Future Intensity Mapping Surveys

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@ CPAD
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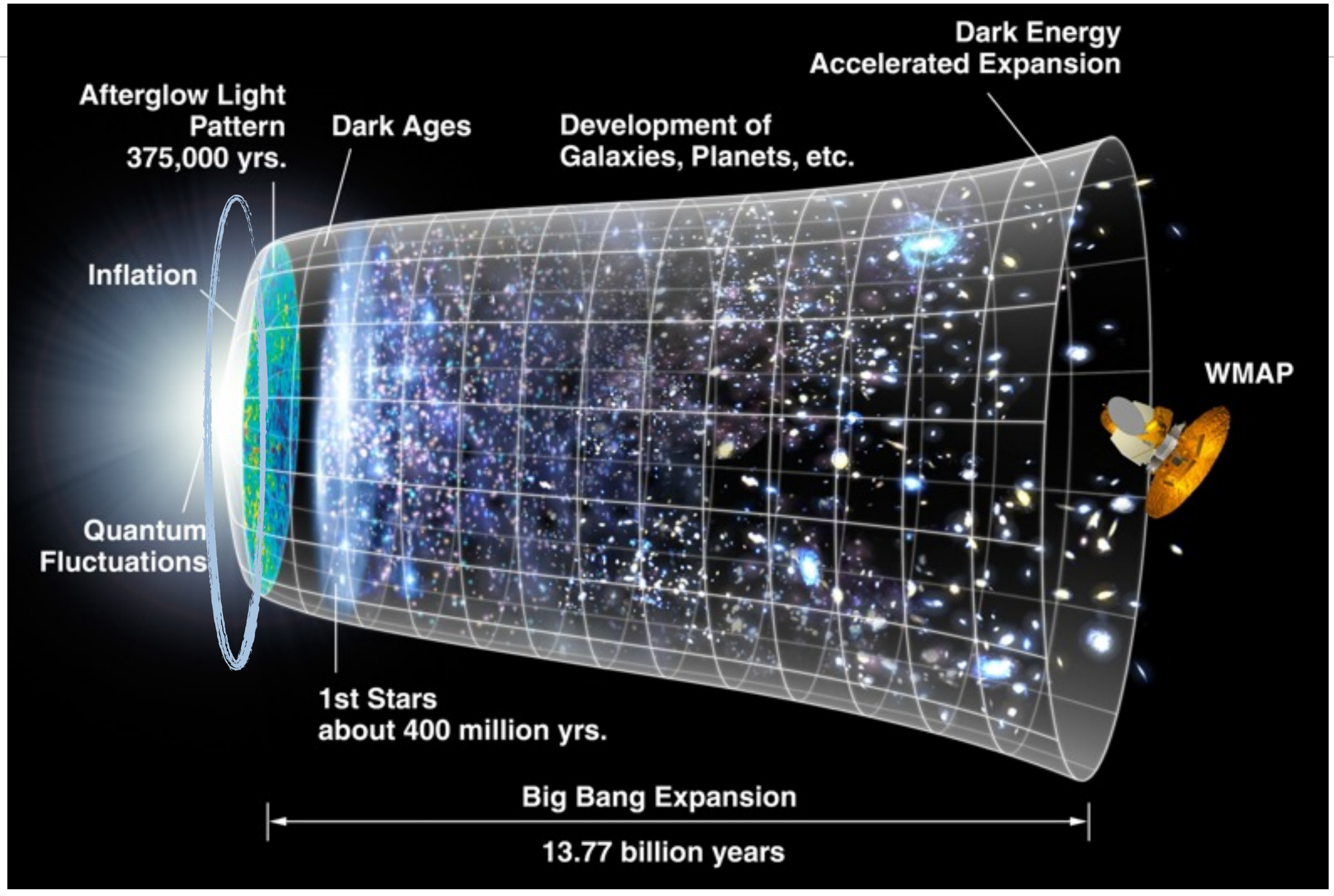
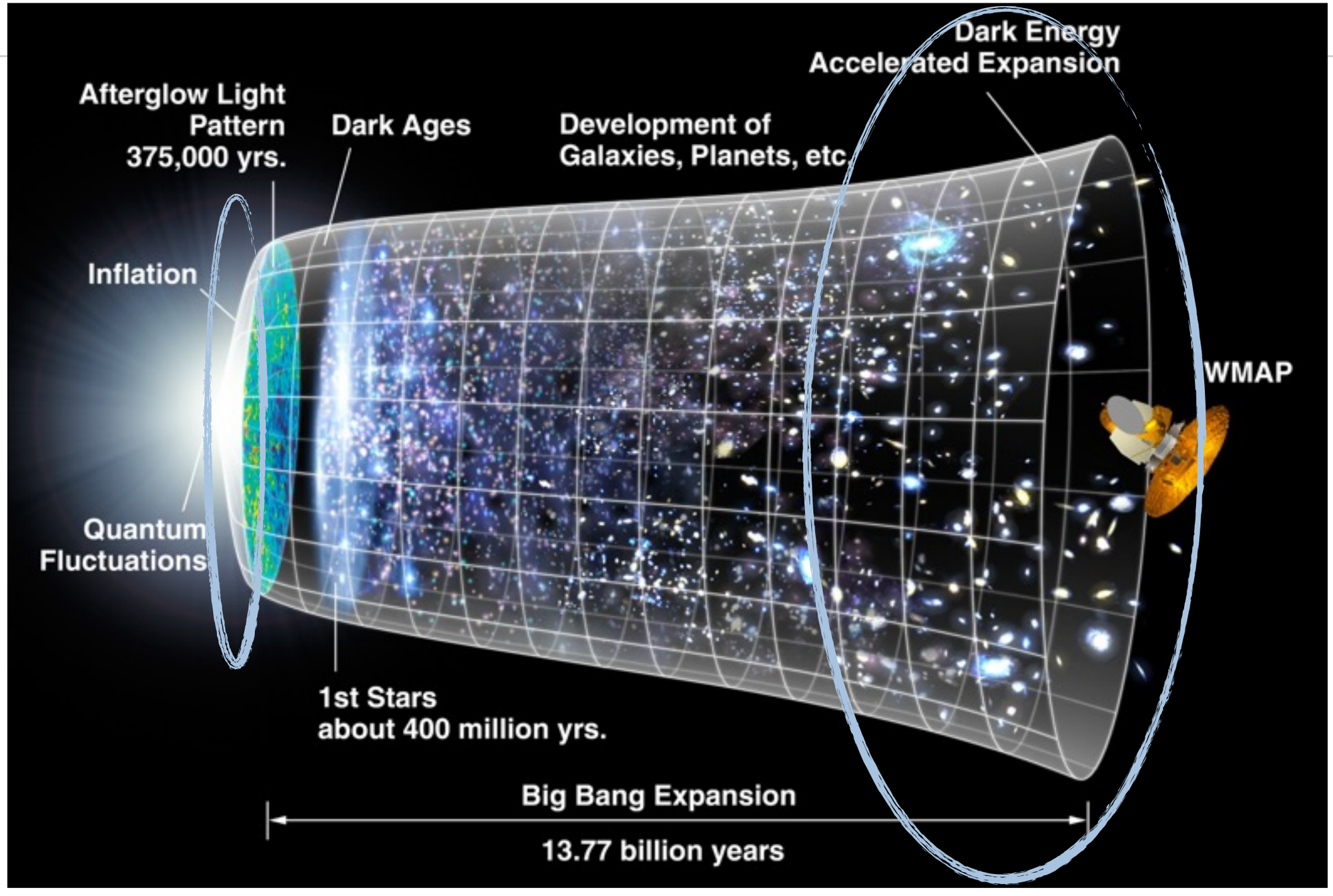
Photo credit:
K Vanderlinde

As everyone just said: LSS is a great cosmological probe



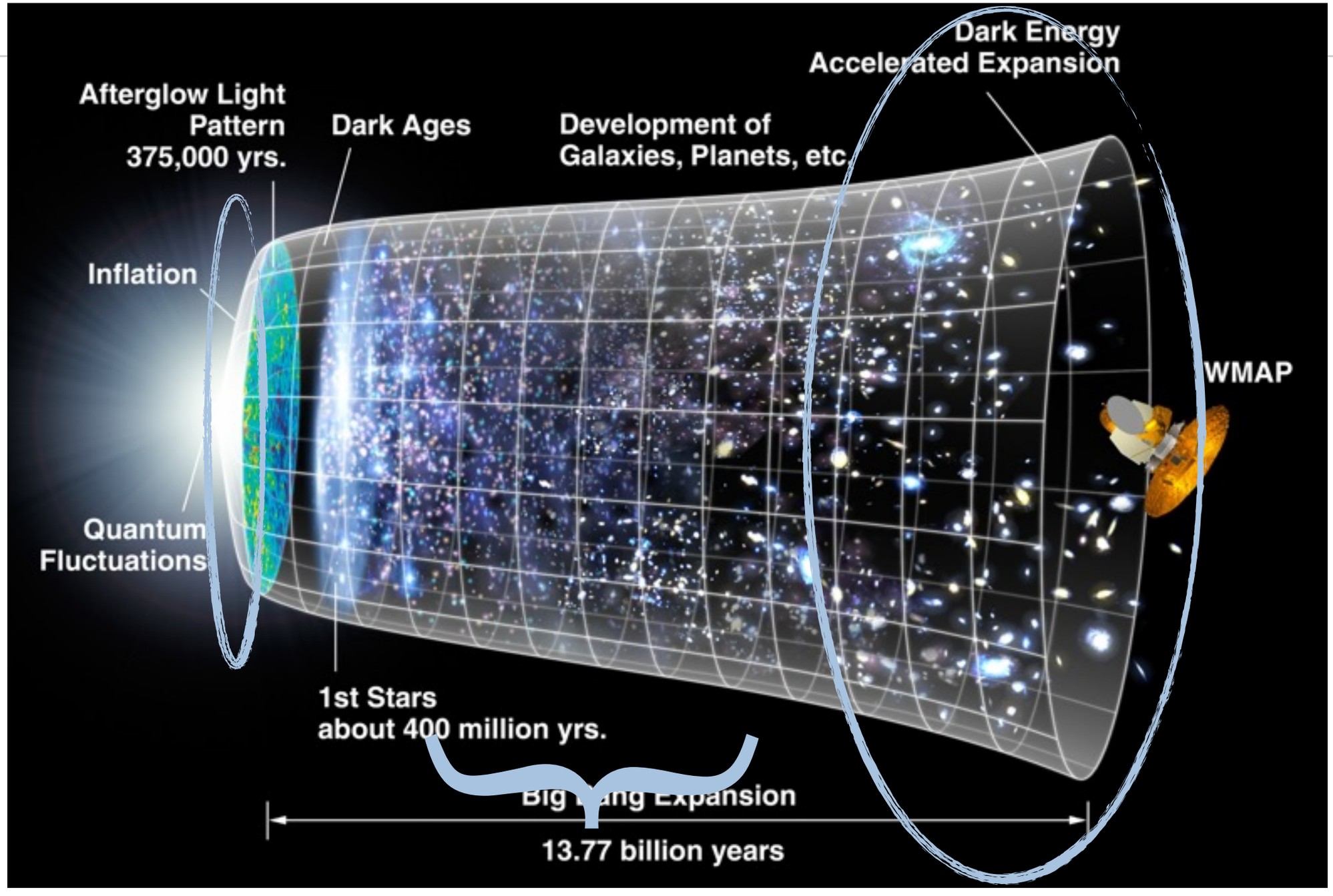
Past accelerated expansion: Inflation via non-gaussianity / scale dependent bias

As everyone just said: LSS is a great cosmological probe



Recent accelerated expansion: Dark Energy

As everyone just said: LSS is a great cosmological probe

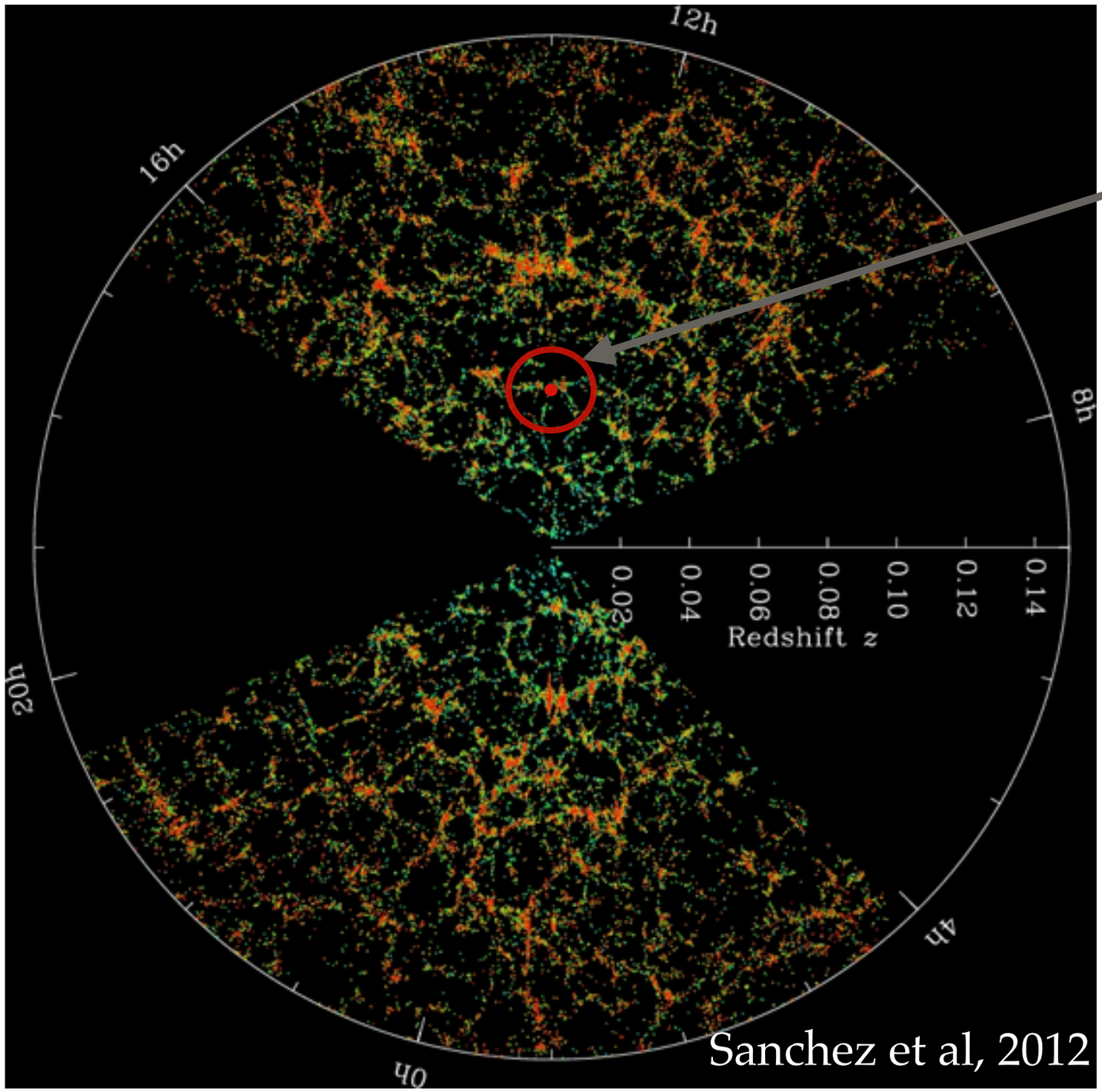


Lots of interesting ‘side’ science with neutrinos, dark matter, modified gravity

As everyone just said: LSS is a great cosmological probe

But, high redshift measurements of galaxies are … not easy

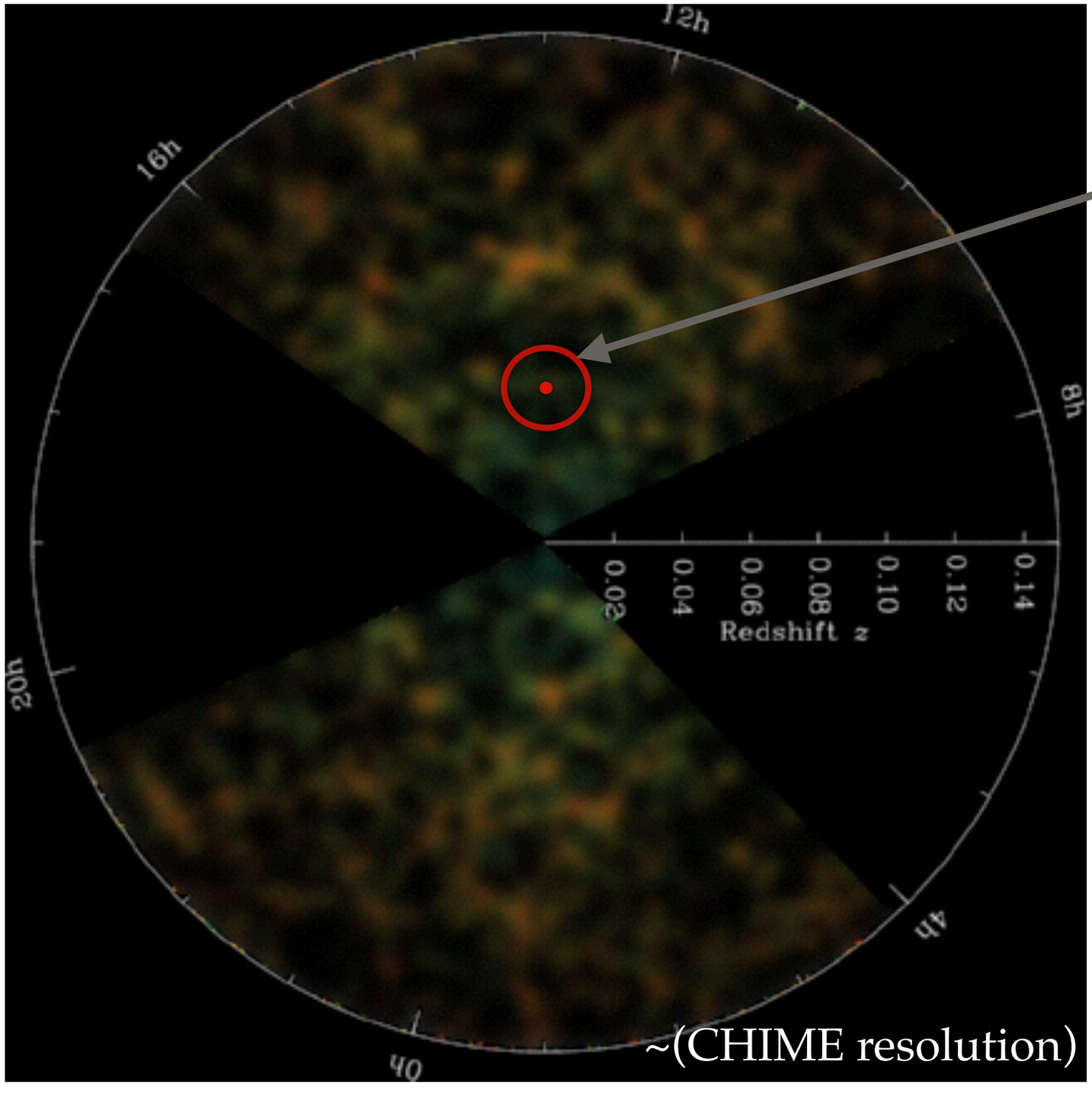
The scale of interest is *Large*…



150 Mpc radius

Sanchez et al, 2012

So we don't need to resolve individual galaxies

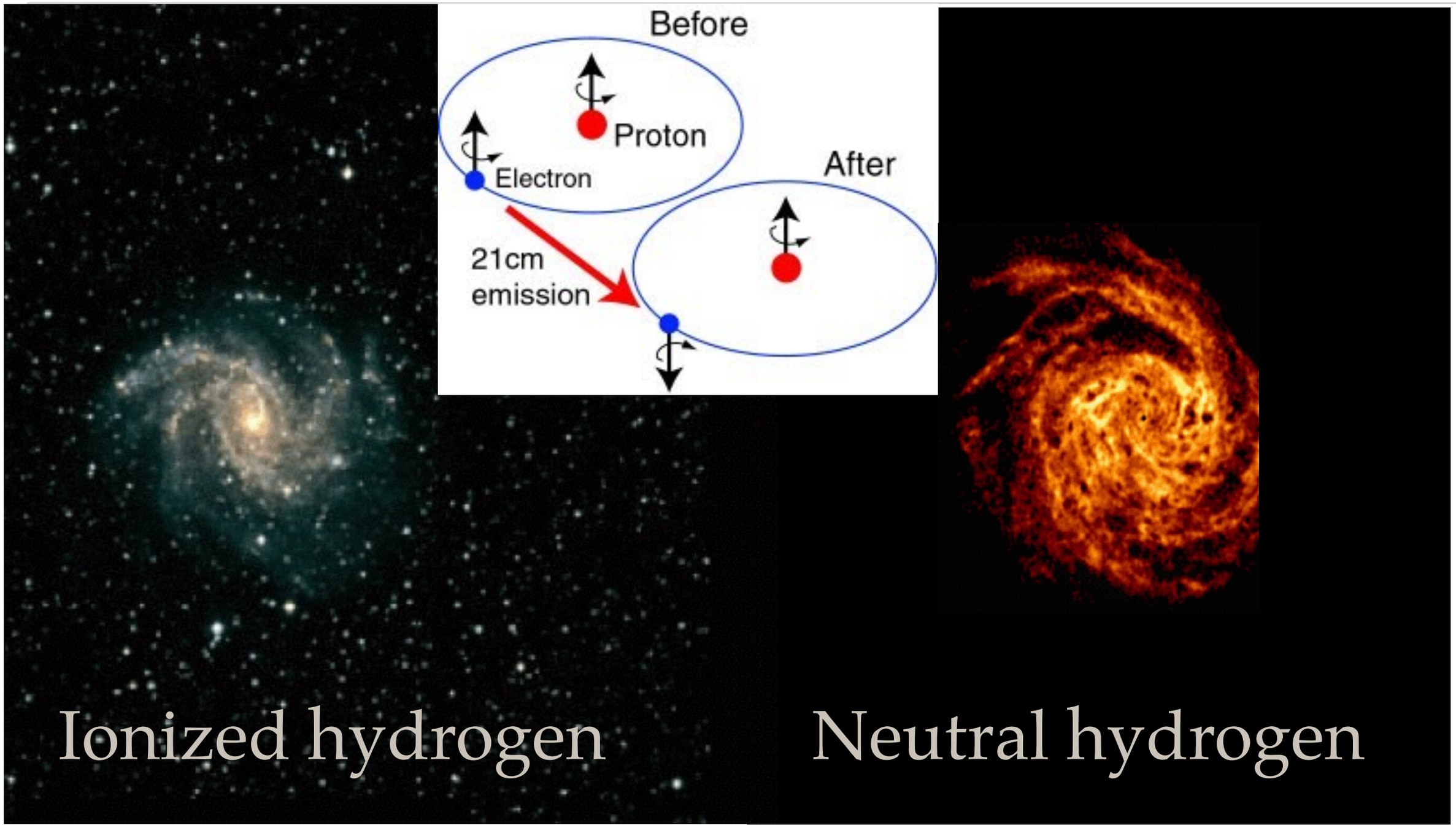


150 Mpc radius

<u>DO</u> need:

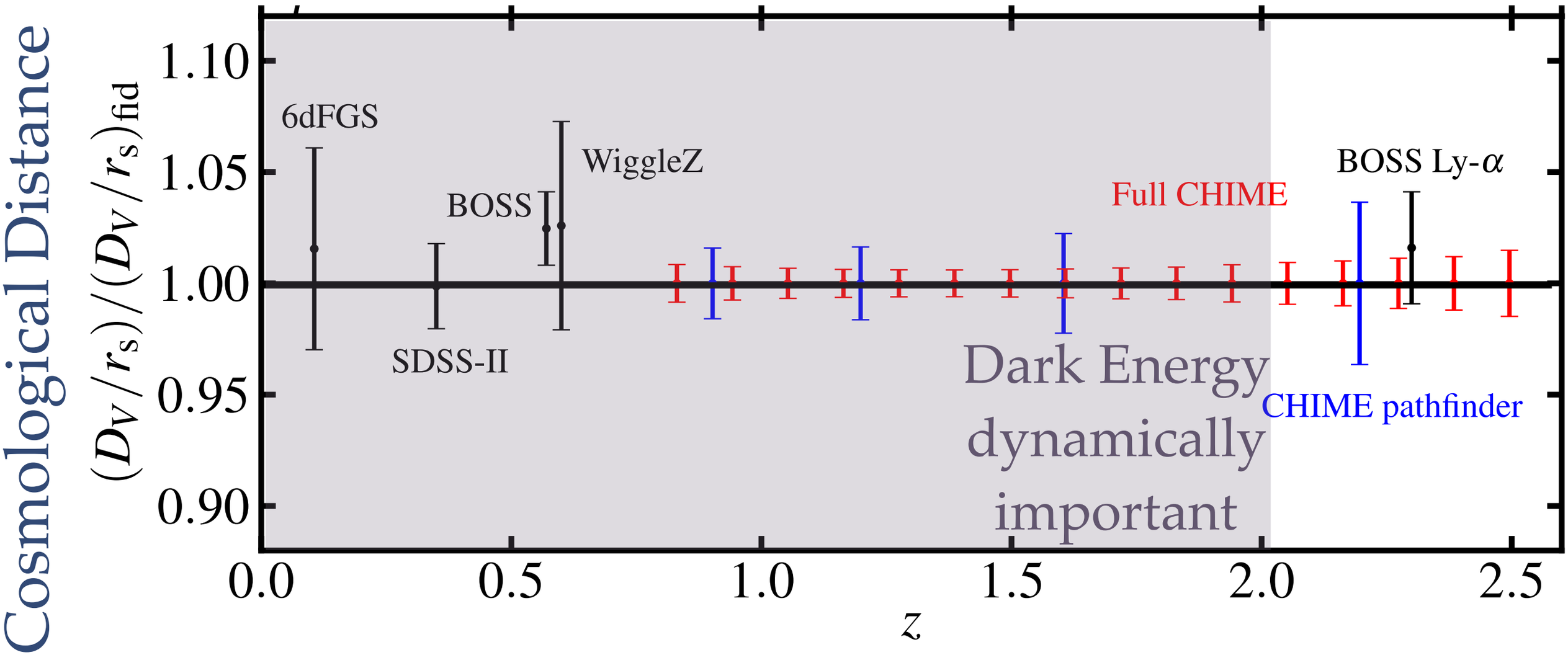
- Traces (dark) matter distribution
- Redshift information (time)

Hydrogen Intensity Mapping



Same Galaxy — Neutral Hydrogen in un-ionized bubbles, supported within galaxies

Why do 21cm intensity mapping?



Why do 21cm intensity mapping?

Cosmological Distance

$(D_V/r_s)/(D_V/r_s)_{fid}$

1.10
1.05
1.00
0.95
0.90
0.(

Planck+current experiments

Planck + current + CHIME (simulations)

w_a

1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5

$w(z) = w_0 + w_a\,(z/z+1)$

−1.4
−1.2
−1.0
−0.8
−0.6

w_0

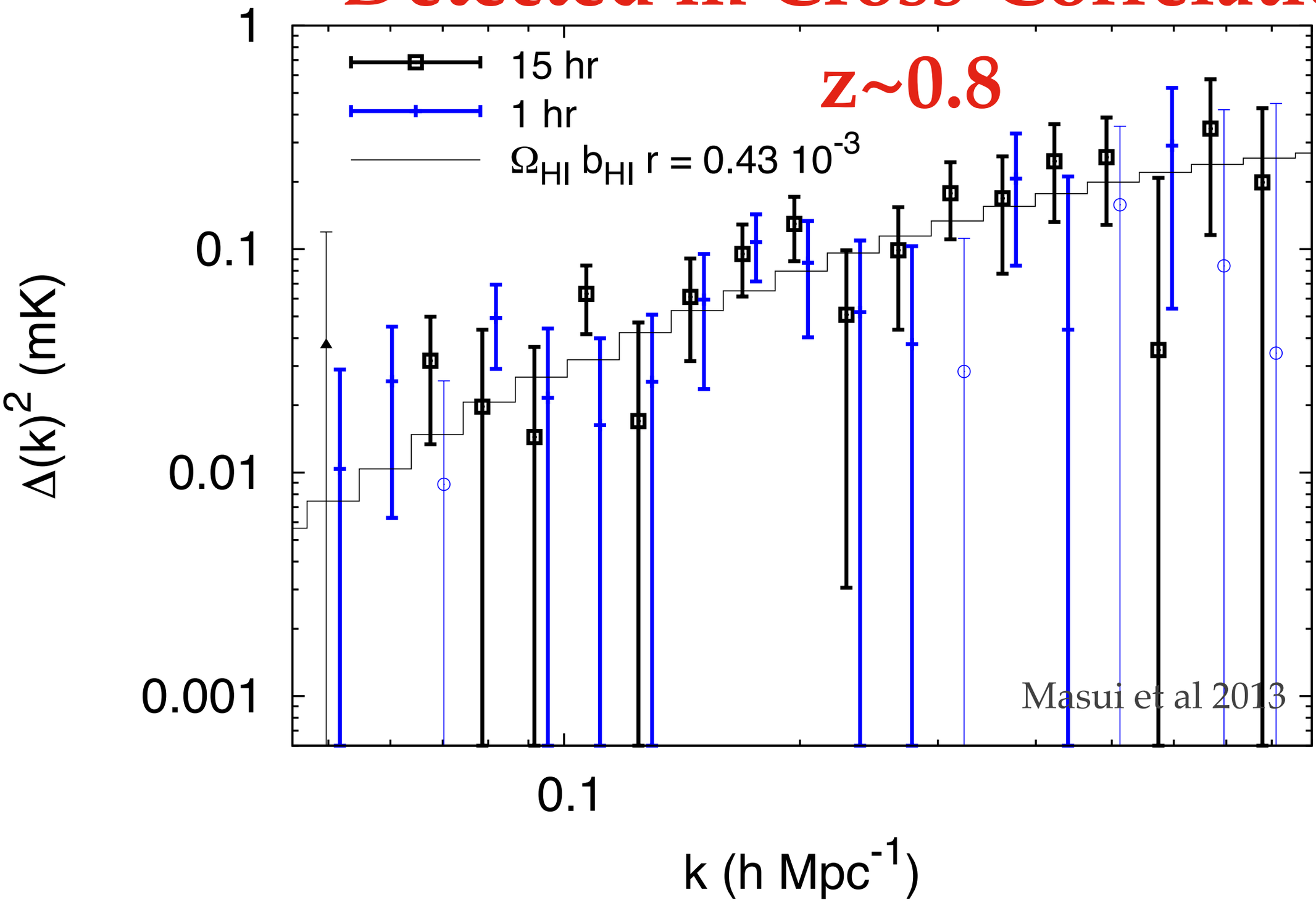
d

‘Future’ Intensity Mapping Surveys

Walking the line between ‘current’ and ‘Future’ 21cm intensity mapping experiments

Current state-of-the-art 21cm measurement

Detected in Cross-Correlation at



The Canadian Hydrogen Intensity Mapping Experiment (CHIME)

- 4 cylinders: 20m x 100m ← Chosen for BAO scales
- 1024 dual-polarization feeds
- 400-800MHz ← Redshifts 0.8 — 2.5
- Constructed, currently being instrumented
- 5 year survey

The Canadian Hydrogen Intensity Mapping Experiment (CHIME)

- 4 cylinders: 20m x 100m
- 1024 dual-polarization feeds
- 400-800MHz
- Constructed, instrumented this year
- 5 year survey

Full CHIME

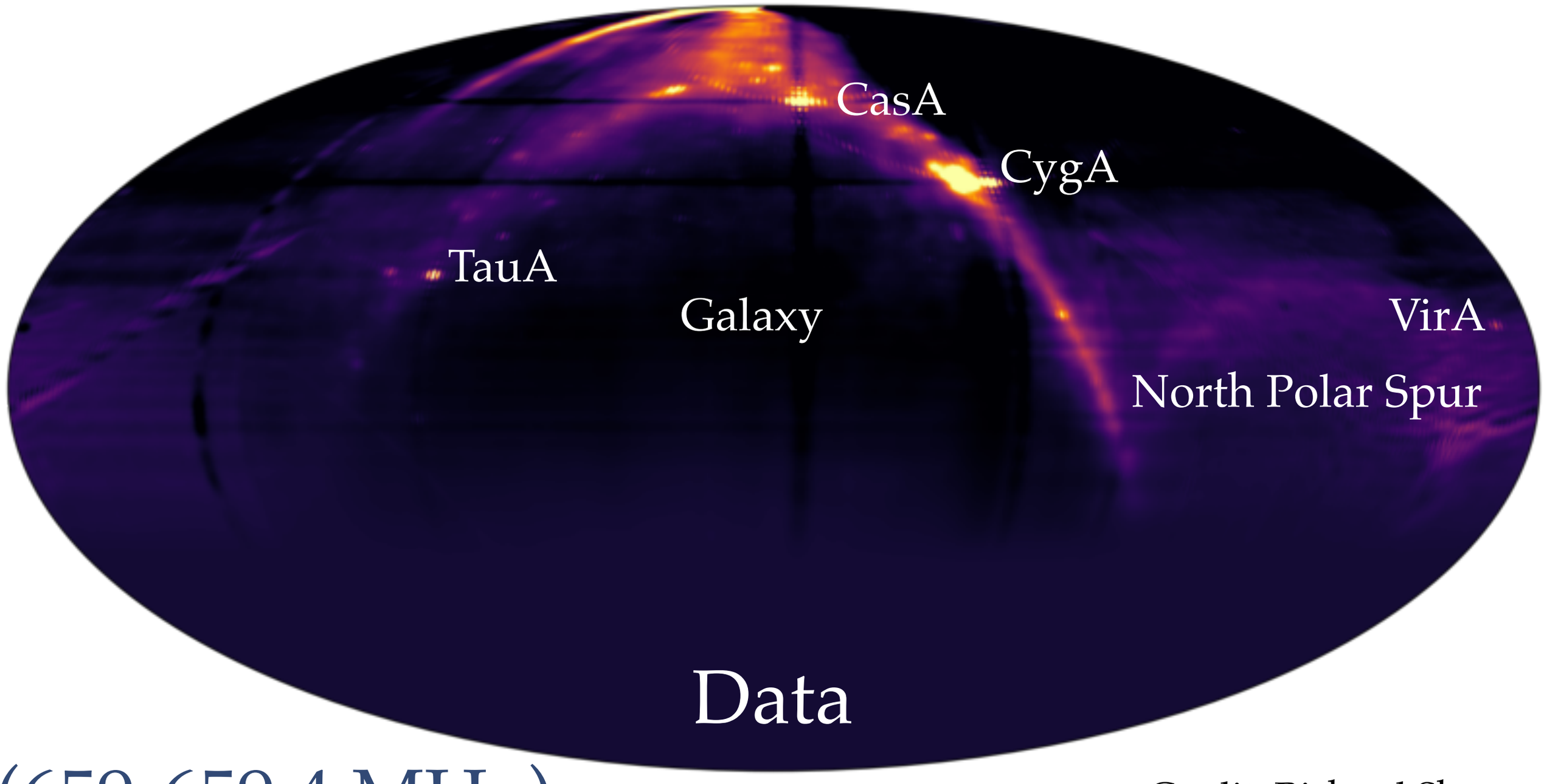
- 2 cylinders: 20m x 37m
- 128 dual-pol'n feeds
- Bandura et al 2014
- 2 year survey

Pathfinder

on sky

Preliminary map

x 1024 frequencies x 2 years

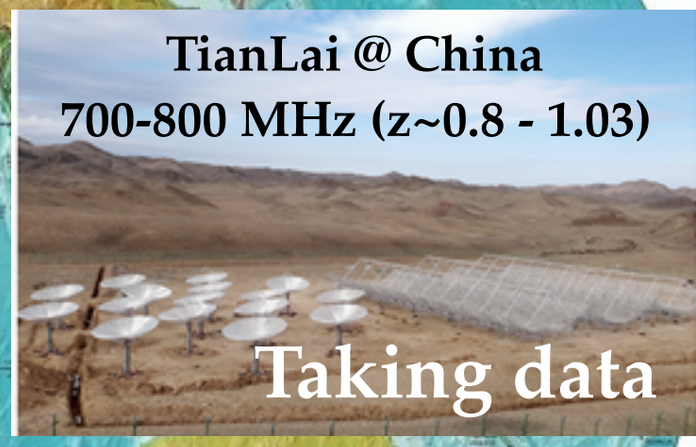


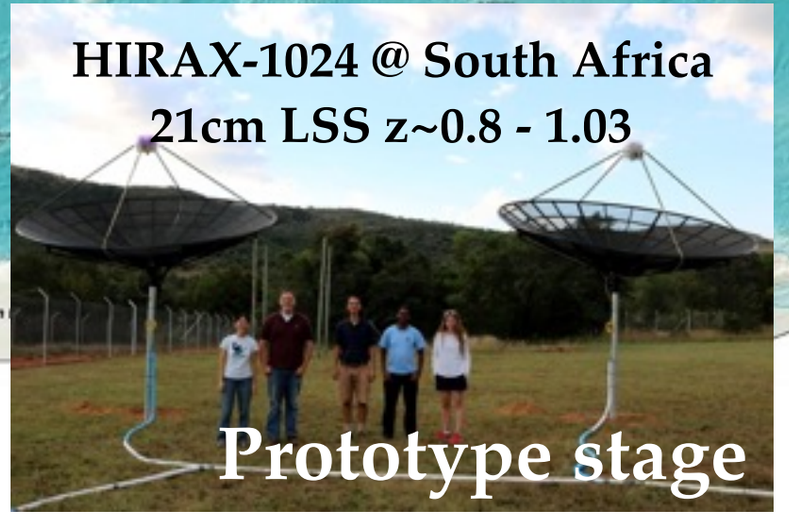
(659-659.4 MHz)

Credit: Richard Shaw

More ‘Future’ 21cm Intensity Mapping Surveys

Taking data

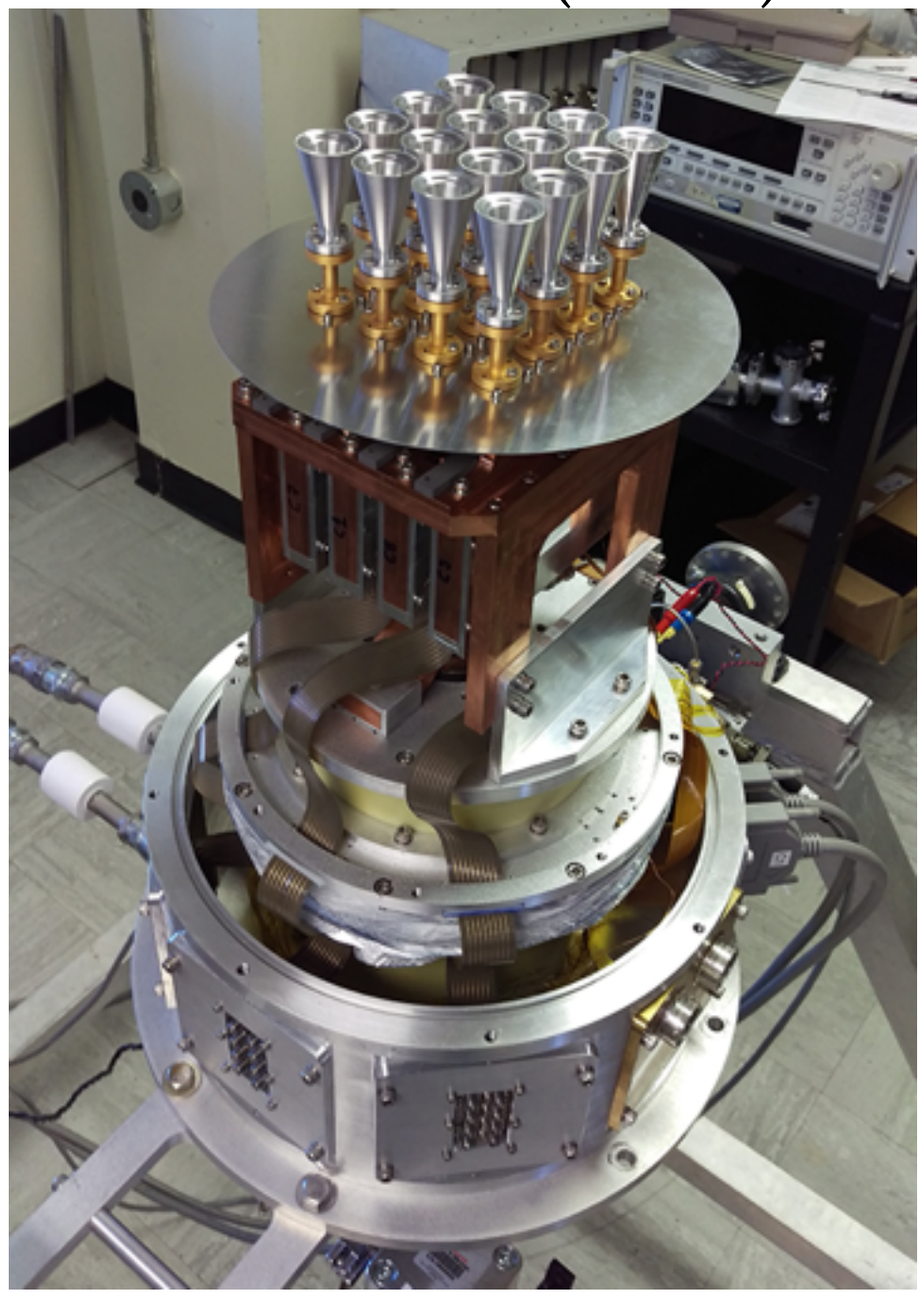




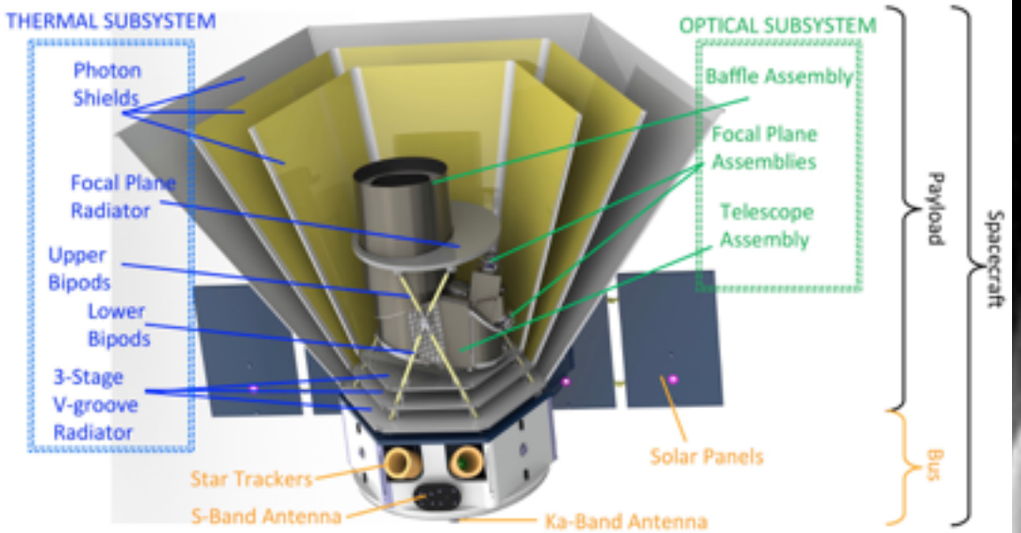
Other intensity mapping lines (currently focused on star formation)

COPSS @ SZA/Ovro
CO (1-0) intensity mapping
27-35 GHz (z~2.3-3.3)
2σ detection (Keating et al 2015)

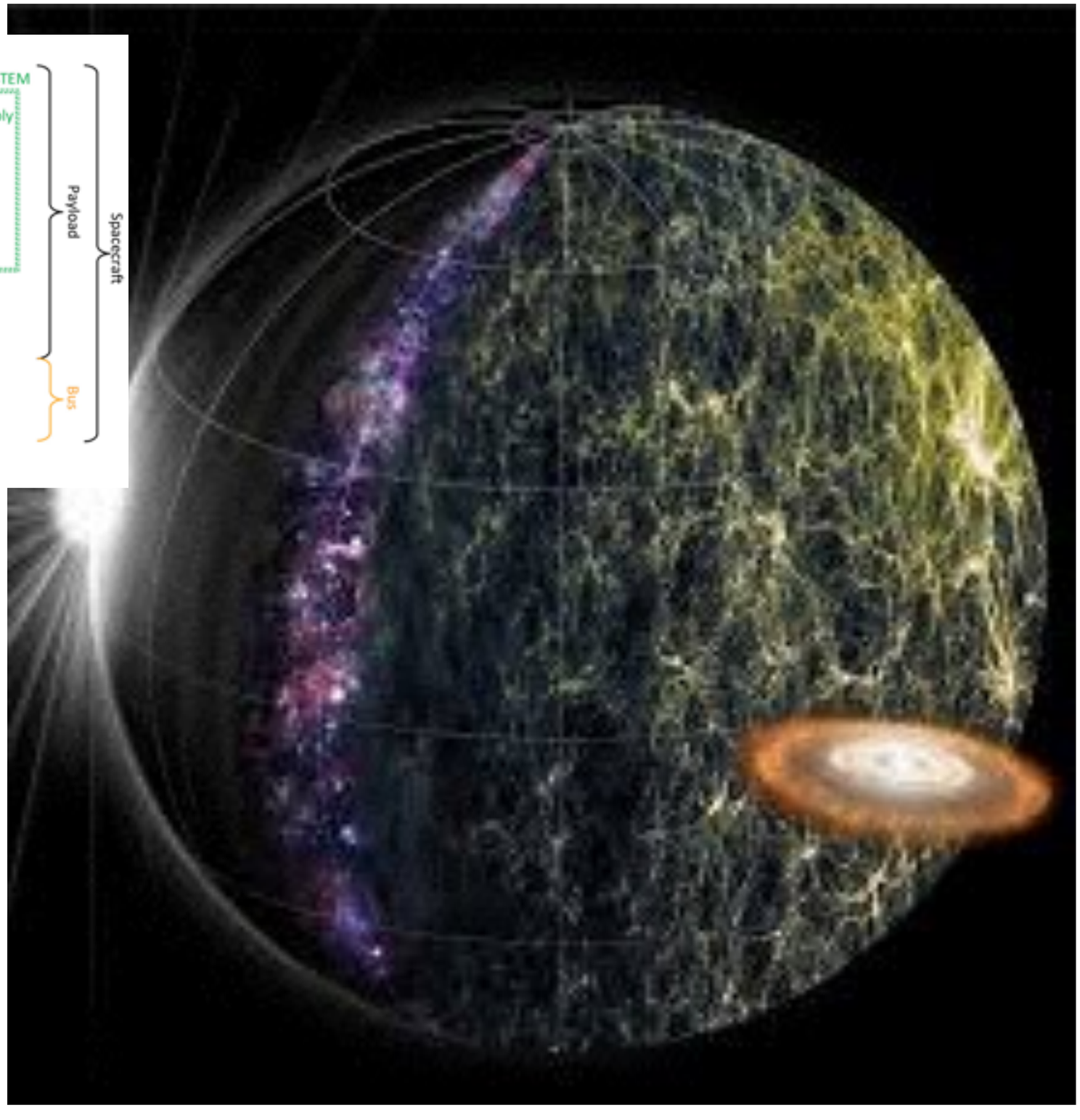
ARGUS @ GBT
High-redshift CO
85-115 GHz (z~1-3)



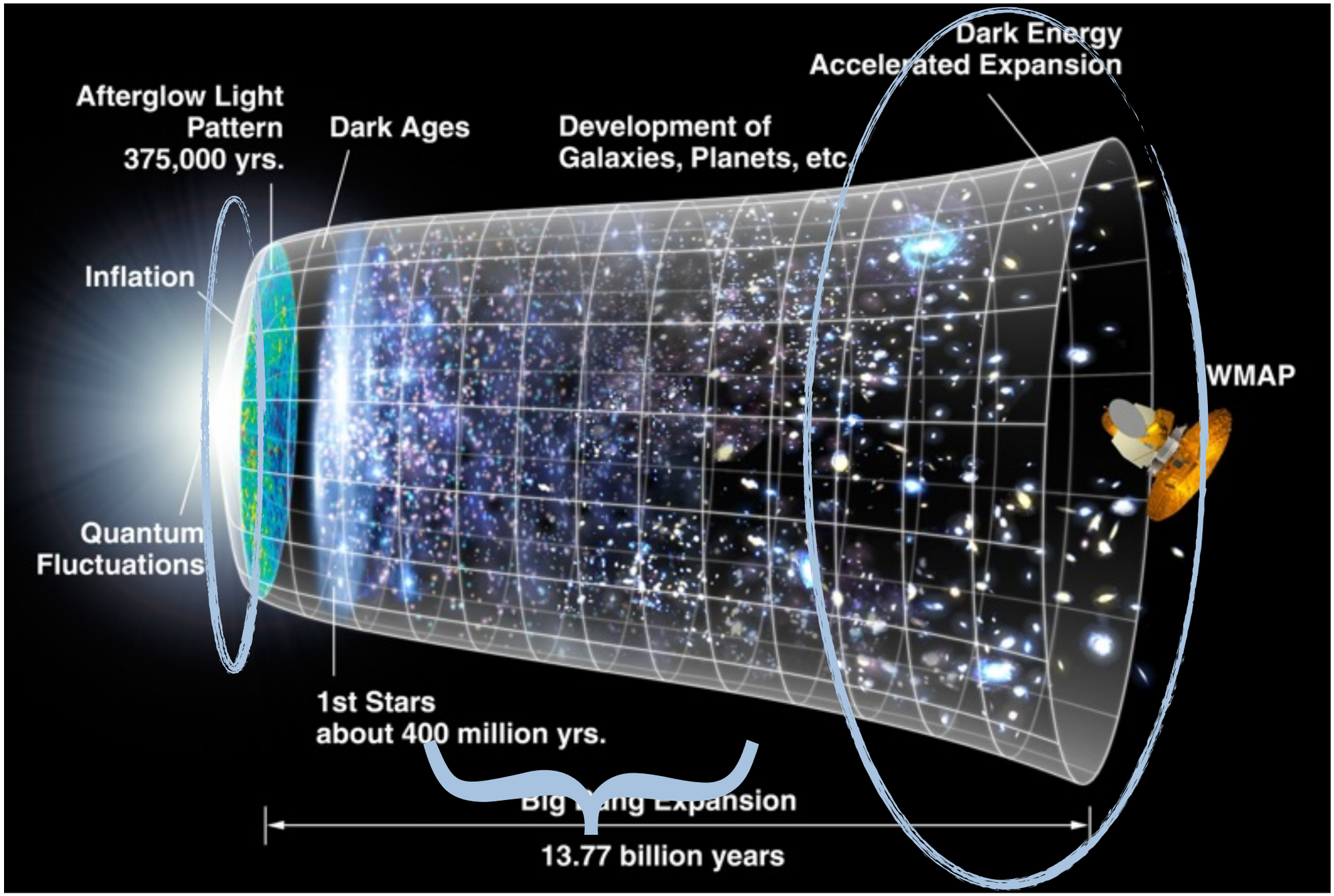
Other intensity mapping lines



SphereX satellite mission



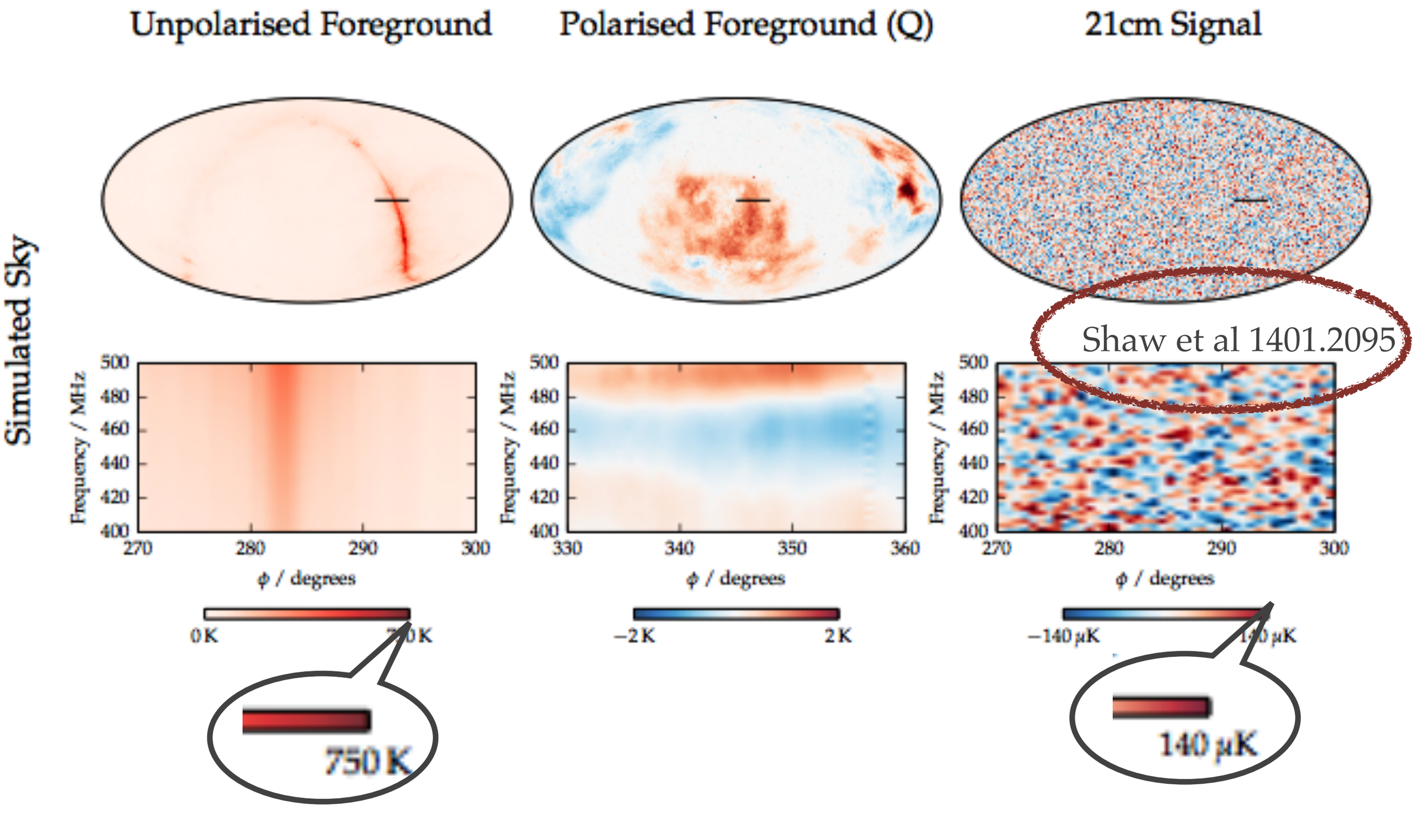
Towards ‘all the modes’: higher redshift



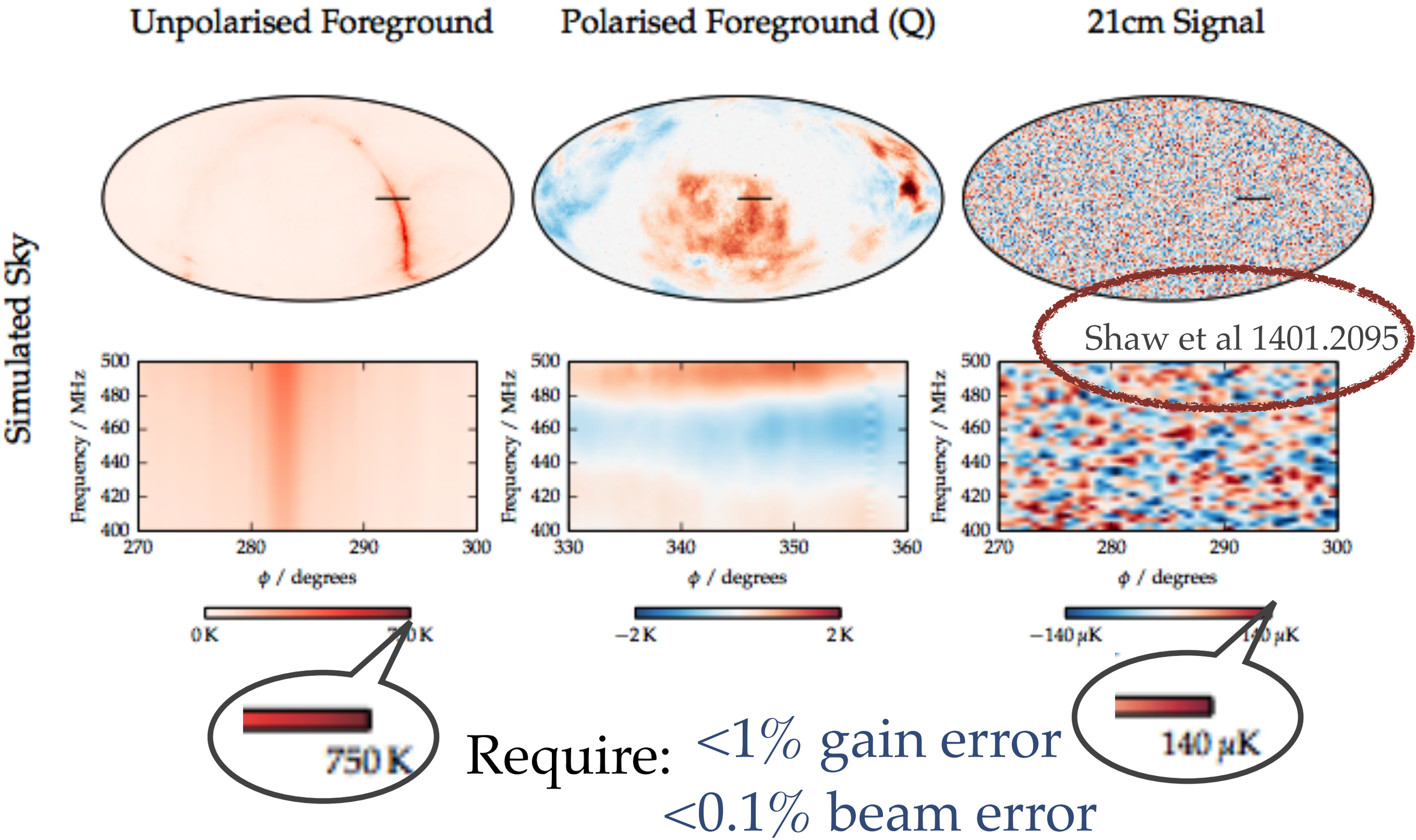
Towards ‘all the modes’: higher redshift

How do we get there with 21cm?

Noise budget ~ dominated by galactic signal



Also our biggest challenge



Require: <1% gain error

<0.1% beam error

Biggest technical challenge
(that we know about with no detection yet)

Higher redshift ⇔ more modes:

- Longer baselines ⇔ require better technology for transmission from dish to correlator (stable, not lossy over many km)
- more elements ⇔ analysis will require high degree of per-dish repeatability