HIGH-FIDELITY SIMULATIONS OF **EXCLAIM** MISSION DATA

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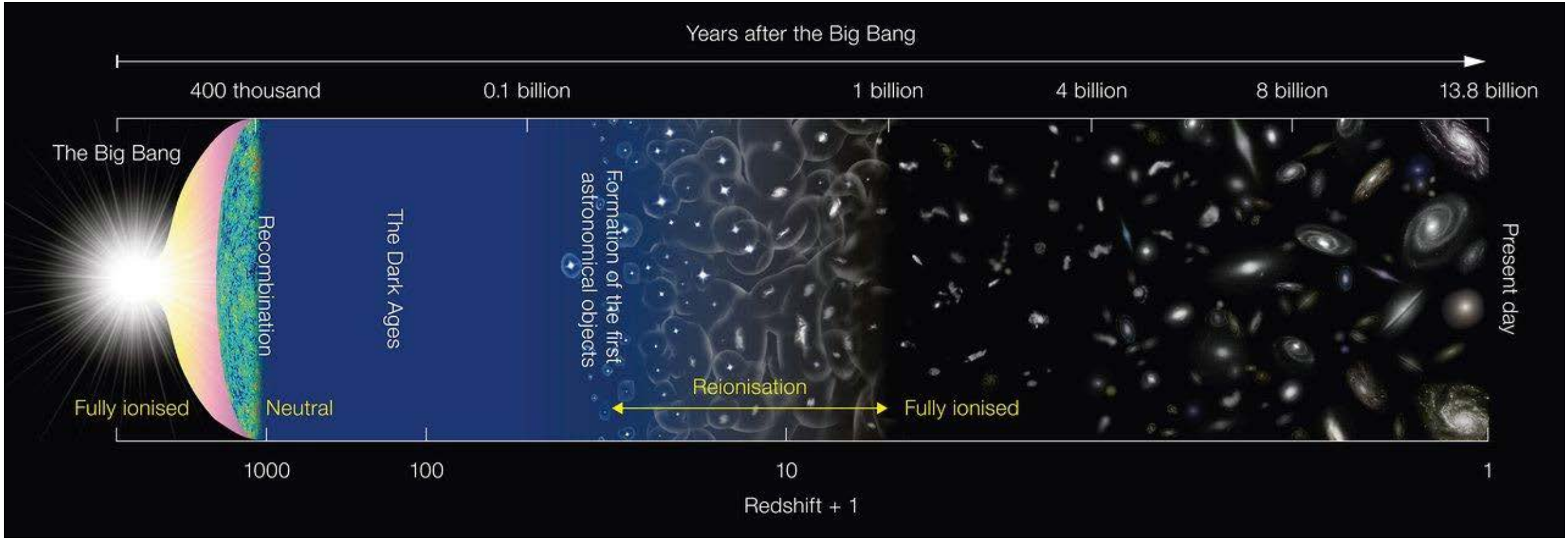
EVOLUTION OF THE UNIVERSE



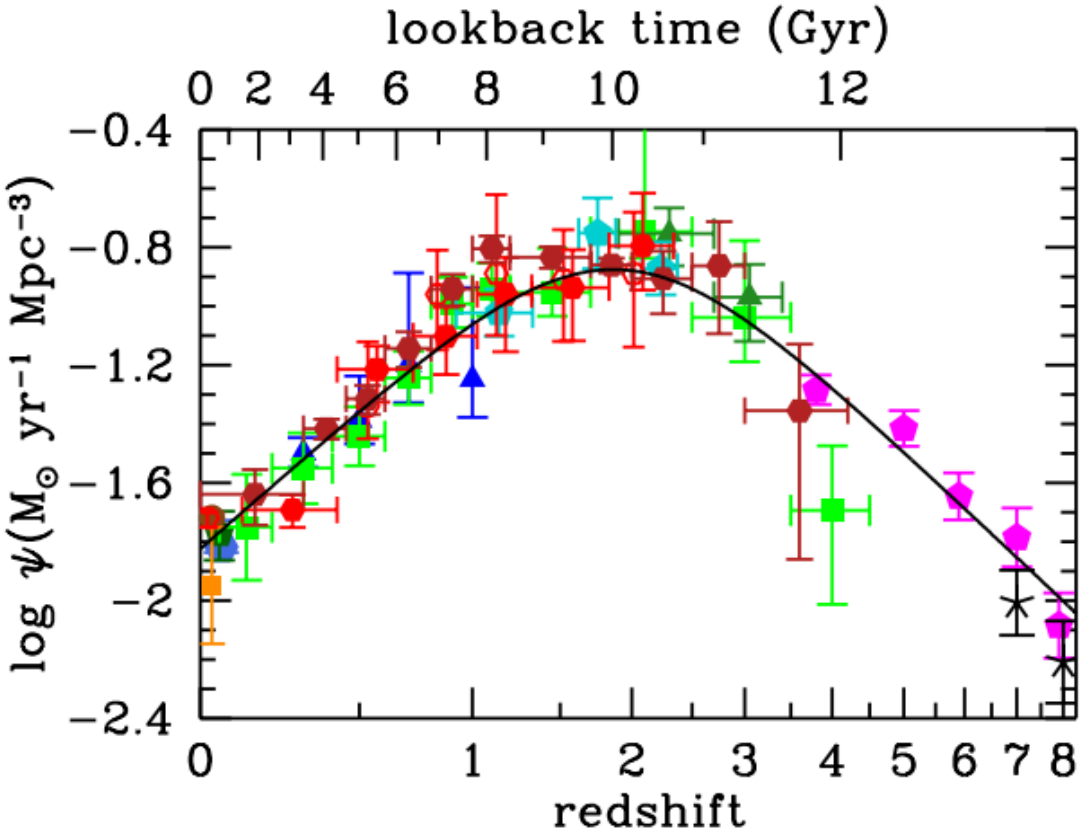
Code 665: *Observational Cosmology Laboratory* – studies the structure, the evolution, and the origin of the universe through observation, using instruments such as telescopes and cosmic ray detectors.

Image Credit: NAOJ, 2016
https://www.eso.org/public/images/eso1620a/

PRIMARY SCIENCE BEHIND EXCLAIM

Motivations

- What led to the rapid decline in star formation?
- What is the typical abundance, excitation, and evolution of the molecular gas which forms stars?
- How can we best use intensity mapping to probe higher redshifts?
- And more!!



Red, brown, and orange data points represents the cosmic star formation rate density from IR data. Blue, Green, Pink, etc. represents rate density from UV data (Dickinson & Madau, 2014).

PRIMARY SCIENCE BEHIND EXCLAIM

Line Intensity Mapping – measures the integrated sky emission from an atomic or a molecular line transition at different redshifts. (NASA/LAMBDA Archive Team, 2021).

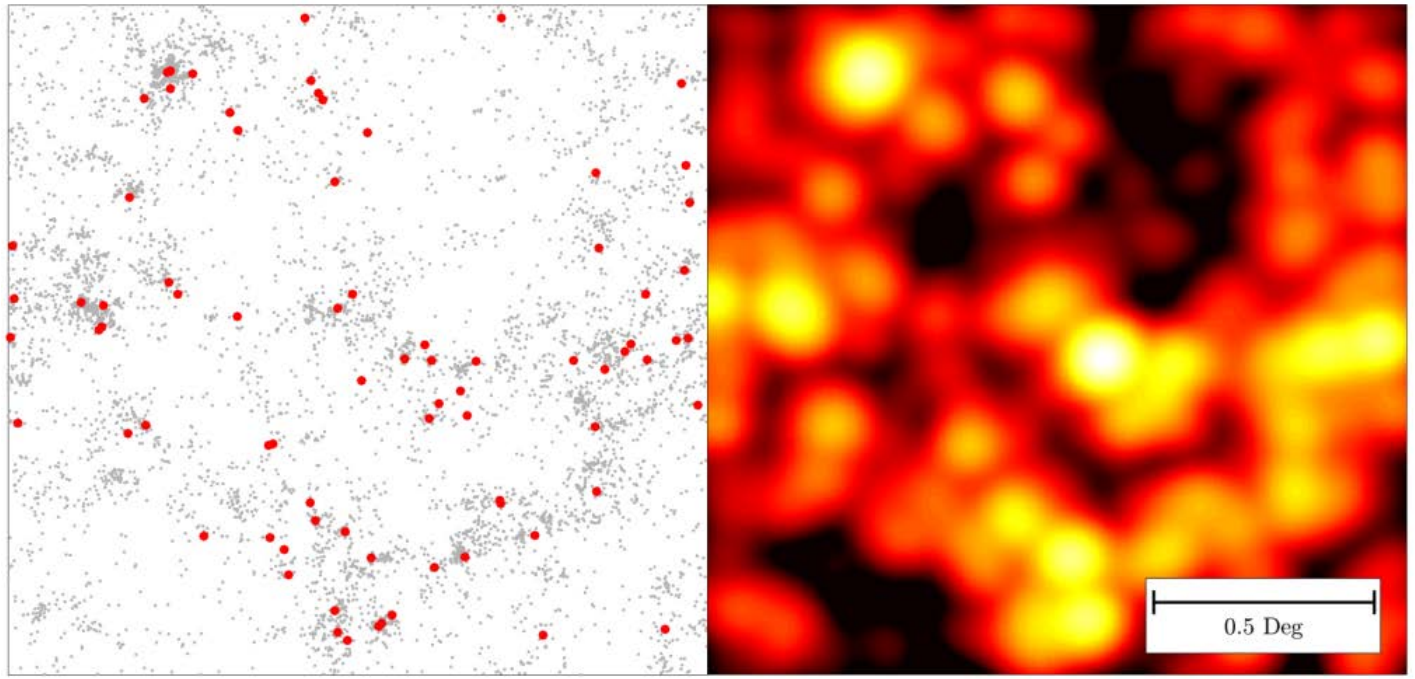
Benefits

- Tracks growth of cosmic structure
- Sensitive to the faintest sources
- Can map large volumes a lot faster
- Cost effective
- Lots of scientific applications

Caveats

- Will measure all other forms of radiation
- Sensitivity is limited
- Cross-correlation with previous surveys is required

(Switzer et. al., 2020)



A simulated 2.5 x 2.5 deg field with galaxy positions shown by red dots (Left) and the corresponding CO intensity map (Right) (Kovetz et. al., 2017).

OVERVIEW OF EXCLAIM

EXperiment for **C**ryogenic **L**arge-**A**perture **I**ntensity **M**apping

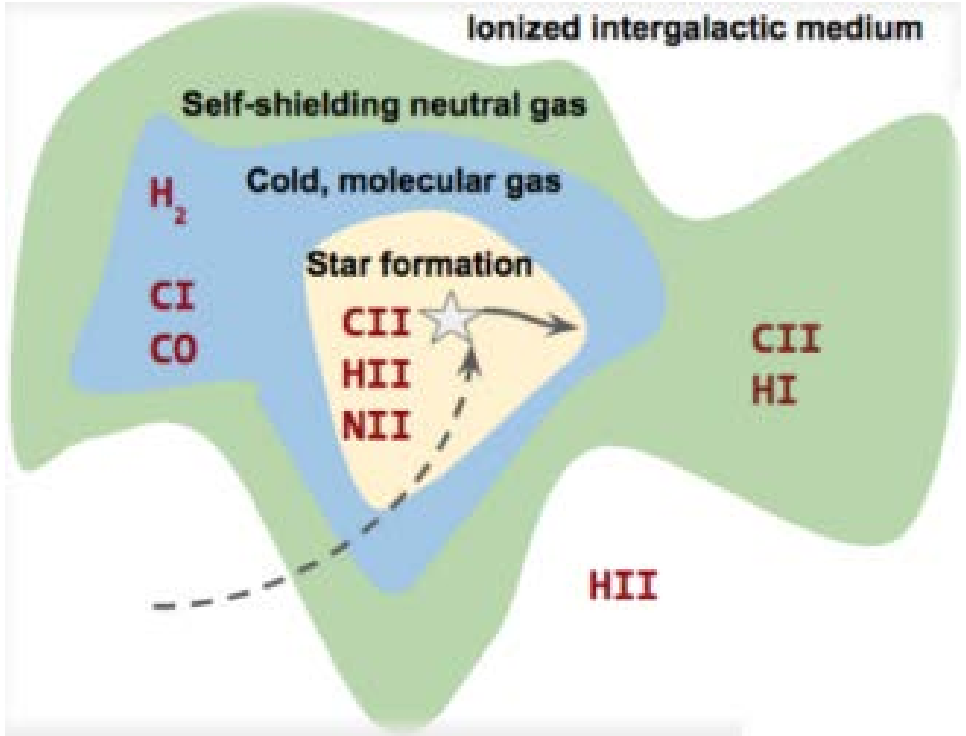


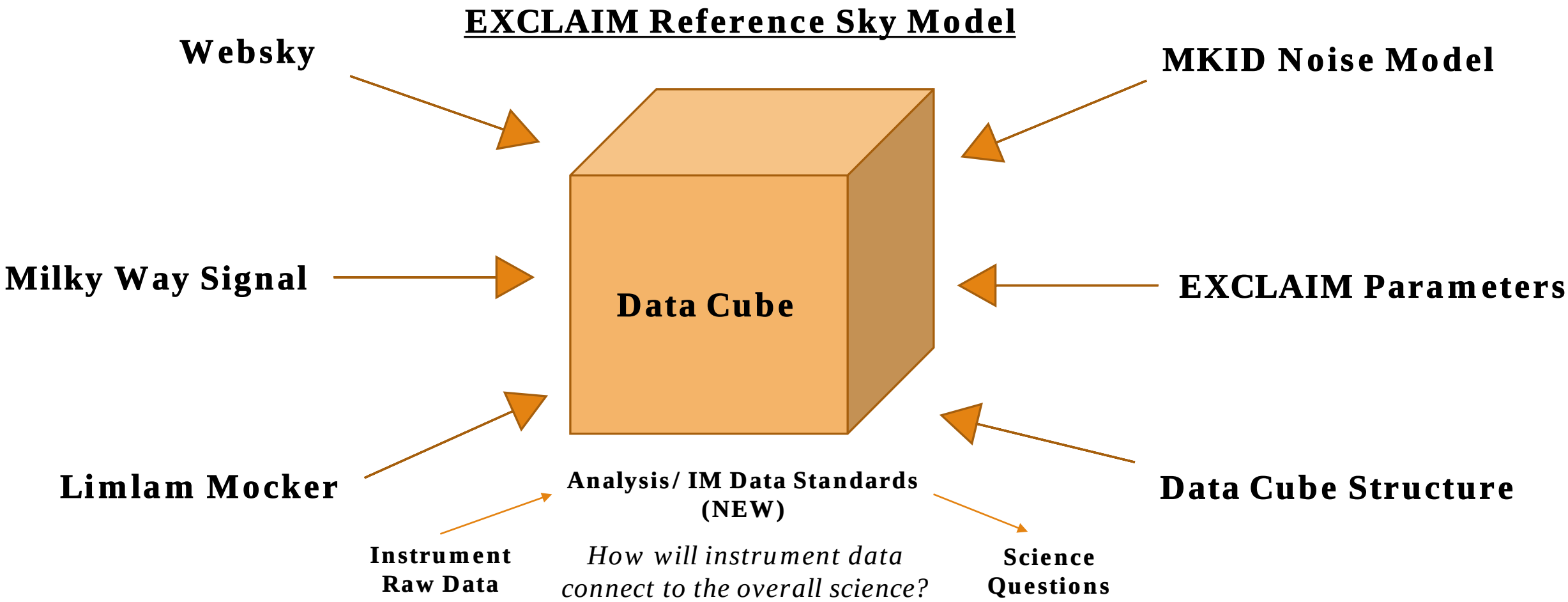
Illustration was created by Dr. Eric Switzer to show the primary science for each tracer.

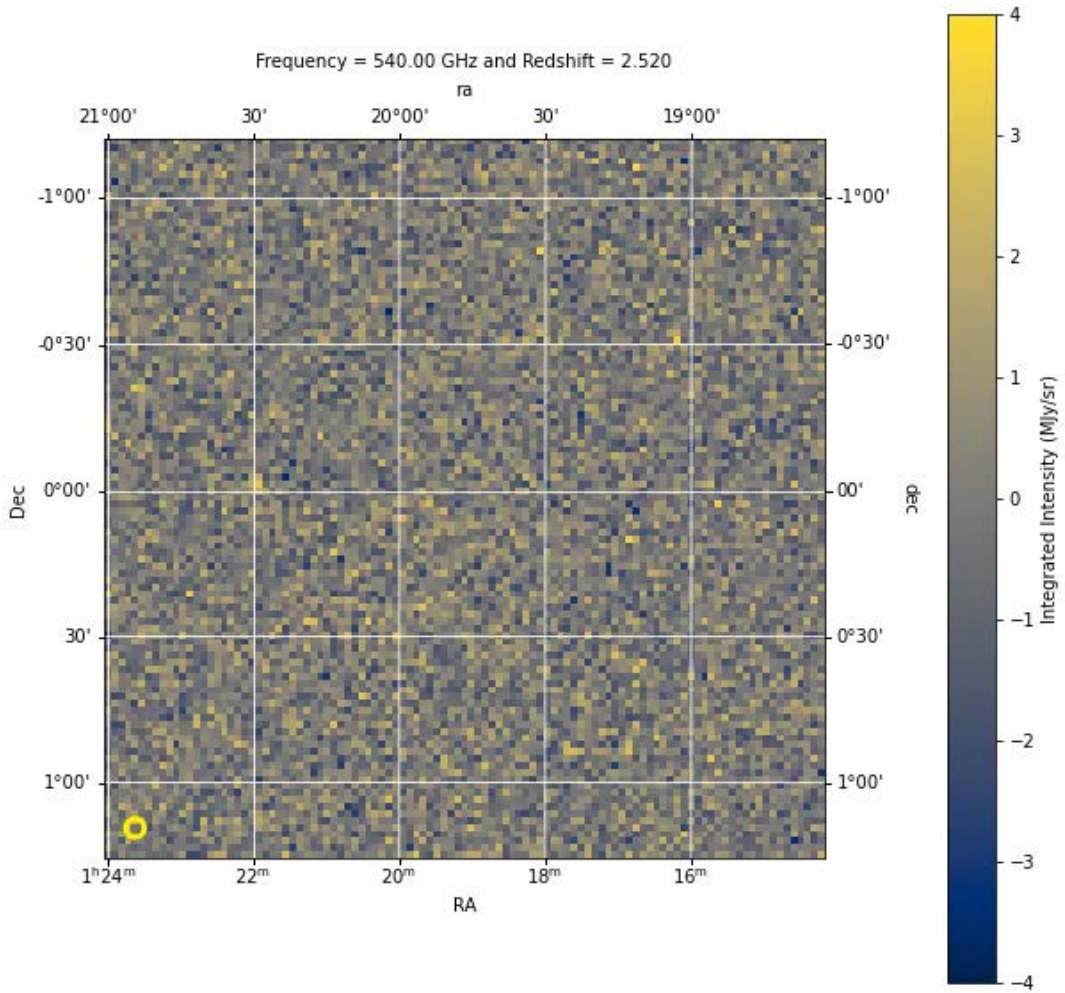
EXCLAIM is a balloon-borne far-infrared telescope mission designed to map redshifted CO and CII.

Band: 420 – 540 GHz
Resolution: R ~ 512
Redshifts: CO $0 < z < 0.7$, **CII** $2.5 < z < 3.5$, **CI** $z \sim 0$
Cross Correlation: Baryon Oscillation Spectroscopic Survey (BOSS) – a well-defined and large-area spectroscopic galaxy redshift survey

(Essinger-Hileman, 2020)

CURRENT SIMULATION WORK





MY SIMULATION WORK

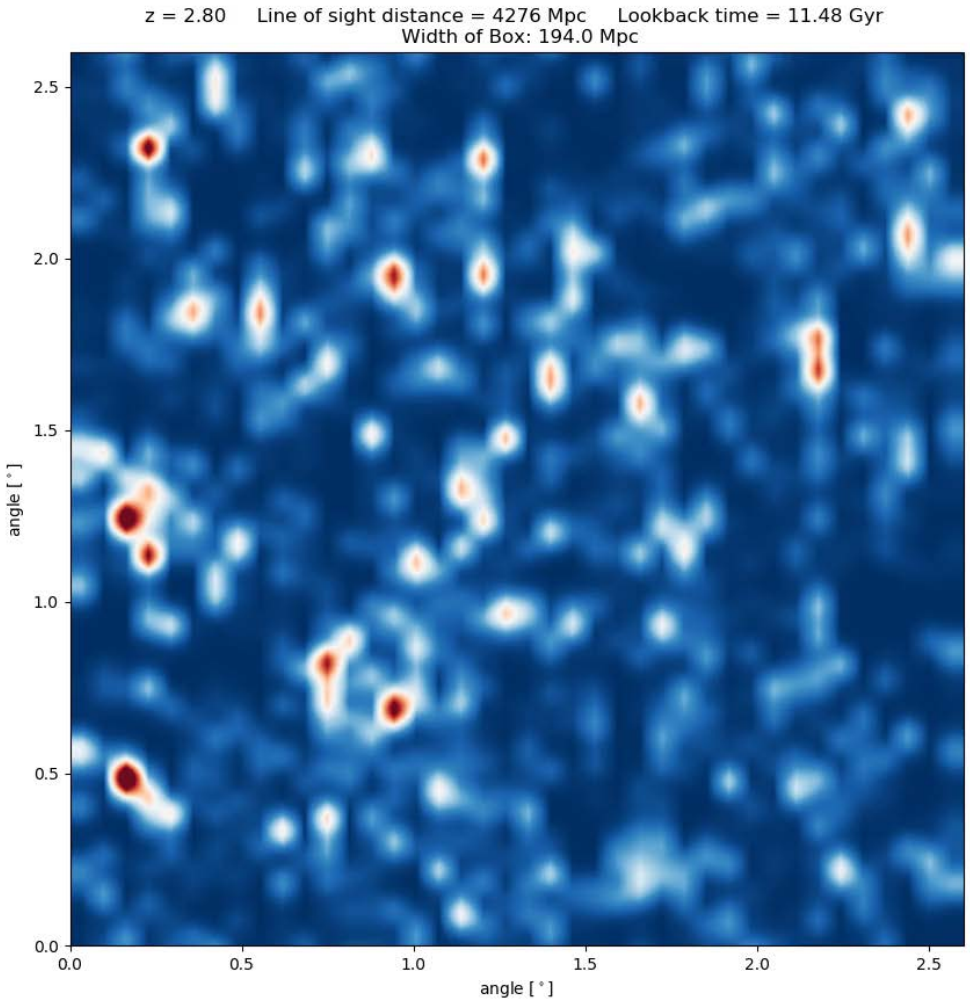
"What constitutes and describes intensity map data?"

My Project: Established the structure for visualizing real intensity map data in Python.

- Celestial coordinates
- Spatial slices with color scale
- Storage and representation of frequency/redshift
- Specifying instrument angular resolution
- Specifying spectral coverage
- Management of related data
- Survey region dimensions
- Pixelization

End Goal: Create a mission reference simulation pipeline

SIMULATED INTENSITY MAP



(Trevor Oxholm, 2021)

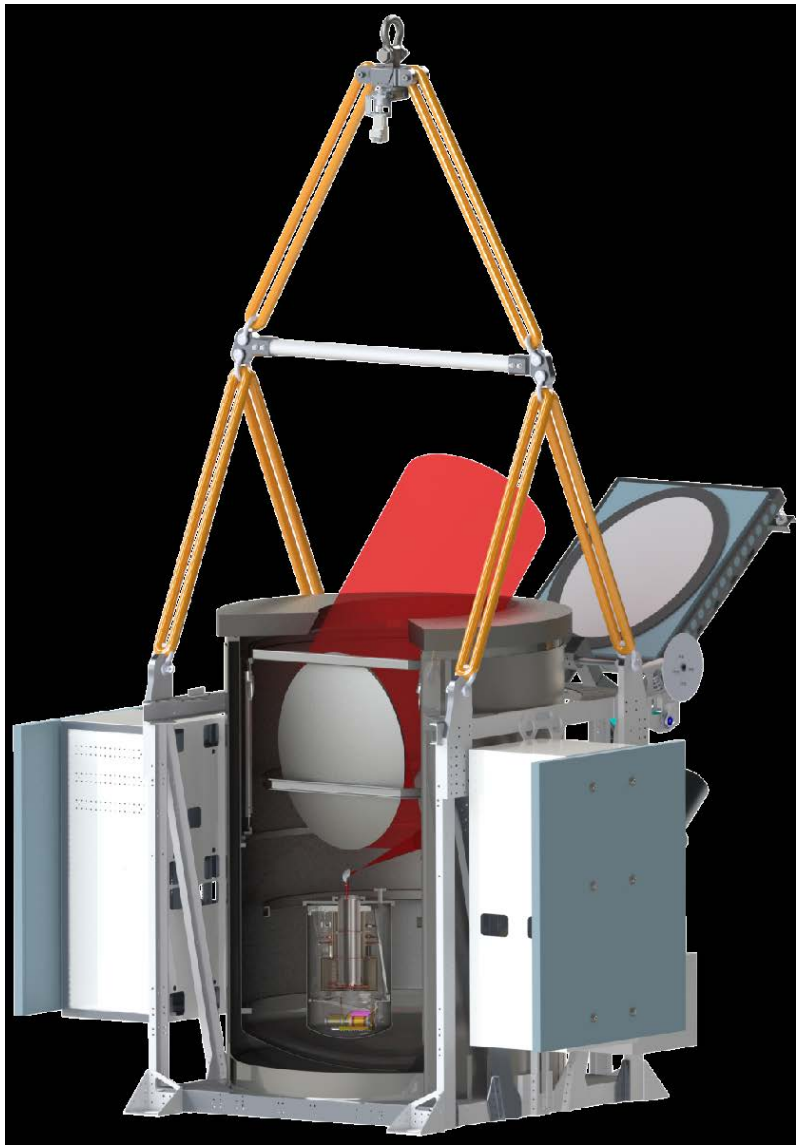
FUTURE WORK

Future Work

- Develop data cubes using limlam mocker and websky.
- Implement EXCLAIM instrument noise
- The data cube will be used to analyze the data taken.
- Modify simulation pipeline for future LIM missions.

EXCLAIM Schedule

Mission Start Date: April 2019
Engineering Flight Date: Sept. 2022
Science Flight Date: Late 2023



(Volpert, 2021)

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