Galaxy morphology

…some thoughts

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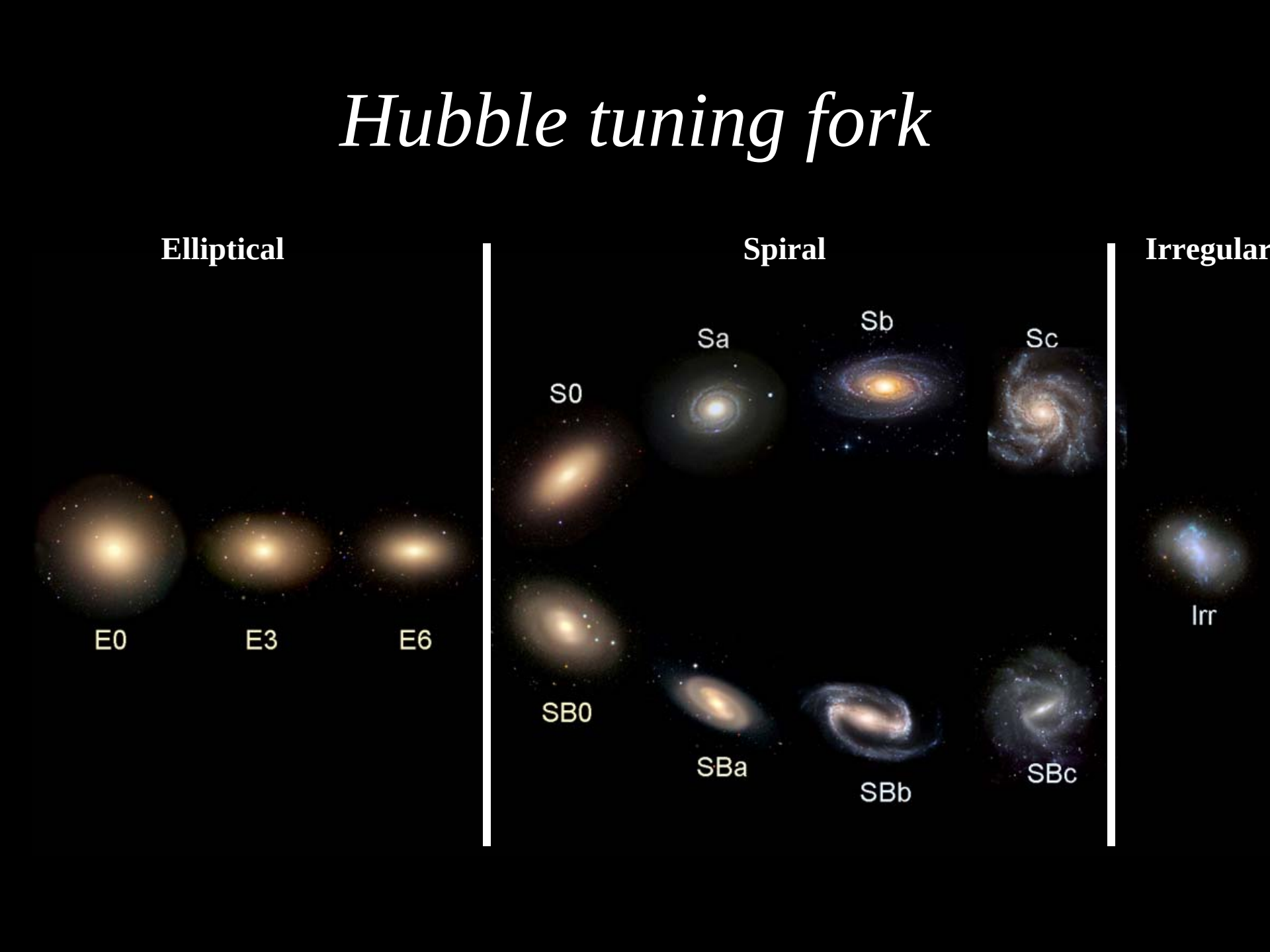
Hubble tuning fork



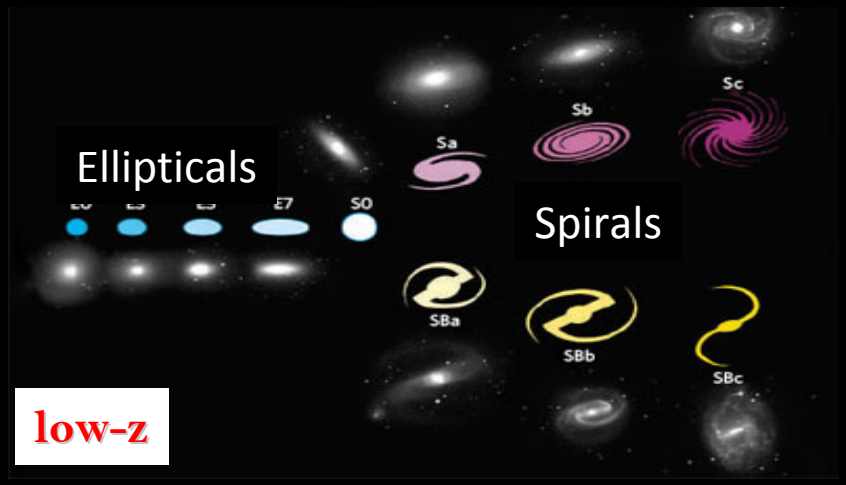
Morphological evolution

Local Galaxies, z~0

Distant galaxies, z~1

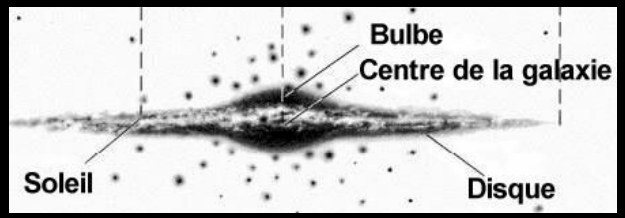
High-z galaxies

Morphology: a key ingredient



high-z

- **How stars distribute in the two main galaxy components: bulges & discs**



- **Does the environment play a role?**
- **Which are the main physical processes at play?**

Why galaxy morphology?

- It is a primary galaxy property
- Galaxy structure is a robust and stable property
- Give us insight on the the physical mechanisms at play to shape galaxies
- Allows to discriminate among different scenarios of galaxy formation & evolution
- Provide simple prescriptions/constraints for simulations
- **The evolving trends, in sizes, structures, and morphologies, reveal the formation mechanisms behind galaxies and provides a new and unique way to test theories of galaxy formation**

Euclid strength

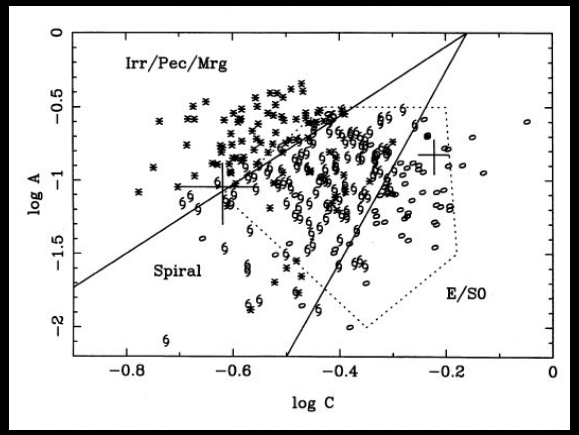
- High statistics (1B sources, 50M spectra)
- Rare populations (blue ellipticals, red spirals)
- Connection to the environment (over-density, groups, …)
- Wide & Deep surveys
- Large redshift range → evolutionary studies
- At low-z, resolved the stellar population of all galaxies within ~5 Mpc, providing a complete census of all morphological and spectral types
- Spectro-photometric properties
- Morphologies, masses, and SFR out to z~2 with a 4 times better resolution, and 3 NIR magnitudes deeper, than possible from ground
- …

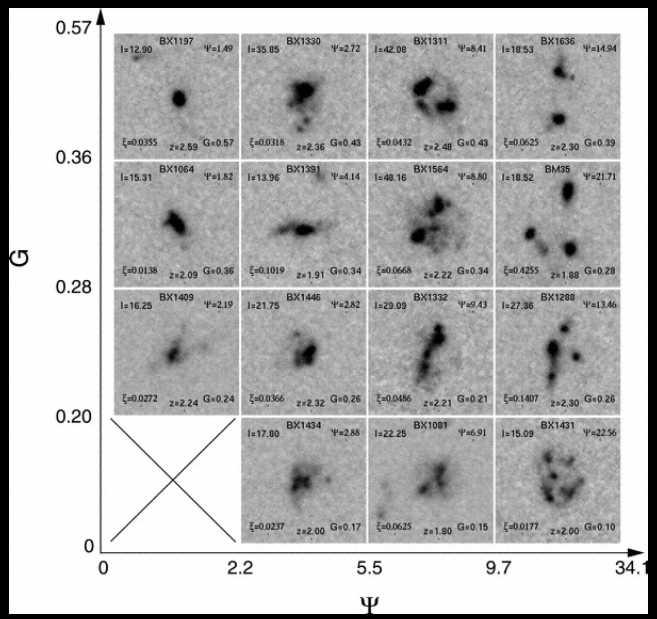
Visual classification

- The classic approach towards understanding the structures of galaxies
- Only possible with Citizen Science projects which provides online tools for non-scientists to classify over a million galaxies

A morphological type is only a visual determination of how a galaxy looks, and does not predispose to a certain local galaxy type or template, or to ascribe a certain formation history or scale.

Non parametric measurement of structures



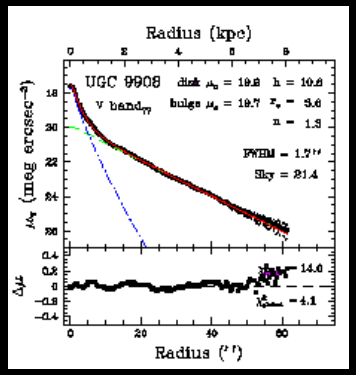


CAS (Conselice, 2003)
GM_{20} (Lotz et al., 2004)
Tψζ (Law et al., 2007)
F (Matsuda et al., 2011)
MID (Freeman et al., 2013)

Structural parameters which allow a multi-space classification scheme.

Parametric measurement of structures

The fitting of galaxy two dimensional profiles with various forms is done with widely used & tested codes: Gim2D (Simard 2011), GALFIT (Peng 2002), …



To study structural properties and galaxy subcomponents

n,r_e (Sérsic, 1968)
r_{out},α,β (Ferrer profile)
r_c,r_t, α (Mod. King profile)
r_b, α, β, γ (Nuker profile)

Which morphology for Euclid?

Zero point: Source extraction (SeXtractor)

First step: "simple" structural measurement

Visual classification
Training sample

Non- parametric measurements
(C, A, G, M20, T, ψ, ζ, ….)

Second step: Automated classification tool (CAS, CAS+, SVM, PCA…)

Morphological classification

Third step: Parametric measurements (SB fit, pixel study)

"High level" morphology

Single component fit:
structural properties

Bulge/Disc decomposition:
galaxy subcomponents

How to implement in SDC?
&
Interaction with OUs, SWG

Synergy with WL

- Accurate PSF
- Inclination & ellipticity (Kaiser & Squires 1993)
- Bayesian galaxy shape measurement (Miller et al. 2012)
- …

Interaction with OU-MER

- WP devoted to implement morphological parameters
- Codes & morphological know-how from morpho-experts
- Clarify parameters needed and their accuracy
- Strong interaction SWG-morphology & OU-MER fundamental
- …

Take home message

- **Galaxy morphology fundamental for Legacy science**
- The evolving trends, in sizes, structures, and morphologies, reveal the formation mechanisms behind galaxies and provides a new and unique way to test theories of galaxy formation
- Need to compute structural parameters while extracting sources
- Clear synergy with WL, MER, VIS, NIR & SIM
- **Need for strong interaction**

Bonus

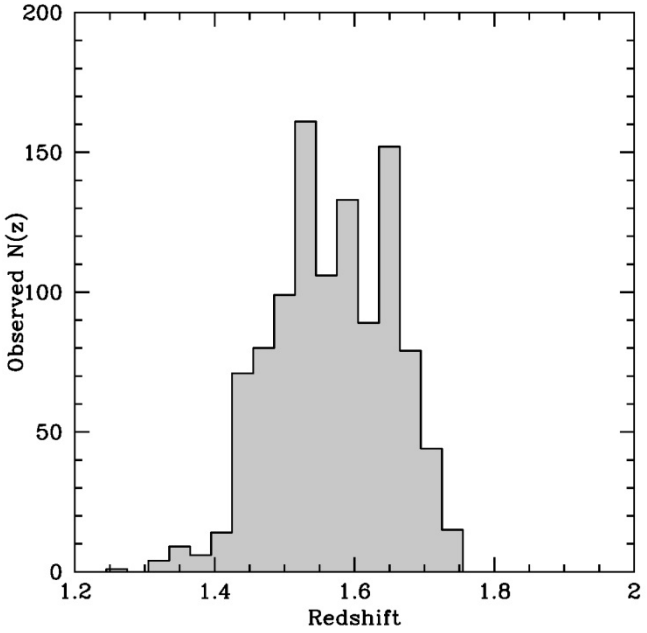
Hα emitters counts

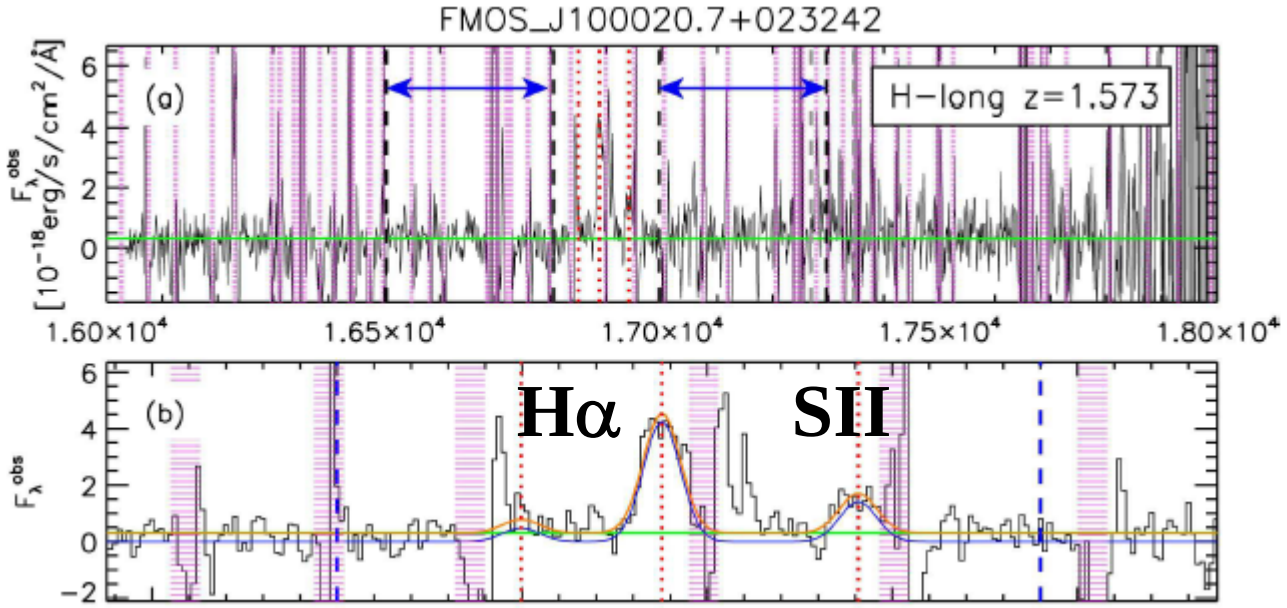
- Volume density of emitters: a key element for clustering signal on BAO and RSD probes
- Recent studies have led to a revision towards a lower number of emitters
  - Worry on the performance of the clustering measurements
  - Led to adjustment of survey strategy
- But: Hα counts at z>1 are difficult given current instrumentation
  - Ground-based infrared spectroscopy surveys limited
  - HST grism spectroscopy surveys: small field limited by cosmic variance and limited wavelength range <1.4 microns; indirect estimates using OIII

Use the new FMOS-COSMOS infrared survey to 1.8 microns to count Hα emitters

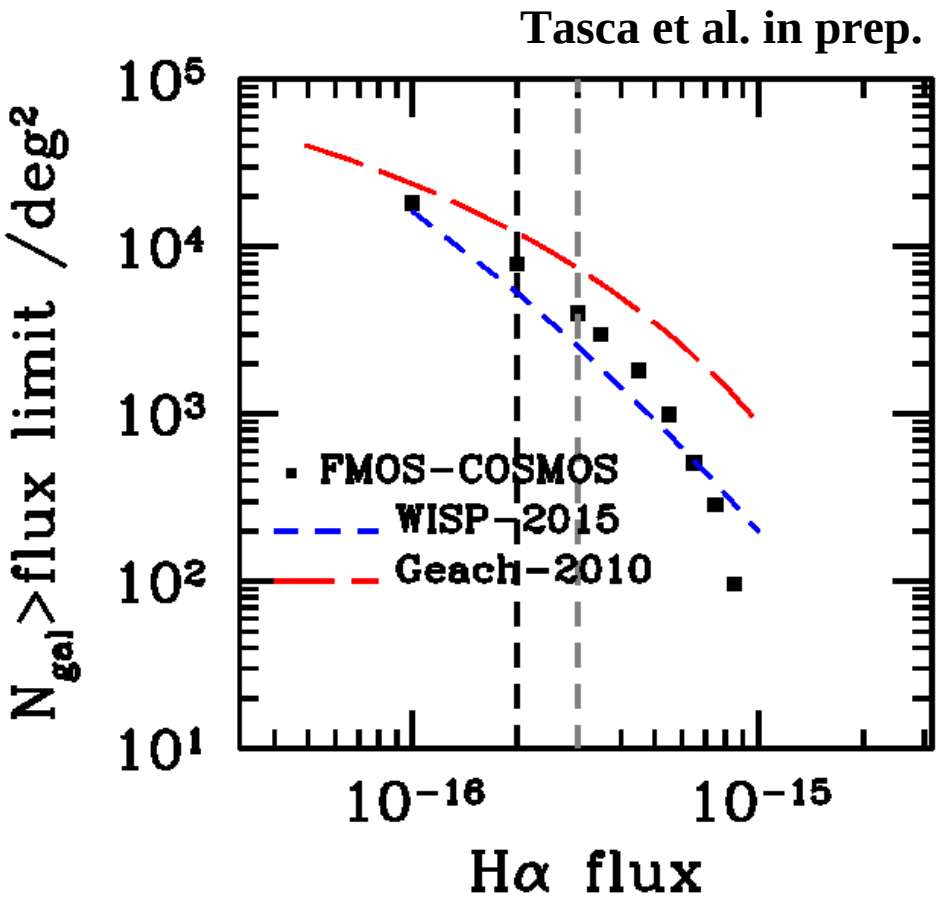
FMOS-COSMOS

- Silverman et al. 2015
  - FMOS on Subaru: J and H bands
- 1000 galaxies, 1.4<z<1.7
- Completeness: ~10^{-16} $erg.s^{-1}.cm^{-2}$
- 1 deg² (cosmic variance < 10%)





Hα counts



Preliminary Results 1<z<2 (not taking into account completeness and purity)

7900 galaxies /deg² with F(Hα)>2×10^{-16} erg.s^{-1}.cm^{-2}

4000 galaxies /deg² with F(Hα)>3×10^{-16} erg.s^{-1}.cm^{-2}

× 1.3-1.5 more than Mehta et al. (WISP)

HAPPY NEW YEAR ☺ !