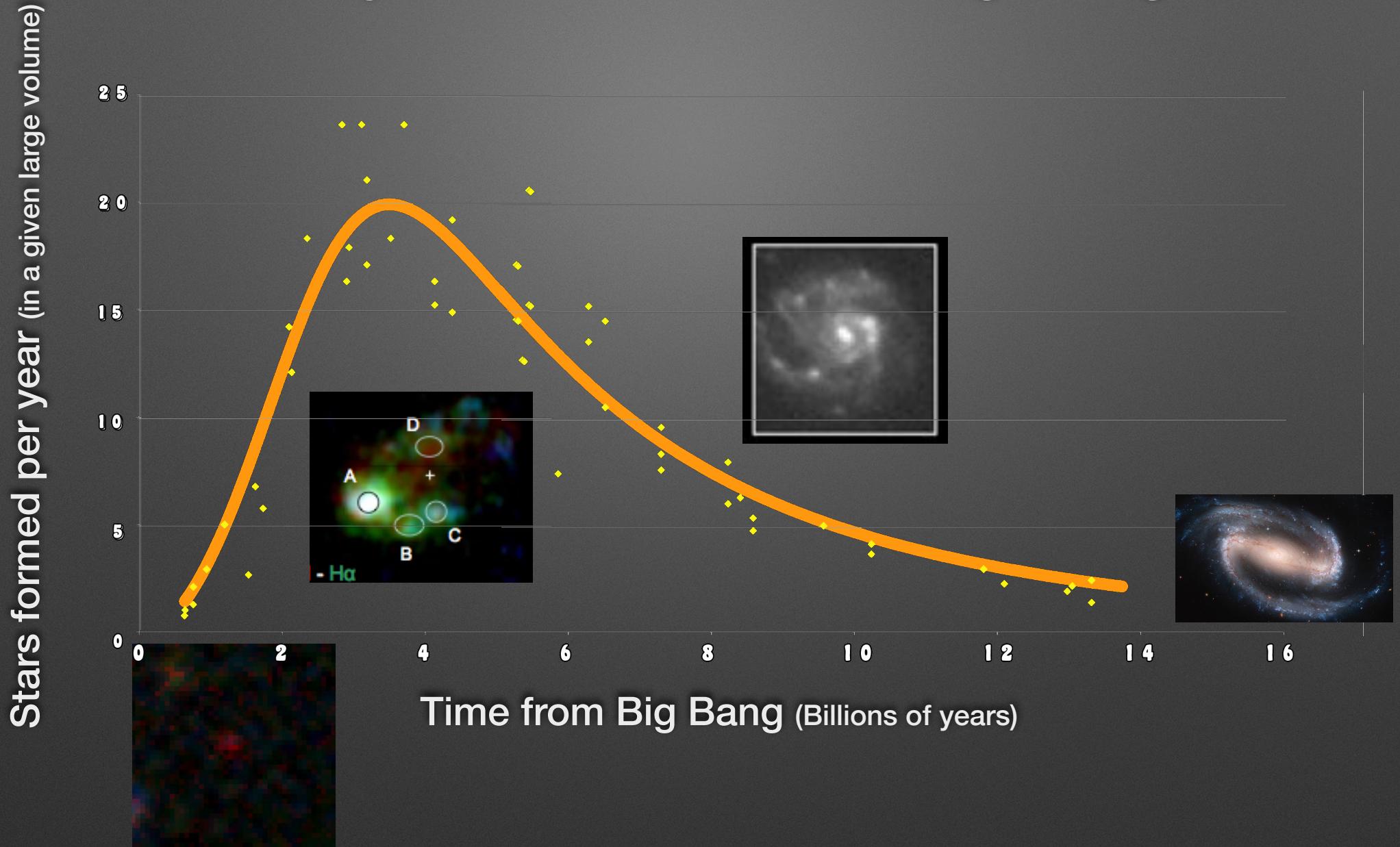


La storia dei barioni: l'evoluzione delle galassie e epoca della reionizzazione

A. Fontana, F. Fiore, M. Marconi, F. Palla

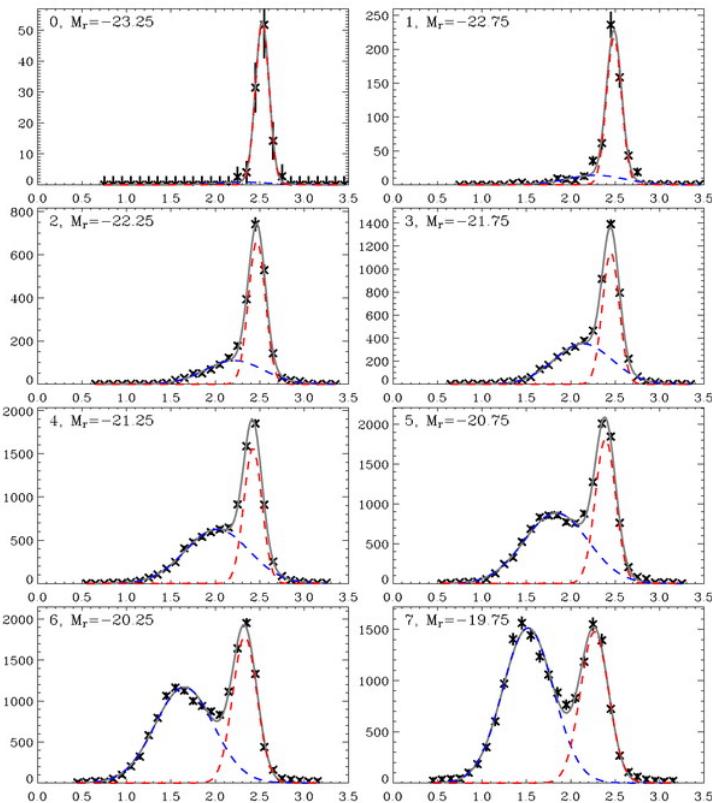
Simone	Bianchi	Roberto	Gilli	Nicola	Napolitano
Marcella	Brusa	Gianluigi	Granato	Laura	Pentericci
Carlo	Burigana	Andrea	Grazian	Enrico	Piconcelli
Giovanni	Busarello	Loretta	Gregorini	Bianca	Poggianti
Massimo	Capaccioli	Carlotta	Gruppioni	Lucia	Pozzetti
Viviana	Casasola	Leslie	Hunt	Isabella	Prandoni
Edvige	Corbelli	Angela	Iovino	Raffaella	Schneider
Giovanni	Cresci	Francesco	La Barbera	Laura	Silva
Gabriella	De Lucia	Laura	Magrini	Veronica	Sommariva
	di Serego	Filippo	Mannucci	Crescenzo	Tortora
Sperello	Alighieri	Alessandro	Marconi	Paolo	Ventura
Fabio	Fontanot	Francesca	Matteucci	Luca	Zappacosta
Filippo	Fraternali	Amata	Mercurio	Stefano	Zibetti
Anna	Gallazzi	Paola	Merluzzi		
Emanuele	Giallongo	Pierluigi	Monaco		

The history of the Universe in a single diagram

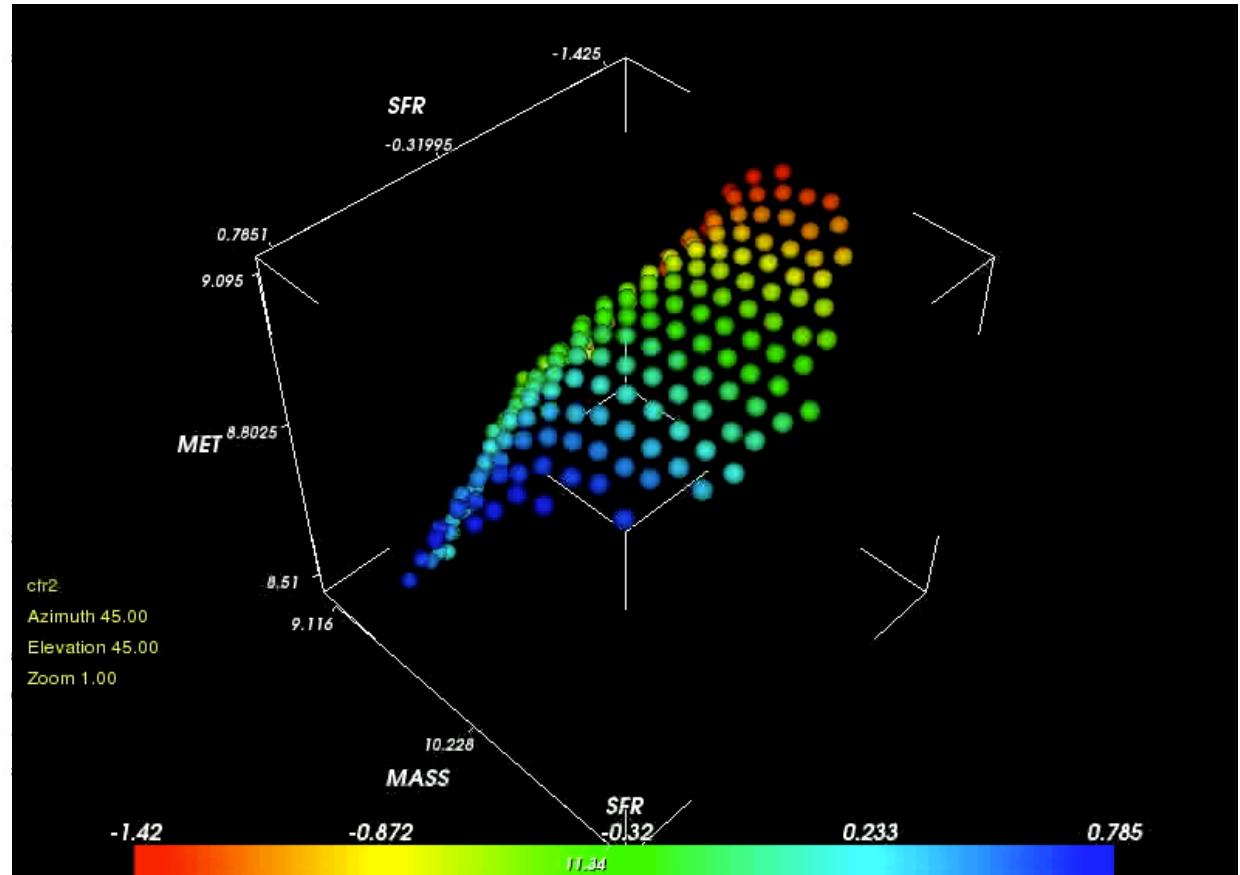


Qual'e' LA domanda?

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}.$$



B-R



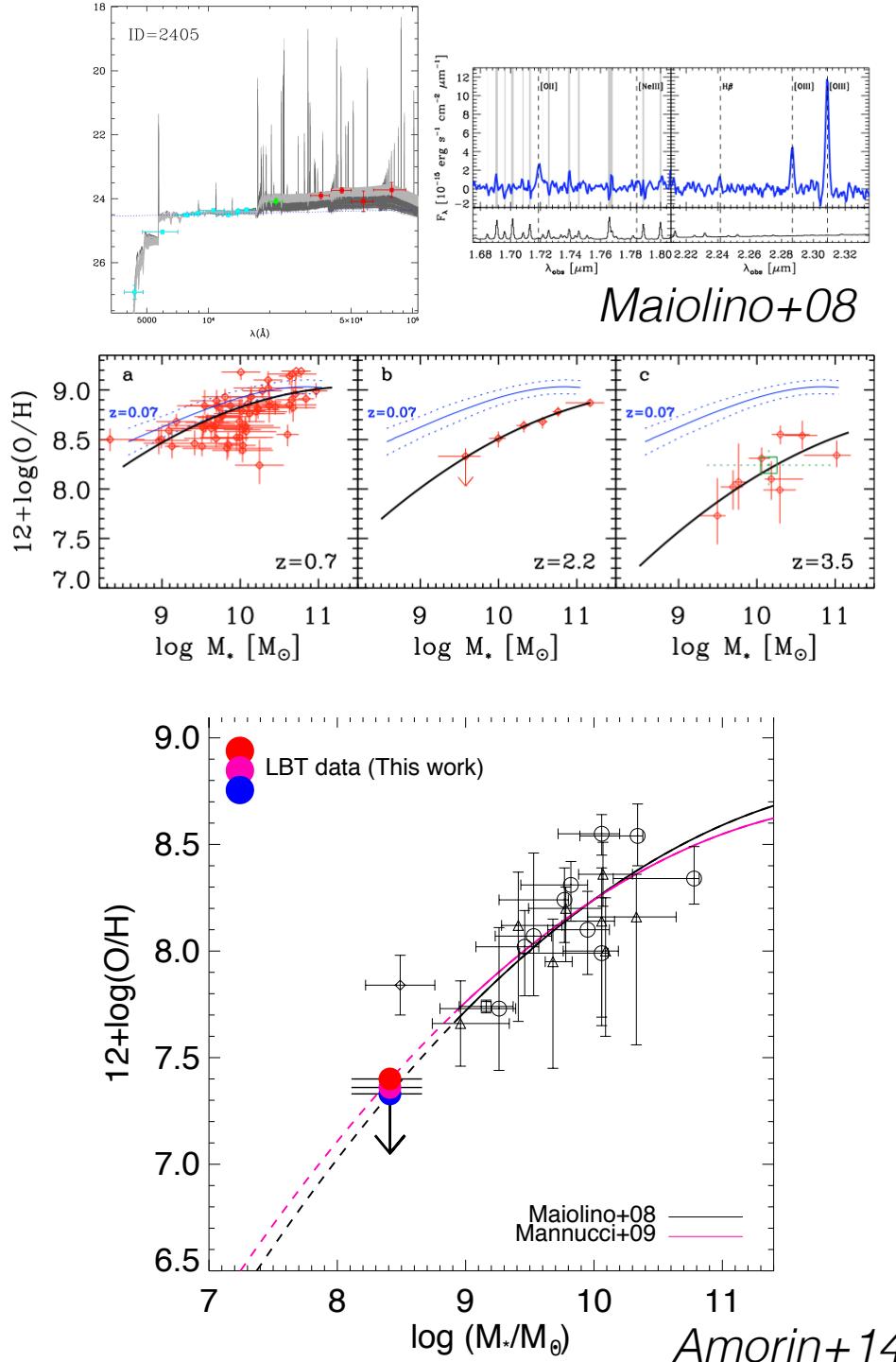
Le proprietà (statistiche) delle galassie rivelano regolarità ("leggi di scala") che sottintendono l'esistenza di meccanismi "universali":

Queste sono leggi altrettanto "fondamentali", sebbene di altra natura.

Le domande “calde” sono molte..

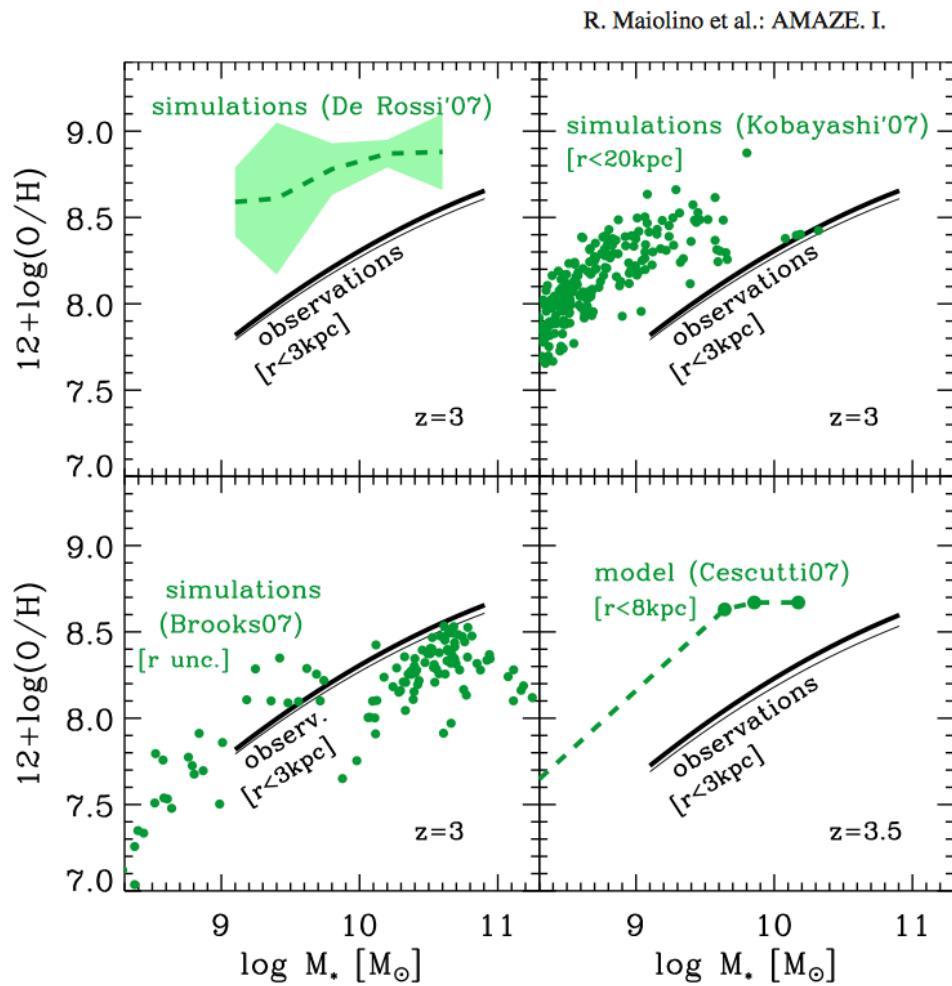
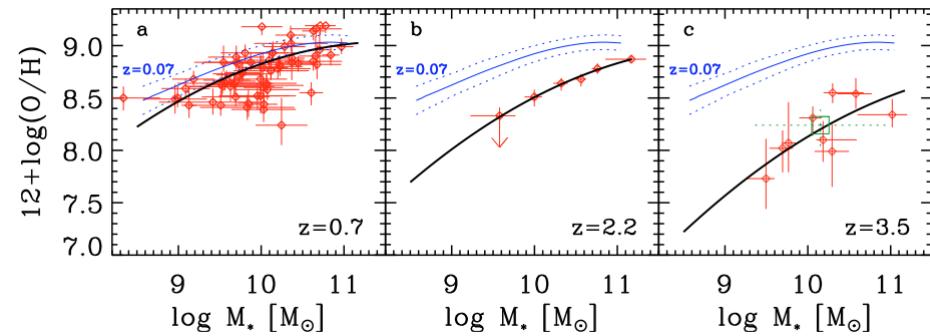
- Fundamental mass-metallicity and its evolution with z , (\Rightarrow MOONS/JWST/ELT)
- Properties as a function of environment (\Rightarrow EUCLID/MOONS/SKA)
- Red compact galaxies at $z \sim 2$ (\Rightarrow LBT-AO/VLT-AO/JWST/ELT)
- The dusty side of galaxy formation at $z > 3$ (\Rightarrow ALMA/JWST/SKA)
- The faint side of the luminosity/mass functions (\Rightarrow ALMA/JWST/SKA/ELT)
- The mismatch between the SFR and the mass densities (\Rightarrow ALMA/JWST/SKA)
- How disk grow? (\Rightarrow LBT-AO+VLT-AO/ALMA/JWST/SKA/ELT)
- The growth of the Hubble sequence (\Rightarrow LBT-AO+VLT-AO/ALMA/JWST/SKA/ELT)
- How did galaxies turn passive? (\Rightarrow LBT-AO+VLT-AO/ALMA/JWST/ELT)
- Is the star-formation-mass relation universal? (\Rightarrow ALMA/JWST/SKA/ELT)
- How did galaxies transform when they enter in clusters? (\Rightarrow MOONS/EUCLID)
- What halts the formation of low mass objects?
- Do we have evidences of non-standard cosmologies?
- How many Kennicutt-Schmidt relations exist? (\Rightarrow ALMA/JWST)
- What is the role of outflows/inflows in galaxy evolution? (\Rightarrow LBT-AO+VLT-AO/ALMA/JWST/SKA/ELT)
- What is the role of AGNs? (Athena/ALMA/SKA)
- Is radio mode a viable mechanism to prevent the overcooling problem? (\Rightarrow SKA)
- Do galaxies contribute to the reionization process?
-

Metodo#1 Approccio “statistico”:



UN Esempio : La relazione massa-metallicità ad alto z

- osservazioni sono multiwavelength/multi-info: L(from X to γ), righe emissione, morfologia, ambiente;
- -> statistica multivariata
- queste quantità si convertono in quantità fisiche rest-frame (M^* , SFR, Z);
- viene fatto in funzione del redshift, con ovvie limitazioni (no oggetti deboli/ molto brillanti, effetti selezione);



• vengono confrontate con i modelli teorici;

La sfida non e' risolta perche':

- a) la "pittura" non e' completa (e.g. non completa in redshift/luminosita' etc)
- b) i risultati non sono consistenti tra loro;
- c) i modelli fisici non riproducono le distribuzioni osservate
e/o
le riproducono ma includendo meccanismi non ben motivati o testati.

Approccio “statistico”:

- “Il regno delle survey”

- VST+VISTA: WINGS, OMEGAWINGS, KIDS, ATLAS, VIKING, UVISTA
- HST: CANDELS, CLASH, GLASS
- VLT: VIPERS, VUDS, HUGS, CANDELSz7, VANDELS, CLASHz,
- LBT: CANDELS-Uband
- Herschel PACS, SWIRE

👍 Tecnologia SW x survey multicolore,



👍 Sfruttamento scientifico di survey multicolore

👍 Tecniche di interpretazione dei dati (“SED fitting”, metallicità etc”)

👎 Far-IR e sub-mm.

- Modelli teorici:

- Semianalitici
- Nbody low resolution

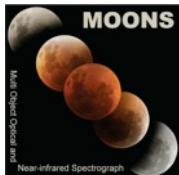
👍 Modelli semianalitici



👍 Simulazioni idrodinamiche/radiative per EoR

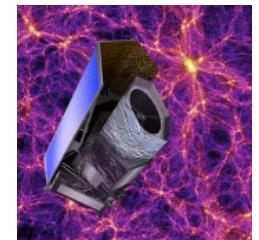
👎 Nbody “in ritardo competitivo”

La statistica delle sorgenti extragalattiche: “Game changer” instruments



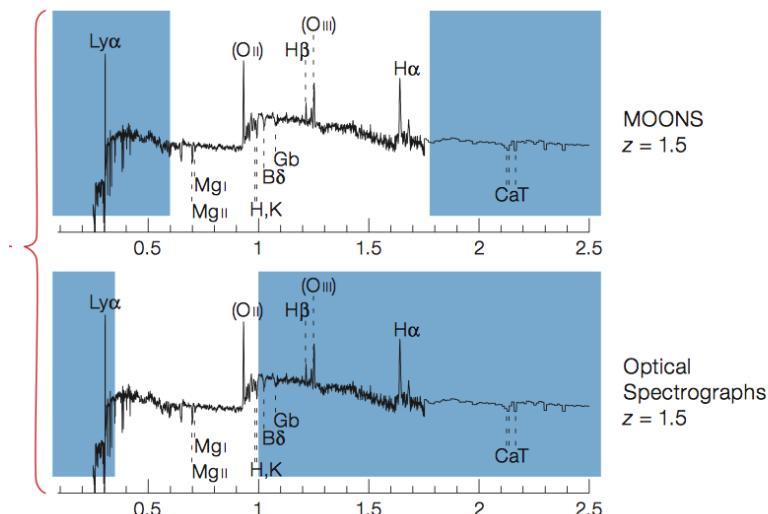
MOONS@VLT

EUCLID



Field of view: 500 sq. arcmin at the 8.2m VLT

Multiplex: 1024 fibers, with the possibility to deploy them in pairs



Survey	Redshift	Volume (h ⁻³ Mpc ³)	#Objects
SDSS	0 < z < 0.2	1 × 10 ⁸	10 ⁶
MOONS	0.8 < z < 1.8	5 × 10 ⁷	2.5 × 10 ⁶

Legacy science

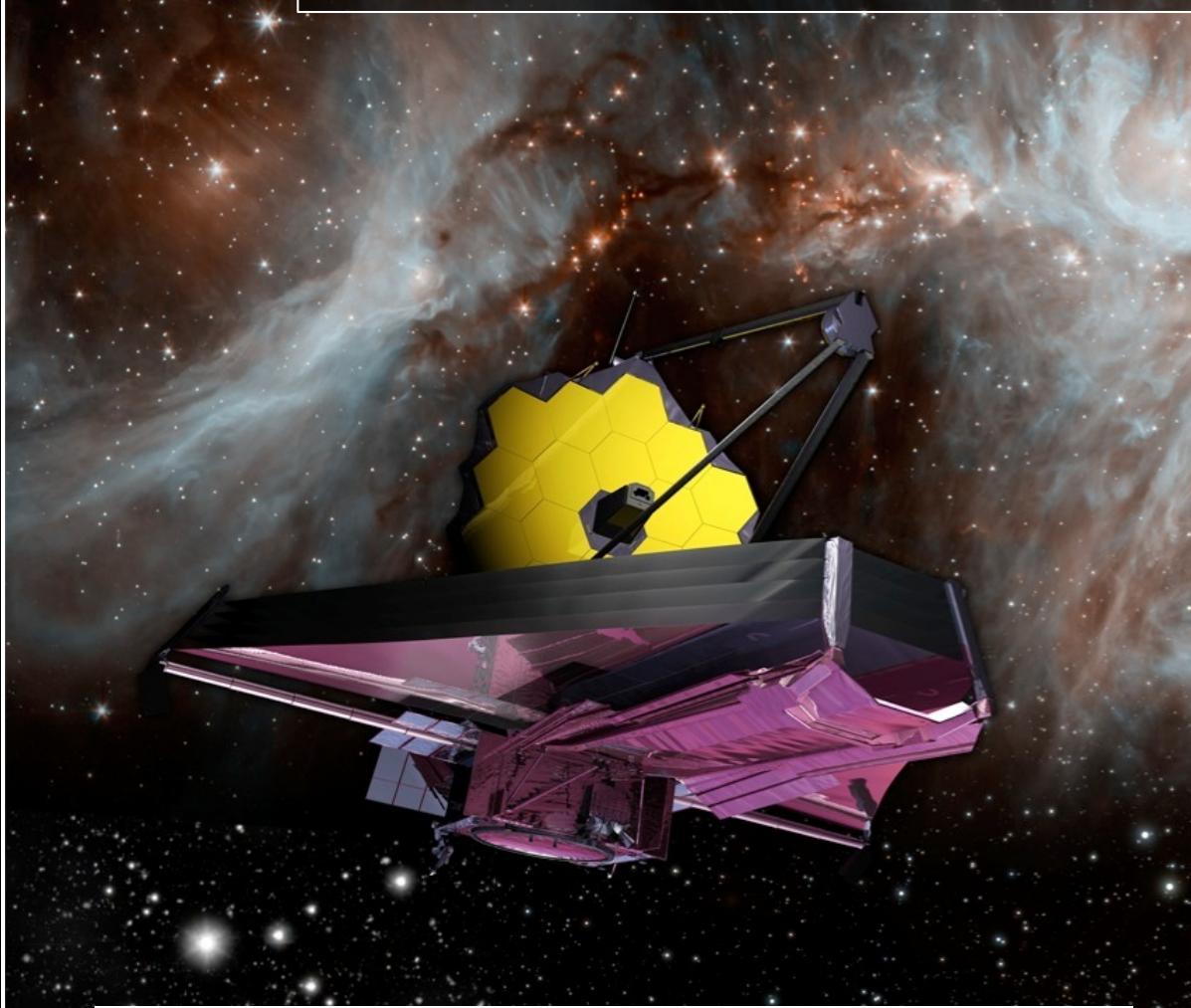
Wide survey: ~15,000 sqdeg (IYJH, I<24.5, H<24)

Deep survey: ~20-40 sqdeg (IYJH, I<26.5, H<26)

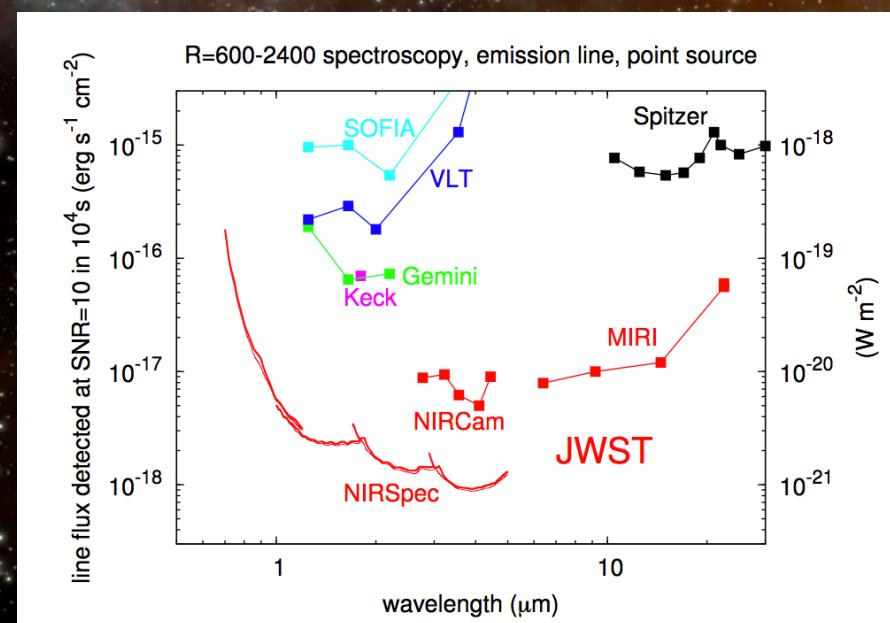
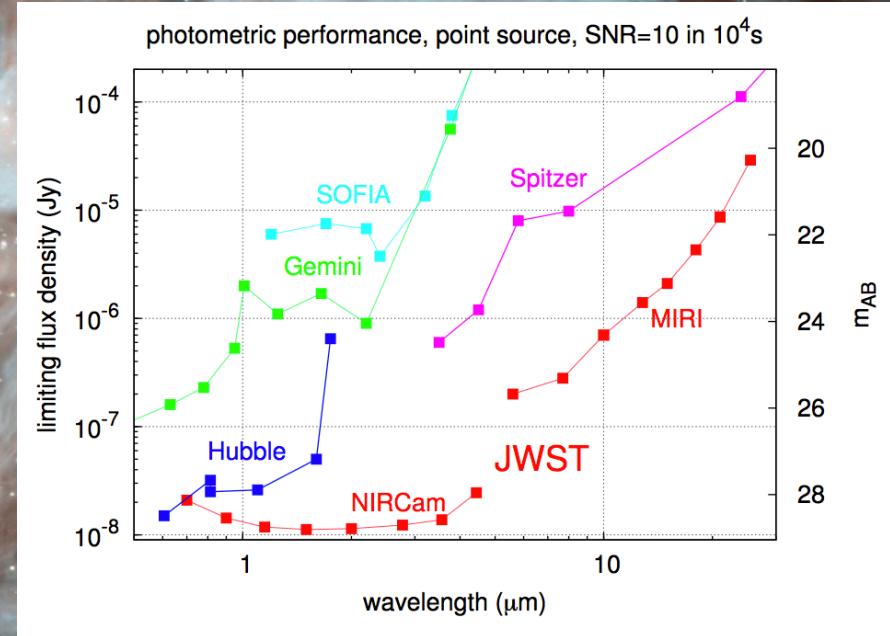
Wide: 2x10⁸ galassie;
 8x10⁶ galassie “quiescenti” @z>1.5

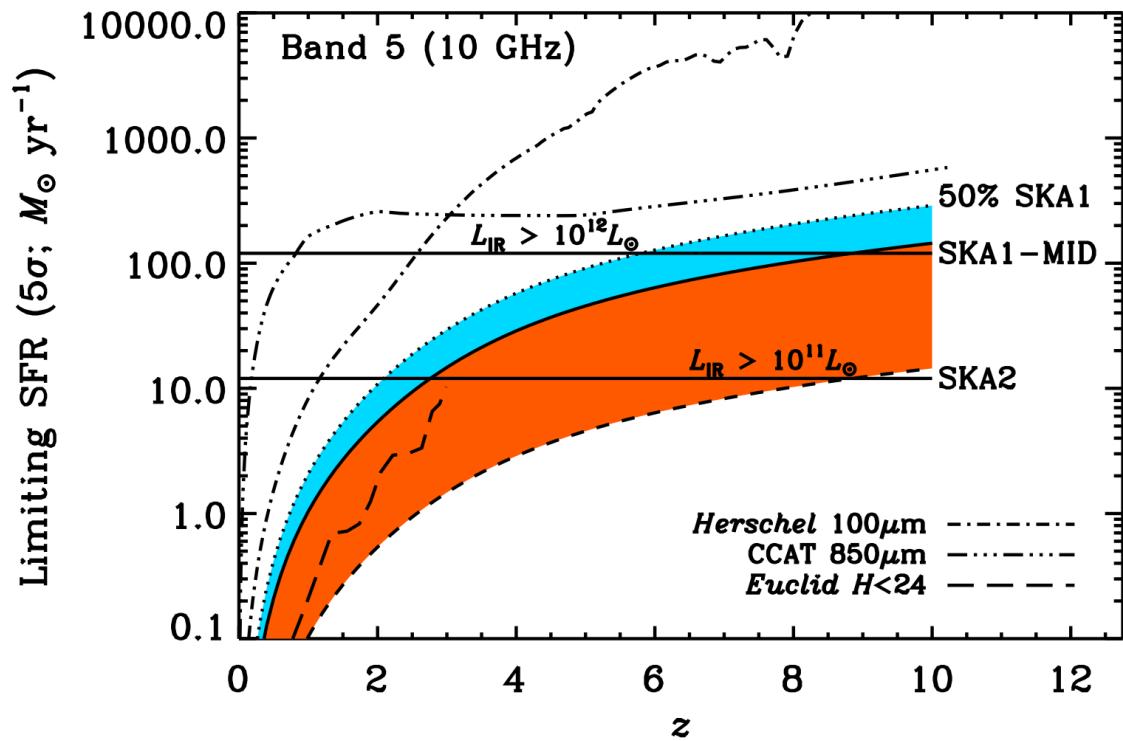
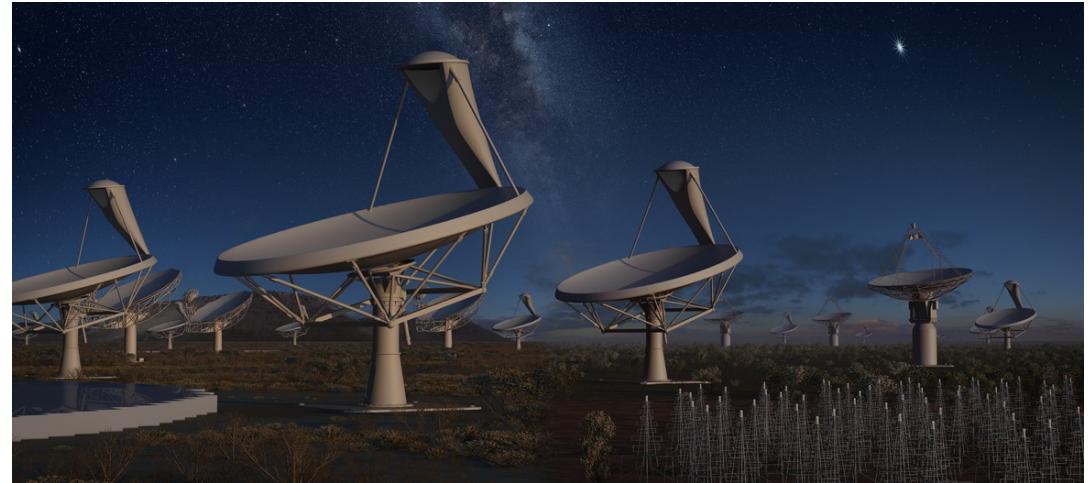
- Proprietà in funzione dell’ambiente
 18,000 cluster members;
- Parte “bright/massiva” delle funzioni di luminosità / massa a z>1;
- Lensed objects:
 300,000 galaxy scale strong lensing;
 1000 multiple quasars

THE JAMES WEBB SPACE TELESCOPE



- E' il successore di HST e Spitzer
- Completo accesso agli oggetti "deboli" fino ad alto redshift;
- near-IR spectroscopy fino a $z=8$ (redshift, metallicity, escape fraction!)
- "The dusty side of the star-formation history"
- morphological evolution up to $z=10$





- Redshift survey up to $z \sim 2$
- HI-selected galaxies up to $z \sim 2$
- SFR from radio continuum up to $z \sim 2$

+ALMA

La statistica delle sorgenti extragalattiche: “Game changer” instruments

EUCLID

- Le due principali survey di “alto z” con importante ruolo italiano;
- Near-IR spectroscopy su grandi aree (metallicity!)
- Euclid e’ la survey imaging IR “definitiva” ($z < 1.5$)
- La survey Euclid-Deep puo’ fornire candidati per E-ELT.

VLT-MOONS

JWST

- E’ il successore di HST e Spitzer
- Completo accesso agli oggetti “deboli” fino ad alto redshift;
- near-IR spectroscopy fino a $z=8$ (redshift, metallicity, escape fraction!)
- “The dusty side of the star formation history”
- morphological evolution up to $z=10$

ELT-HARMONI
ELT-MOS

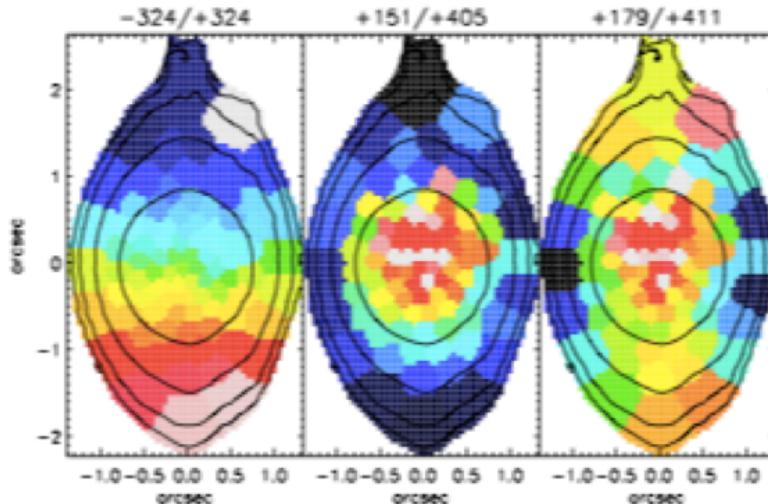
- Piu’ sensibile di JWST a medio/alta risoluzione
- Science cases probabilmente da rivalutare dopo JWST

SKA1

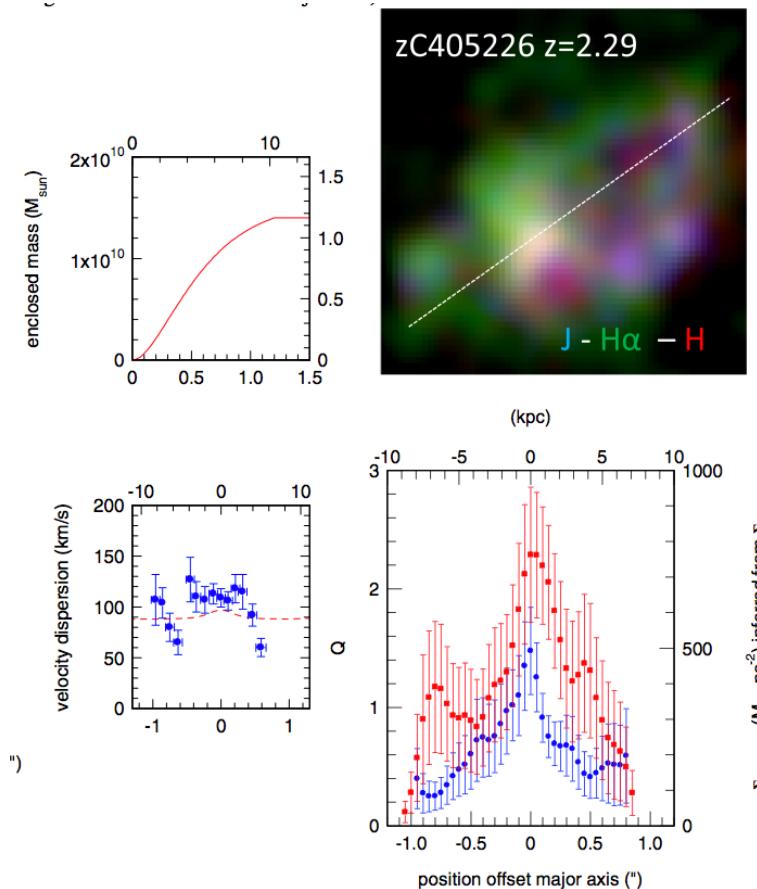
- Redshift survey up to $z \sim 1-2$
- HI-selected galaxies up to $z \sim 1-2$
- SFR from radio continuum up to $z \sim 2$

Metodo#2: Fisica degli oggetti individuali

Moretti, Poggianti..+15



Low-z



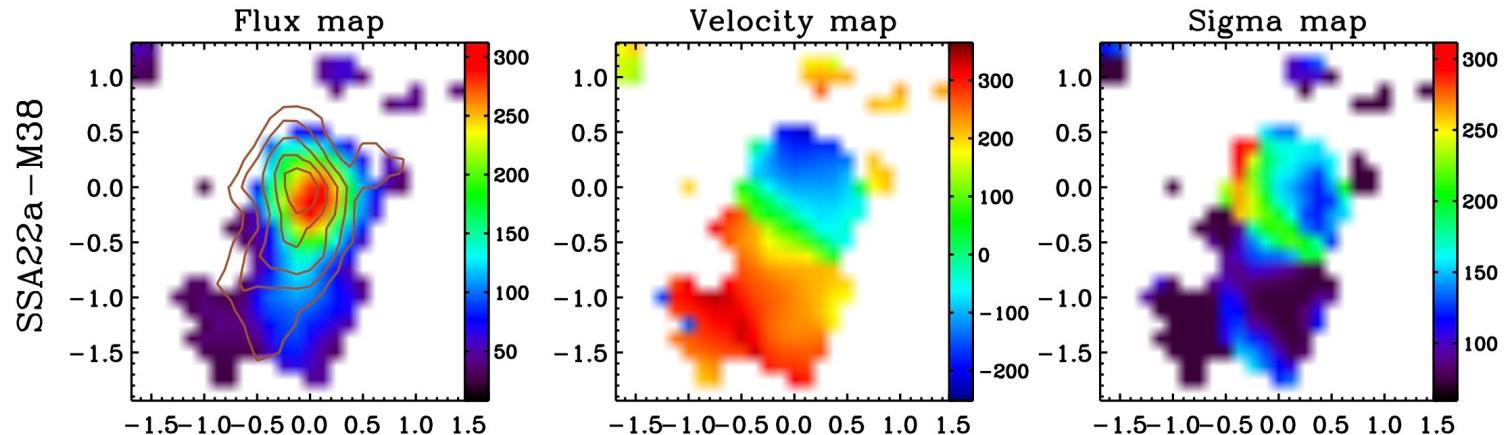
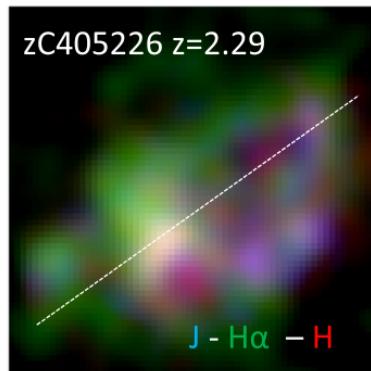
Genzel+14

$z \sim 2$

.. "observations support a scenario in which cloud fragmentation and global star formation are secularly suppressed in gas-rich high-z disks from the inside out, as the central stellar mass density of the disks grows."

Fisica degli oggetti individuali

Gnerucci+11



Tecnologia AO (LBT, VLT, ELT, GMT)



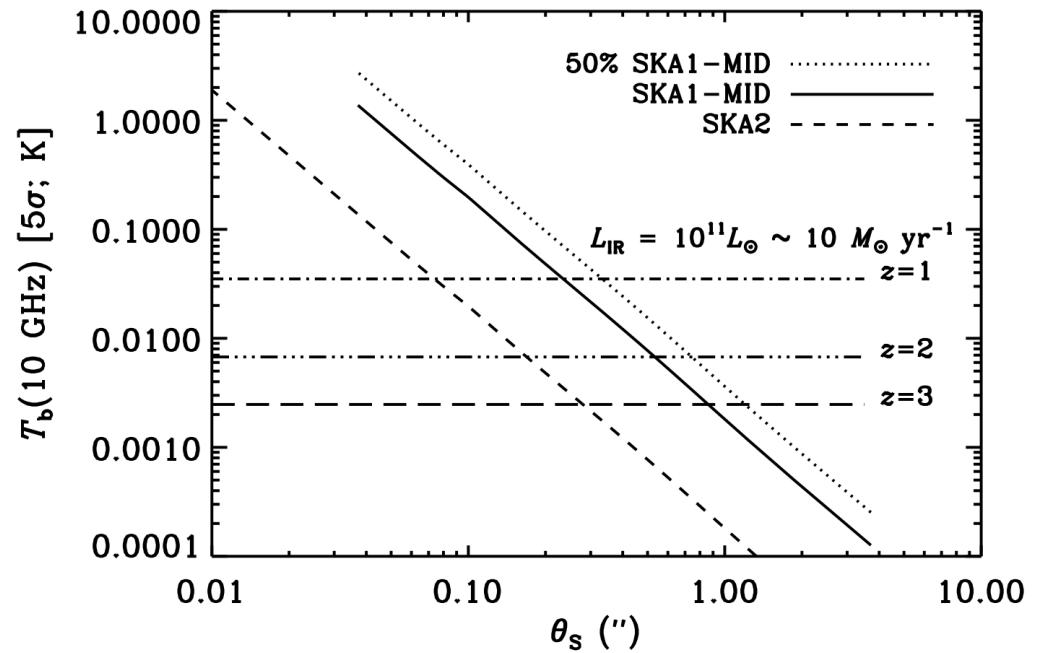
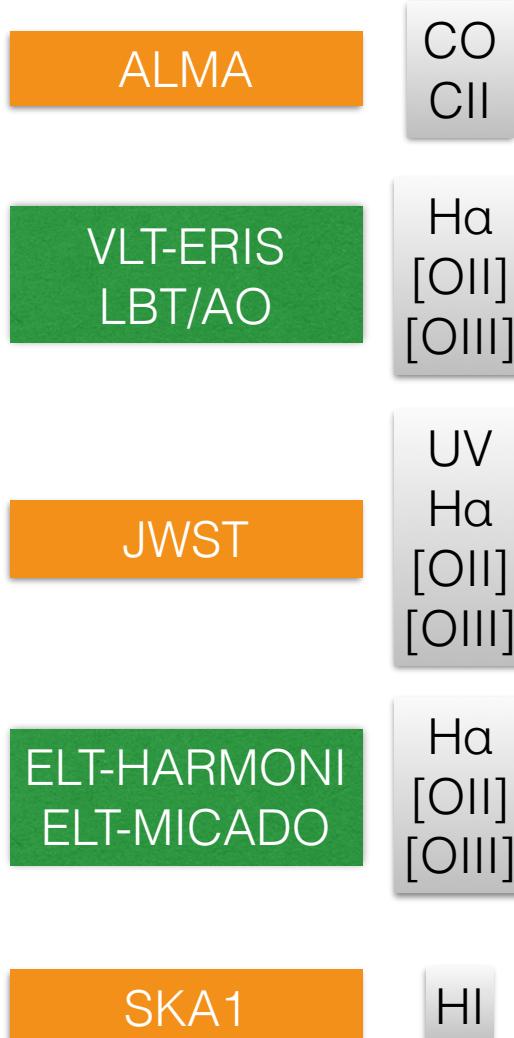
Osservazioni AO/IFU di oggetti individuali
(con qualche notevole eccezione)



N-body ad alta risoluzione

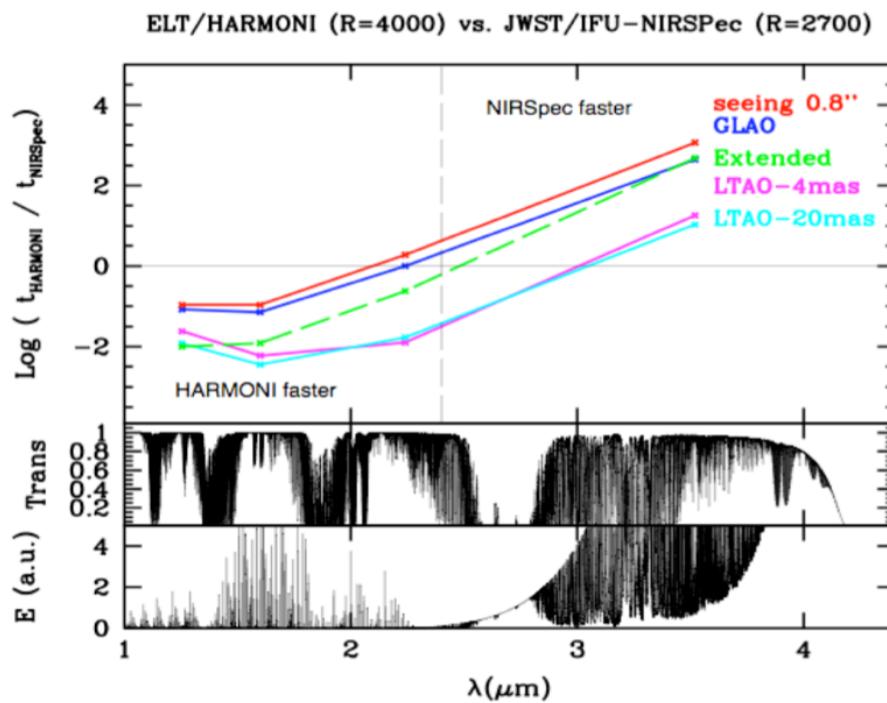
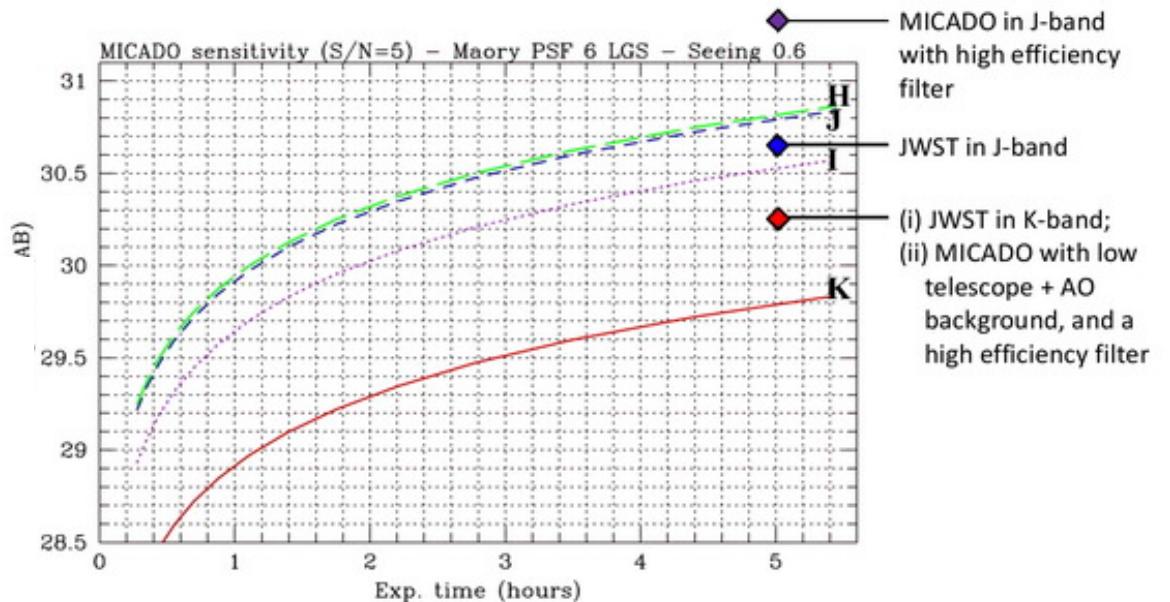
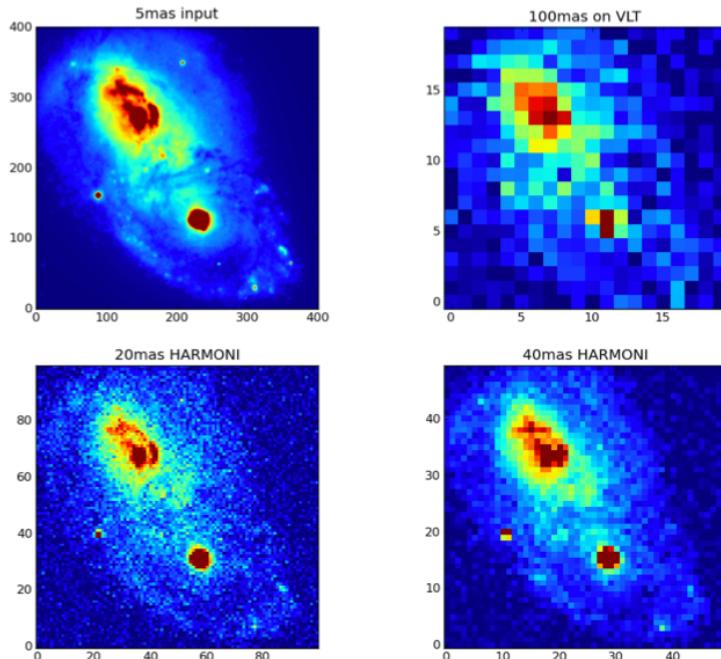
La fisica delle sorgenti extragalattiche: “Game changer” instruments

Tutti questi strumenti possono osservare galassie a $z=1-3$ con risoluzione $<<1\text{kpc}$

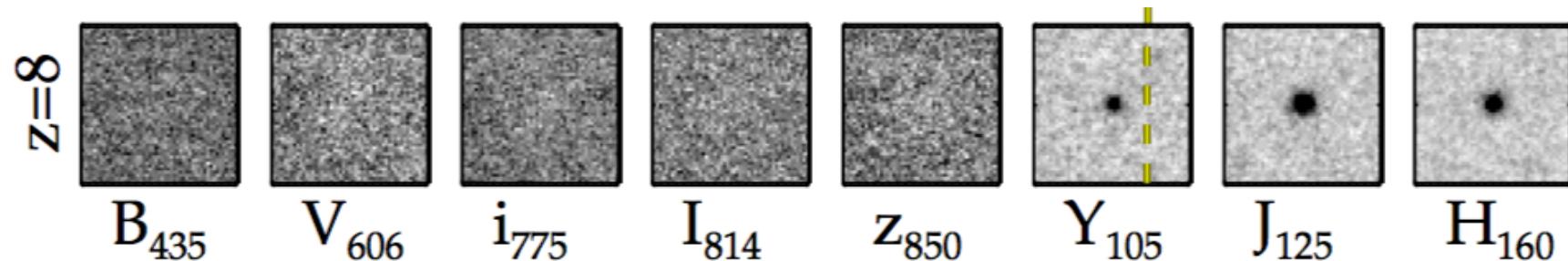


ELT-HARMONI ELT-MICADO

H α in z=2 ULIRG

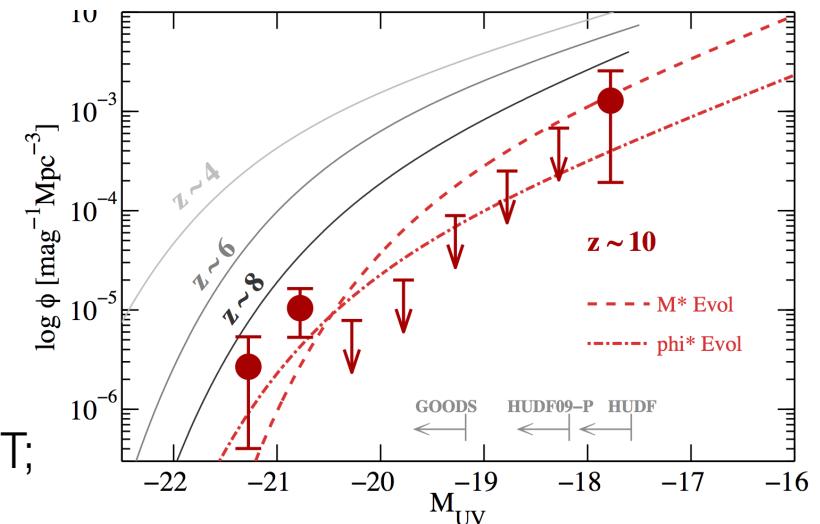


Statistica delle sorgenti nell'EoR.



State dell'arte:

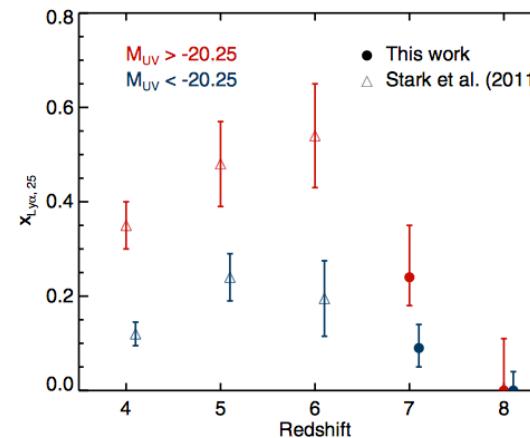
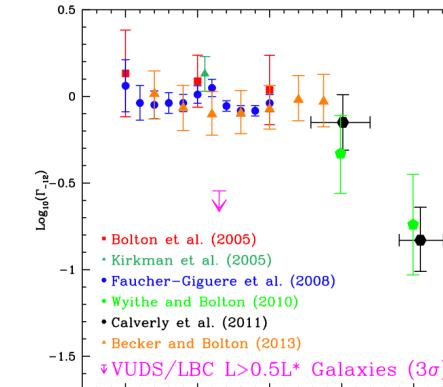
- fino a $z=7$ combinazione di Ground-based a HST;
- $z>7$ HST e' l'unico "player"
- No Ly α -> pochissimi redshift spettroscopici
- debole evidenza di bassa metallicita', forse evolve con z
- ALMA: upper limit su CII implicano che la relazione locale SFR-CII non vale -> diverso stato ionizzazione del gas rispetto starburst locali
- Quelli che abbiamo osservato sono oggetti "evoluti" non possiamo ancora osservare le vere prime sorgenti
- Sostanzialmente stiamo ancora "contando" gli oggetti, abbiamo solo poche informazioni frammentarie sulle loro proprietà fisiche rest-frame.



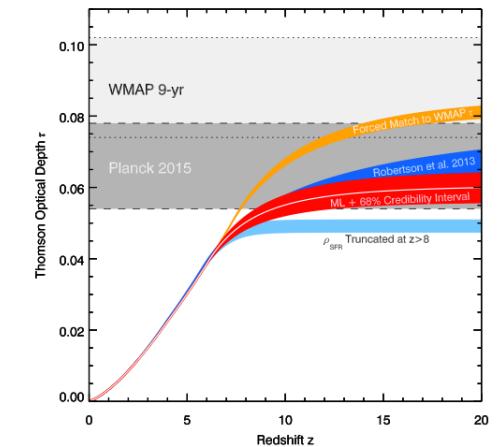
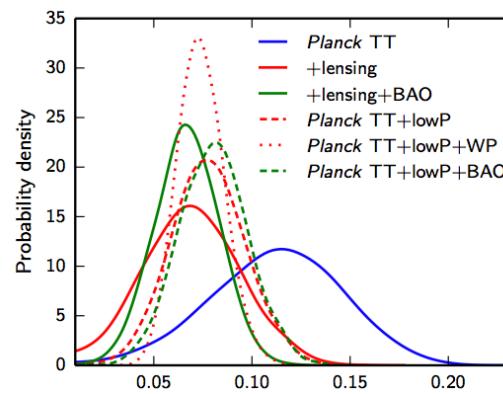
Il processo di reionizzazione dell'Universo

IGM e' ionizzato fino a $z \sim 6$

La "sparizione" della Ly α a $z > 6.5$ puo' indicare una rapida evoluzione della ionizzazione IGM



I risultati di Planck pongono dei limiti sull'epoca di reionizzazione $z < 9$



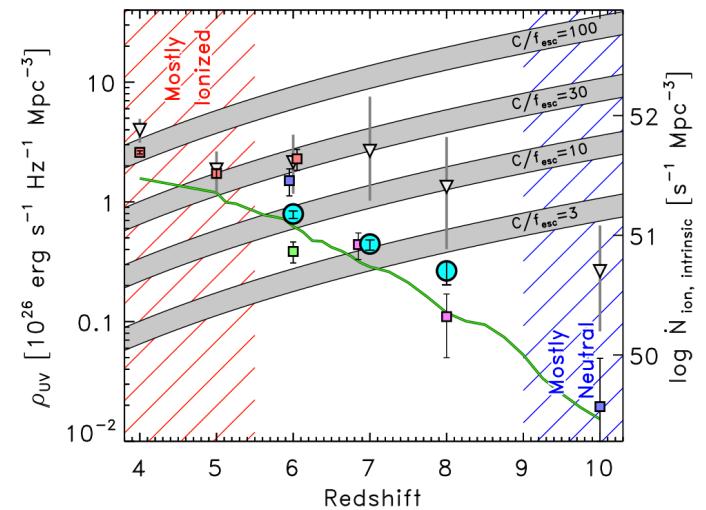
Quali sono le sorgenti responsabili della reionizzazione?

Le galassie osservate a $z > 7$ non bastano;

Bisogna assumere:

- 1) che ce ne siano altre più deboli
+
- 2) che almeno una parte della loro radiazione ionizzante esca

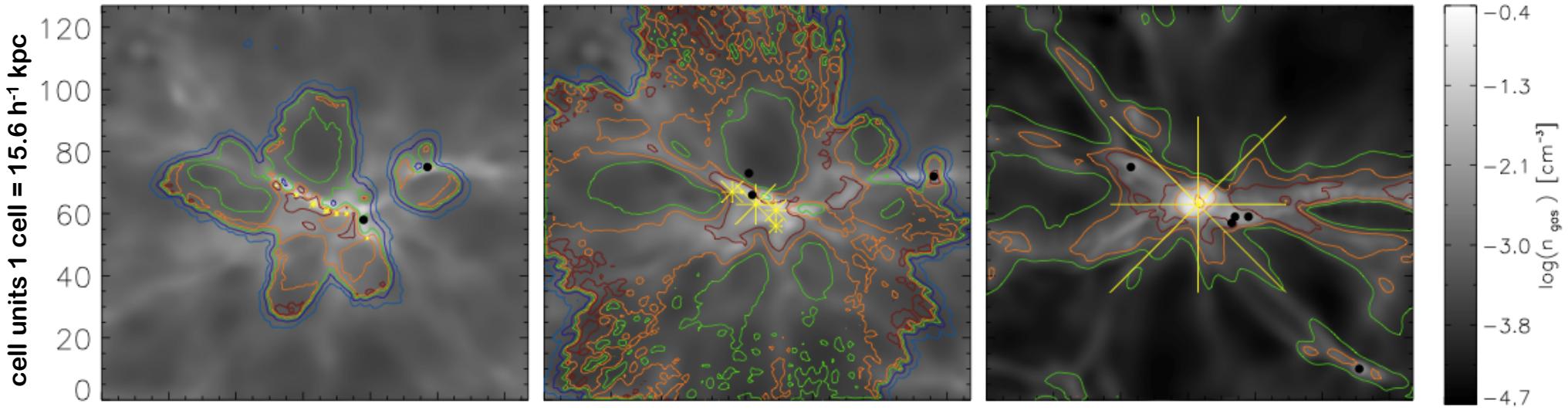
C'e' spazio per un contributo da altre classi di sorgenti: AGN, miniBH.



The Milky Way reionization simulation

Graziani, Scheider +2015

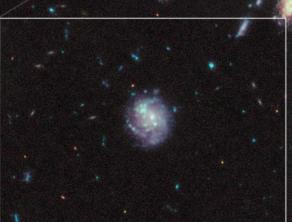
Effects of inhomogeneous radiative feedback



HST



JWST





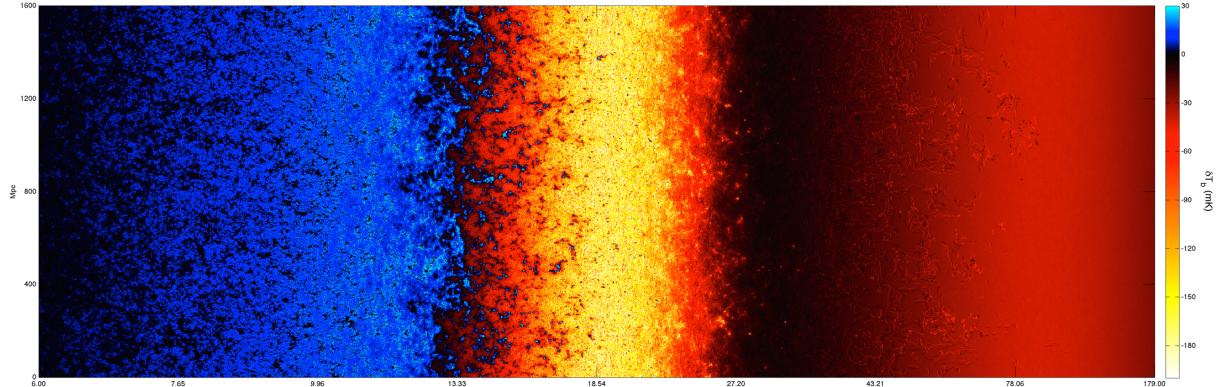
Brightness Temperature Evolution

HI 21CM LINE VIEW
emission

Mesinger, Ferrara & Spiegel 2013

strong absorption

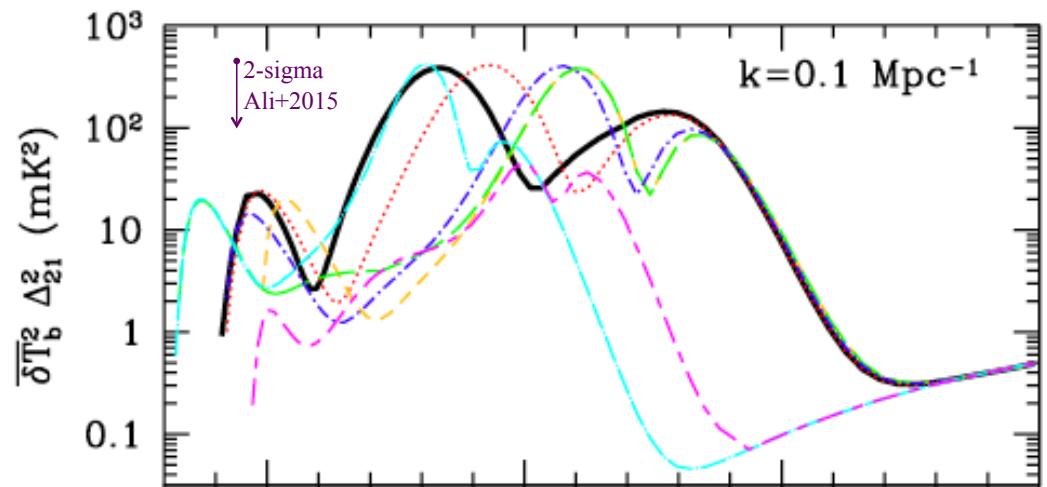
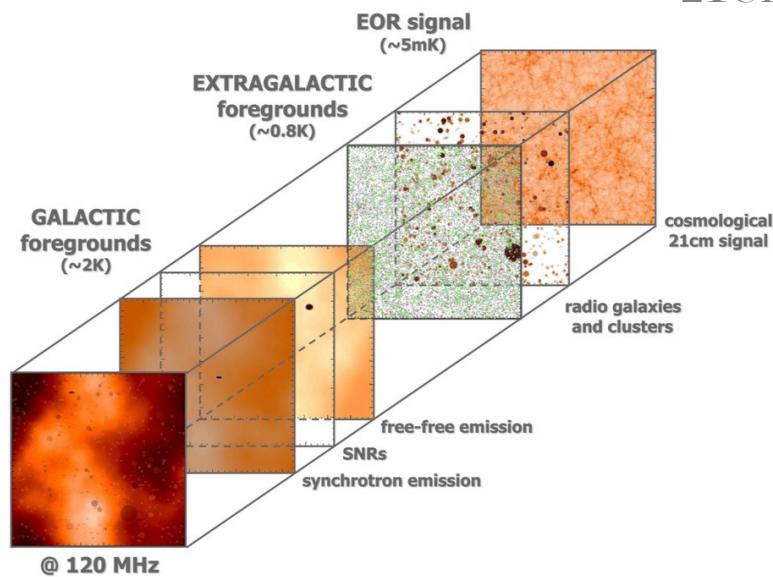
absorption



15 27

redshift

21CM POWER SPECTRUM



PAPER-64 RESULT
135 days/64 elements

Le sorgenti nell'epoca della reionizzazione: "Game changer" instruments

Cluster!

Use of gravitationally magnified galaxies to anticipate JWST-class science

JWST

Statistics of galaxies $z=7-20$
Supernovae(??)
Spectral properties of high z galaxies:
- PopIII galaxies
- Escape fraction -> Reionization

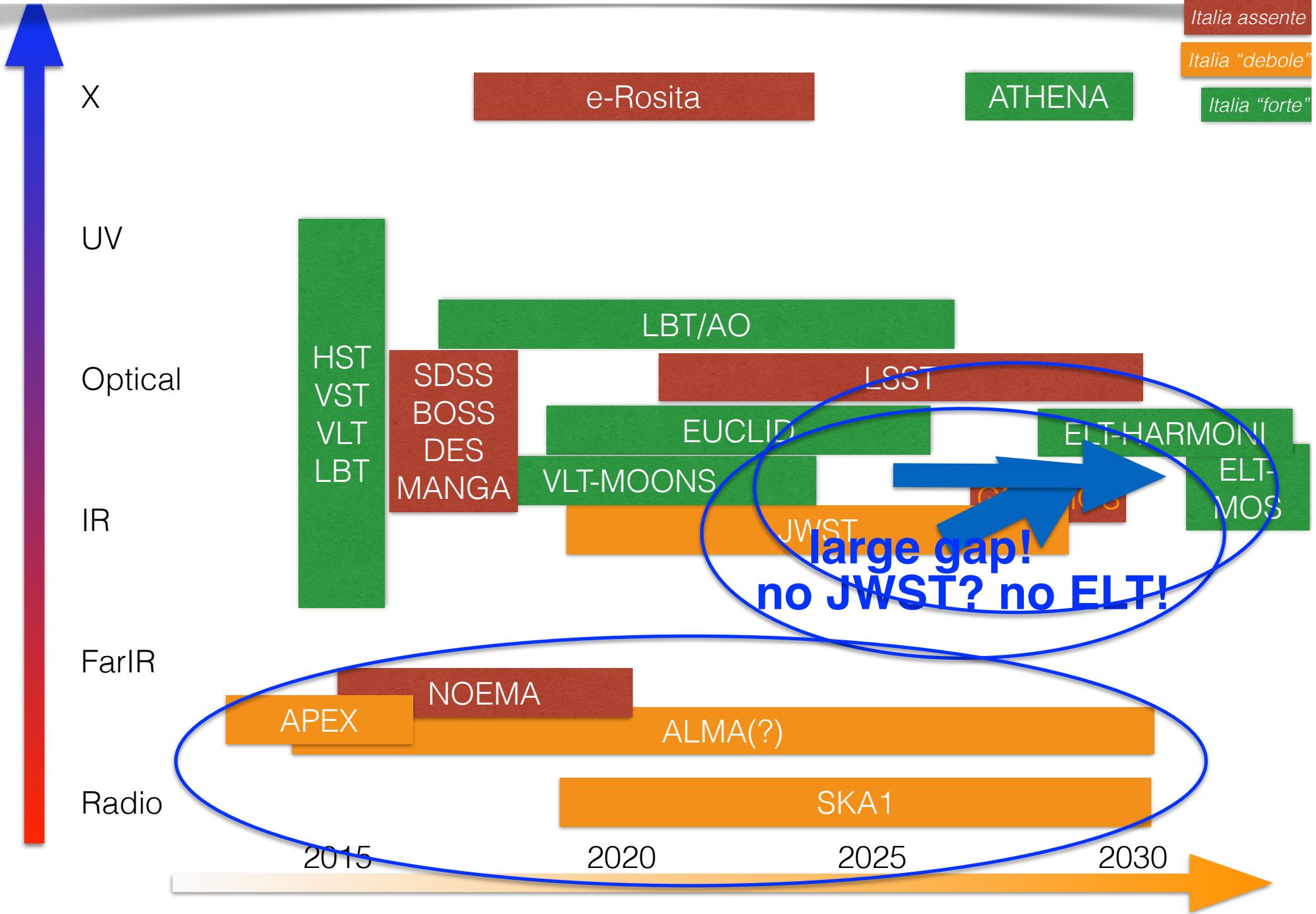
ATHENA

- Early, faint black holes;
- their contribution to reionization

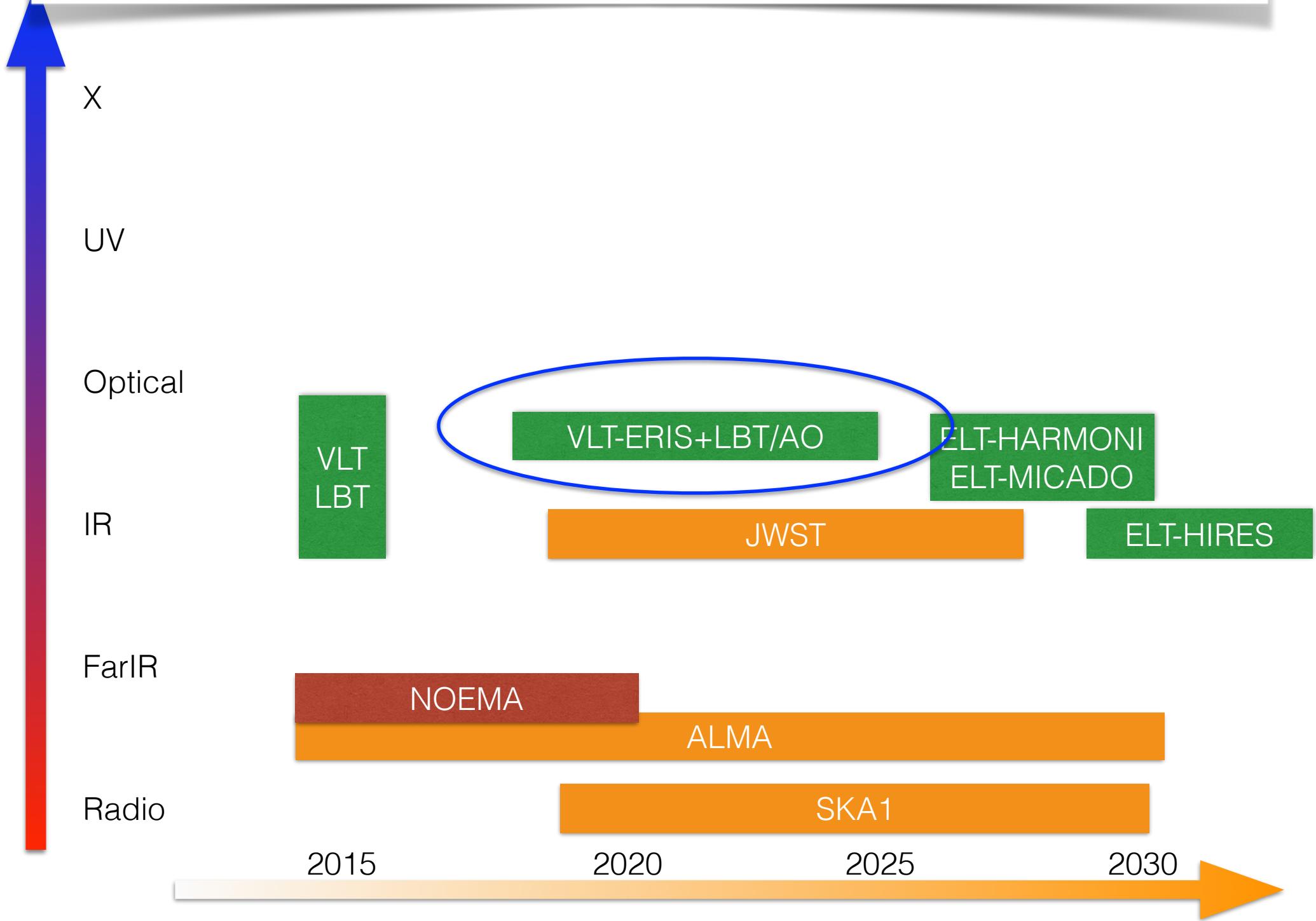
SKA1

- HI 21-cm map at $z>7$
- $z>7$ radio-loud QSOs to study IGM

La statistica delle sorgenti extragalattiche: “Game changer” instruments



La fisica delle sorgenti extragalattiche: “Game changer” instruments



Le sorgenti nell'epoca della reionizzazione: “Game changer” instruments

