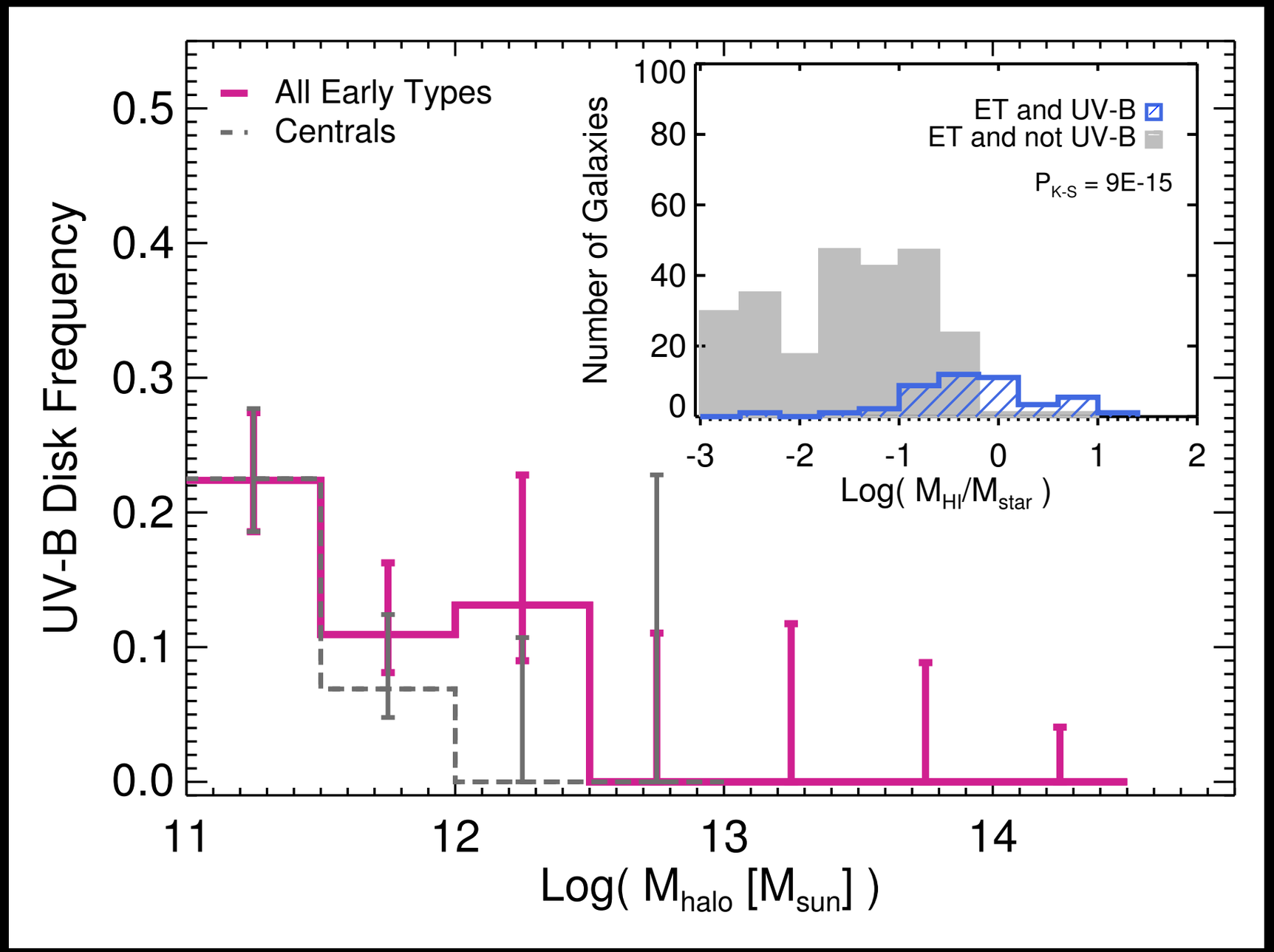
Dividing Red from Blue



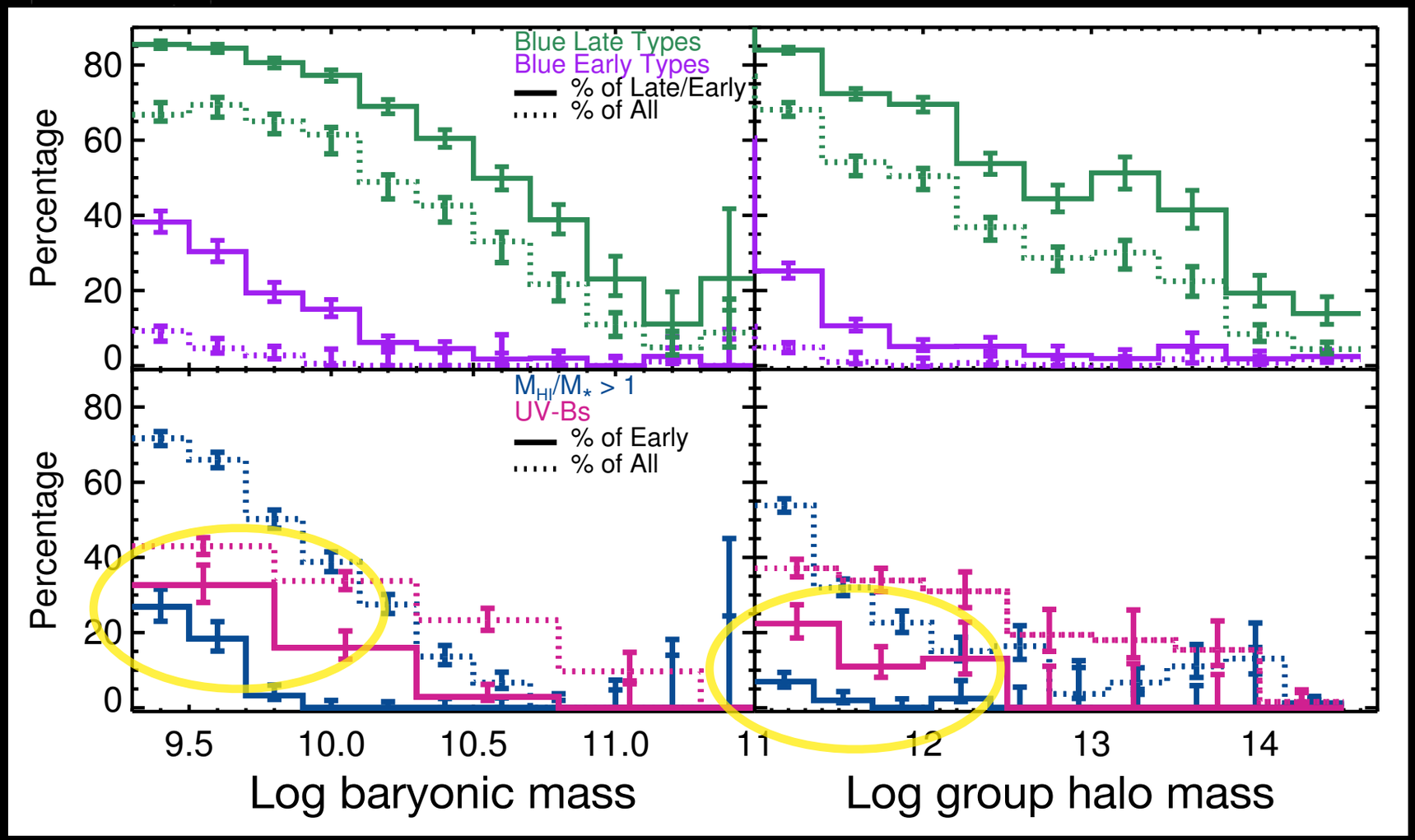
ECO GALEX Coverage



ET UV-B Disks


All Early Types
Centrals
UV-B Disk Frequency
0.5
0.4
0.3
0.2
0.1
0.0
11
12
13
14
Log(M_halo [M_sun])
Number of Galaxies
100
80
60
40
20
0
ET and UV-B
ET and not UV-B
P_K-S = 9E-15
-3
-2
-1
0
1
2
Log(M_HI/M_star)

Disk Growth at Low Mass



- Frequency of UV-Bright disks in ETs greatest at low galaxy mass and group mass
- ET UV-B disks host larger HI gas reservoirs than non UV-B disks
- ~75% of blue ETs in ECO host UV-B disks