The Canadian Hydrogen Intensity Mapping Experiment

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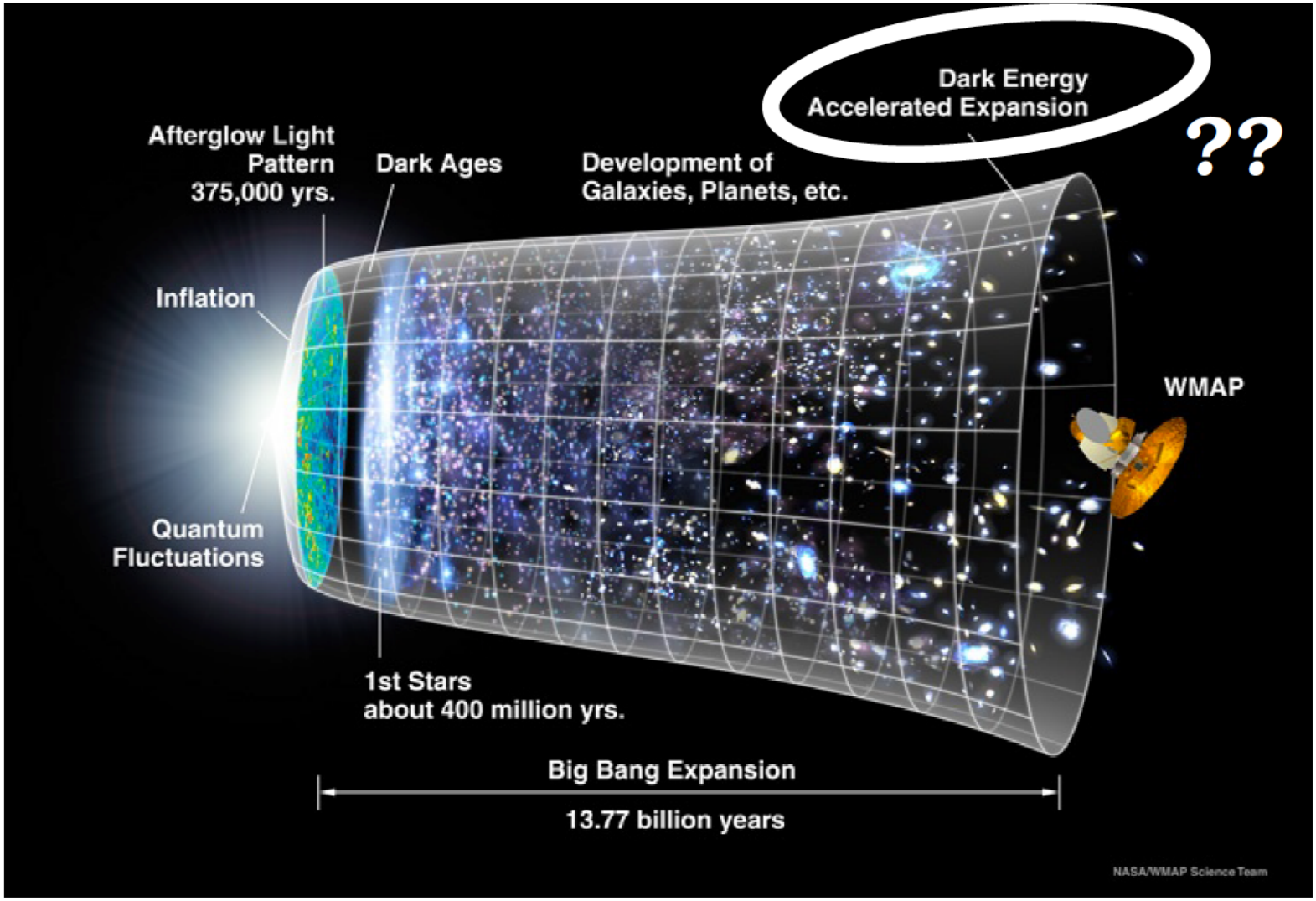
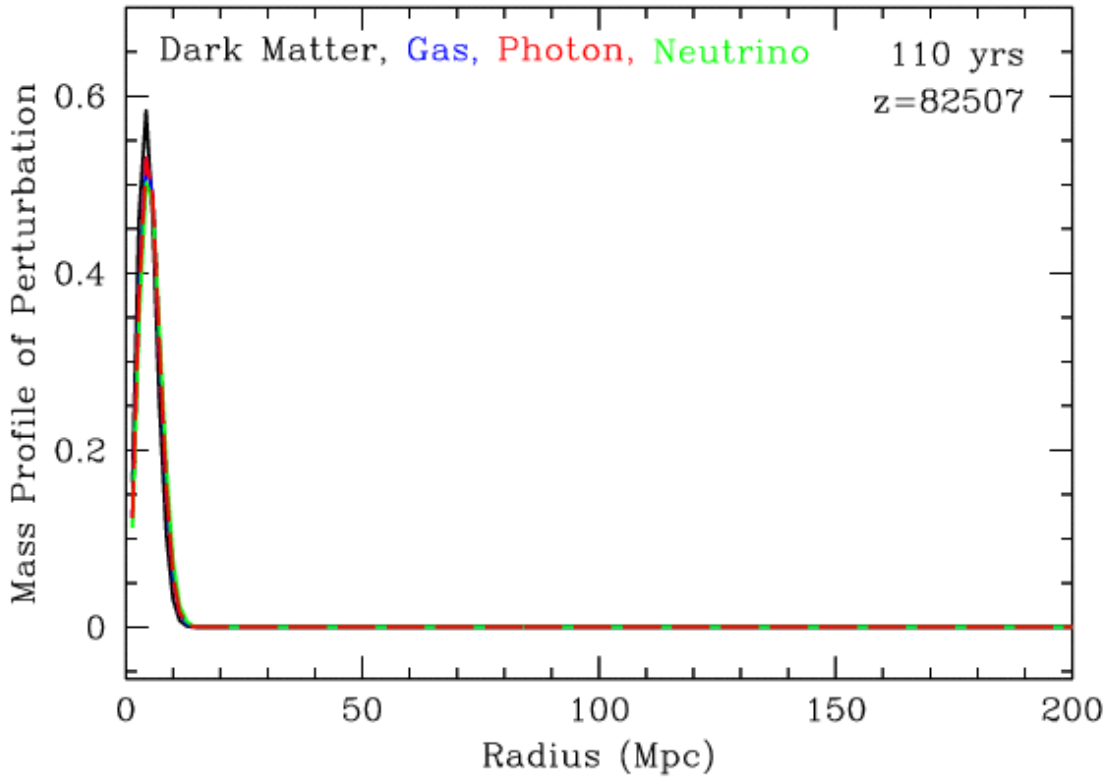
Motivation


Dark Energy
Accelerated Expansion
??
Afterglow Light
Pattern
375,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
WMAP
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.77 billion years
NASA/WMAP Science Team

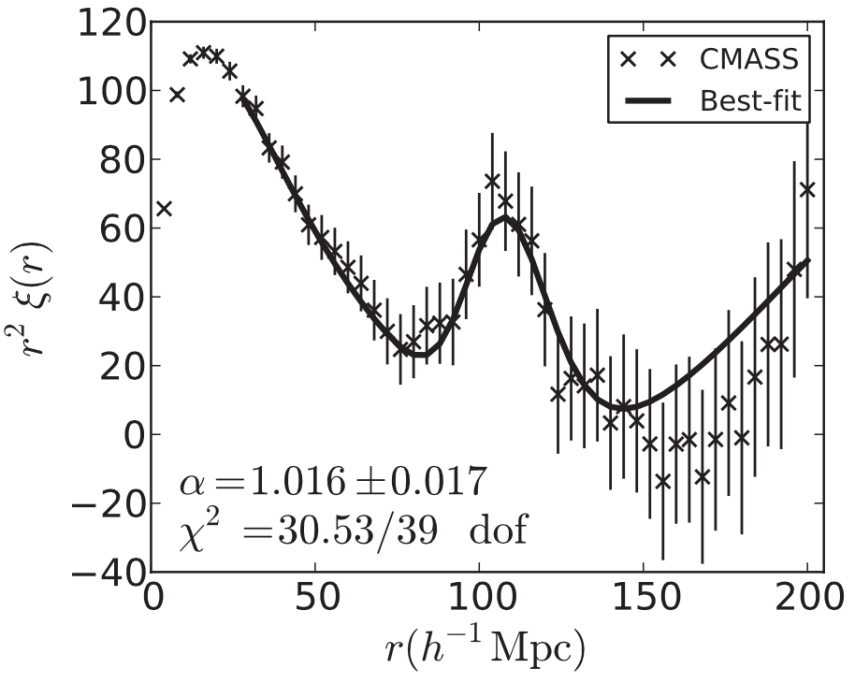
Baryon Acoustic Oscillations (BAO)

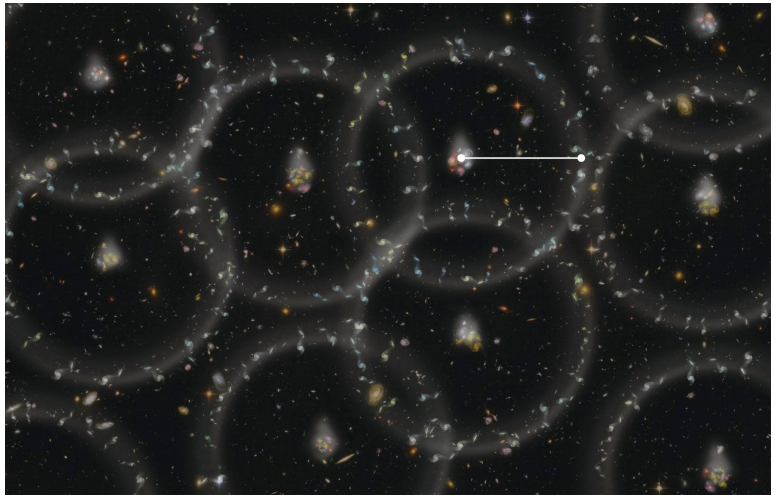
- Sound waves travel through early Universe
- Acoustic scale set at recombination



BAO Detections in Galaxy Redshift Surveys

BOSS-CMASS, Anderson et al. 2012

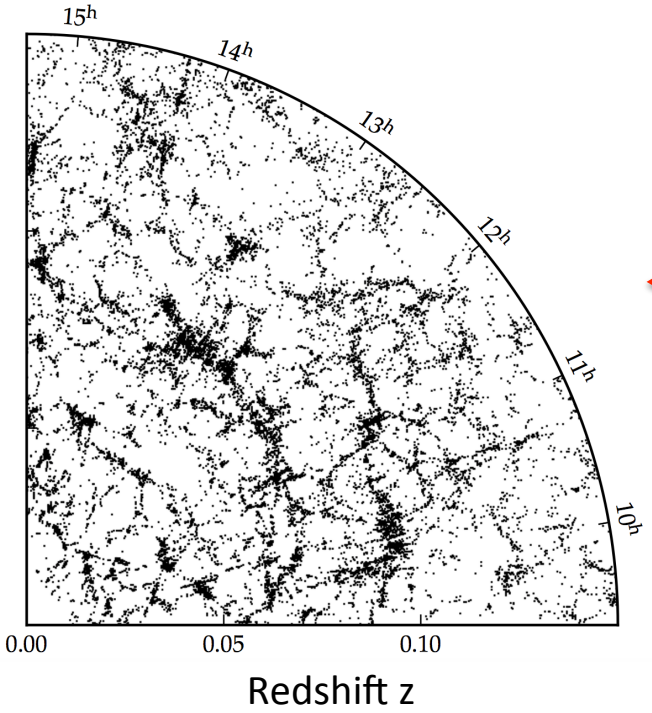


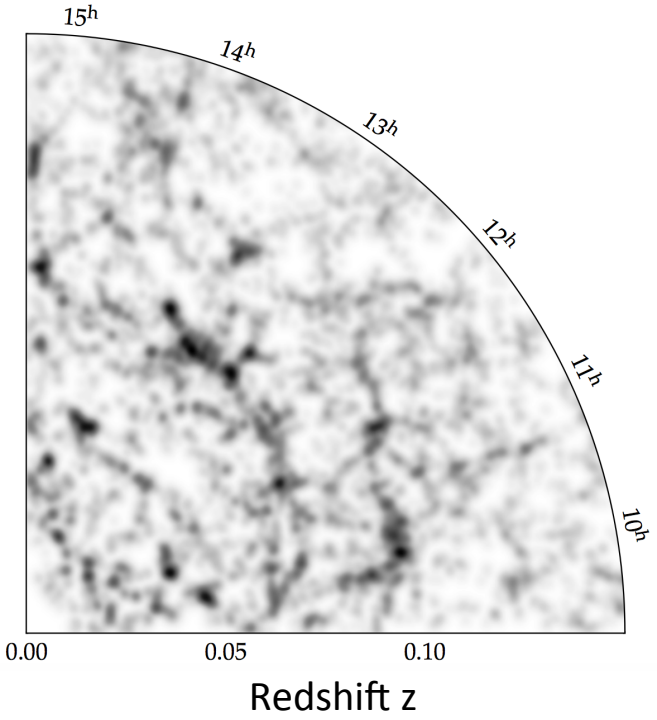


Artist's conception of the BAO rings
(Image by Zosia Rostomian, Lawrence Berkeley National Laboratory)

21 cm Intensity Mapping

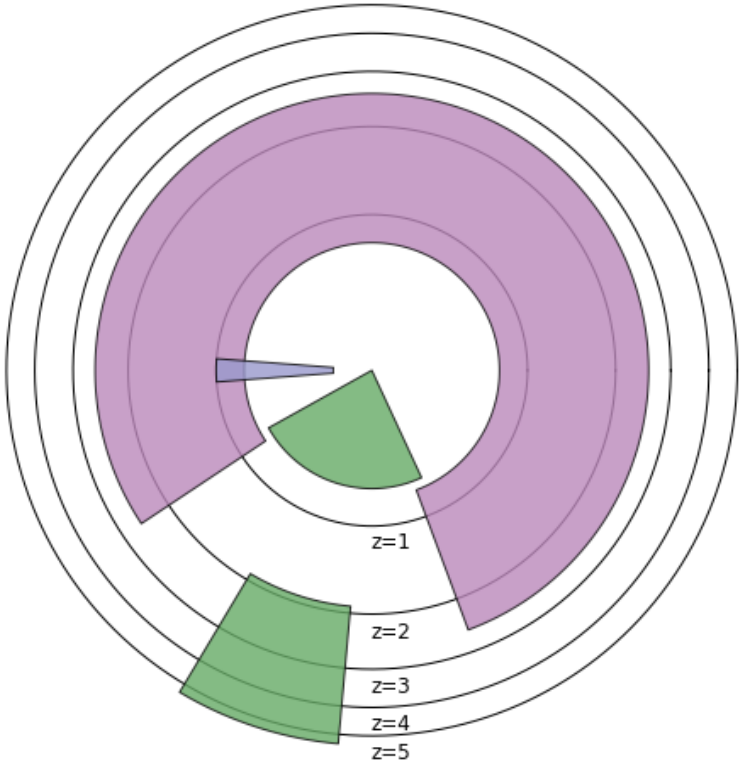
Galaxy Redshift Surveys versus 21 cm Intensity Mapping





Survey Volume

Slide from Richard Shaw



- WiggleZ: 1.2 $(h^{-1}\ Gpc)^3$
- BOSS
  - LRG: 5.3 $(h^{-1}\ Gpc)^3$
  - Lyα: 37 $(h^{-1}\ Gpc)^3$
- CHIME: 203 $(h^{-1}\ Gpc)^3$

Scaled such that:
area of patch = volume of survey

The Telescope

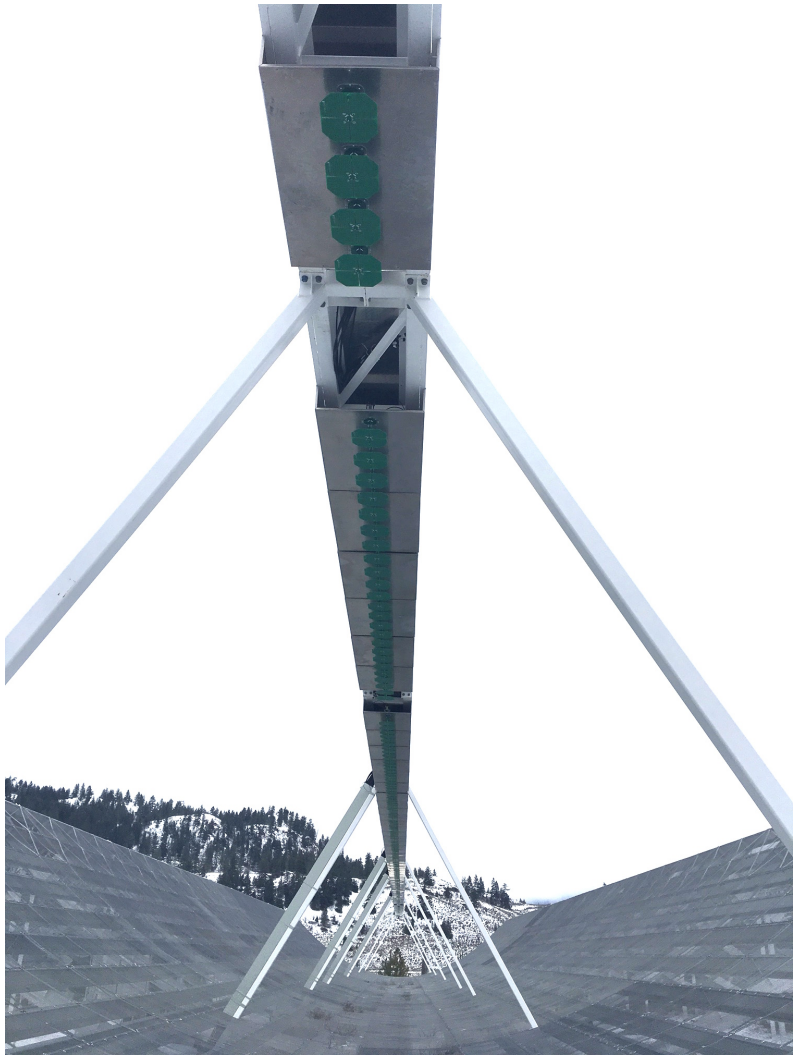
CHIME is situated in at the Dominion Radio Astrophysical Observatory, Penticton, Canada

The Telescope

CHIME is a cylindrical transit interferometer

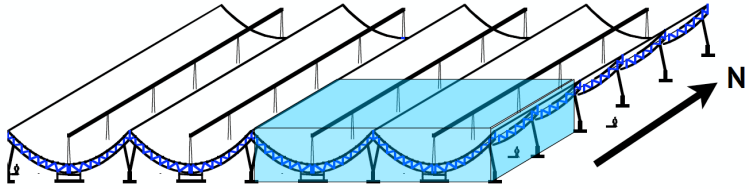
The Telescope

- Instrumented with 1024 dual-polarization antennae
- Largest FX-correlator in operation
- Observing frequencies: 400 – 800 MHz (redshift: $0.8 < z < 2.5$)
- Installation of hardware to be finished Summer 2017
- First light expected Fall / Winter 2017



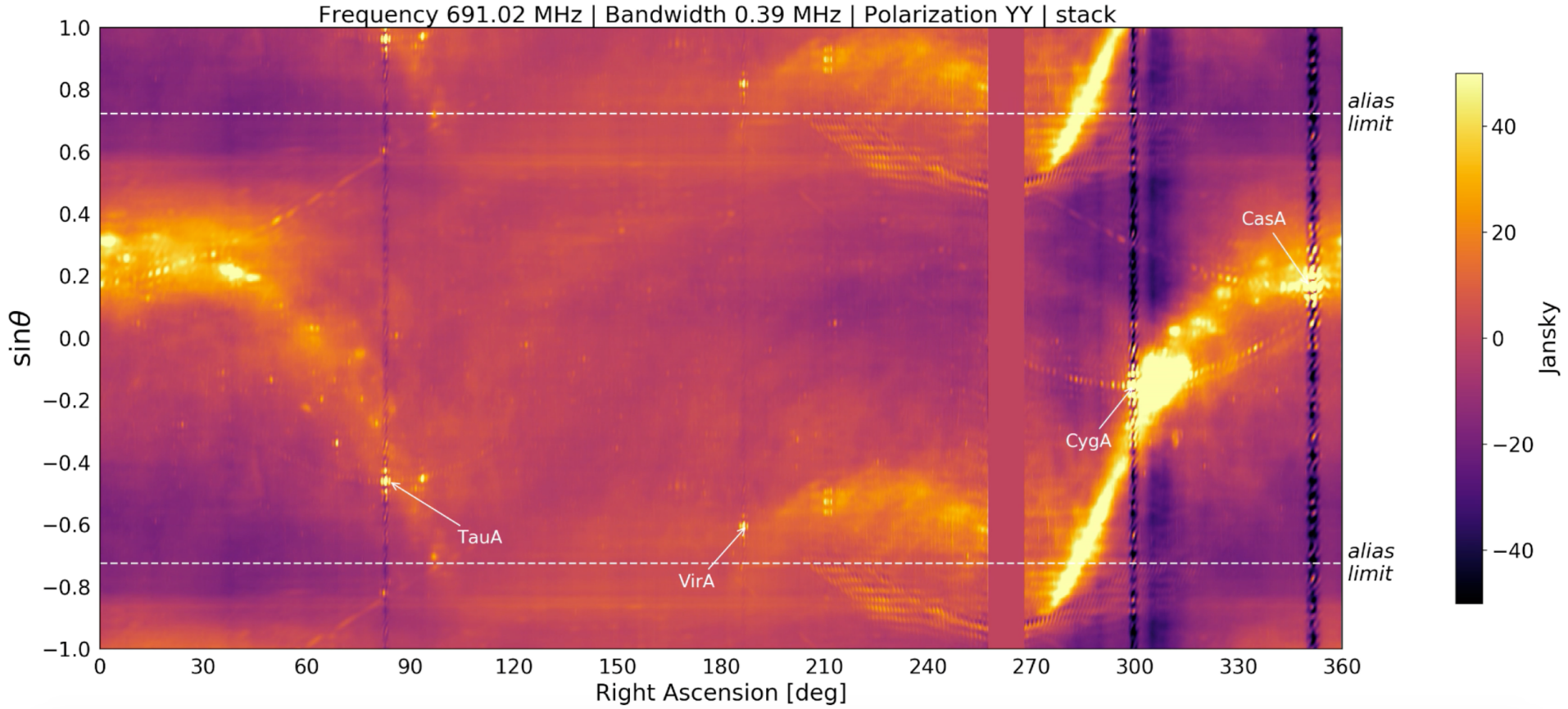
CHIME Pathfinder

- 2 reflectors
- 128 dual-polarization antennae
- Data collection since December 2014



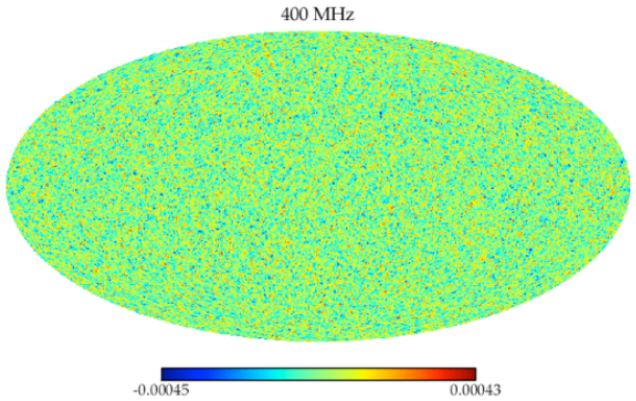
CHIME Pathfinder - Sky Map

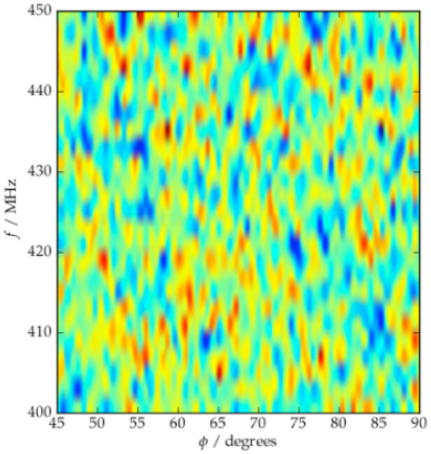
Processed data by Seth Siegel

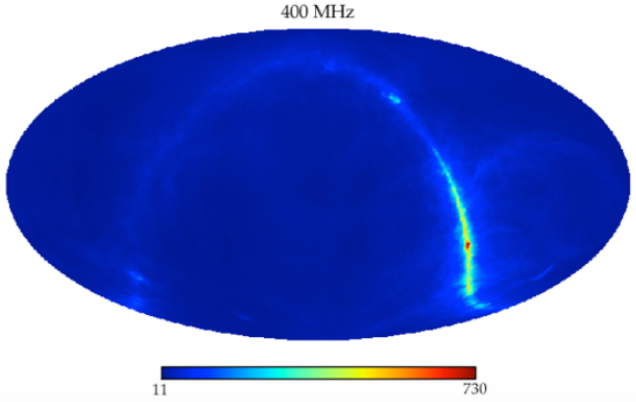


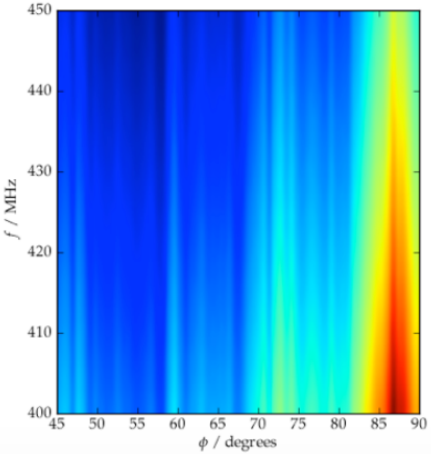
Challenges: Foreground

Slide from Richard Shaw





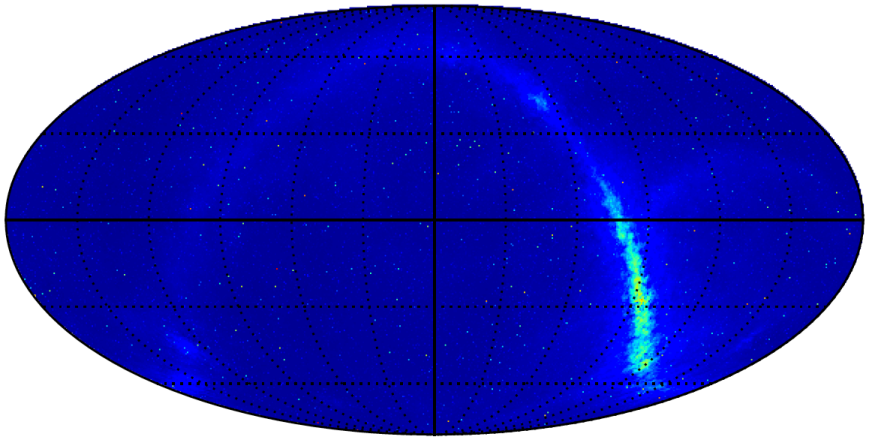




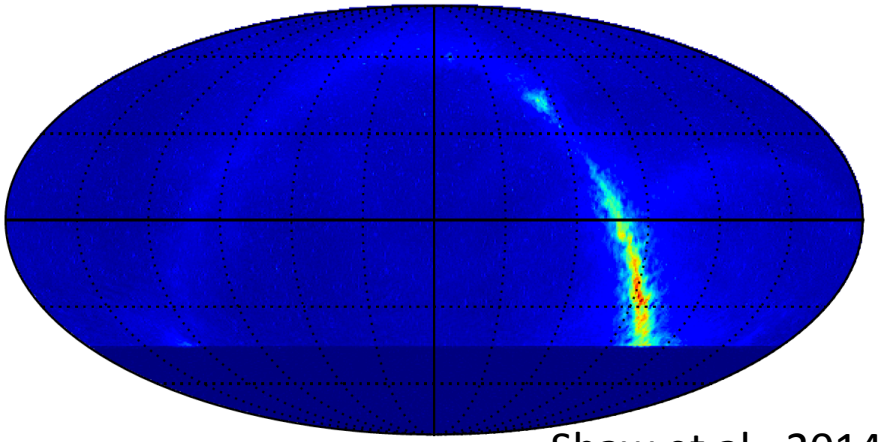
Simulations

- Instrumental effects complicate foreground subtraction
  - Study gain errors
  - Study beam errors (feed dependence, frequency dependence)
- Need new end-to-end simulations based on realistic inputs

Point sources and foregrounds



Sky as seen through instrument



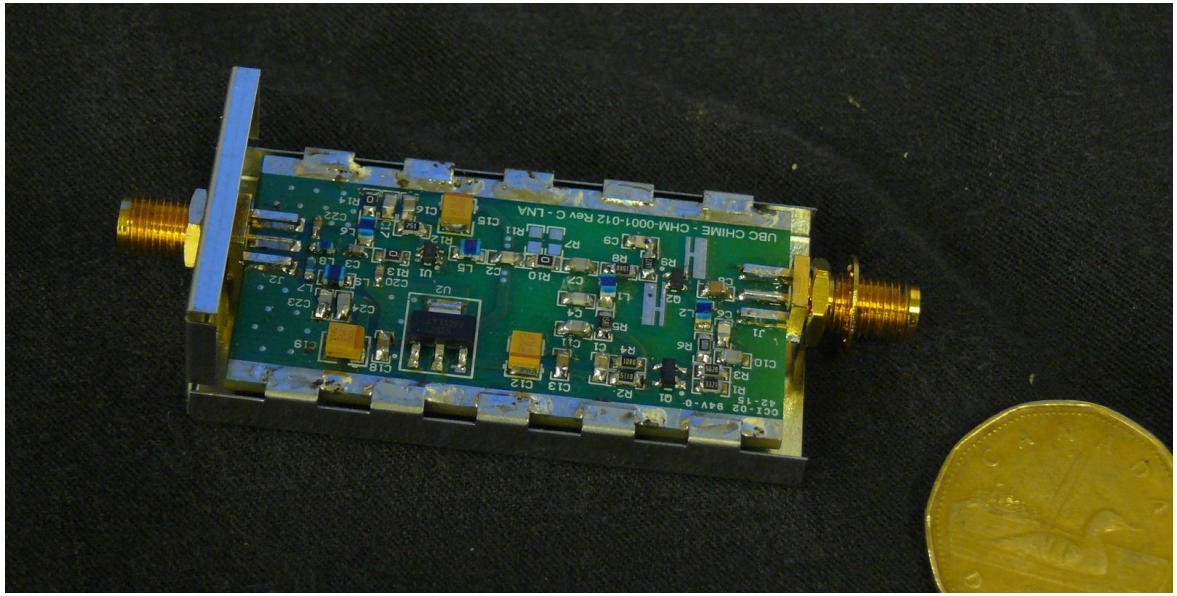
Shaw et al., 2014

Complex Gain

- Simulations suggested high precision knowledge of gain

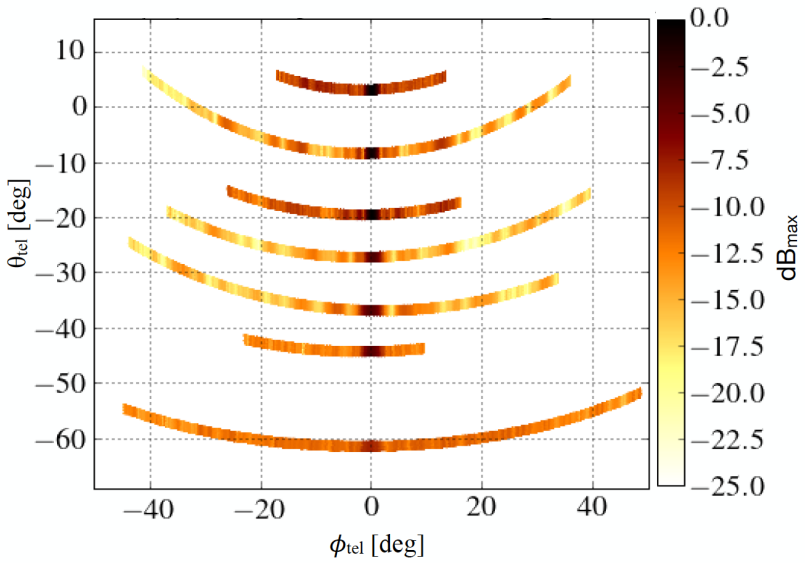
Shaw et al., 2014

- Now – complex gain simulation with realistic inputs
- Example input: lab measurements of low noise amplifiers



Primary Beam

- Simulations suggested need to know FWHM to 0.1%
- Need realistic beam perturbations
- Use holography measurements with 26m single dish



Berger and
CHIME collaboration, 2016

Questions?

Thanks!