Developing a Simulation Pipeline for CII and CO Line Intensity Mapping Experiments

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Line Intensity Mapping (LIM) is a novel observational technique that measures the integrated sum of all spectra emitted at a particular frequency in a given pixel in the sky.

LIMs of different spectral lines have the ability to probe fainter/higher-redshift signals coming from all epochs of the Universe, and may even be sensitive to signals coming from the Epoch of Reionization, signatures of inflation and the cosmic microwave background.

LIM has yet to demonstrate success on it's own, but there is promise in detecting a signal through cross-correlating LIM maps with galaxy surveys.

For this reason, pathfinder LIM experiments will help us understand the capabilities and limitations of LIM as a competitive observation technique to galaxy surveys.

My project involves developing a simulations pipeline for a CII and CO example LIM mission covering a redshift range $(2.5 \leq z \leq 3.5)$

Take a look at some plots I have made so far on the following slide!

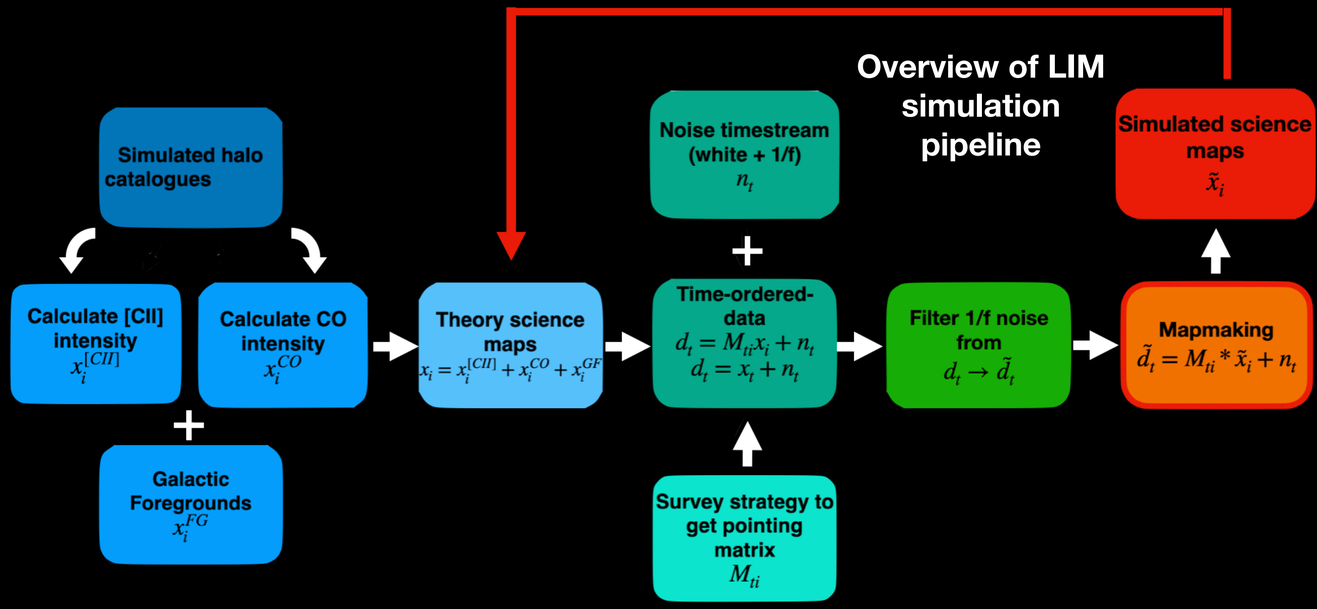
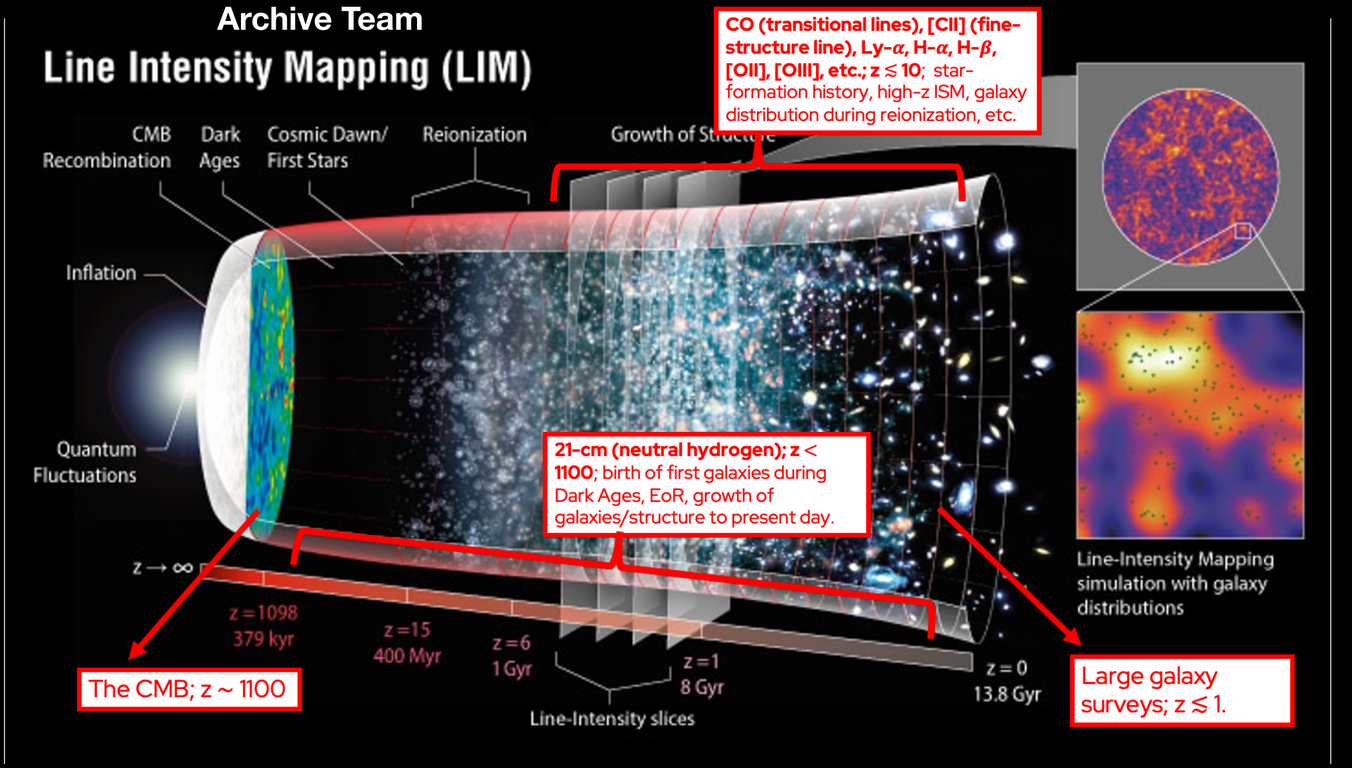


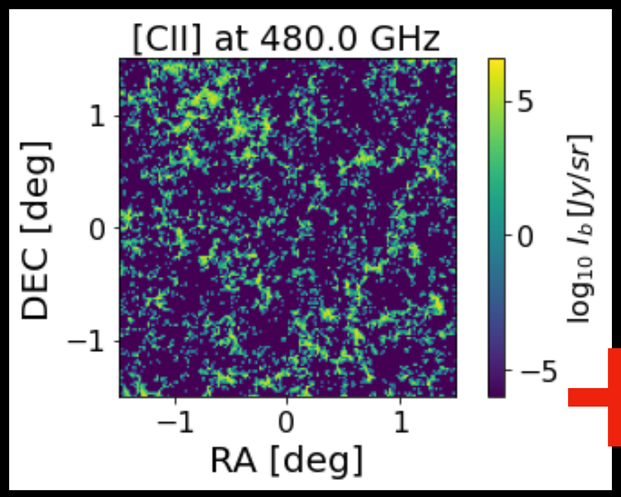
Image Credit: NASA / LAMBDA Archive Team

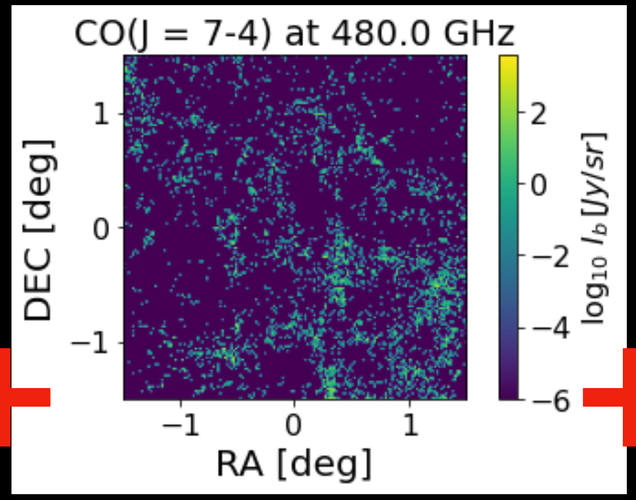


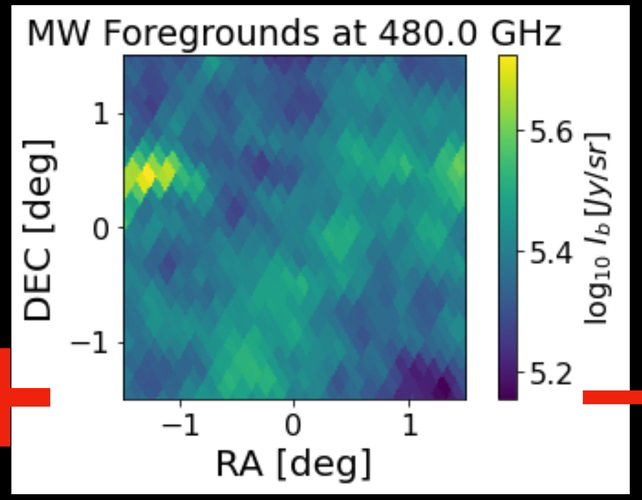
(z = 2.5 - 3.5)

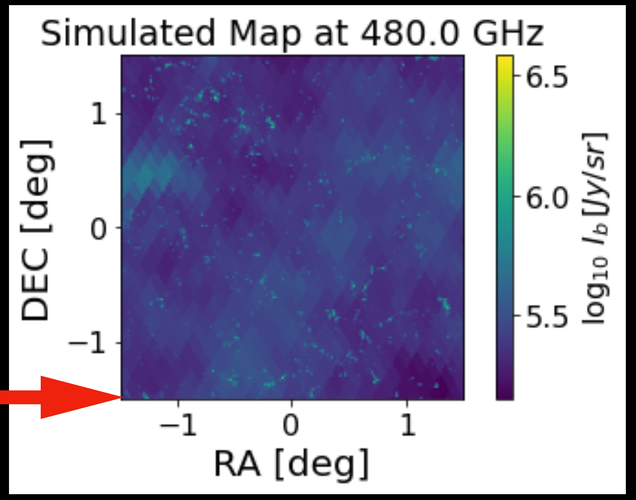
(z = 0.1 - 1.0)
CO(7-4) = CO(7-6) + CO(6-5) + CO(5-4)

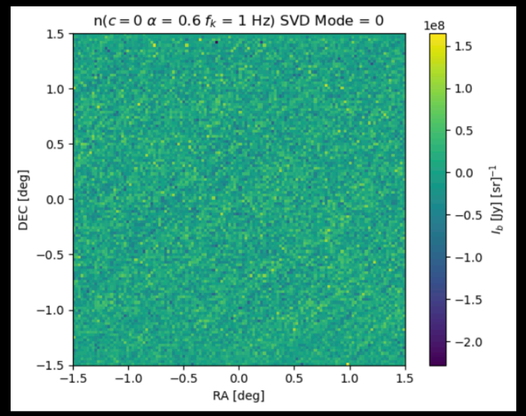
(Planck data)

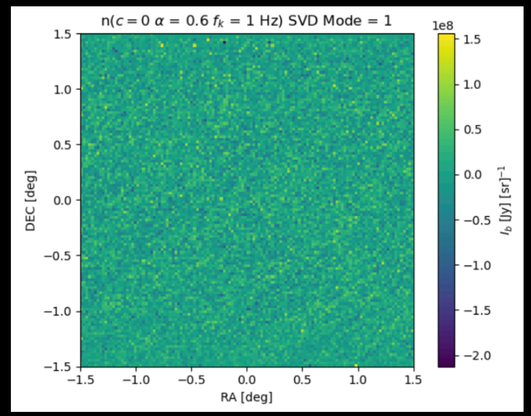


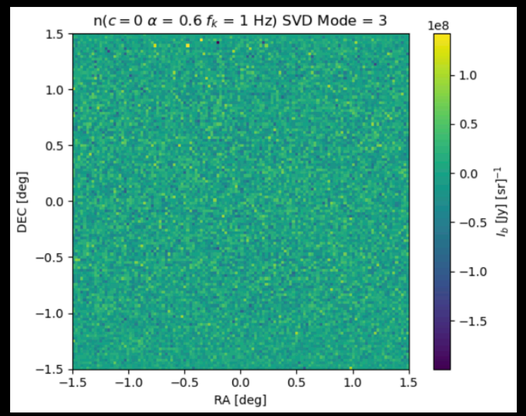


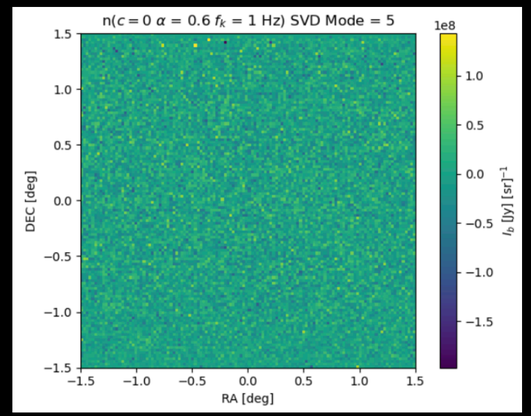




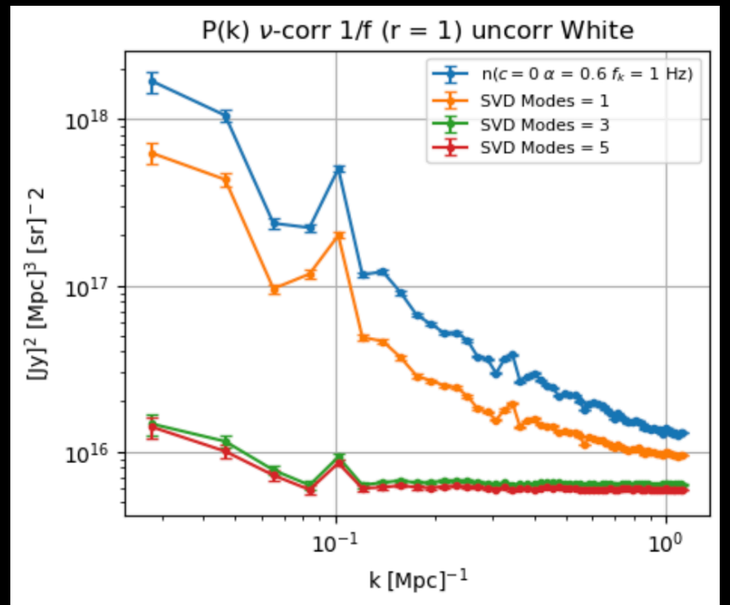








(Plots on the left) Instrumental and atmospheric 1/f + white noise. The value c on the plots on the left indicate the level of correlated noise between different frequency channels. This is a case with highly correlated noise. The SVD cleaner seems to perform quite well on reducing the 1/f noise (bottom plot)



(Top row plots) Maps generated using limlam-mocker - A package for LIM mapping (Stein G., Chung D.):

- mass-Peak Patch halo catalogues from CITA (G Stein 2018)
- Min halo mass ~2.5e10 M-solar
- [CII] → (Padmanabhan 2019)
- CO → (Li 2016 / Keating 2020)
- Generally, $I_{[CII]} > I_{CO}$ over 420 - 540 GHz
- Milky Way Foregrounds → PySM Python package. Thermal dust as a single-component modified blackbody. Uses Planck data (B. Thorne et al 2017)