Connecting the dots: linking massive spheroids across cosmic time till catching their precursors with GT MOONS data

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Thanks to: Francesco La Barbera(1), Danilo Marchesini(2)

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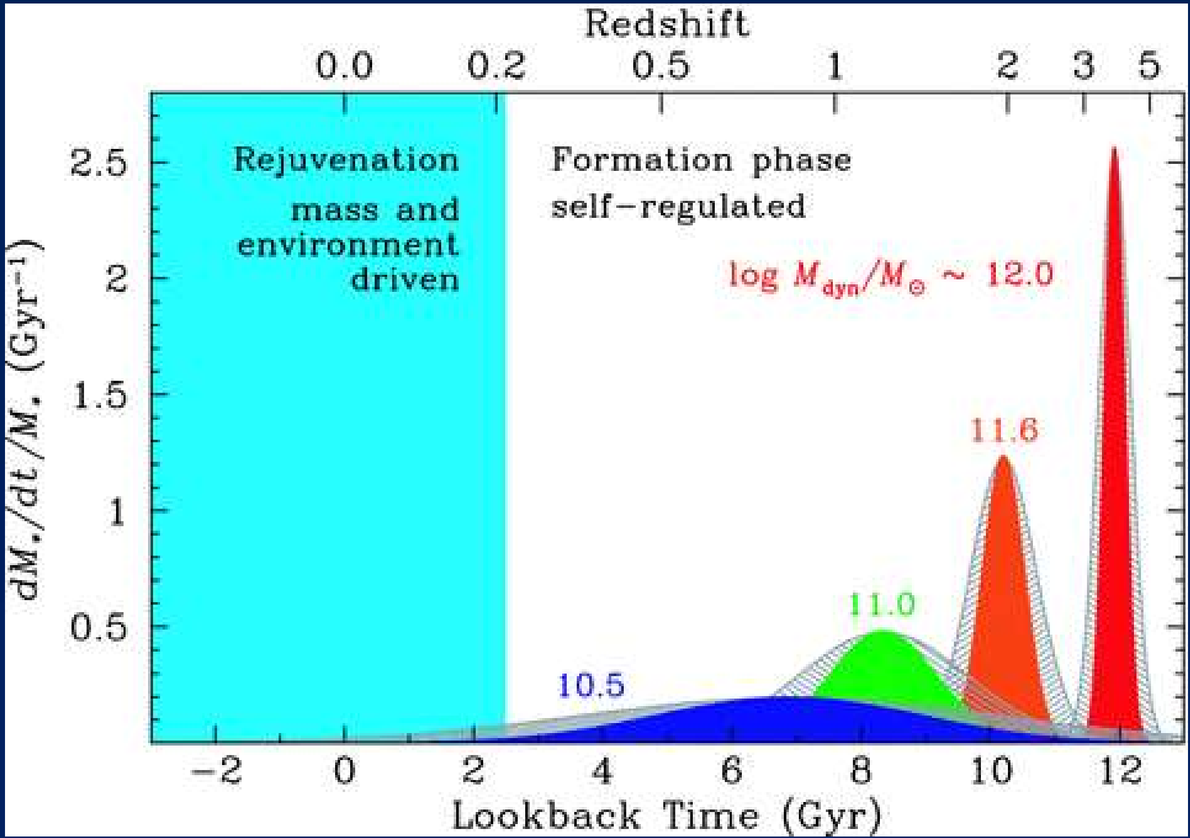
(2) Tufts University, MA, USA

The epochs of spheroids formation.

The bulk of stars of today's spheroids is thought to have formed in a short burst at early epochs, followed by a quiescent phase. If so, their progenitors should have physical and chemical properties similar to those observed today.



Thomas et al. 2010

τ_{form} shorter for larger masses.

Is the mass the true driver?

Aims

1. Establishing the relationships between high-z spheroids (1<z<2.3) with today's ones;

2. Establishing the link with their most likely precursors:
   star-forming galaxy not regularly shaped, dominated by stellar random motions (rather than angular momentum).

Local spheroid

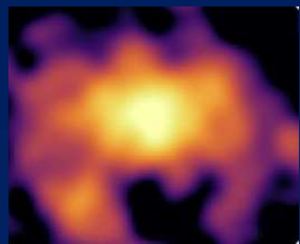
1

High-z spheroid

?

2

Precursor



Starburst/ starforming galaxy

Gas-rich merger
(Naab+07)

Disc instability
(Dekel+09)

Tools

1. High-z *vs* local spheroids: comparison of physical and chemical stellar population properties (σ, Z, α/Fe, age);

Mg/Fe → τ_{form} (duration of star formation; *e.g. Matteucci et al. 1994*)

2. Precursors *vs* high-z spheroids - Comparison of evolved (τ_{form}) stellar population properties of precursors given their SFR, their gas and stellar metallicity Z.

Local spheroid

Zstar, M*, α/Fe

1

High-z spheroid

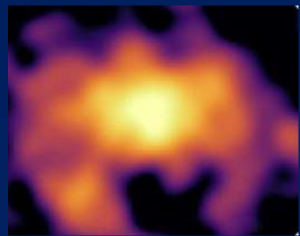
Zstar, M*, α/Fe

?

2

$\approx \tau_{form}$

Precursor



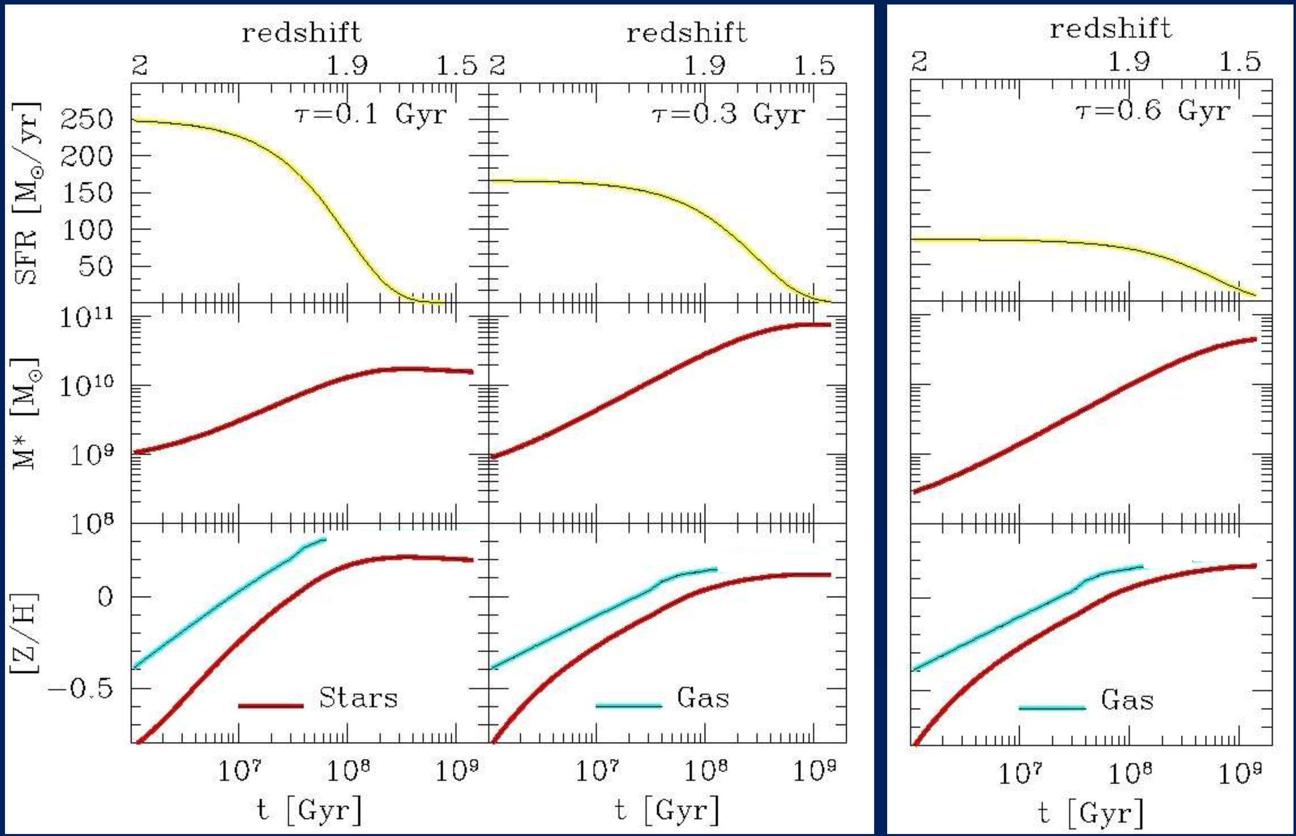
SFR, Zgas
Zstar, M*, α/Fe

Gas-rich merger *(Naab+07)*

Disc instability *(Dekel+09)*

Can starburst galaxies (not regularly shaped, dominated by stellar random…) be the progenitors of high-z spheroids?

Toy model (no inflow/outflow, closed box)



Δt=1 Gyr

SFR exponentially declining, e-time τ

Stellar mass growth

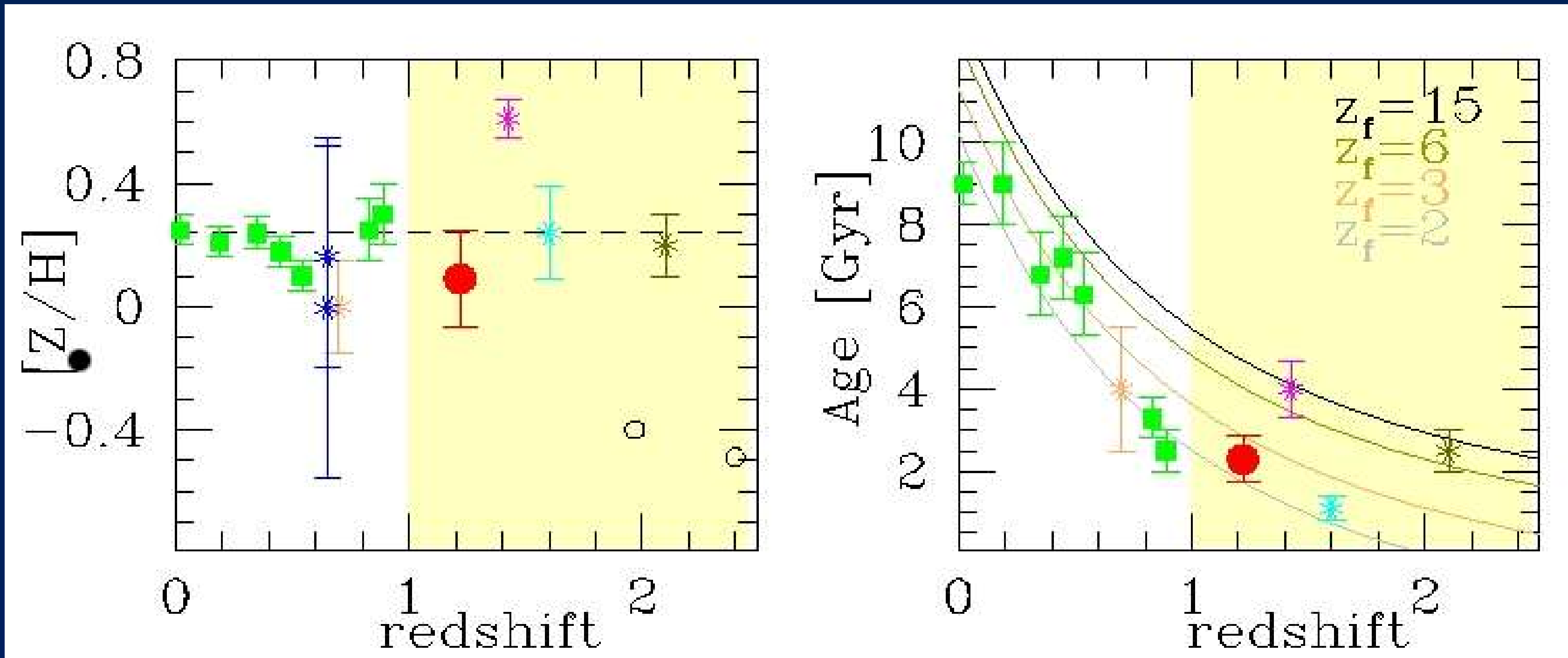
Gas and stellar metallicity enrichment

$\dot{M}_{gas}$= -SFR+$\dot{M}_{ej}$, $\dot{Z}_{gas} \propto \varepsilon \dot{M}_{ej}$, $\dot{M}_{star}$= SFR-$\dot{M}_{ej}$ $\dot{Z}_{star} \propto Z_{gas} * \dot{M}_{star}$

(Tinsley et al. 1980)

Stellar age and metallicity at different redshifts

Current spectroscopic measurements



- ✳ Comparat+18 (eBOSS ~5000 field galaxies z≃0.6)
- ✳ Gallazzi+14 (dozens field galaxies z≃0.7)
- ■ Jorgensen+17 (dozens gal/cluster 0.2<z<0.9)
- ● Saracco+18 (7 cluster spheroids z=1.22)
- ✳ Lonoce+15 (1 field galaxy z=1.4)
- ✳ Onodera+15 (stacked spec. field galaxies z≃1.6)
- ✳ Kriek+16 (1 field galaxy z≃2.1)
- ○ Morishita+18 (2 field lensed galaxies z≃2.1)

(adapted from Saracco et al. 2018)

Expected z>1 measurements

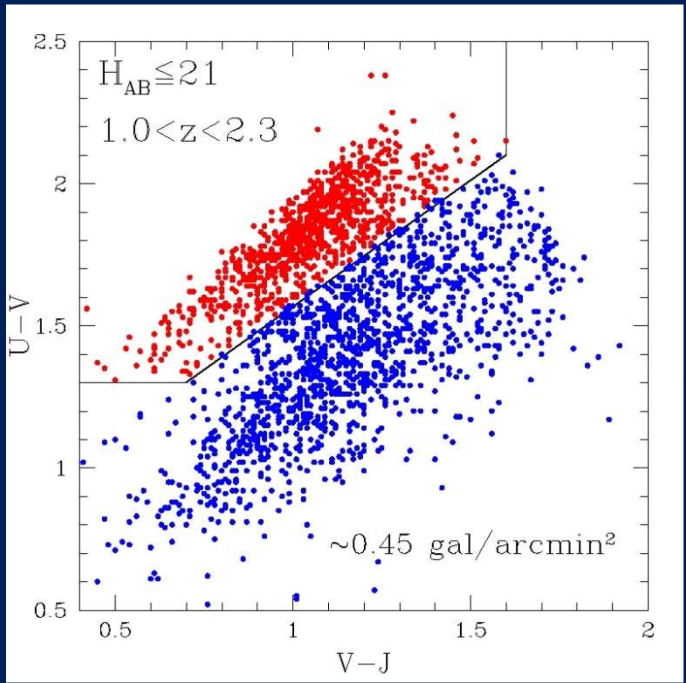
MOSDEF (*Kriek et al.)*

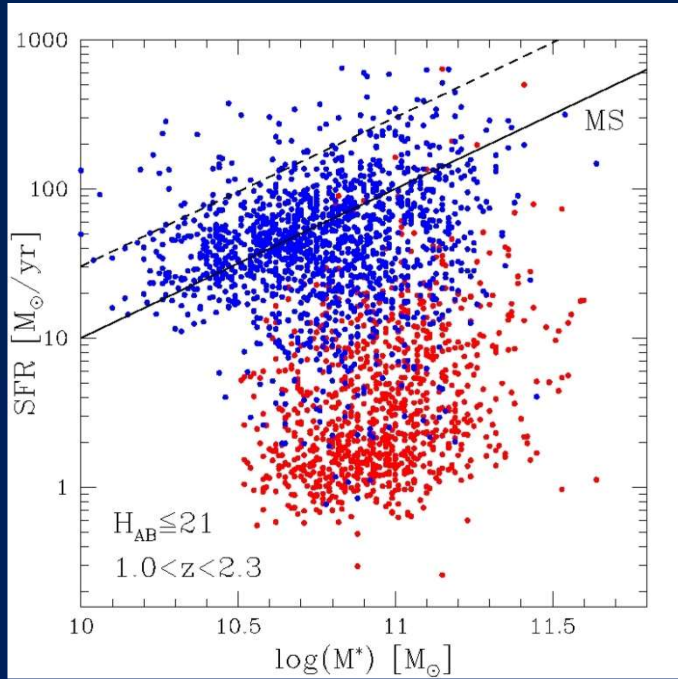
GTC/LBT z=2 targeted spheroids

VLT-Xshooter archival data

….

Linking spheroids and their precursors with GT MOONS data





UVISTA DR1
1.62 deg2

H(AB)<21
1.0<z<2.3

0.45
gal/arcmin^2

Expected numbers for one MOONS pointing (500 arcmin^2)

S/N≥ 30 per Å rest-frame → 10-15hr exp (survey Legacy)

≈ 250 gal (no preselection needed); ALMA CO(3-2) follow-up (subsample)

≈ 50-60 spheroids (≈ 90 passive)

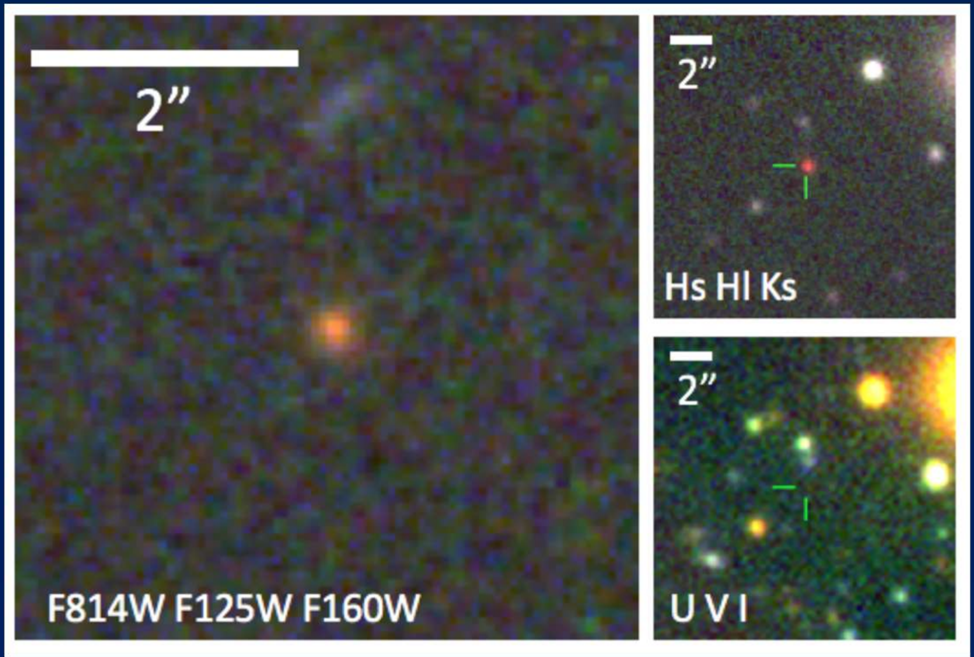
≈ 20 extreme starburst (progenitors ?)

Thank you!

The relationships between high-z and local spheroids.

Spheroids less affected by progenitor bias: once an high-density spheroid is formed, it is unlikely that it is disrupted or assembles efficiently a disc.

(Brooks & Christensen 2016 and ref. therein)



Glazebrook et al. 2017, Nature

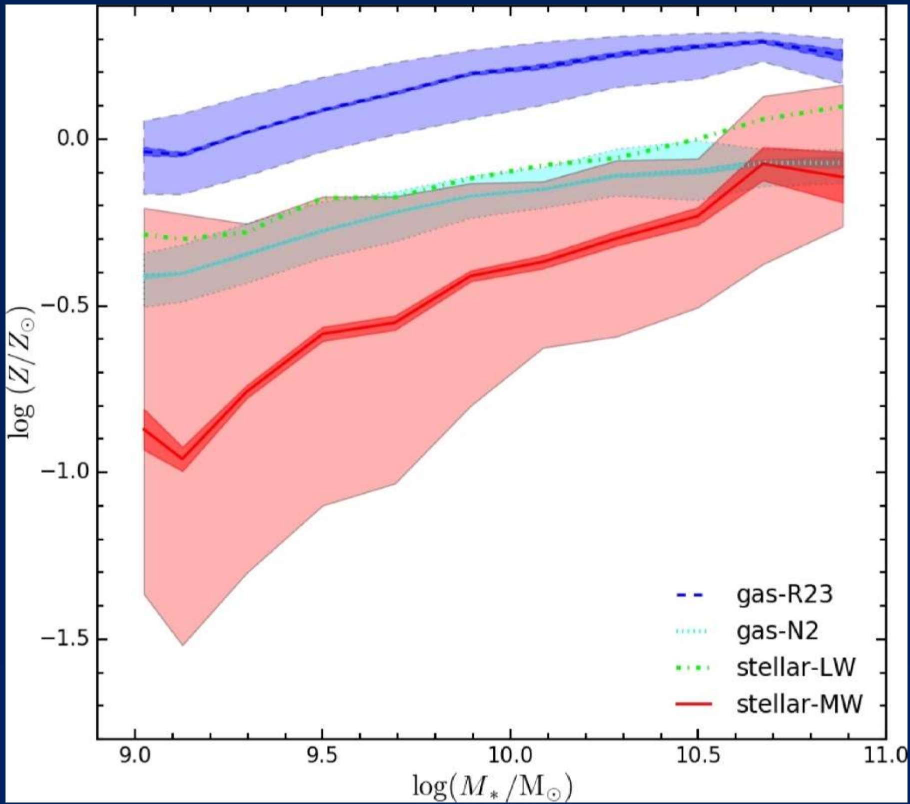
τ_{form} shorter for larger masses

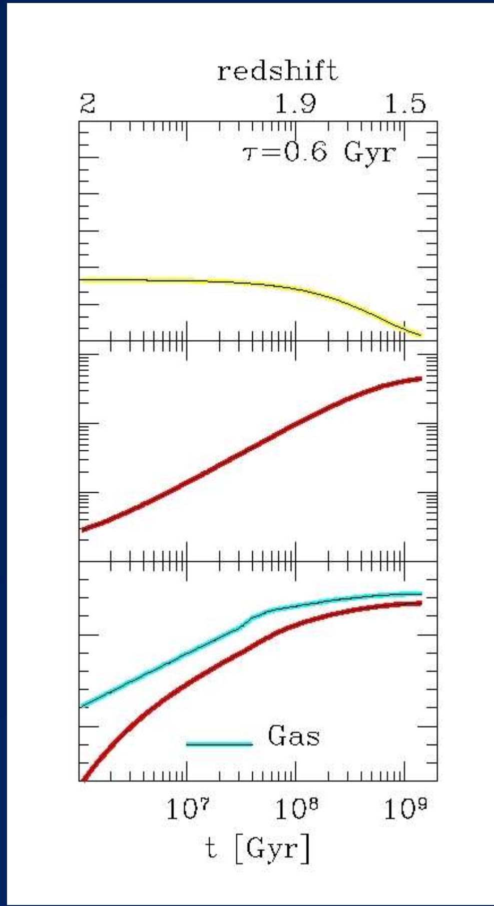
M~10^{11} Msun
R_e=0.5 kpc
z=3.7
age of the Universe 1.5 Gyr

High-redshift spheroids are the progenitors of some of the local ones.

Stellar mass growth, stellar and gas enrichment.

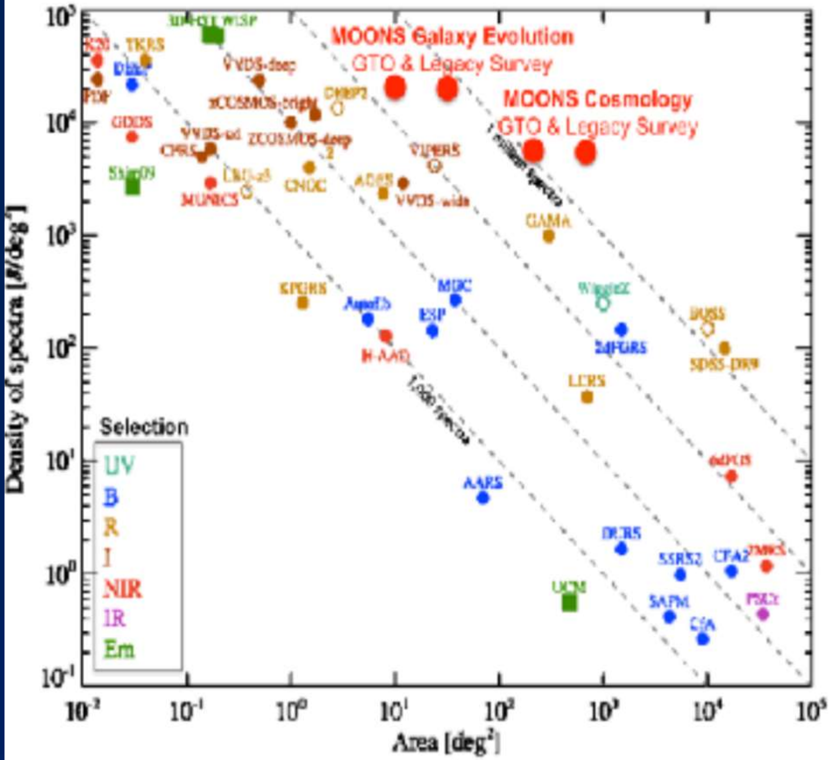
Toy model (unphysical, no inflow/outflow, closed box)

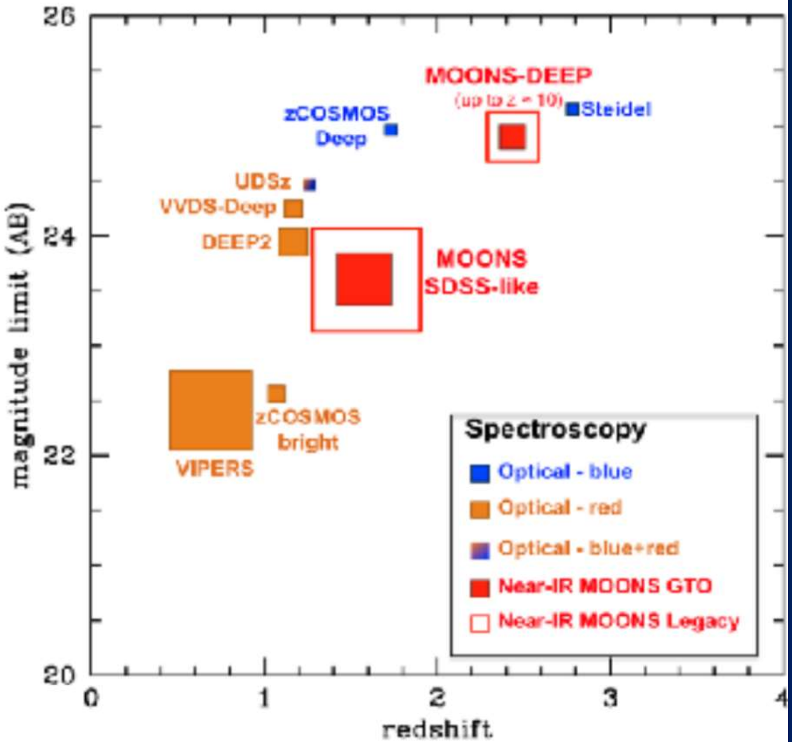




Lian et al. 2018

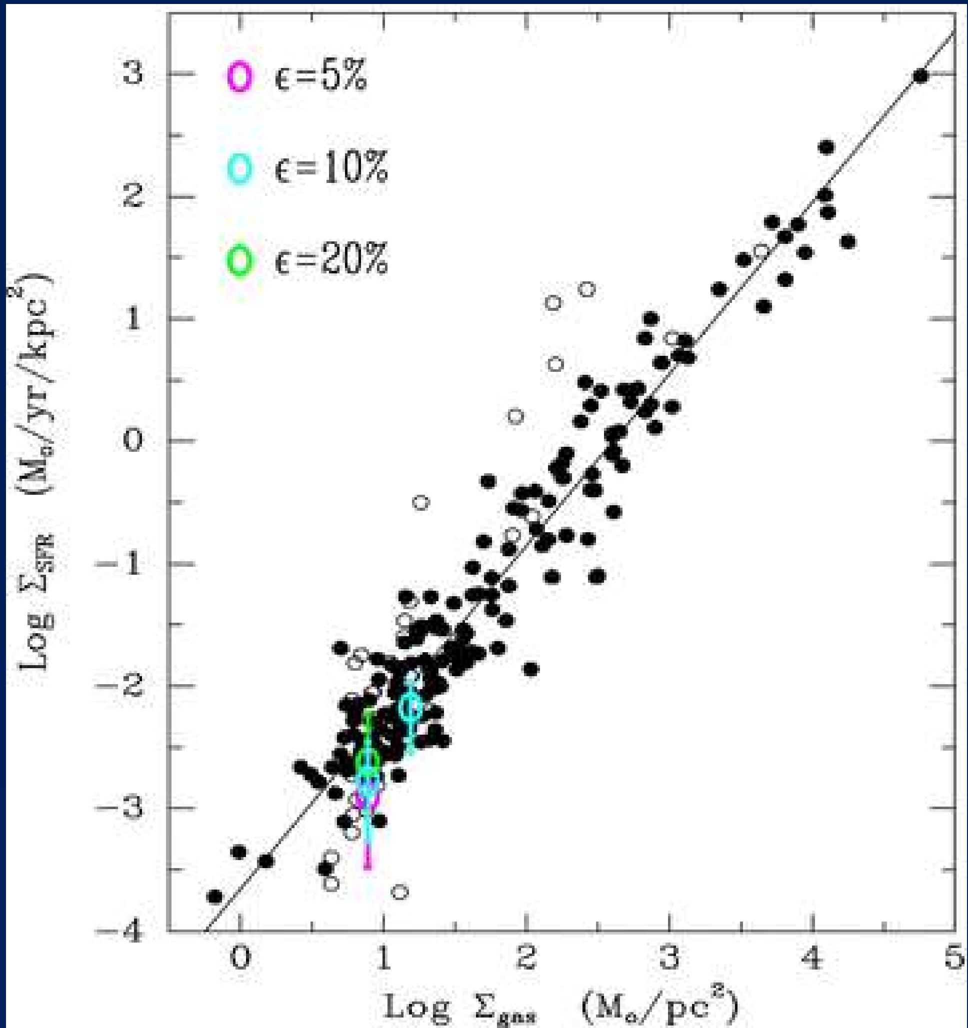
Extragalactic Surveys





Survey	Mag. Limit	Redshift	Spectra	Integration time (hr)	Area sq. deg	Galaxies	Nights
SDSS-like	$H_{AB} < 23.5$	$0.8 < z < 1.8$	Continuum + Em. lines	0.5-4	10	200k	100
Deep	$23 < H_{AB} < 25$	$z > 1.5$	mostly Em. lines	2-16	2	30k	50
Legacy	$H_{AB} < 25$	$0.8 < z < 10$	Continuum + Em. lines	0.5-16	30	700k	400

Kennicutt-Schmidt relation



Kennicutt 1998