Looking at the Universe

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M101 in wide field, by Mike Hyde (Amateur astronomer)

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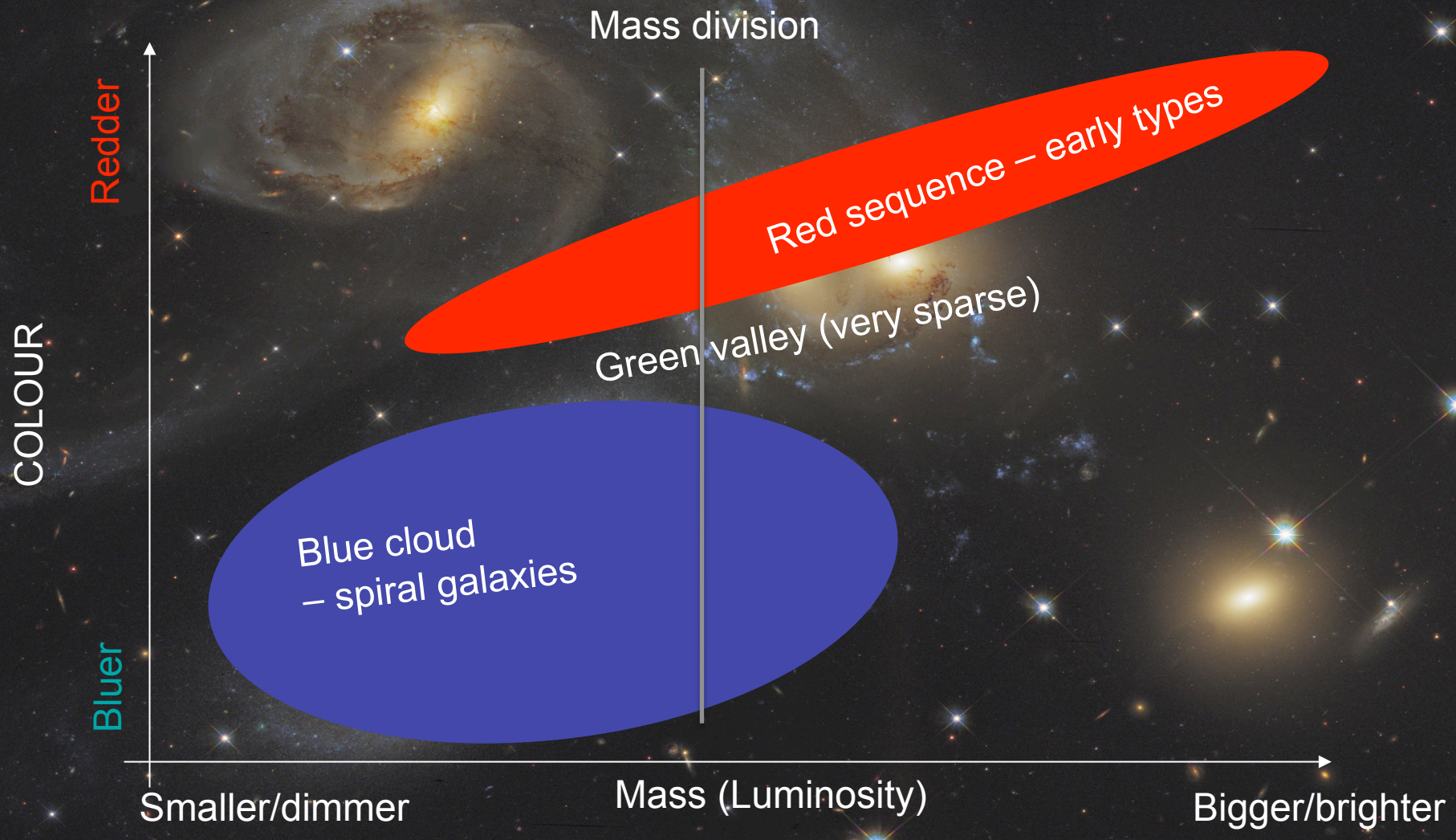
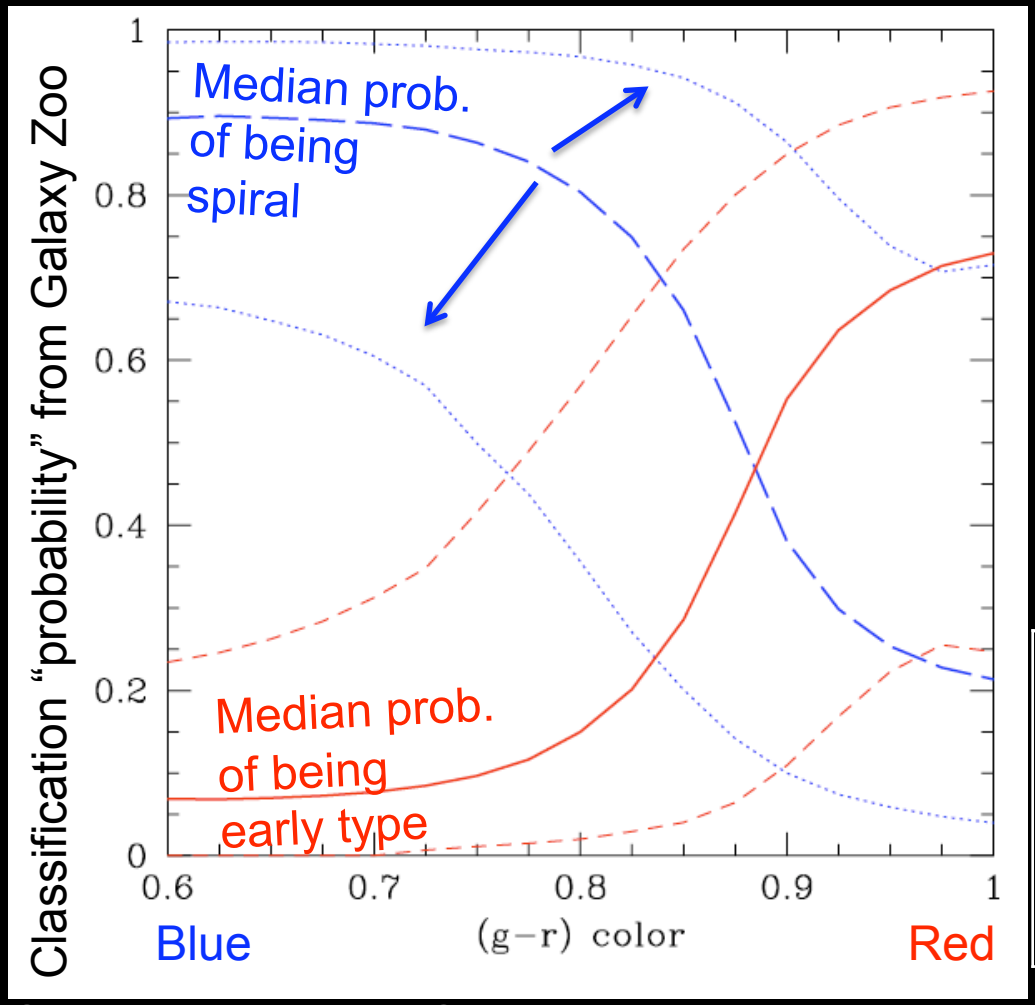
GALAXY ZOO

Why Look – galaxies aren't all the same…



Morphology ≠ Colour



Colour and morphology are correlated, but not equivalent

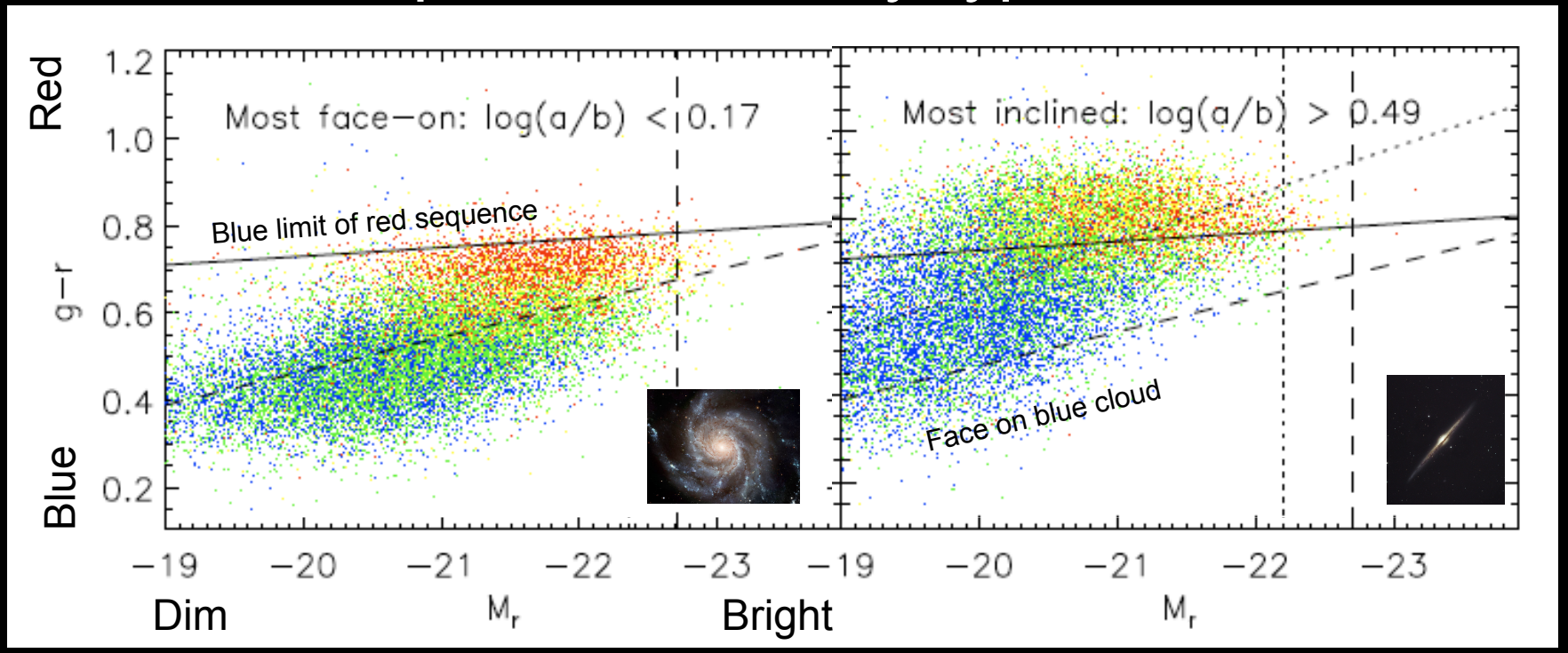
Colour = star formation history

Morphology = dynamical history

SF History	Dynamical History: Bulge (Early)	Dynamical History: Disk (Spiral)
Red		
Blue		

Skibba et al. 2009 (Colour, morphology and environment)

Dust makes edge on spirals masquerade as early-types

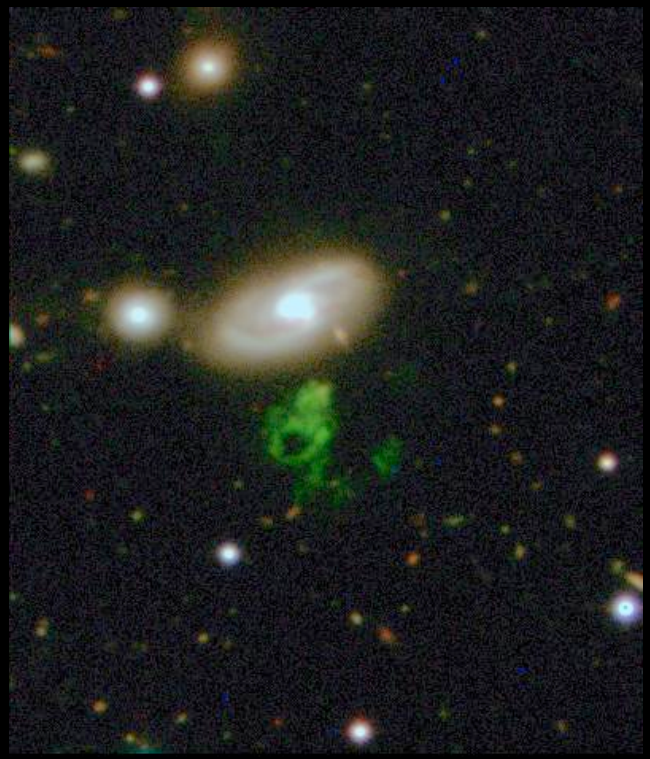


Masters et al. 2010a (MNRAS 404, 792) – Galaxy Zoo: Dust in Spirals

Dust reddens and dims inclined spirals

- they are missing from volume limited samples
- they masquerade as early types in colour (and concentration) selected samples
- at the very least use a shape cut…

You never know what you'll find…

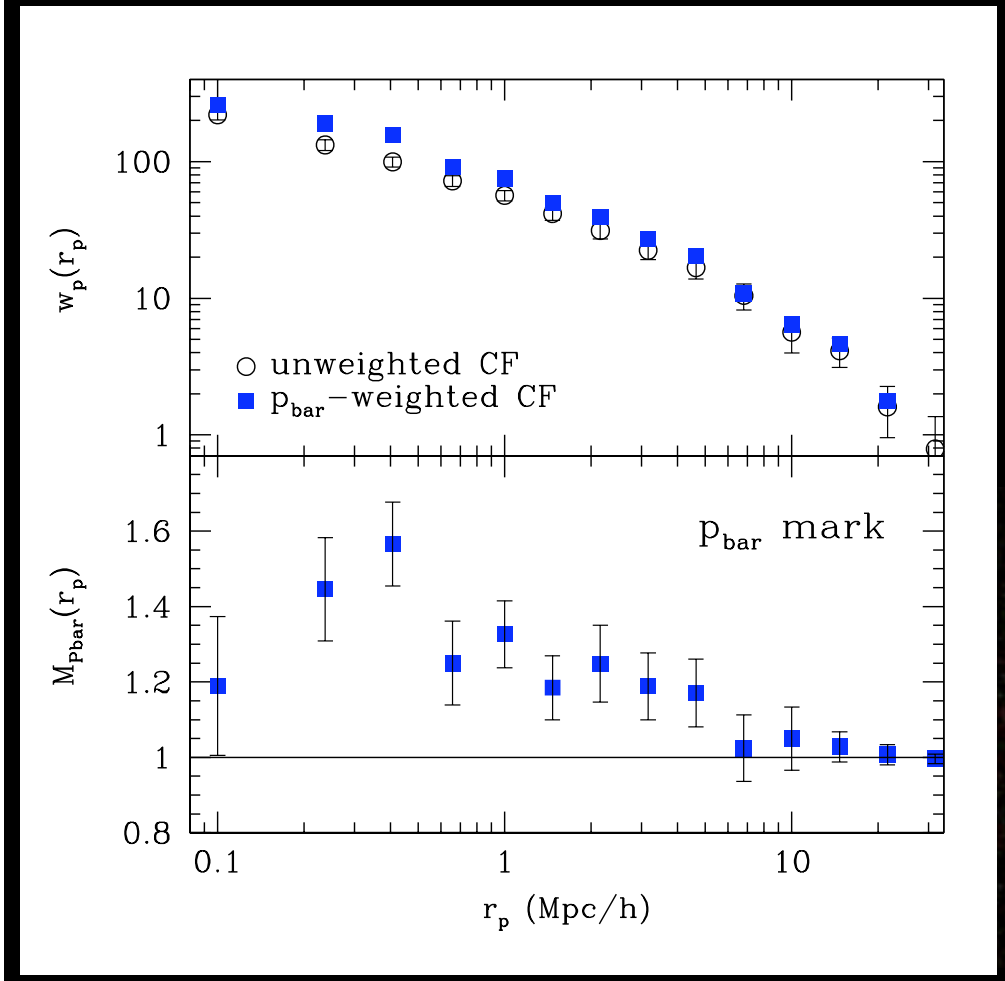


A quasar which has recently turned off….

"Hanny's Voorwerp"

So what….?

Cosmological measurements getting so precise that systematics are becoming most important source of error. For example:



- Ross et al. 2012 – stars in our Galaxy affecting large scale angular correlation functions
- Skibba et al. 2012 – barred spirals cluster differently to unbarred spirals

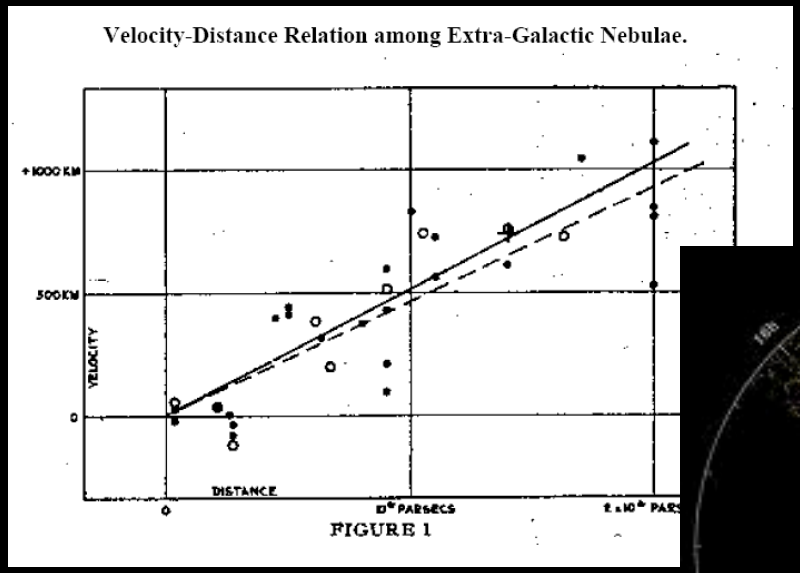
How Many Galaxies Are There?

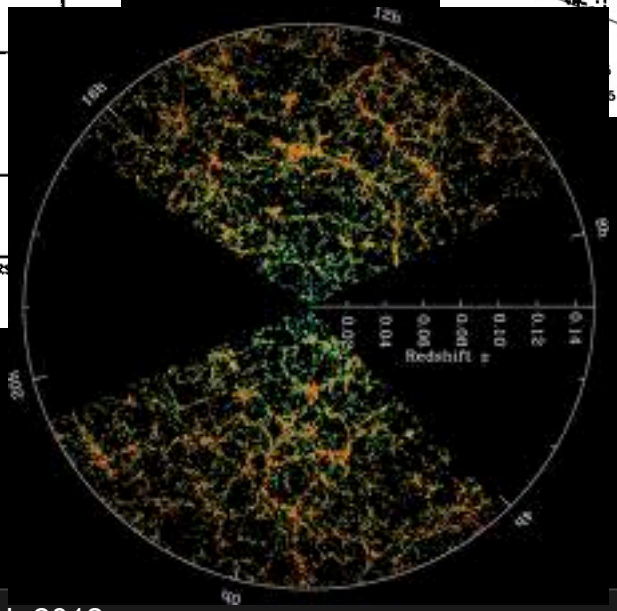
1929: Edwin Hubble discovers expansion of the Universe (24 galaxies)

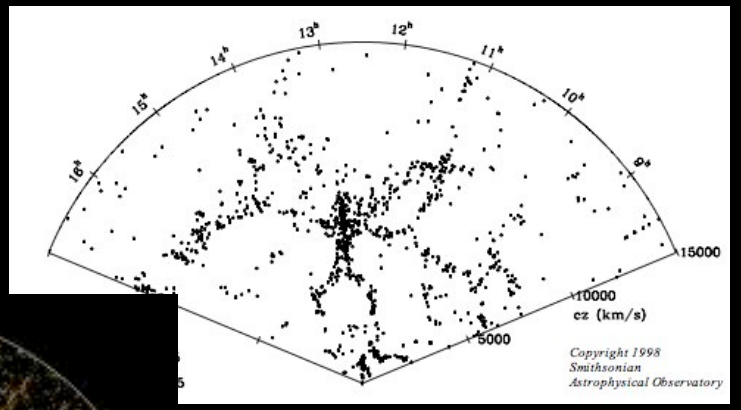
57 years

x 50

1986: CfA redshift survey - discovery of large scale structure (1100 galaxies; Huchra & Geller)







22 years

x 1000

2008: Final release of SDSS Main Galaxy Sample (1 million galaxies)

ENGLISH | POLSKI

GALAXY ZOO .org

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How to Take Part - Tutorial

How to look at a million galaxies – ask for help!

Your job is very simple! All you need to do is look out for the features that mark out spiral and elliptical galaxies. In fact, as you're a human and not a computer, most galaxies should be easy to classify since they're obviously spirals or obviously ellipticals. On this page, you will practice classifying galaxies. On the next page, you will take a short trial to test your skills. If you don't pass the trial, you can try again. Once you pass the trial, you can start contributing to Galaxy Zoo science!

Part 1A ... Spiral or Elliptical Galaxies?

This is a face-on **Spiral Galaxy**. You can clearly see the spiral arms and a central bulge.

This **Elliptical Galaxy** is composed entirely of a bulge of stars. There is no disk or spiral arms.

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ZOONIVERSE
REAL SCIENCE ONLINE

in one slide…

One of the most popular citizen scientist projects – 200,000+ contributors, and inspired the 600,000+ strong "Zooniverse" – which requires science to be central to all projects.

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

Try it at: www.galaxyzoo.org

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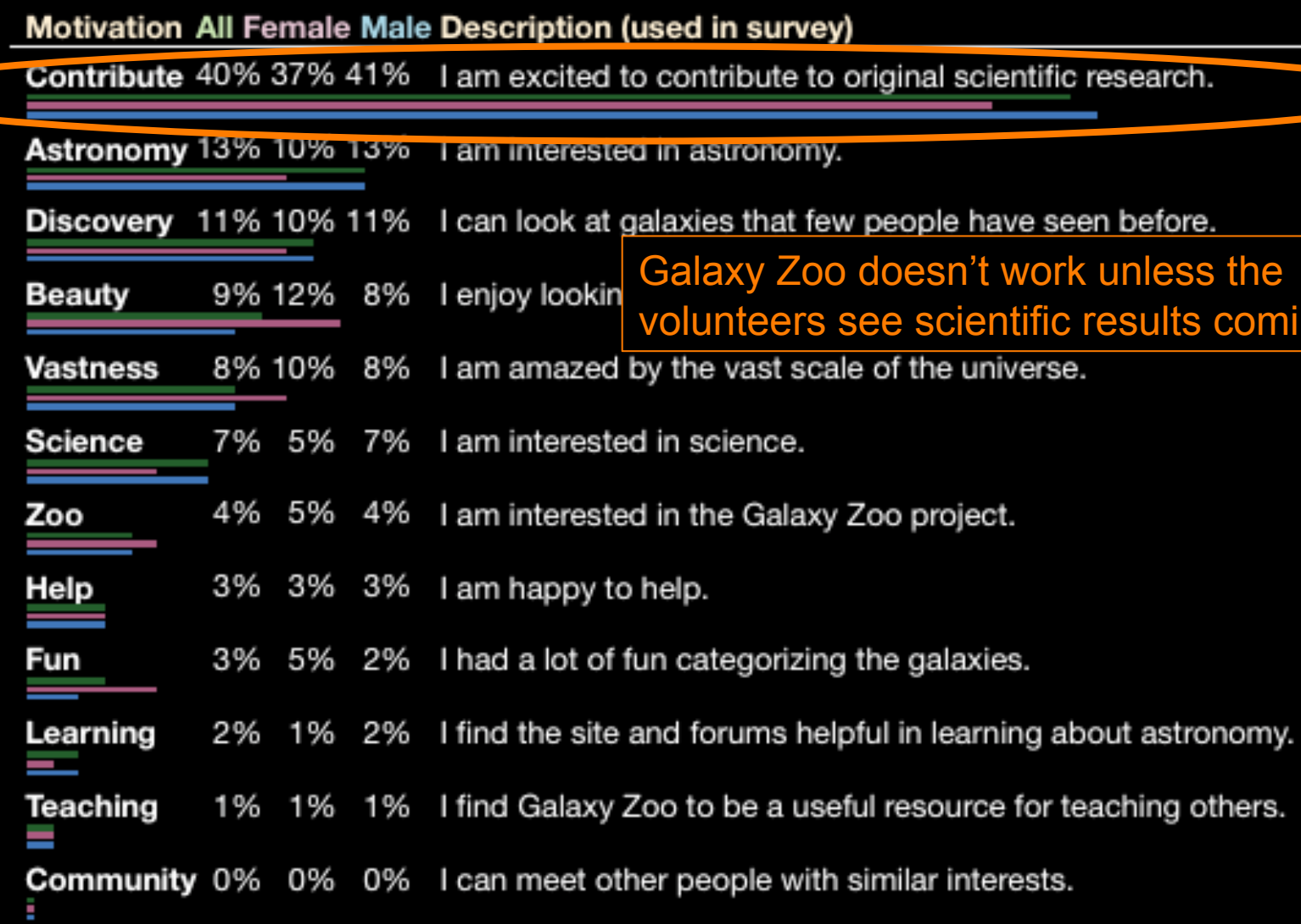
Why Do People Do This?

Galaxy Zoo: Exploring the Motivations of Citizen Scientists. (Raddick et al. 2009 astroph/0909.2925)



Galaxy Zoo doesn't work unless the volunteers see scientific results coming out.

Pushing to higher redshift from the Ground…

SDSS3 Project – Baryon Oscillation Spectroscopic Survey

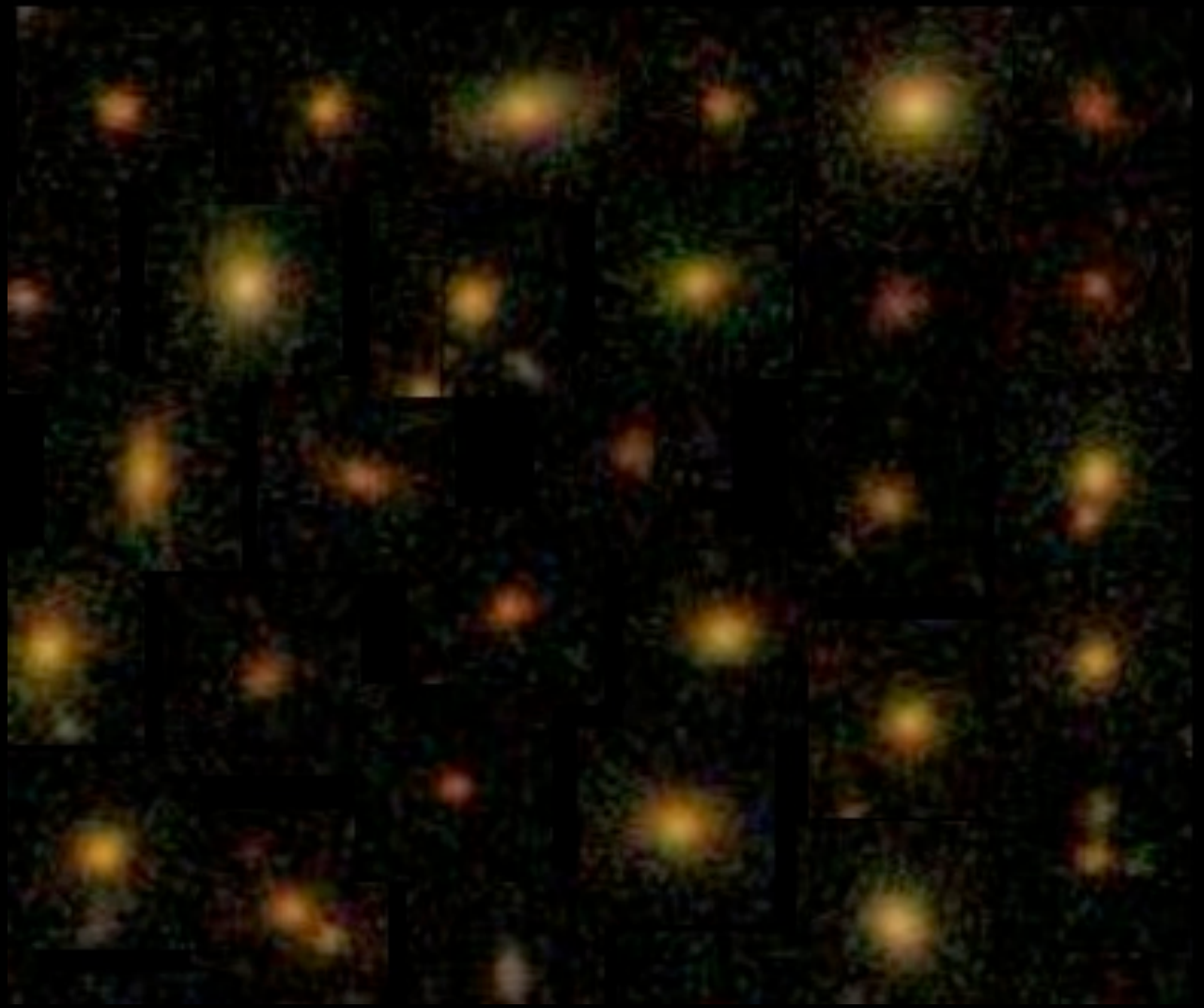
1.4 million galaxies… BUT

BOSS galaxies have median size: 1.5”
(median SDSS3 seeing 1.1”)

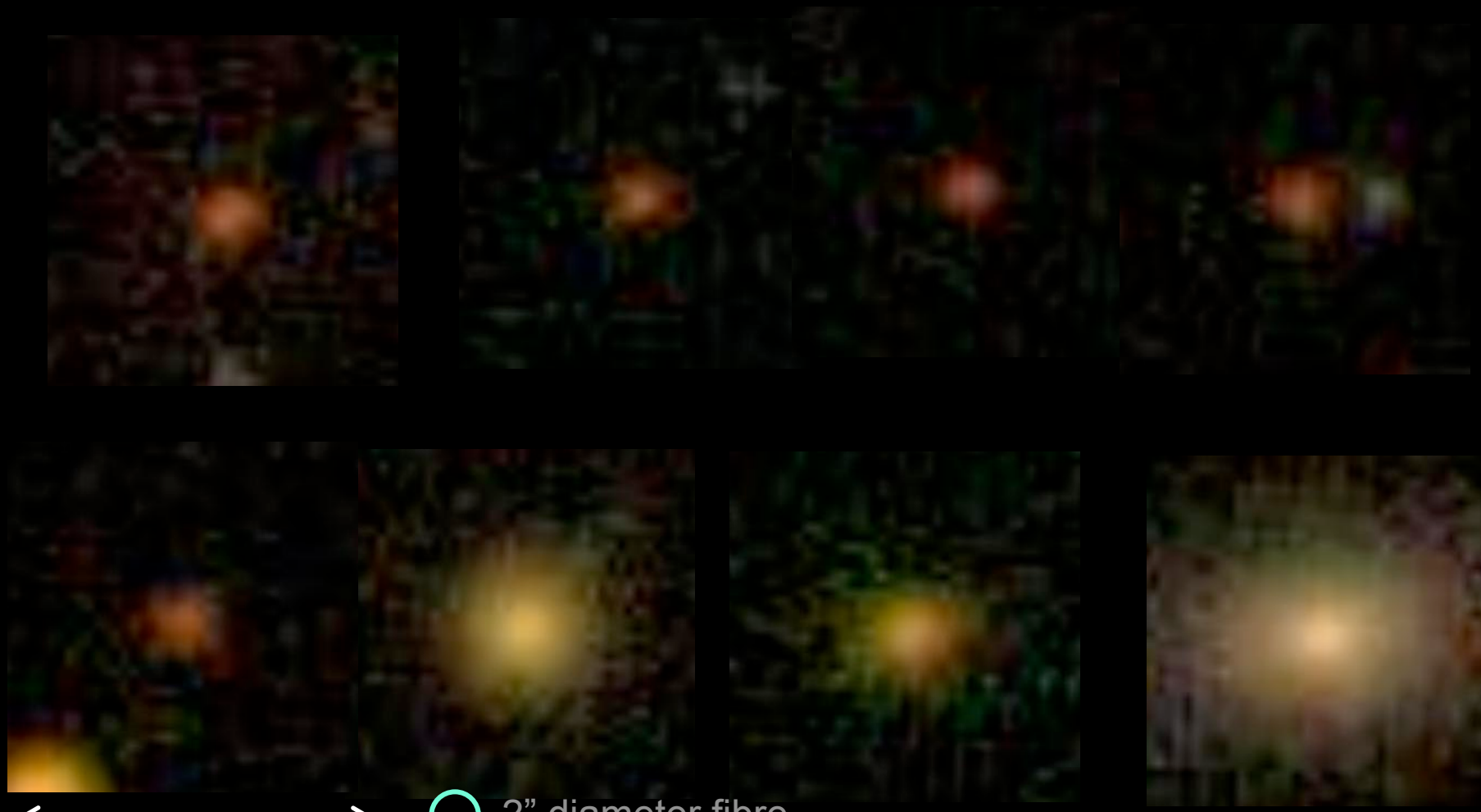
Star-galaxy separation is becoming critical

All galaxies look like fuzzy blobs…

but 240 are in COSMOS field…..



SDSS Images of BOSS galaxies



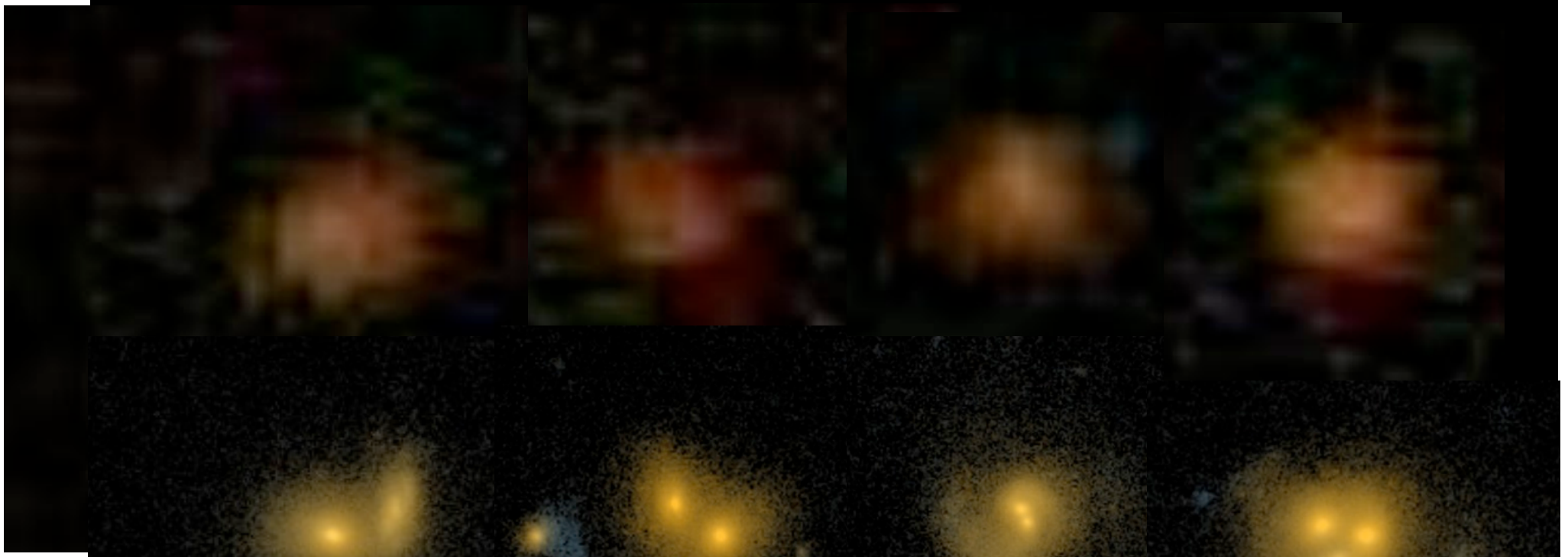
HST Images - 74% Early types

All HST colour composites are those made for Galaxy Zoo: Hubble (IDs by me)

Masters et al. 2011 (MNRAS 418, 1055)

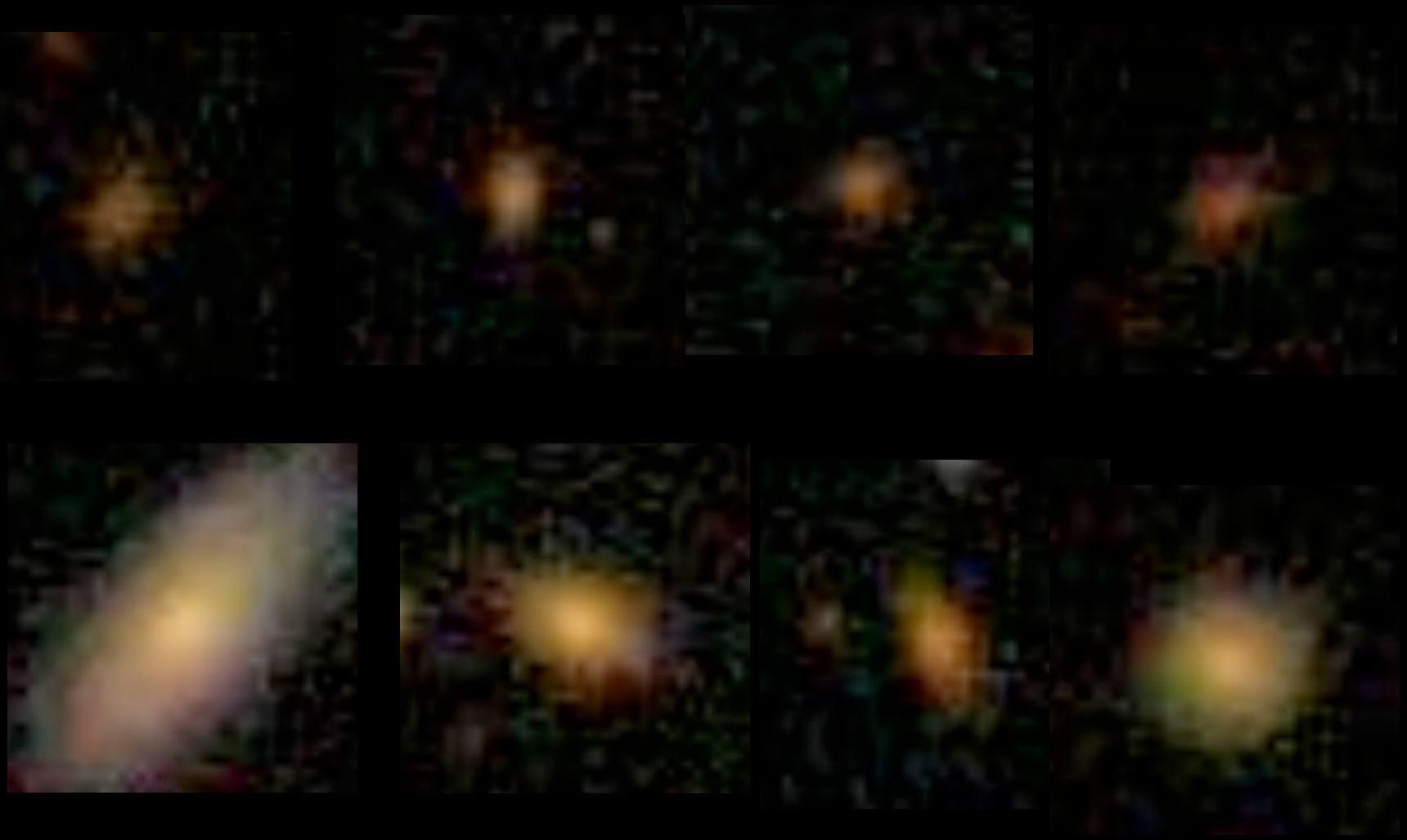
2” diameter fibre

15 % of the early types are multiples within the SDSS PSF (1.1” for DR8)



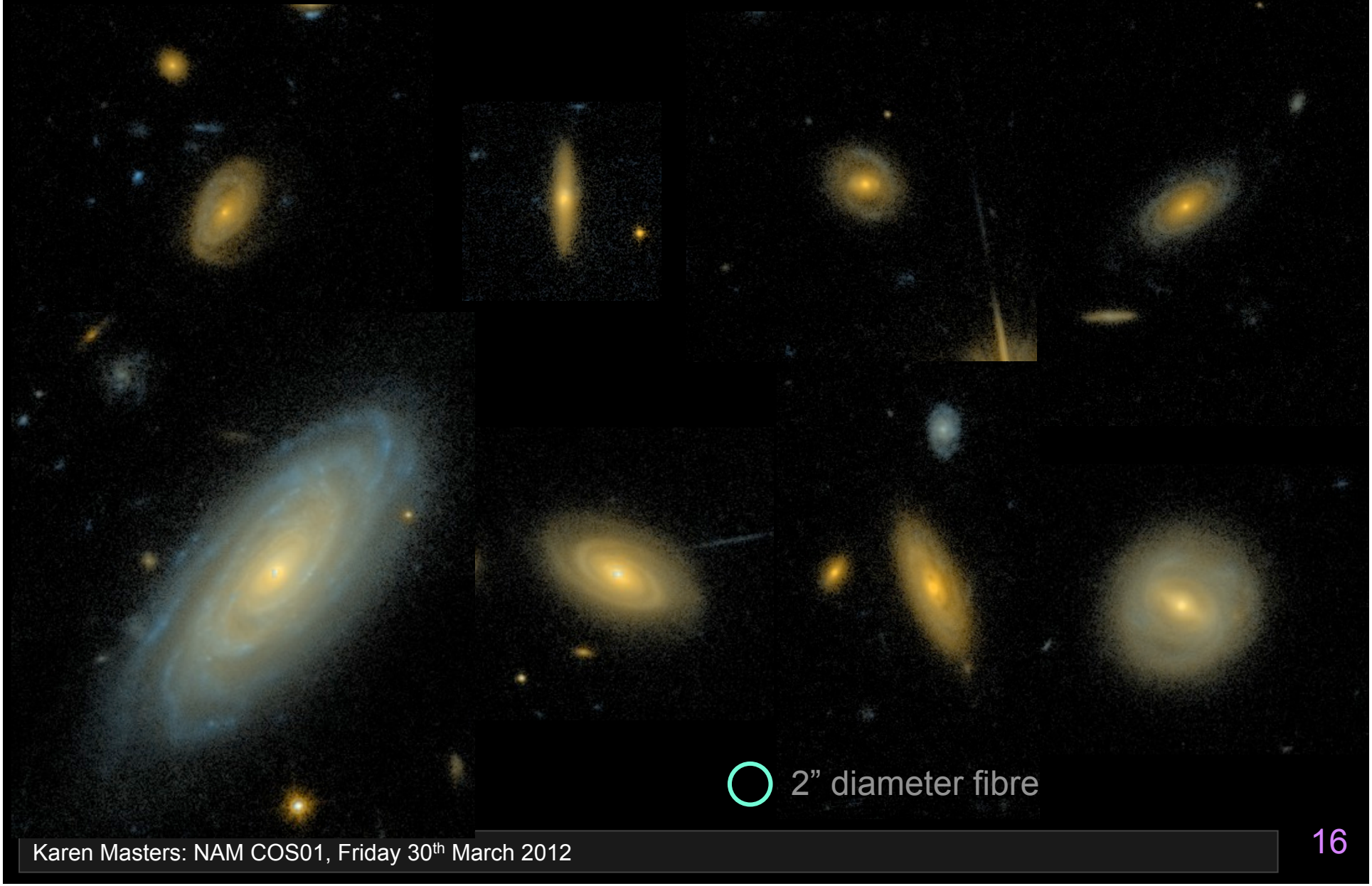
At z~0.5 this is ~7kpc

More SDSS Images of BOSS galaxies



2” diameter fibre

HST Images - 24% Late types



Summary

- Not all galaxies are the same (red ≠ early type)
- You should/will care about this:
  - when you find systematic effects (e.g. Ross et al. 2012, Skibba et al. 2012)
  - when simulations start including it
- Galaxy Zoo provides reliable morphologies for statistically interesting sample sizes
- Galaxy Zoo/Zooniverse projects only work when based on scientific goals/needs
- Pushing to high redshift from the ground makes all galaxies look the same (fuzzy blobs)
  - But that doesn't mean they are all the same (Masters et al. 2011)