

HI survival through cosmic time

Concluding Remarks

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NRAO

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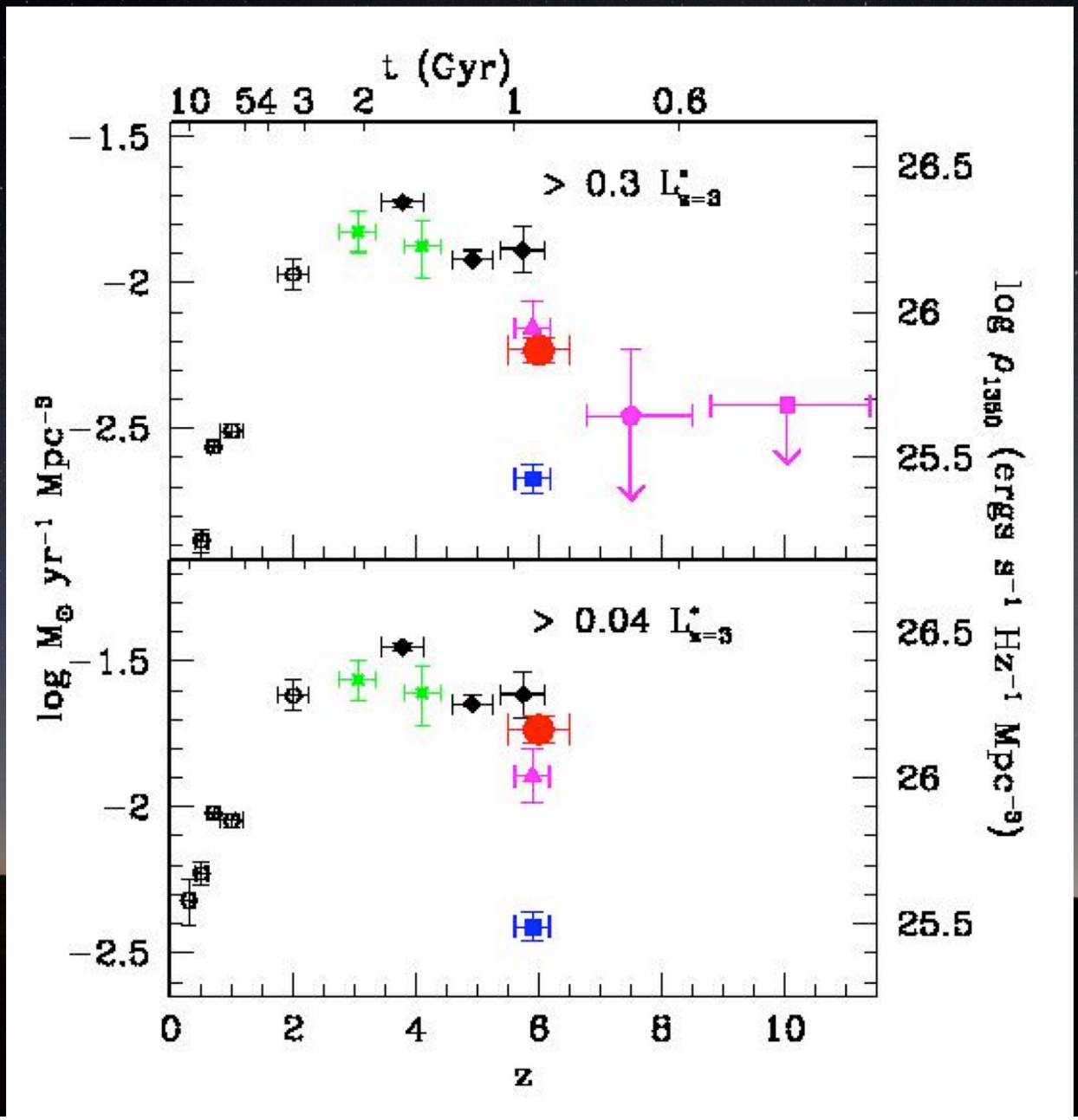
The most frequently shown figures

Star formation rate density evolution



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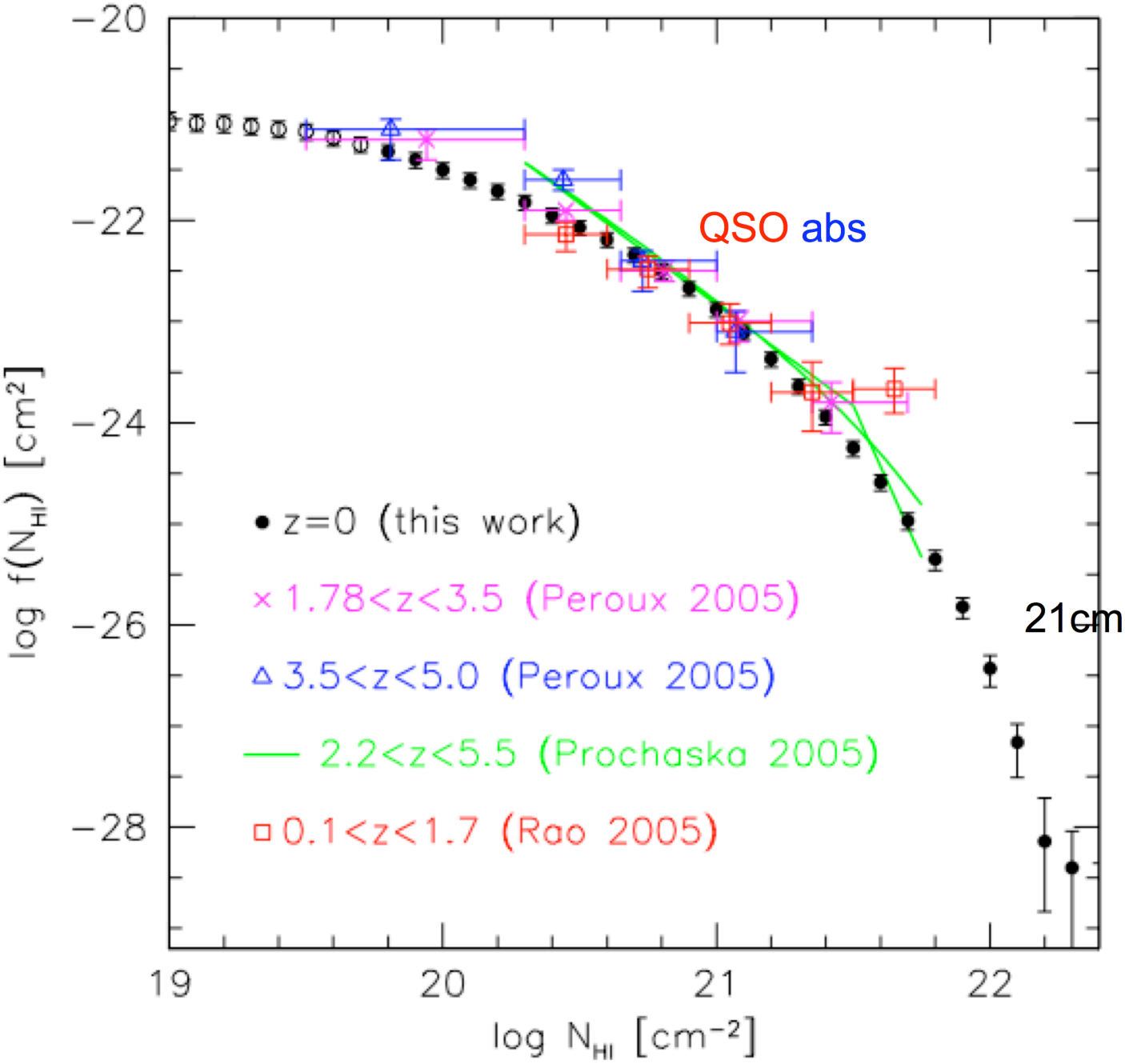
HI column density distribution function



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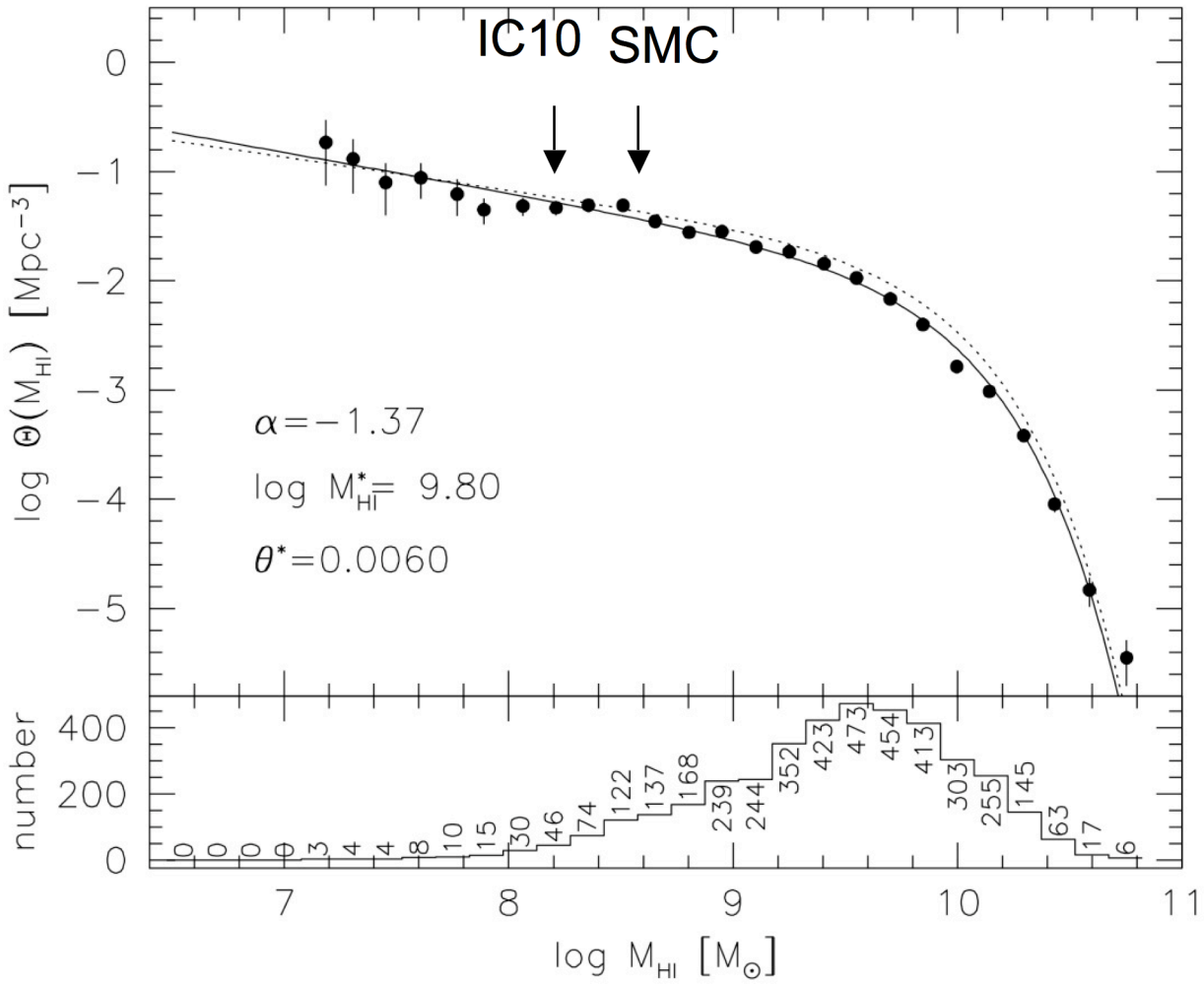
HI Mass Function



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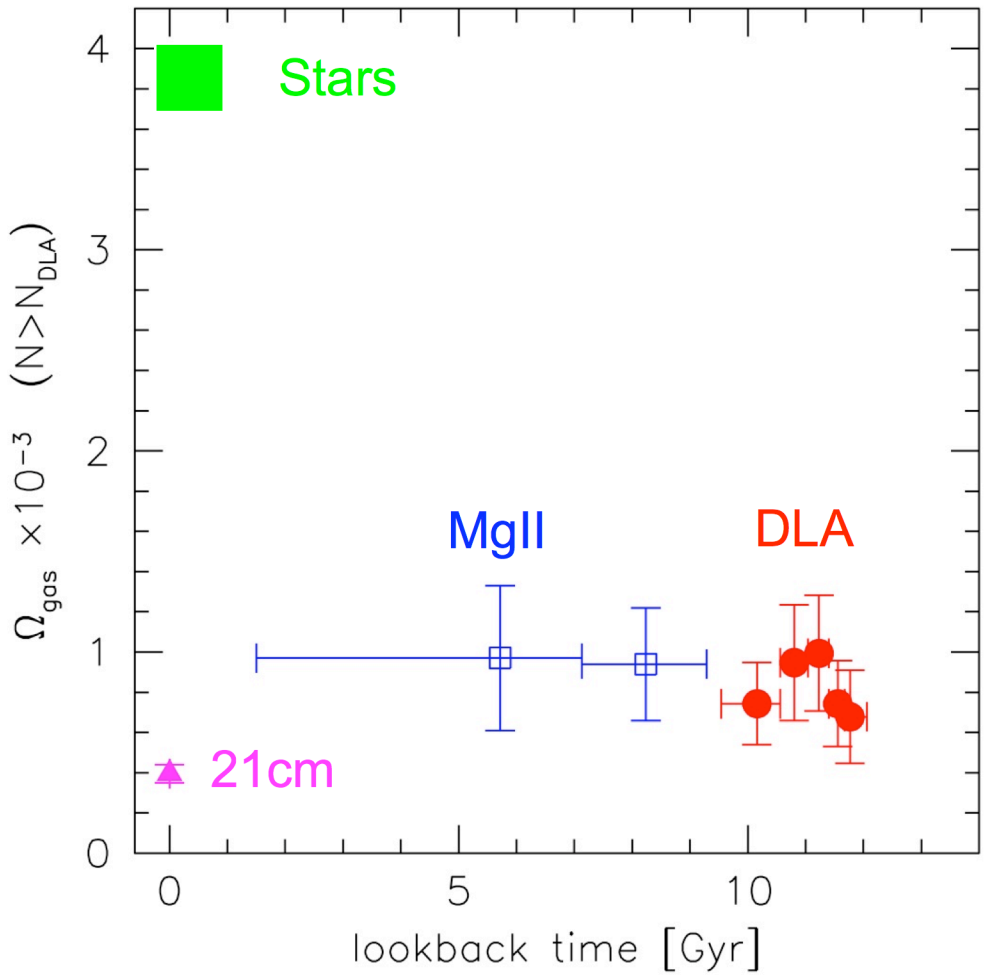
Number 3


Stars
MgII
DLA
21cm
$\Omega_{gas} \times 10^{-3}$ (N>N_{DLA})
0
1
2
3
4
0
5
10
lookback time [Gyr]

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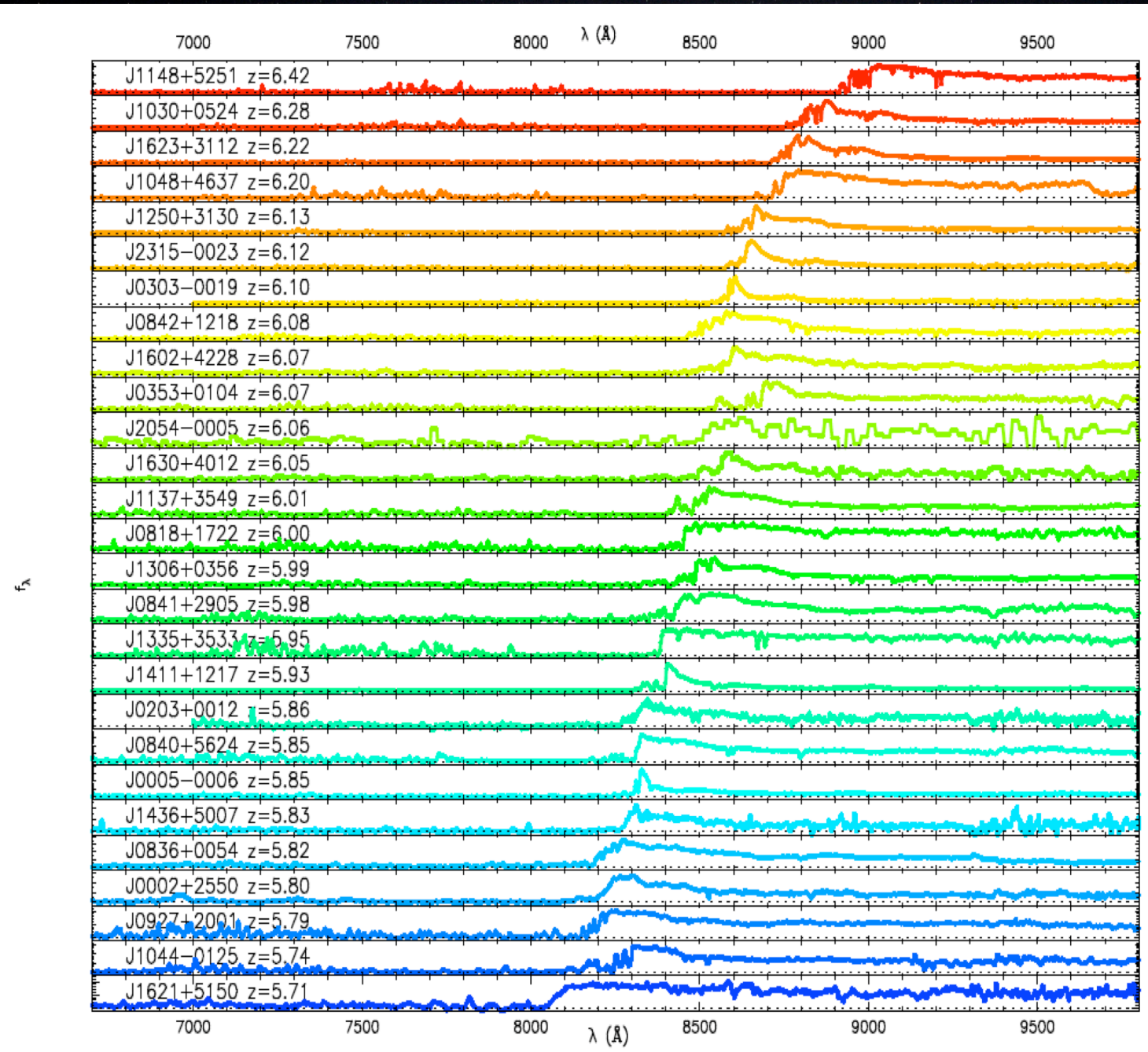
Number 1 1 1 1 1



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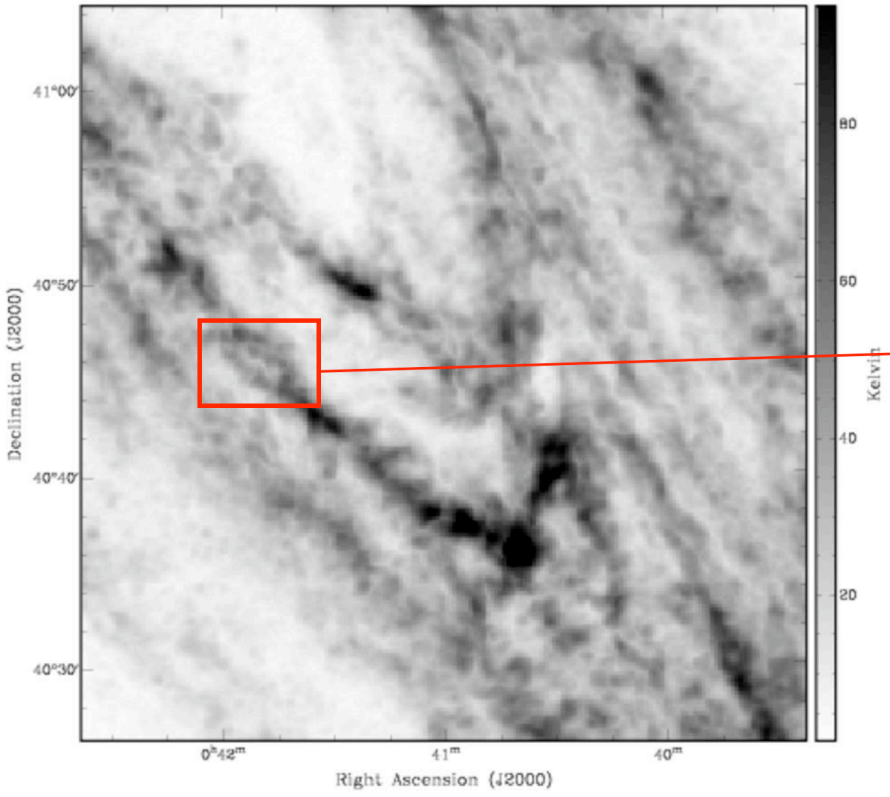
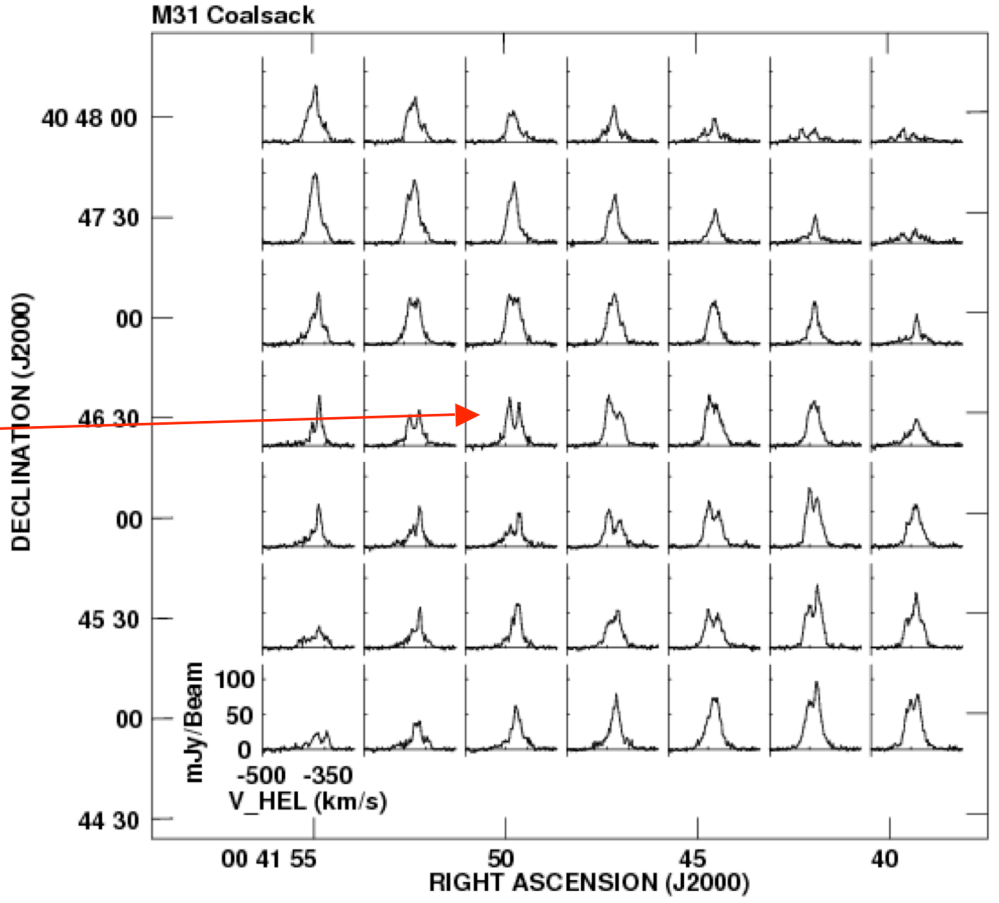
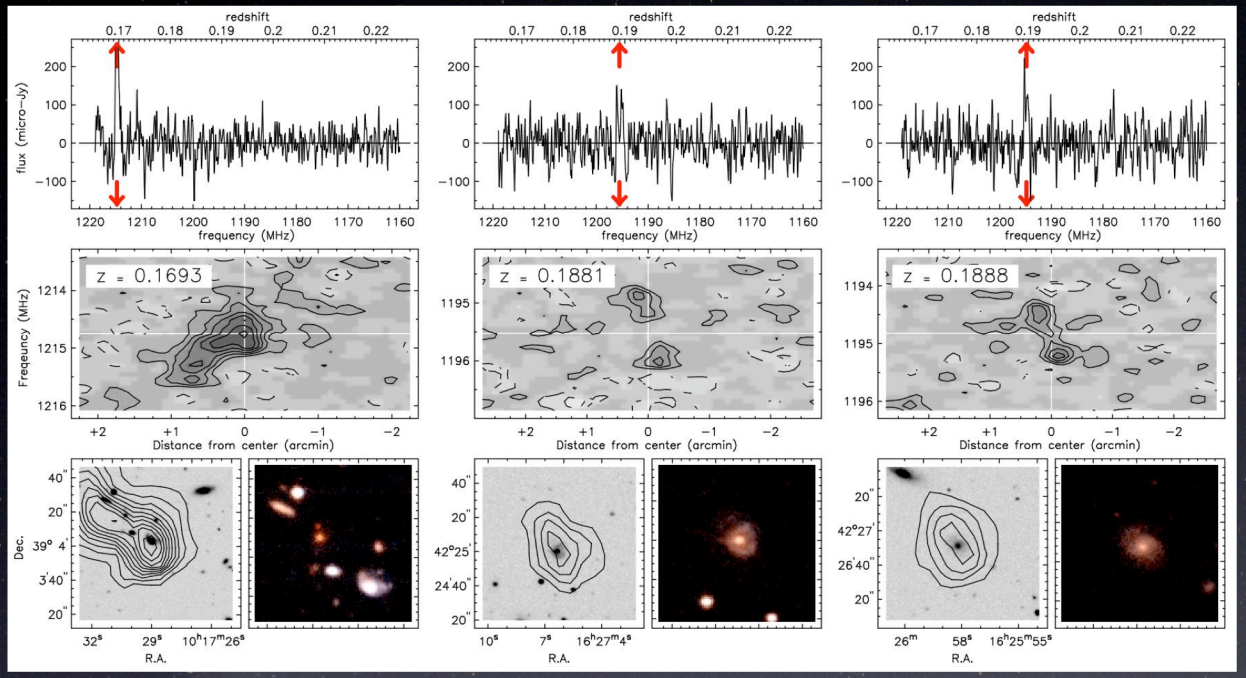
Eye-openers

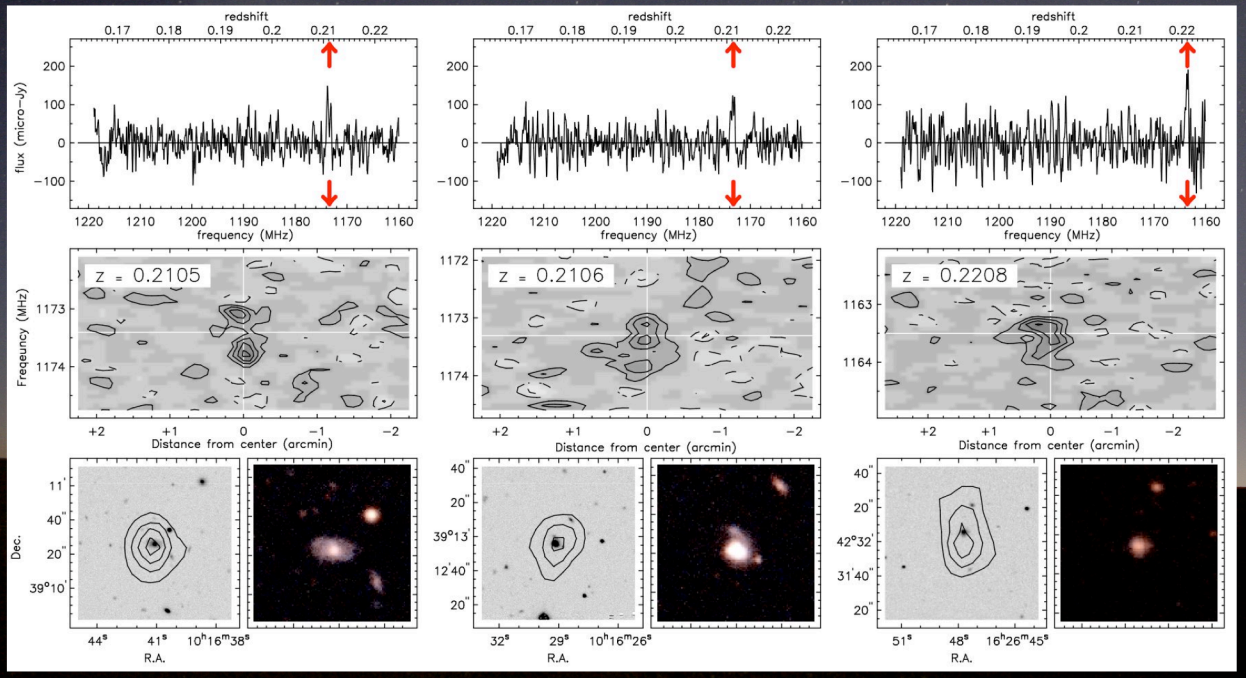
Braun +: Self-absorbed HI on kpc-scales





Verheijen + z=0.2 HI





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Que viva!

Que Viva!

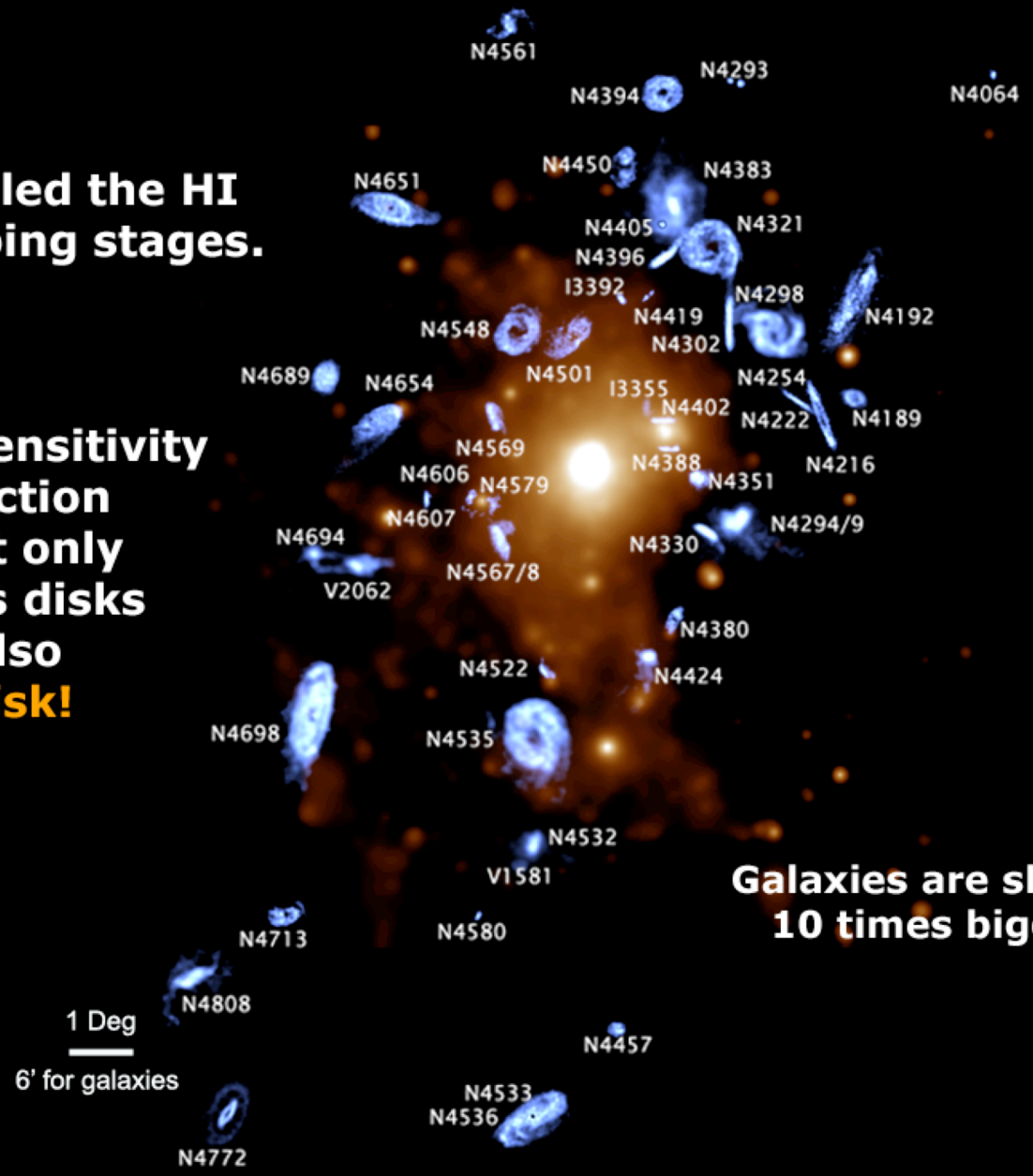


Que viva!

HI Atlas of VIVA Sample

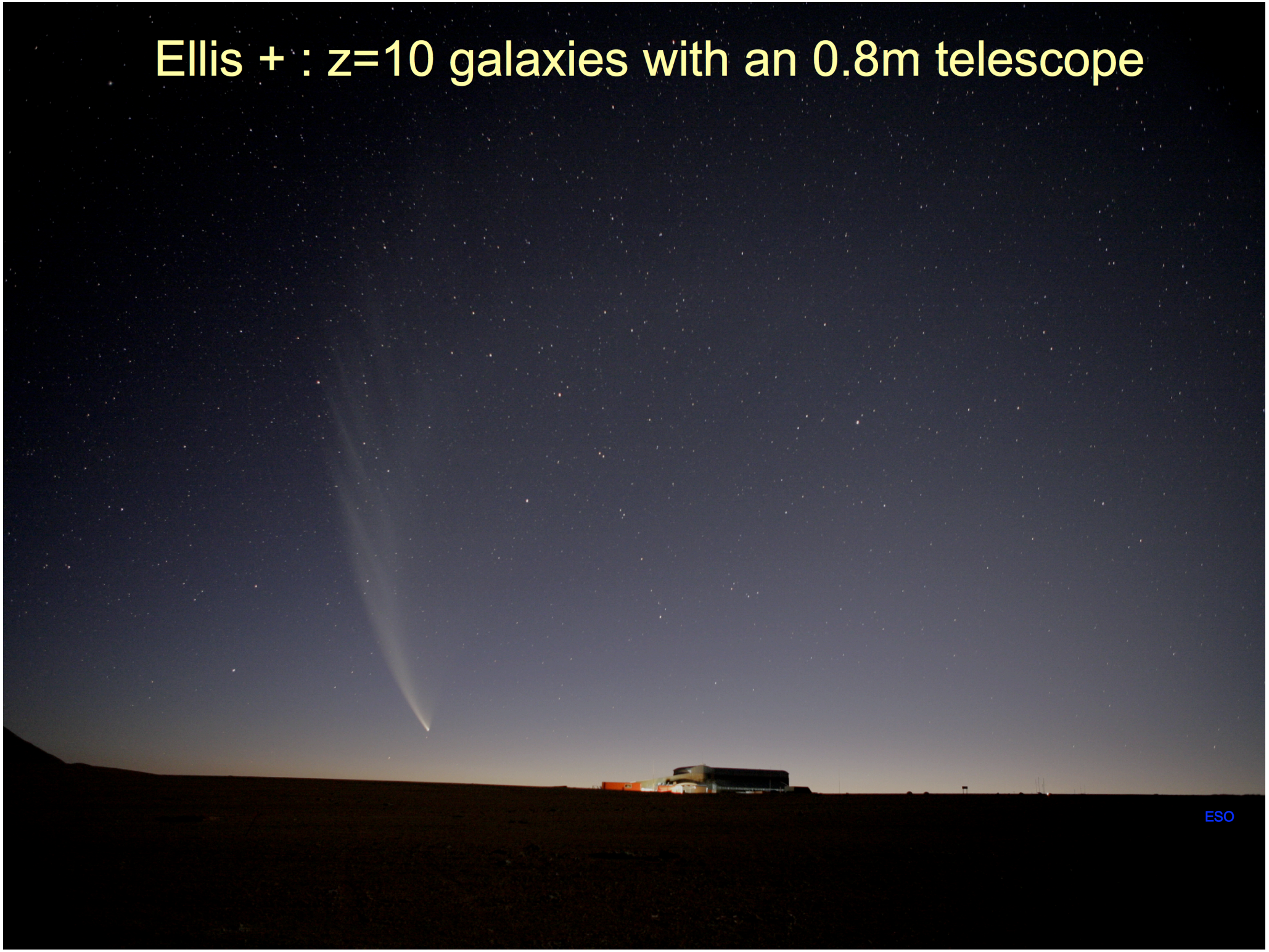
The result has revealed the HI gas at various stripping stages.

The imporved VLA sensitivity and our sample selection allowedus to see not only the truncated HI gas disks after stripping but also the HI leaving the disk!



Galaxies are shown 10 times bigger

Ellis + : z=10 galaxies with an 0.8m telescope

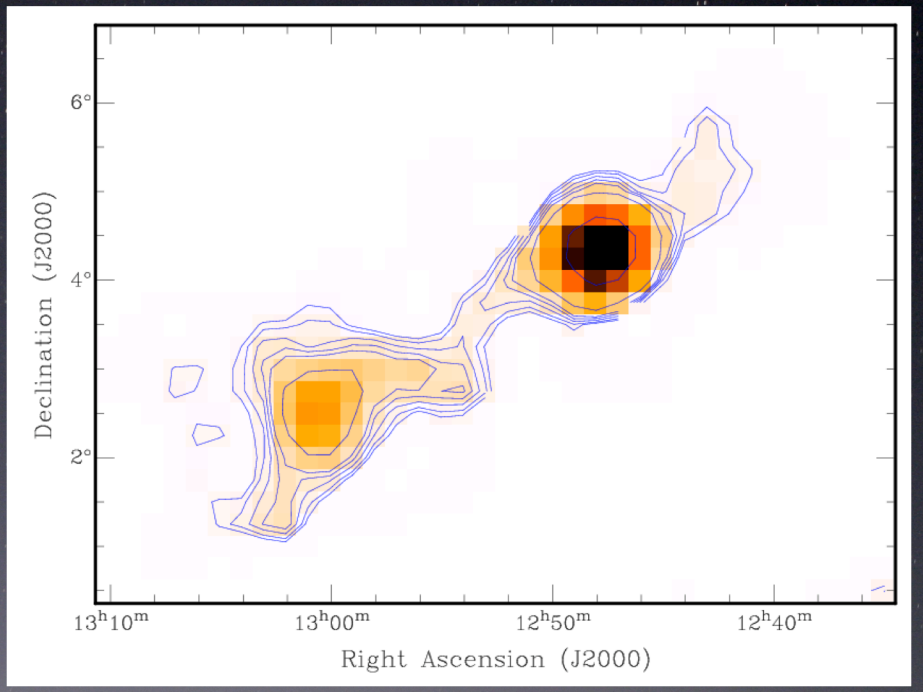


Popping ++: HI on 100kpc scales

Probing the Ly-limit in the 21cm line

- Connecting NGC 4900 and NGC 4688

- NHI ~ 8×10^{16} cm^{-2}
- Velocity width ~60 km/s
- Distance ~ 12 Mpc
- Mass ~ 5×10^{7} M_{sun}
- Size ~ 300 kpc
- Full size ~1.5 Mpc



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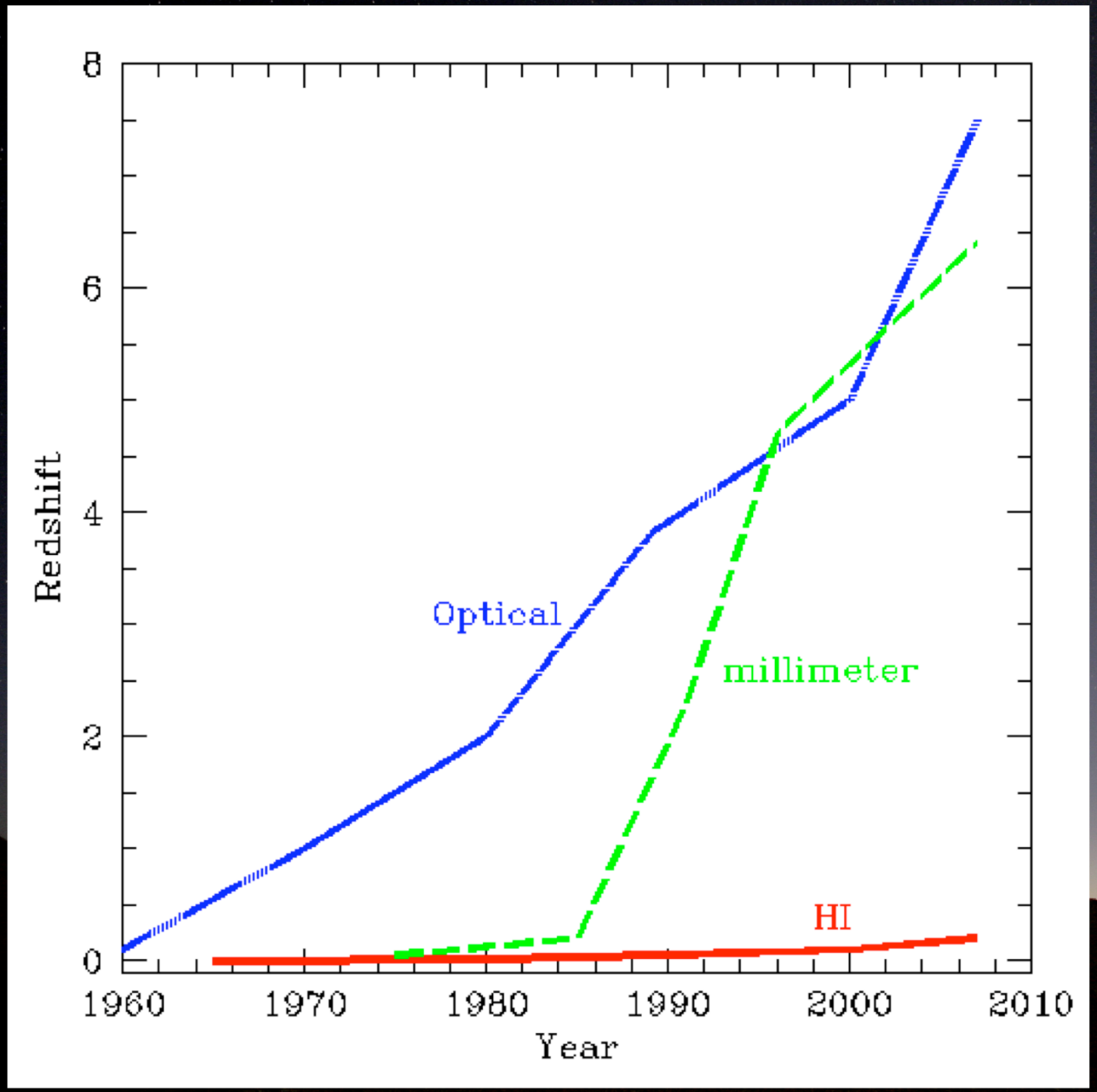
Personal remarks I: Gaseous evolution of galaxies

We need the SKA-mid (0.3 -- 2GHz) !



Cosmic reionization and first galaxies

QSO epoch and massive galaxy/SMBH formation

Secular galaxy evolution

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Personal remarks I: Gaseous evolution of galaxies

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Personal remarks I: Gaseous evolution of galaxies

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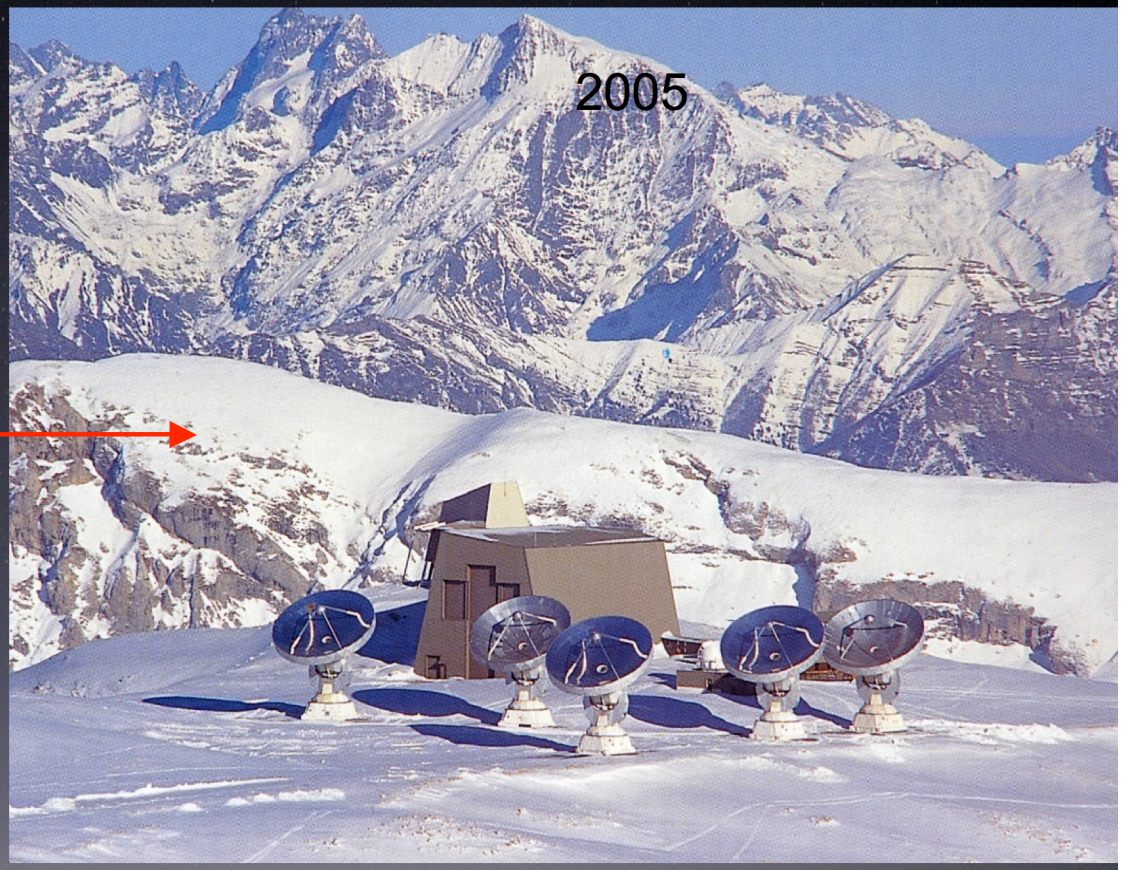

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Personal remarks I: Gaseous evolution of galaxies

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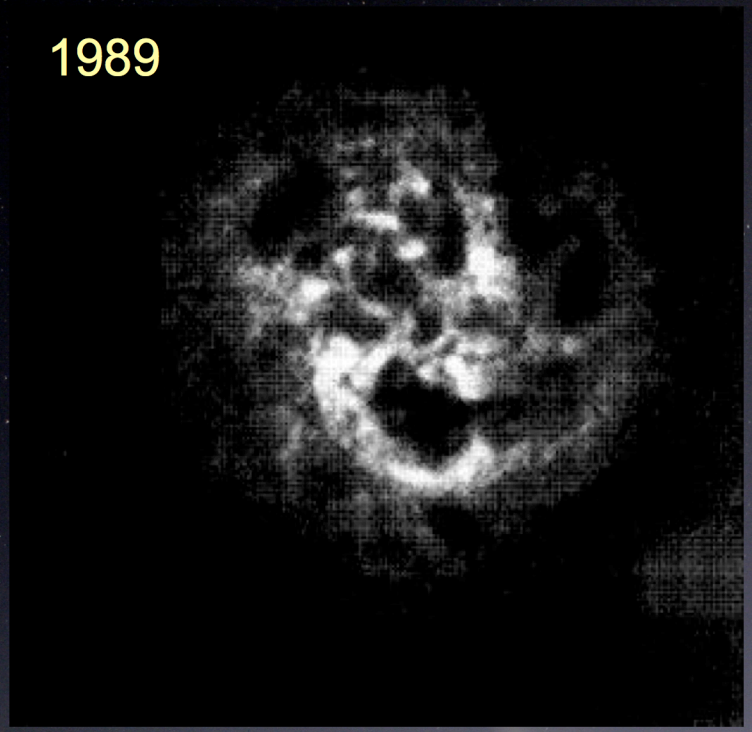
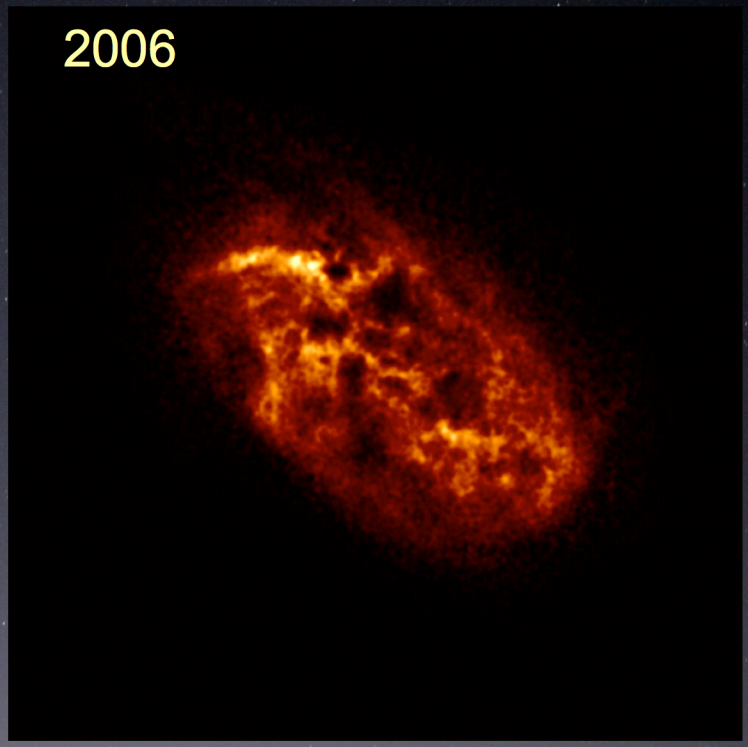
Personal remarks I: Gaseous evolution of galaxies

We need the SKA-mid!

1989



2006



Creativity of observers has maintained flow of discoveries, but, ultimately, imaging, too, has stalled (eg. NGC891).

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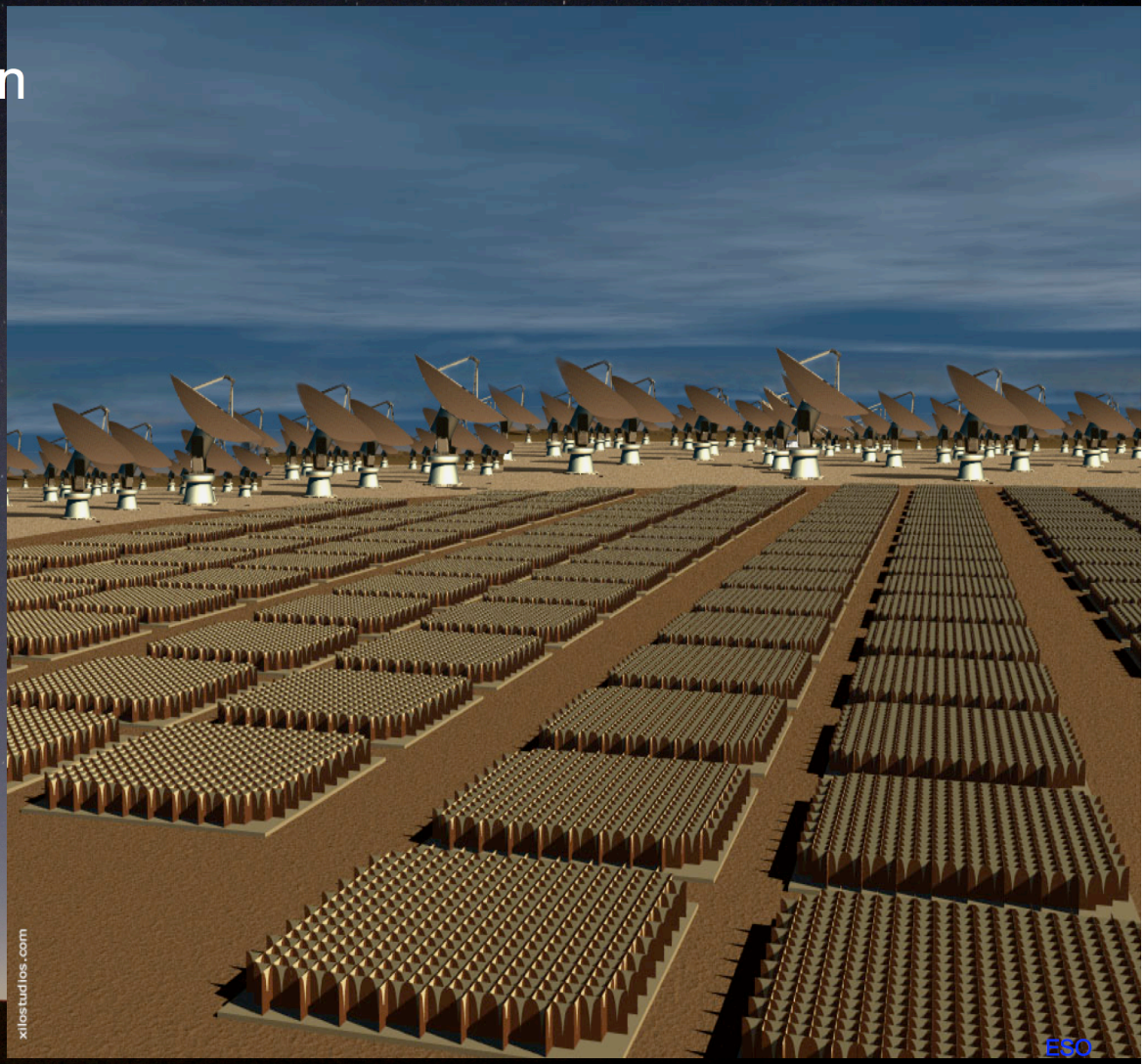
Personal remarks I: Gaseous evolution of galaxies

We need the SKA-mid!

A simple calculation (a la Wilkinson c. 1990)

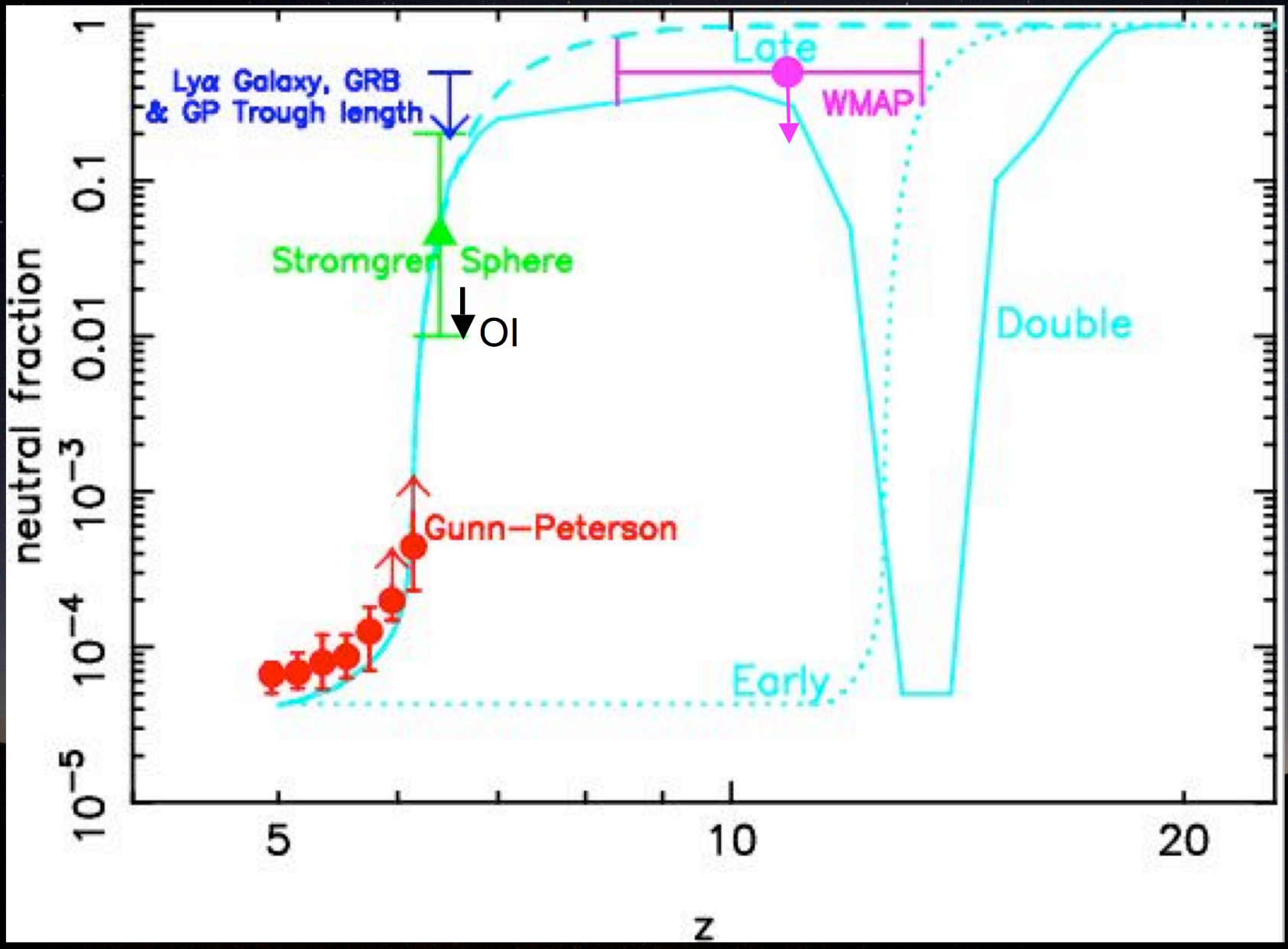
- Milky Way HI mass = 3e9 $M_\odot$
- At z=1, HI signal: S_{710MHz} = 2uJy
- VLA sensitivity in 12hr ~ 200uJy

=> Need 100x VLA = SKA !



Personal remarks II: Cosmic reionization

We need the SKA-low (<0.2GHz)!



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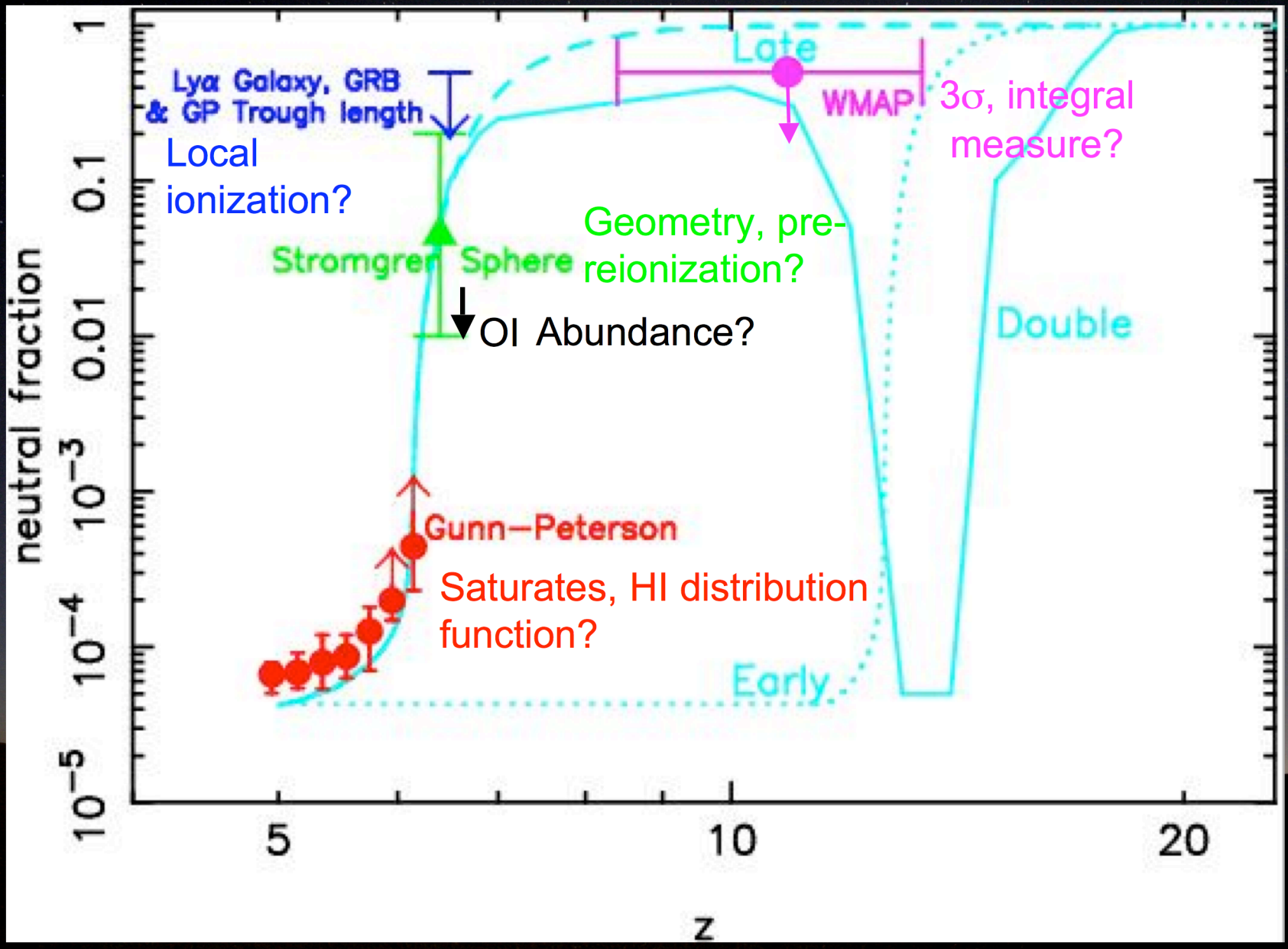

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Personal remarks II: Cosmic reionization

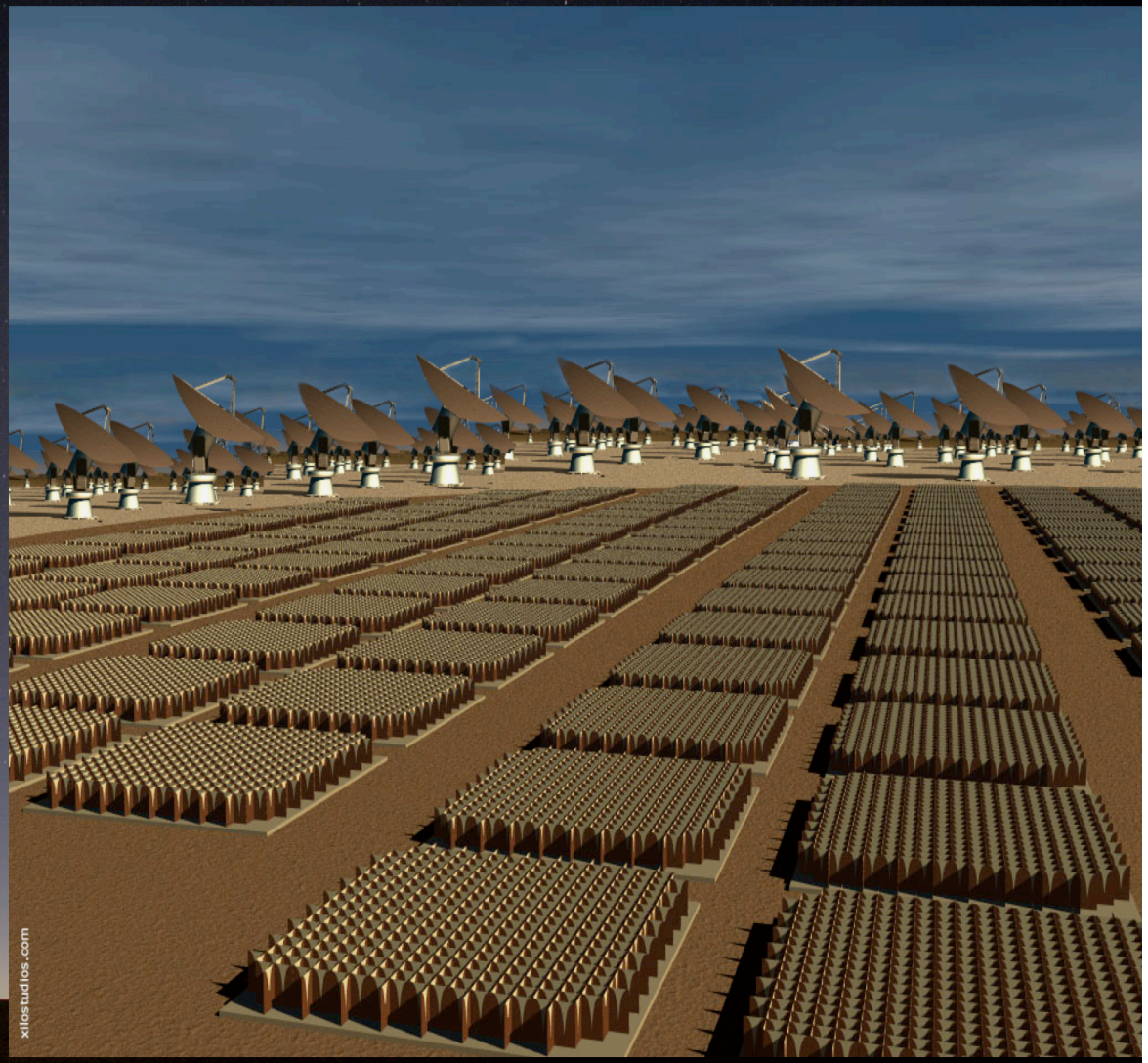
We need the SKA-low!

A simple calculation

- EoR signal ~ 20 mK on scales ~ 2', 0.3MHz at z~9 => S_{140} = 5 uJy
- SKA with 300K, 1 month integration => rms = 1.3 uJy

Peeling the problem onion

- Ionosphere
- Non-thermal foregrounds
- Interference

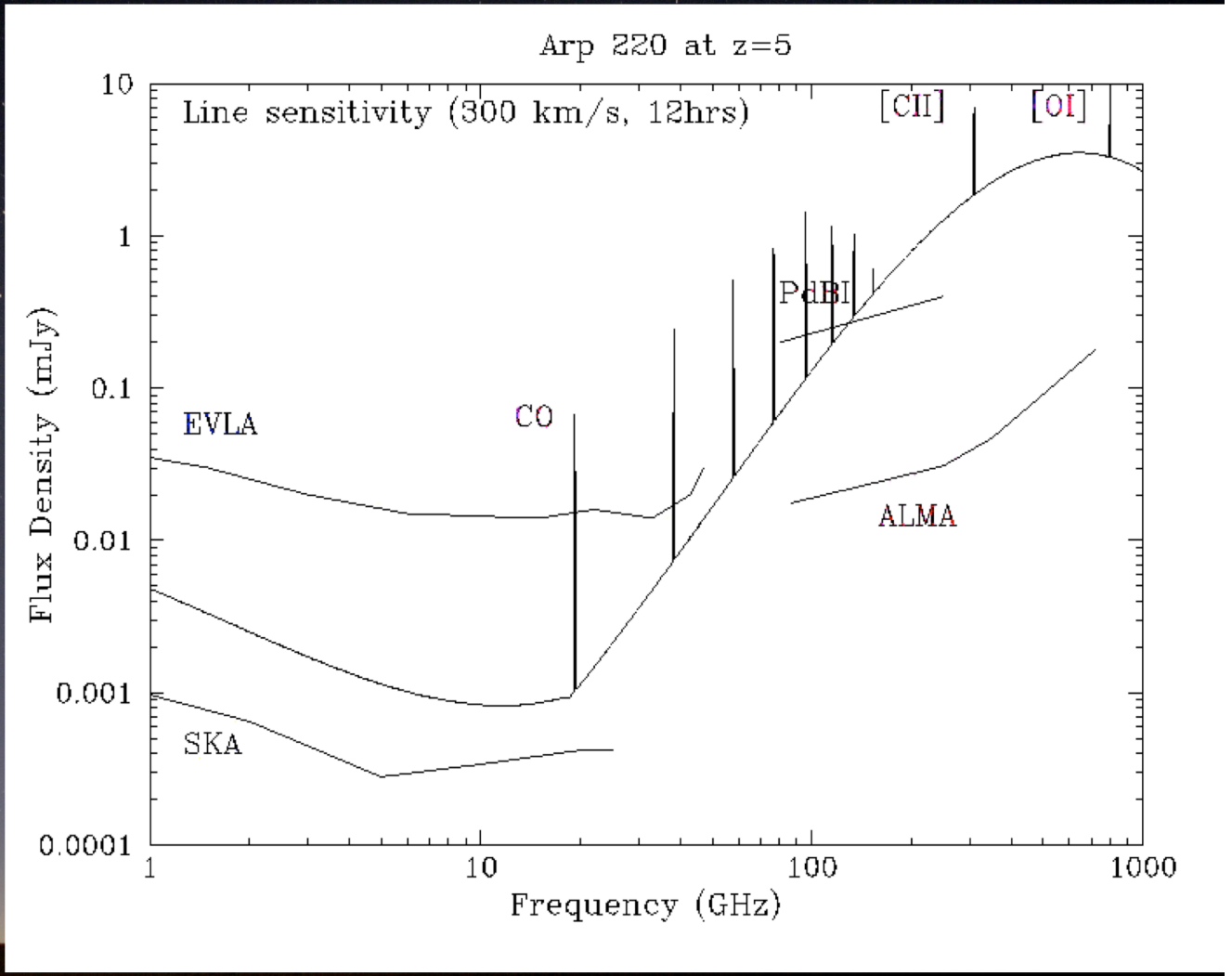


Personal remarks III: Molecular gas in first galaxies

We need the SKA-high (3 -- 30 GHz)!

Telescopes at ~ 1cm are critical for observing:

- Low order CO transitions: best tracer of total gas mass
- High density gas tracers (eg. HCN) = gas directly associated with star formation
- High order transitions may not be excited in many (most?) galaxies



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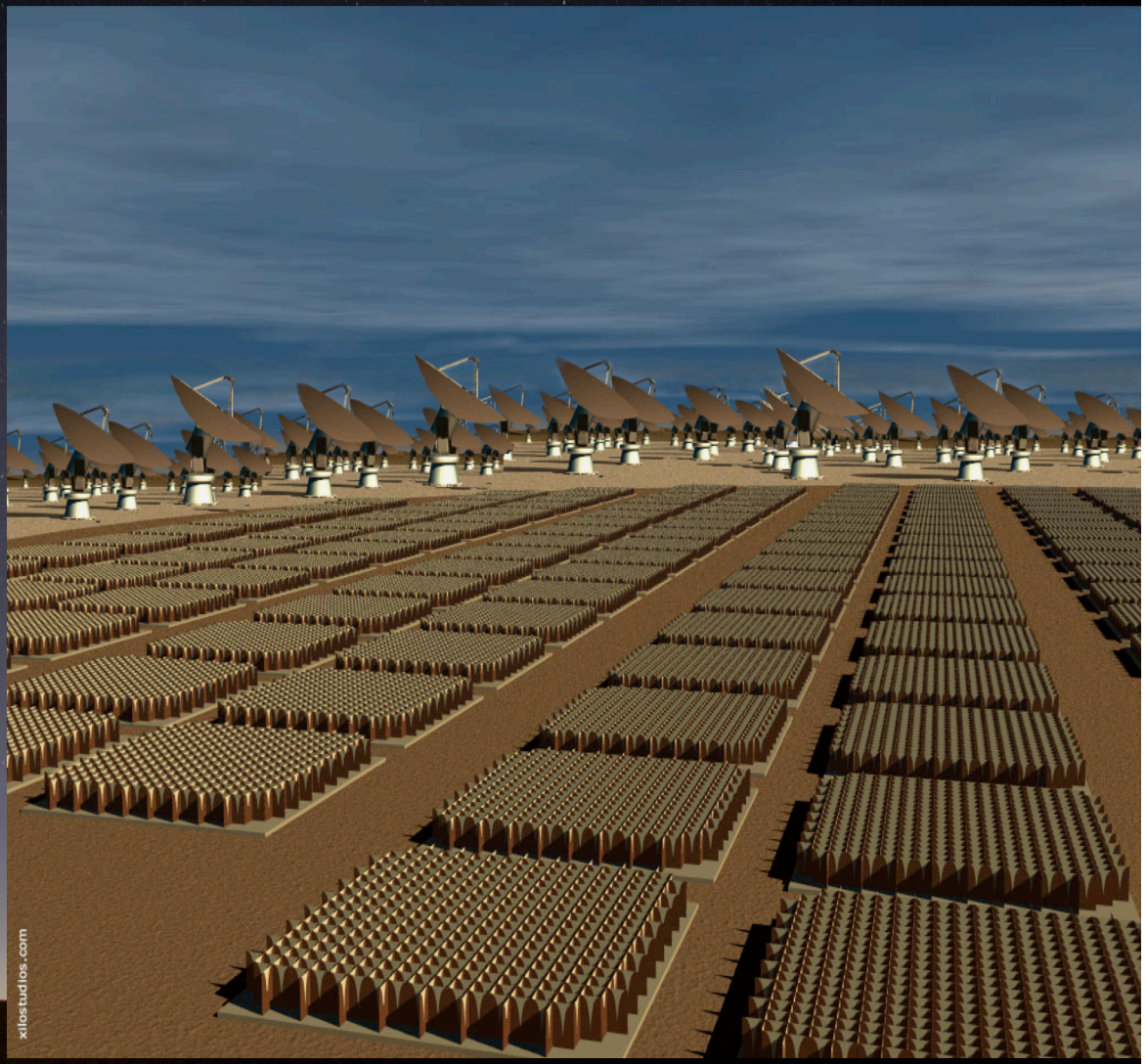
Personal remarks: We need the SKA!

- Low = 0.1 to 0.2 GHz
- Mid = 0.3 to 3 GHz
- High = 3 to 30 GHz





St. Benedict c. 400AD

"It is time now to rise from sleep…and listen and attend with the ear of your heart"

"Founding a monastery is a continuous process of sawing to build your design, and trying to dispose of the saw dust, while you are always being forced to reconstruct. You have to give it your all and it is never done."

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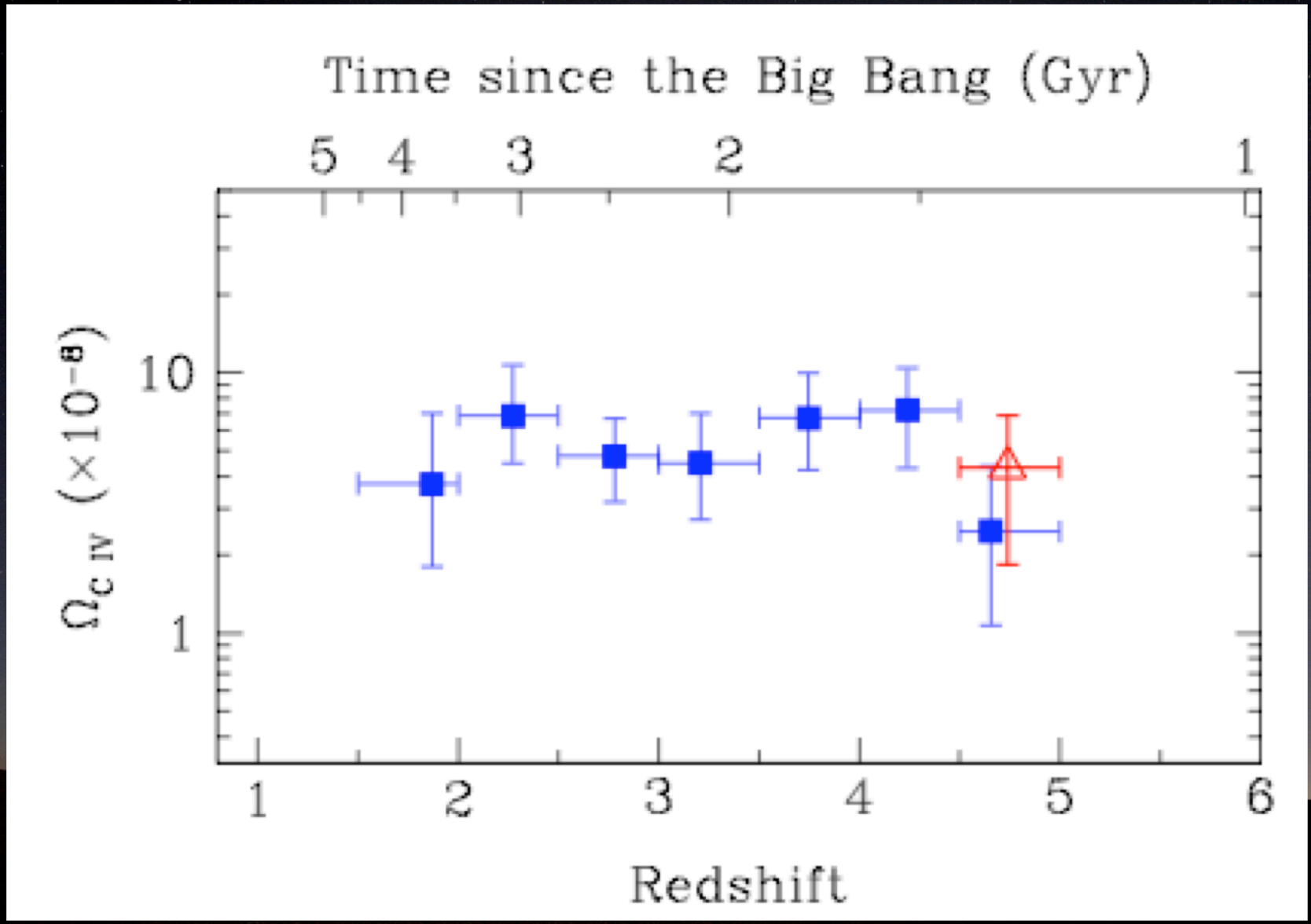
Number 7


Time since the Big Bang (Gyr)
5
4
3
2
1
10
1
$\Omega_{C\ IV}$ ($\times 10^{-8}$)
1
2
3
4
5
6
Redshift

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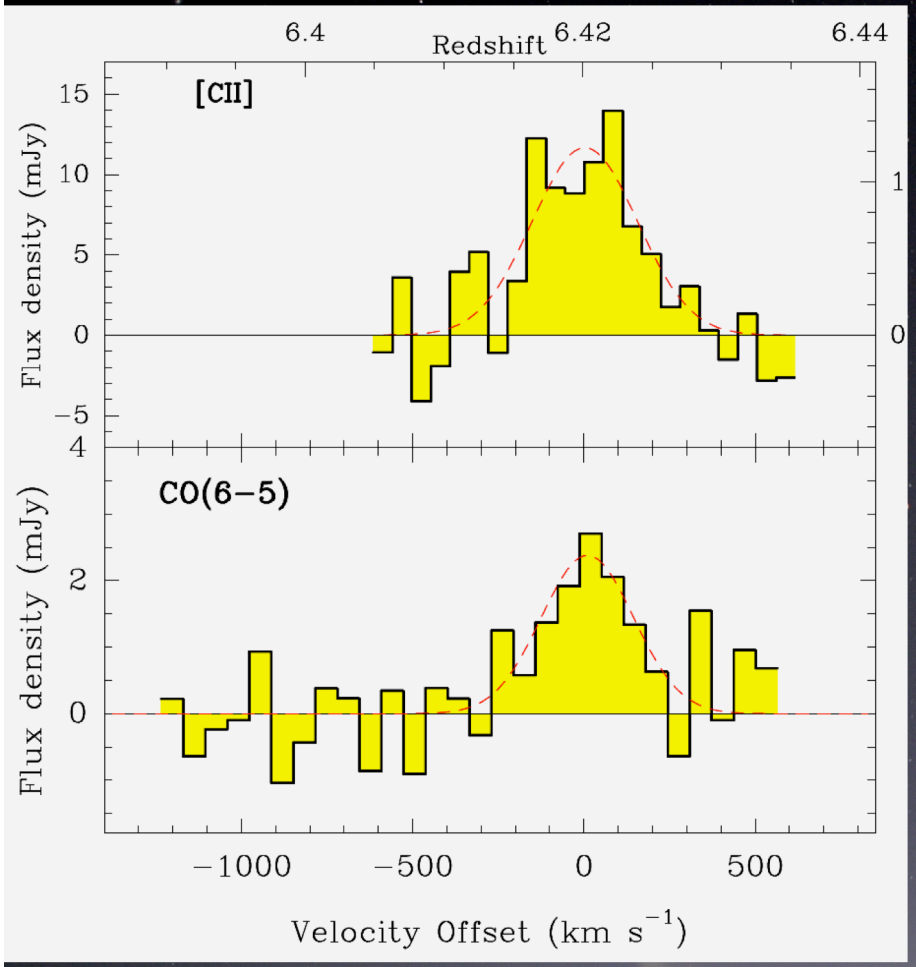
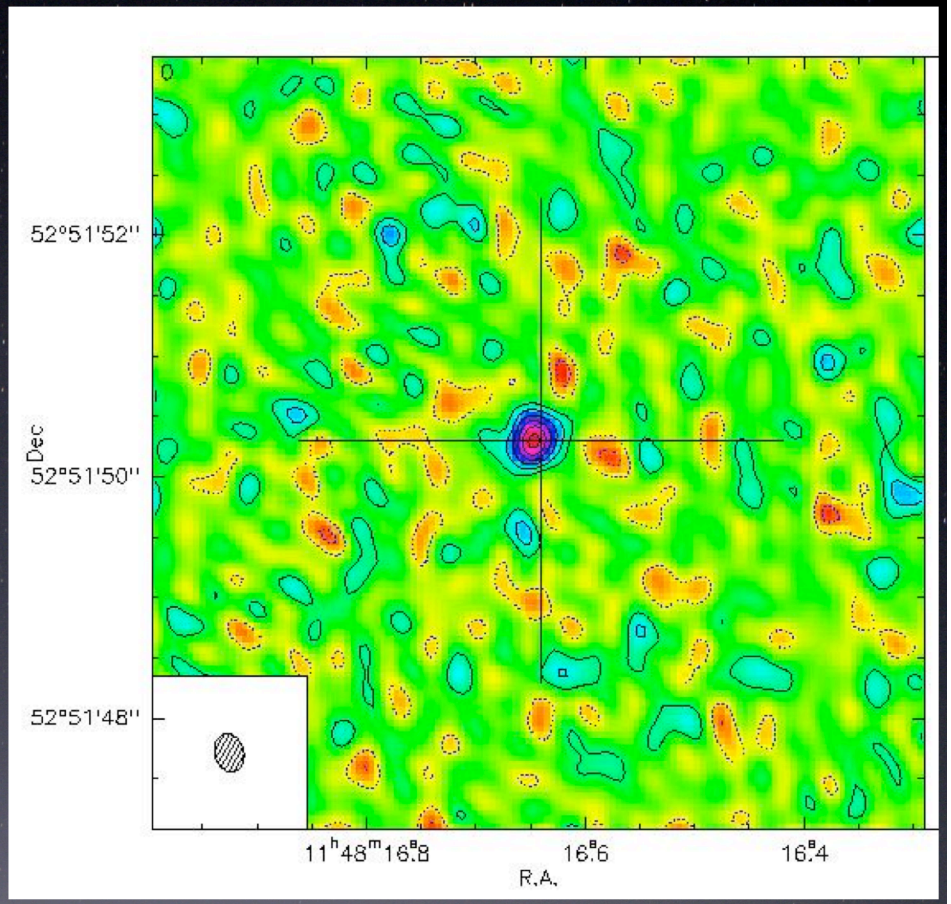
C+ 158um at z=6.42





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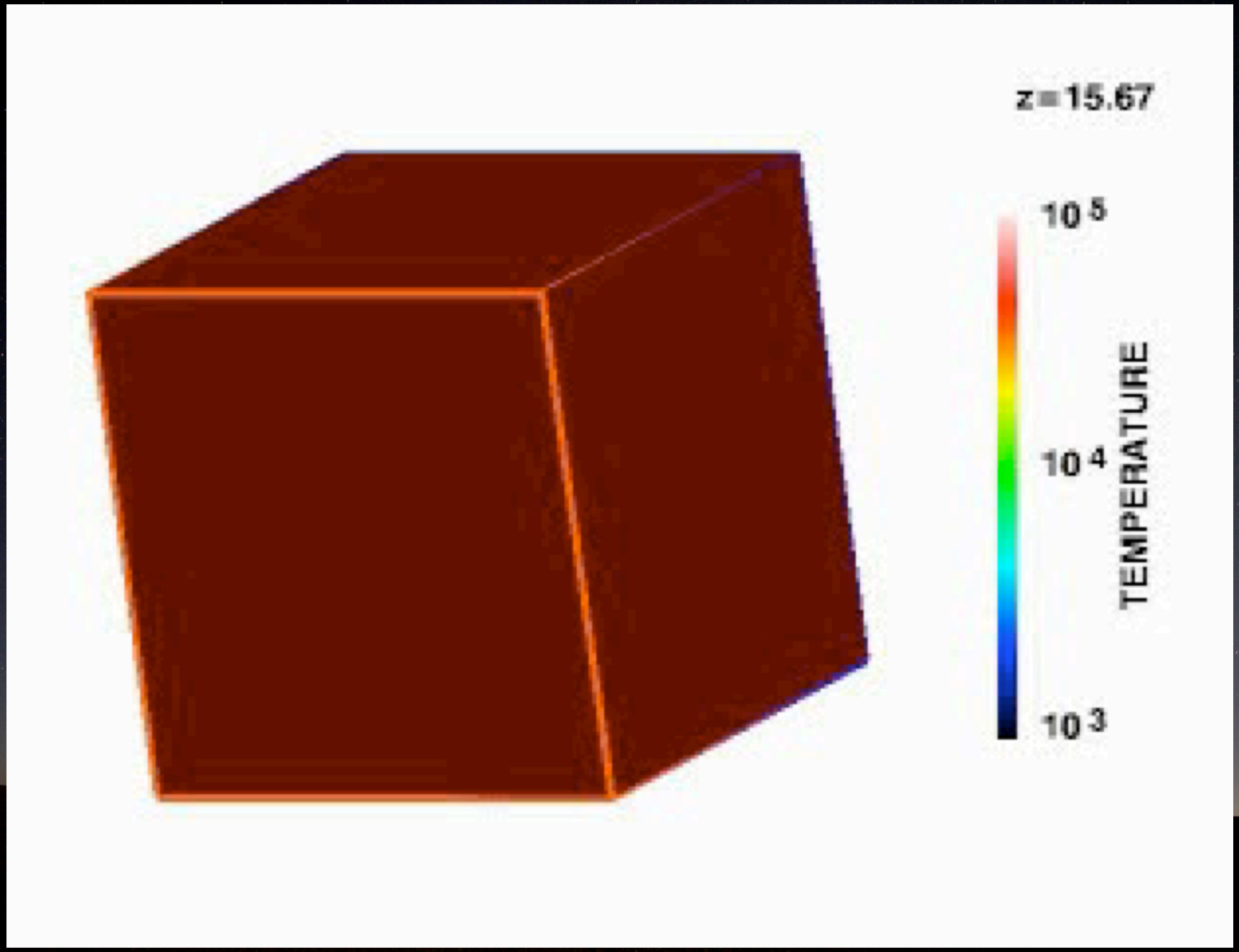
Numerical simulations of IGM evolution



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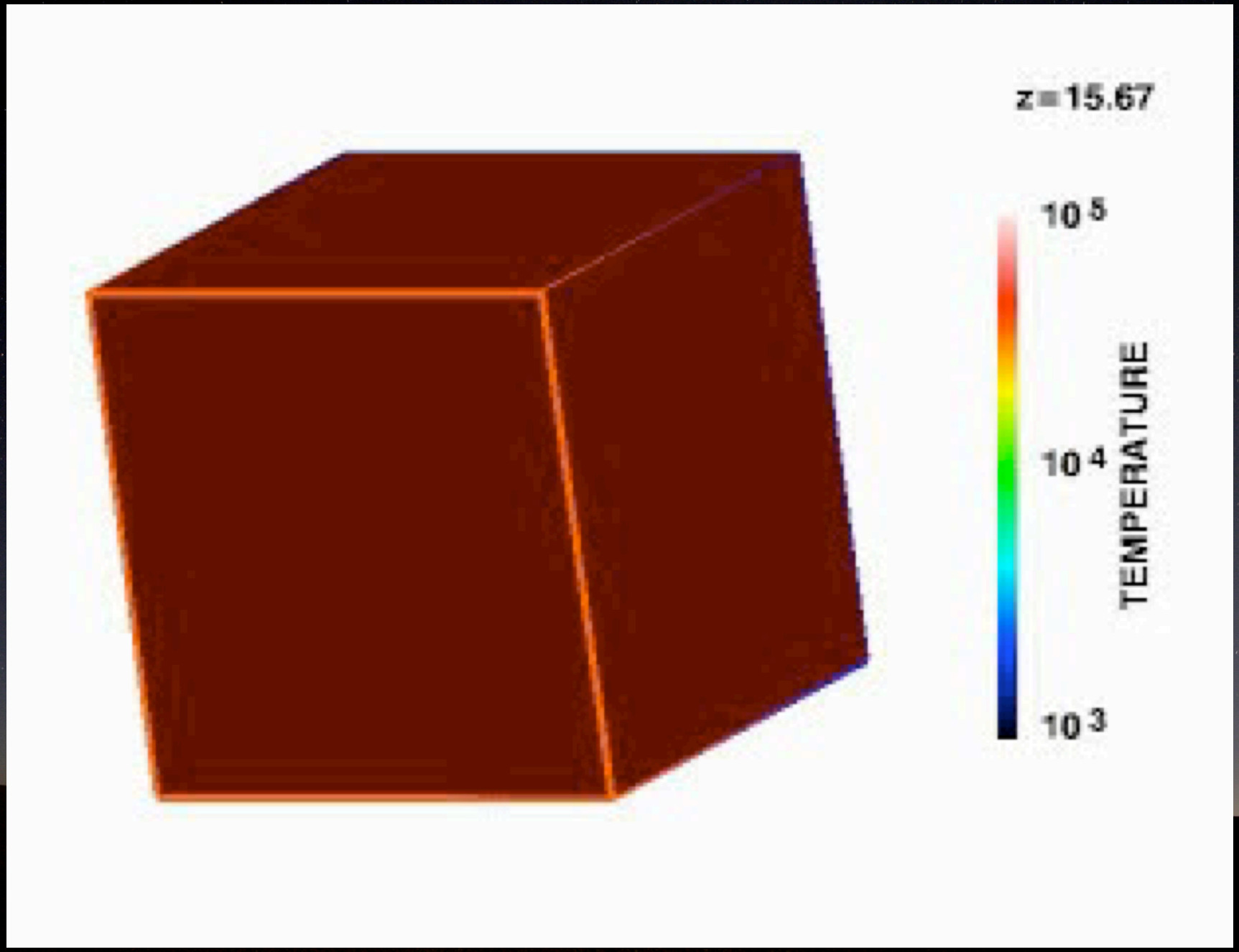

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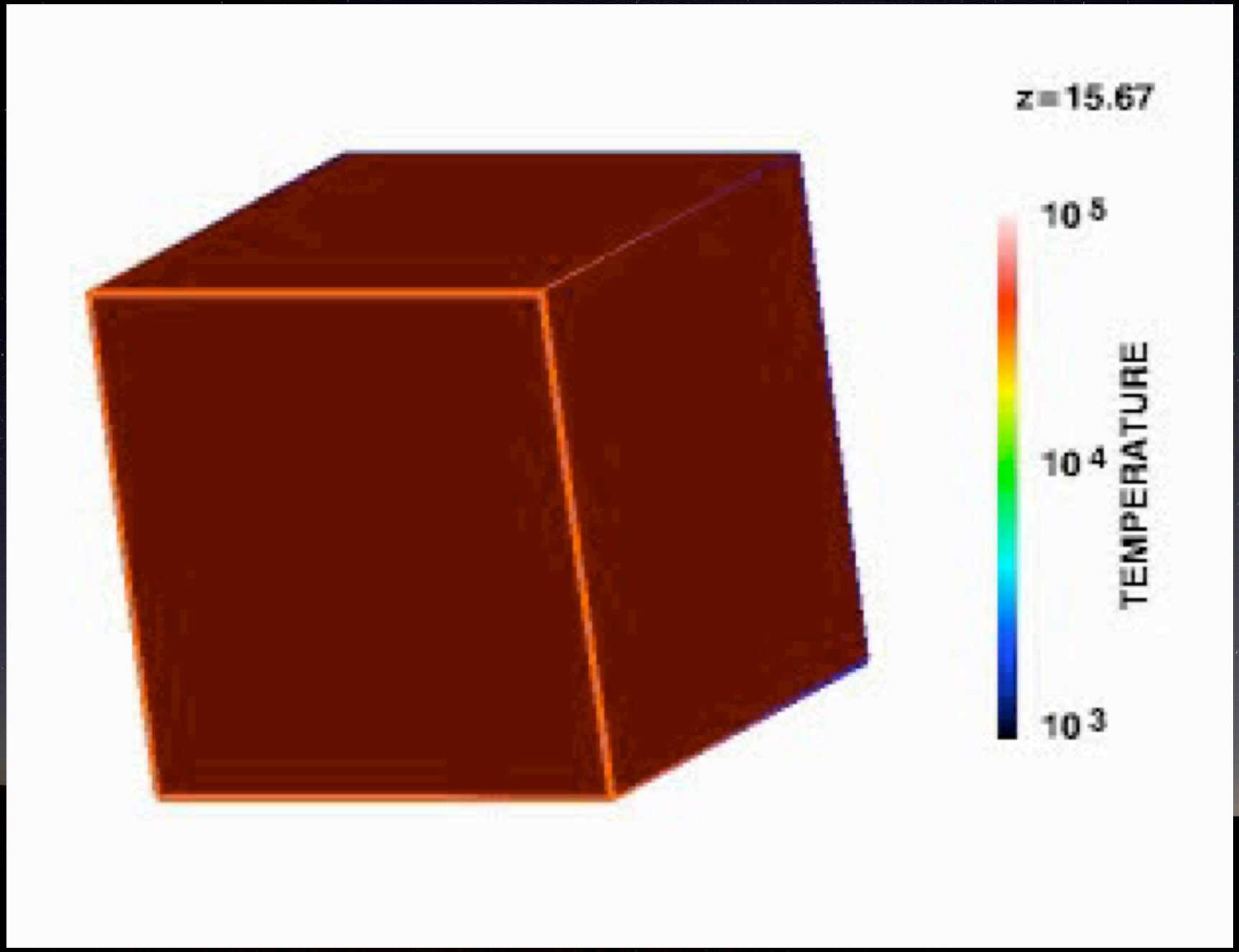

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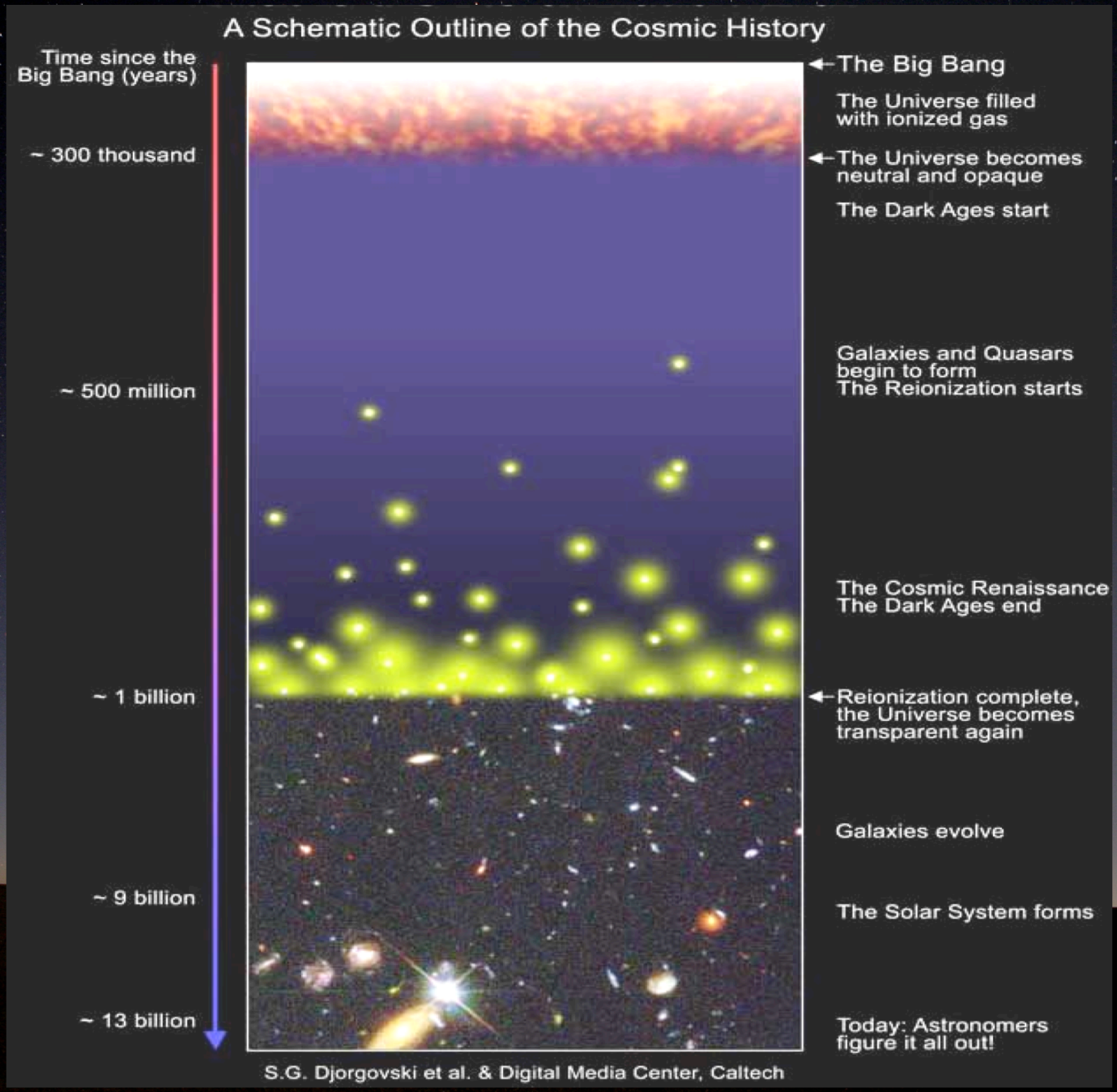
Schematic evolution of IGM



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