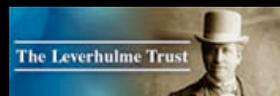


# BARRED SPIRALS ON THE RED SEQUENCE FROM GALAXY ZOO

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Masters et al. 2010b MNRAS 405, 783 (Galaxy Zoo Red spirals)  
Masters et al. 2011 MNRAS 411, 2026 (Galaxy Zoo Barred spirals)  
Hoyle, Masters et al. 2011 MNRAS 415, 3627 (Galaxy Zoo Bar Lengths)  
Skibba, Masters et al. 2012 MNRAS in press (GZ: Environments of Bars)

in one slide...

One of the most popular citizen scientist projects – 200,000+ contributors, and inspired the 600,000+ strong “Zooniverse”.

Surveys of contributors suggest they mostly do this out of a desire to help with science – science results are vital to success.

Visual classifications for SDSS galaxies (and now also HST surveys).

Classifications by **multiple independent citizen scientists** = extremely reliable, and not easy to fool (ie. a bar is a bar).

30+ peer reviewed papers using Galaxy Zoo classifications.

Phase 1 data is public (1 million MGS galaxies spiral or early-type).  
Lintott et al. (2011); [www.data.galaxyzoo.org](http://www.data.galaxyzoo.org)

Try it at: [www.galaxyzoo.org](http://www.galaxyzoo.org), propose a project...



# Barred Red Spirals in Galaxy Zoo

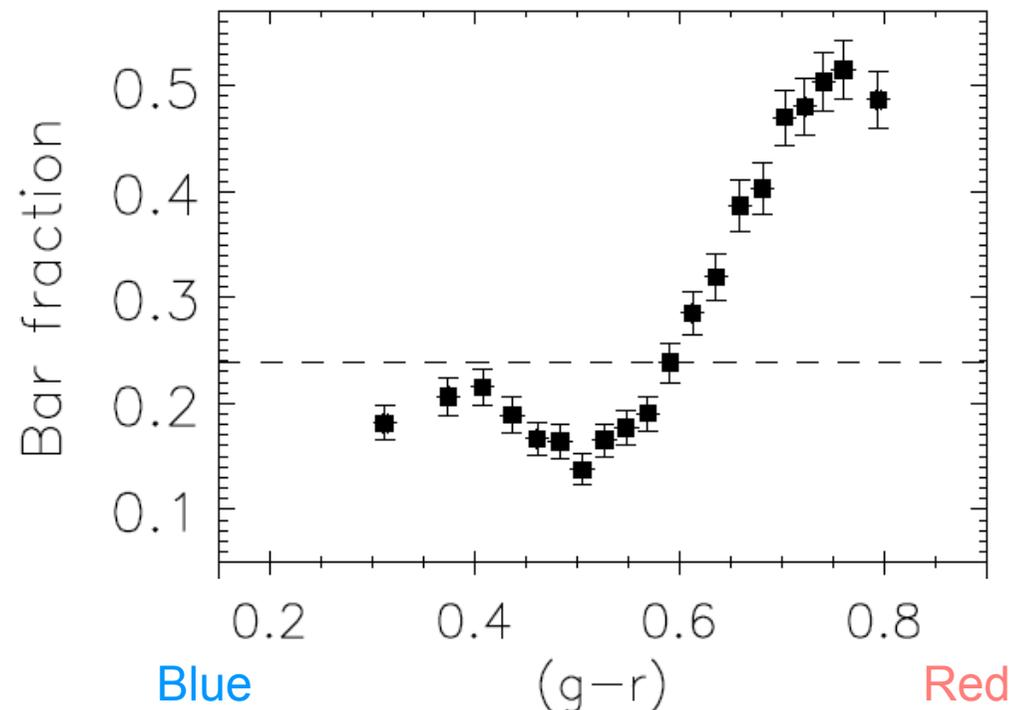


A red spiral galaxy (c), flanked by blue spiral (l) and red elliptical galaxies (r)

Red, massive disk galaxies are much more likely to have strong bars than blue disk galaxies...

...also more likely to be satellites (Skibba et al. 2009)

Masters et al. 2010 (MNRAS 405, 783)  
Masters et al. 2011 (MNRAS 411, 2026)

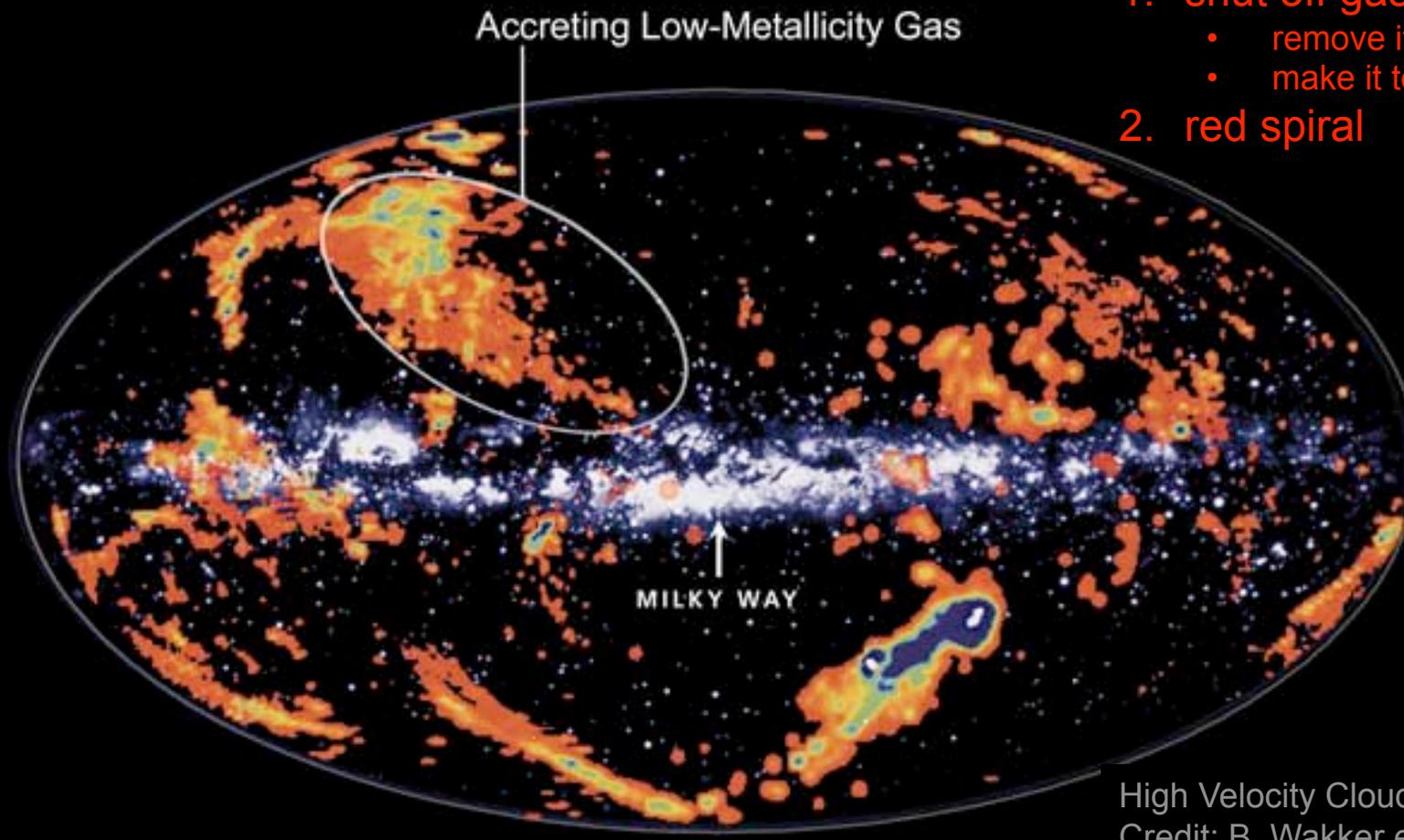


# How to make a spiral red?

- gas in the disk of spirals will run out in much less than a Hubble time ( $\sim 2$  Gyr)
- must be replenished from somewhere (Larson, Tinsley & Caldwell 1980)

- hot gas in halo
- continuous infall of gas

1. shut off gas supply
  - remove it – strangulation
  - make it too hot - harassment
2. red spiral



High Velocity Clouds and the Milky Way  
Credit: B. Wakker et al. and NASA

- Bars enable exchange of angular momentum -> they move material around...
  - growing central concentrations
  - feeding AGN?
  - using up gas more quickly?
  - limiting external inflow of gas (beyond co-rotation)
  - self destructing?



Suggestions that bars are transient (e.g. Combes 2004) but no consensus (e.g. Sellwood 2010)

Gas is important (e.g. Athanassoula 2004)

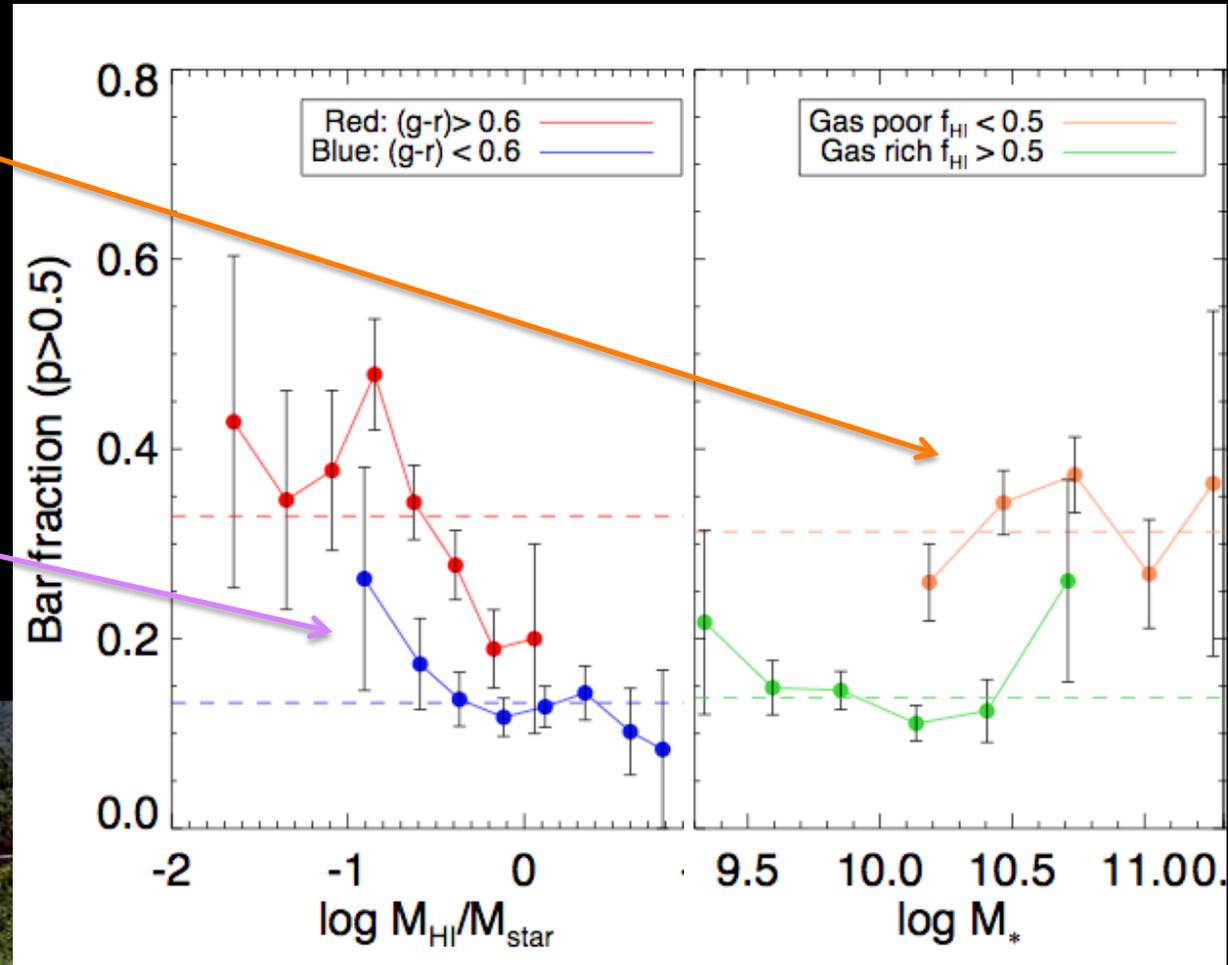
- bars in gas free discs very stable
- bars in gas rich discs hard to make (in numerical simulations)

No bars (or effects of bars) in semi-analytic models of galaxy formation.

# Bars killing spiral galaxies?

At fixed  $M_{\text{star}}$   
 – gas poor galaxies  
 more likely to have bar  
 than gas rich

At fixed gas fraction  
 – barred galaxy more  
 likely to be red than  
 unbarred galaxy

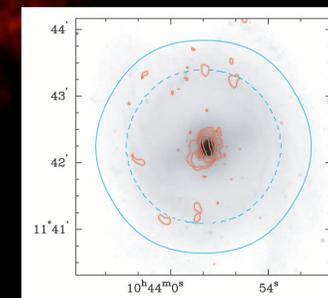
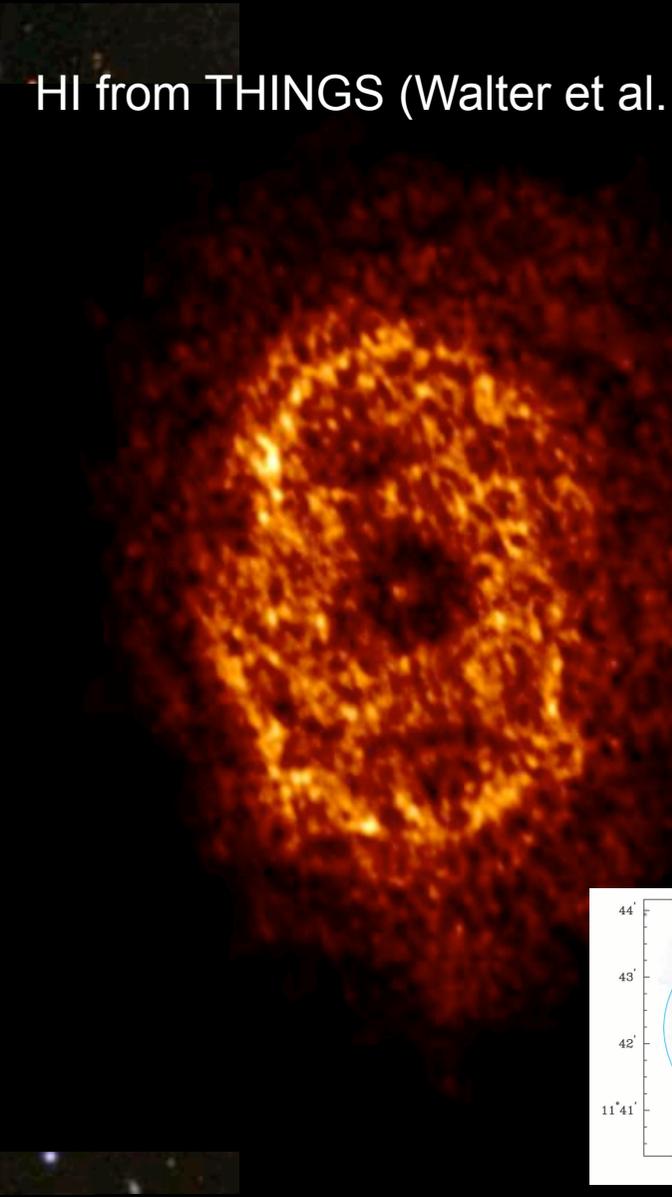


HI data from the 40% release of the Arecibo Legacy ALFA Survey - blind HI survey of Arecibo sky; Haynes et al 2011.  
 (Masters et al. in prep.)



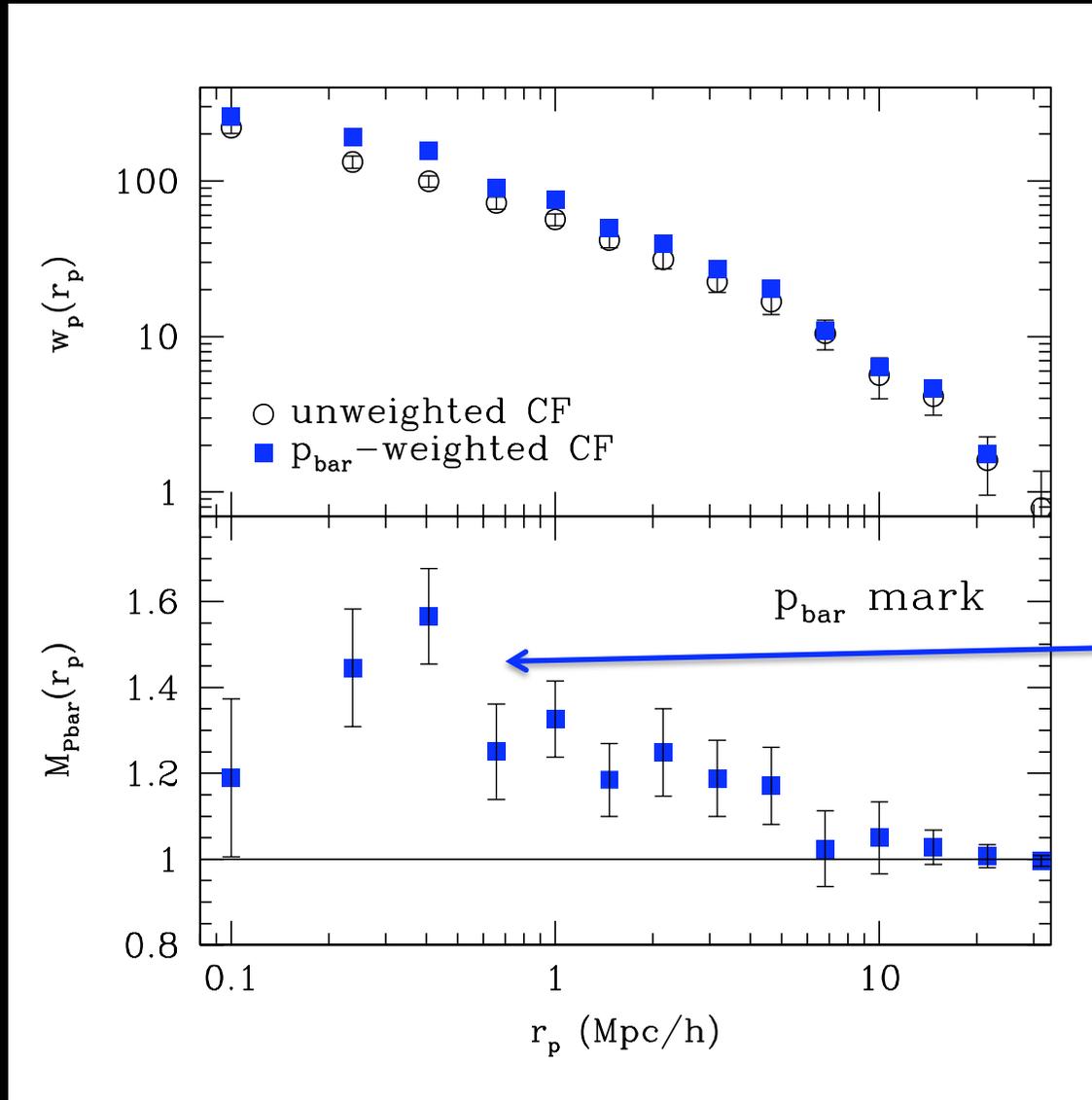
Optical gri from SDSS (DR8)

HI from THINGS (Walter et al. 2008)



CO from BIMA (Helfer et al. 2003)

# Bars and Environment

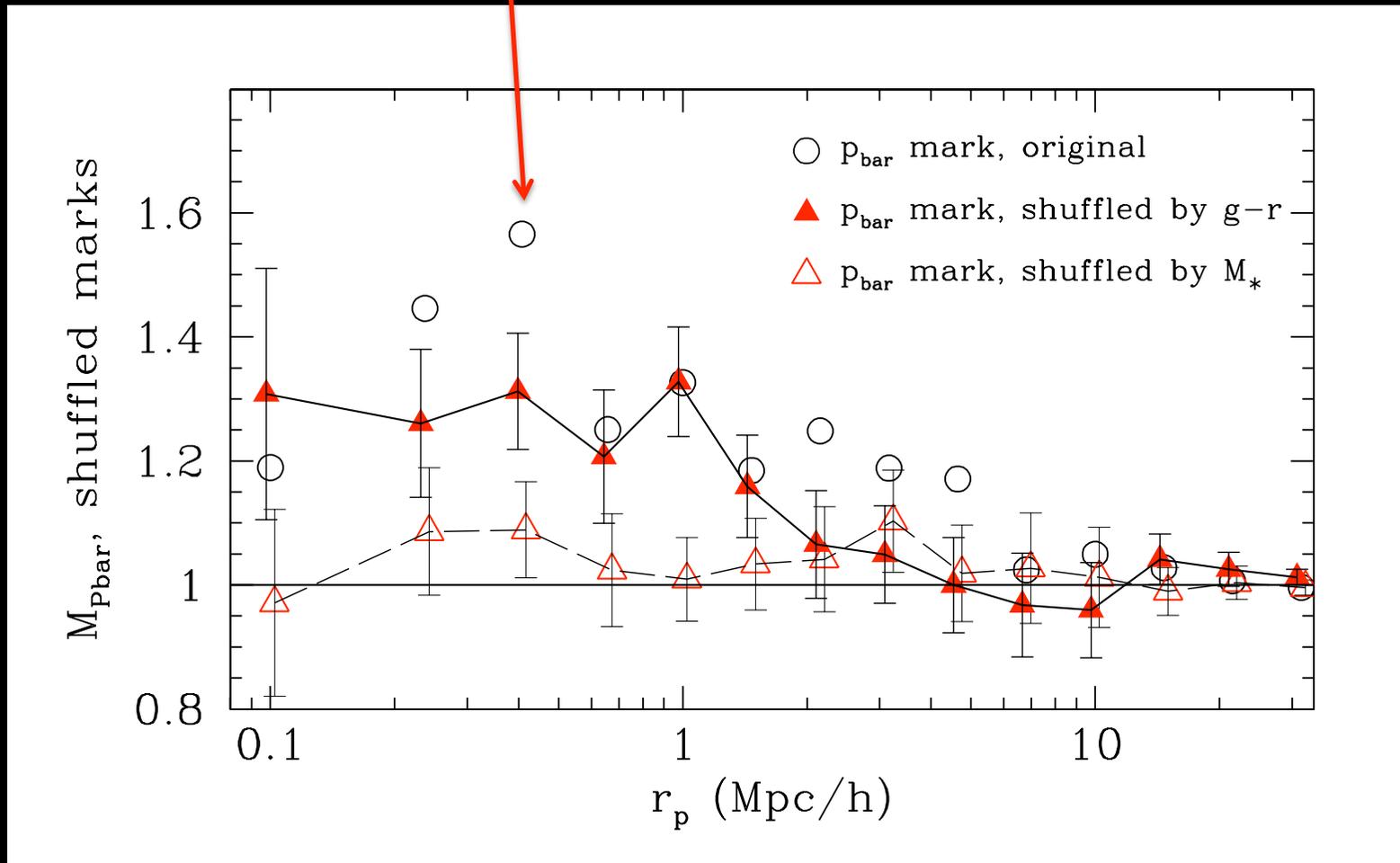


Are bars a side effect of environmental processes quenching satellite disc galaxies?

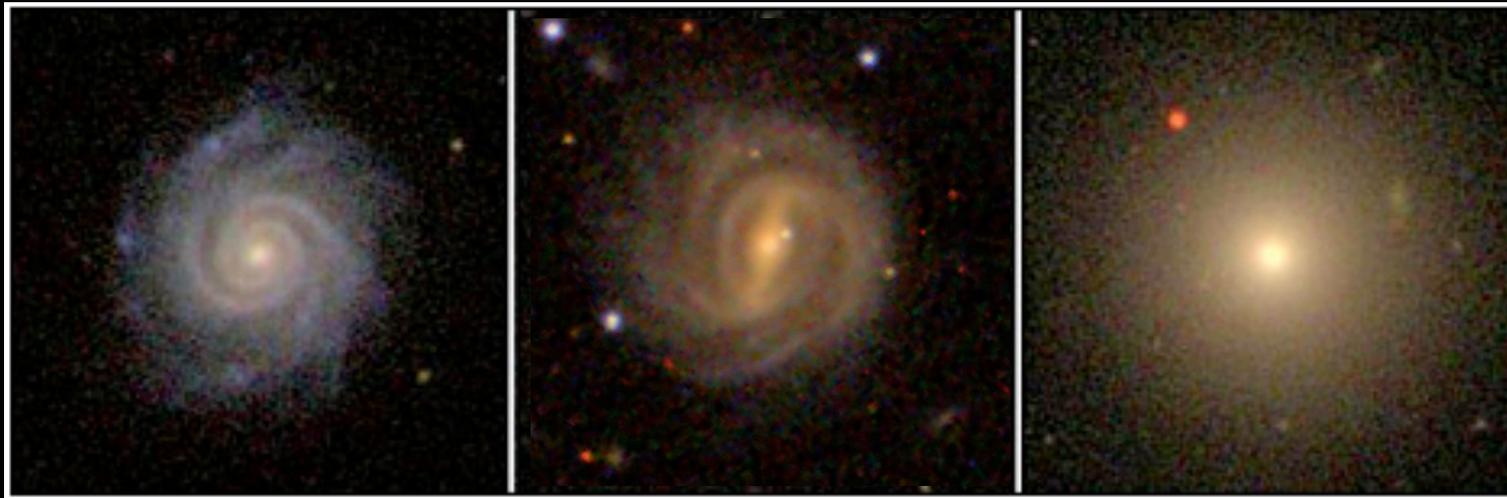
barred spirals are more clustered than spirals on some scales

Skibba, Masters et al. 2012 (MNRAS in press; astro-ph/1111.0969)

- ~50% of environment correlation explained by preference for barred galaxies to be in massive red discs
- **on some scales red barred discs more clustered than red discs**
- barred disc galaxies more likely to be satellites than unbarred disc galaxies



- Morphology is an important clue to the history of galaxy evolution
- Galaxy Zoo provides reliable morphologies for statistically interesting sample sizes
- (Galaxy Zoo as a public engagement project does not work without science output)
- Relationship between bars, environment and evolutionary status of disc galaxies is complicated.





To our 200,000 co-authors, listed at:  
[www.galaxyzoo.org/volunteers](http://www.galaxyzoo.org/volunteers)