

# Galaxy Zoo Hubble: the passive disk fraction decreases from $z = 1.0$ to $z = 0.3$ or maybe increases who even knows

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## ABSTRACT

### 1 INTRODUCTION

- main idea: spiral/disk galaxies tend to show ongoing star formation, elliptical/spheroidal galaxies tend to exhibit little to no star formation. Relative numbers of populations are not constant over time - blue cloud : red sequence decreases as Universe evolves, suggesting a morphological evolution of galaxies coupled with quenching of star formation.

- driver of evolution (morphologically and in SFR) is not known; also not known to what degree the morphological and quenching transformations are linked, or which occurs first

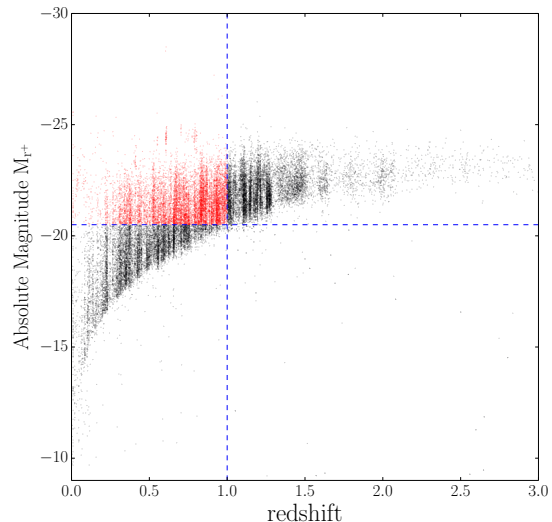
- significant population of red sequence disks could represent major stage in transformation, for some or all galaxies

### 2 DATA

The parent sample of galaxies in this paper is drawn from the Galaxy Zoo: Hubble (GZH) catalog (cite Willett et al. 2016), which provides morphological classifications for galaxies sourced from the HST Legacy Surveys. From the main catalog we select galaxies with imaging from the Cosmic Evolution Survey (COSMOS, Scoville et al. (2007)) in the redshift range  $0 < z < 1$ . From this, we apply a magnitude cut of  $M_{r+} < -20.5$  to create a volume-limited sample (see Figure 1). Rest frame NUV-r and r-J colors are taken from the UltraVISTA catalog (McCracken et al. 2012; Ilbert et al. 2013).

#### 2.1 Selecting passive disk galaxies

We identify a sample of non-clumpy disk galaxies using the morphological classifications provided by GZH. The sample includes subjects which meet the following criteria:  $f_{\text{features}} > 0.23$  and  $f_{\text{clumpy,no}} > 0.30$ , where  $f$  is the debiased vote fraction. We also require at least 20 votes for each question ( $N_{\text{smooth or features}} \geq 20$  and  $N_{\text{clumpy}} \geq 20$ ) to reduce uncertainty in the vote fractions.



**Figure 1.** 70,198 COSMOS galaxies cross-matched in GZH and UltraVISTA (black). 27,584 are in volume-limited sample (red).

### 3 FERENGI

- 1300ish galaxies, r mags from SDSS (Abazajian et al. 2009)
- NUV mags from GaLEX (Martin et al. 2005)
- J mags from 2Mass (Skrutskie et al. 2006)

### 4 RESULTS

### 5 DISCUSSION

### 6 CONCLUSIONS

The data in this paper are the result of the efforts of the Galaxy Zoo Hubble volunteers, without whom none of this work would be possible. Their efforts are individually acknowledged at [authors.galaxyzoo.org](http://authors.galaxyzoo.org). Please contact the author(s) to request access to research materials discussed in this paper.

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This project made heavy use of the Astropy packages in Python (Robitaille et al. 2013), the `seaborn` plotting package (?), and the Tool for Operations on Catalogues And Tables (TOPCAT), which can be found at [www.starlink.ac.uk/topcat/](http://www.starlink.ac.uk/topcat/) (?).

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