Title: Creating Mock Maps for Line Intensity Mapping Experiments

Speakers: Doğa Tolgay

Collection/Series: Cosmic Ecosystems

Subject: Cosmology

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Abstract:

Line Intensity Mapping (LIM) experiments are innovative techniques for studying structures at high redshift. They allow us to uncover previously inaccessible astrophysical data by making 3D tomographic maps with 2D spatial line intensity fluctuations. As efforts like COMAP progress in detecting carbon monoxide (CO) and other spectral lines, generating precise mock maps becomes crucial for data analysis, prediction of future observations, and development of new statistical methods for LIM analysis. These mock maps are generated by interpolating line luminosities across the specified dark matter halo distribution, using response functions that are defined by the relationship between the line luminosities and both observable and derived properties of simulated galaxies.

In my presentation, I will elucidate the statistical relationship between the calculated line luminosity and inherent/derived observables for simulated FIRE (Feedback In Realistic Environment) galaxies, focusing on CO(1-0) to CO(8-7) lines at four different redshift regimes: z=0, 1, 2, and 3. I will examine the correlations between CO emission and galactic properties at different redshifts and explore the potential causal relationships they may suggest as well as how they can define essential response functions for creating mock maps.

Modelling Line Emissions from Simulated FIRE Galaxies to Make Mock Maps for LIM Experiments

Doğa Tolgay

With

D. Chung, N. Carlson, J. R. Bond, and N. Murray

University of Toronto / Canadian Institute for Theoretical Astrophysics

LIM Experiments are powerful experiments to probe the EoR

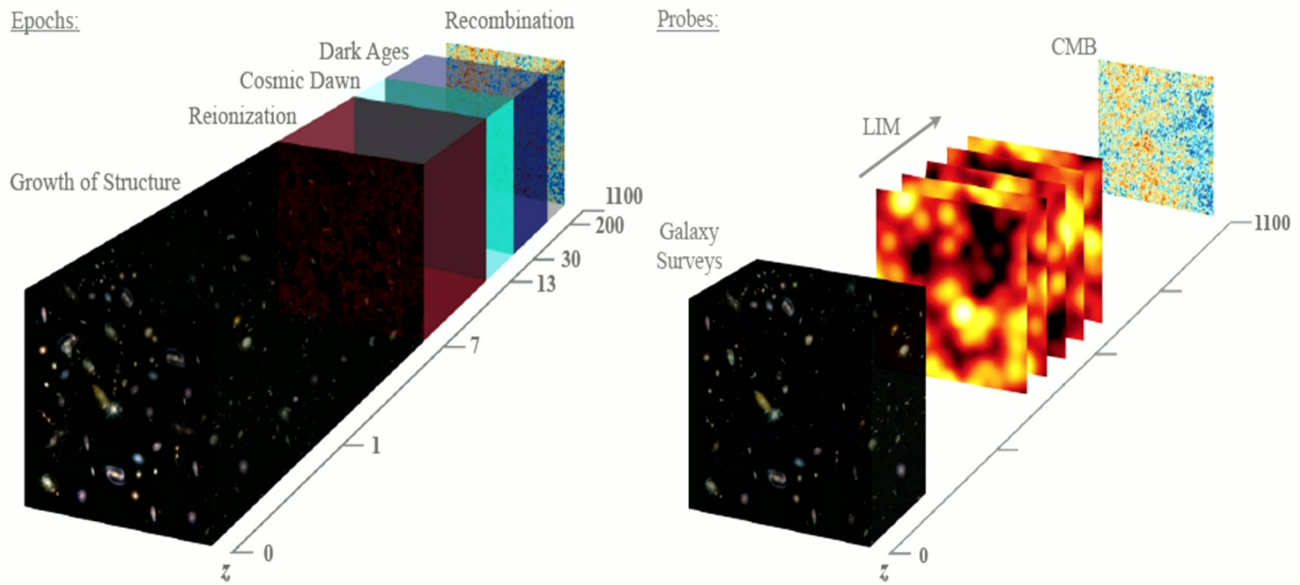
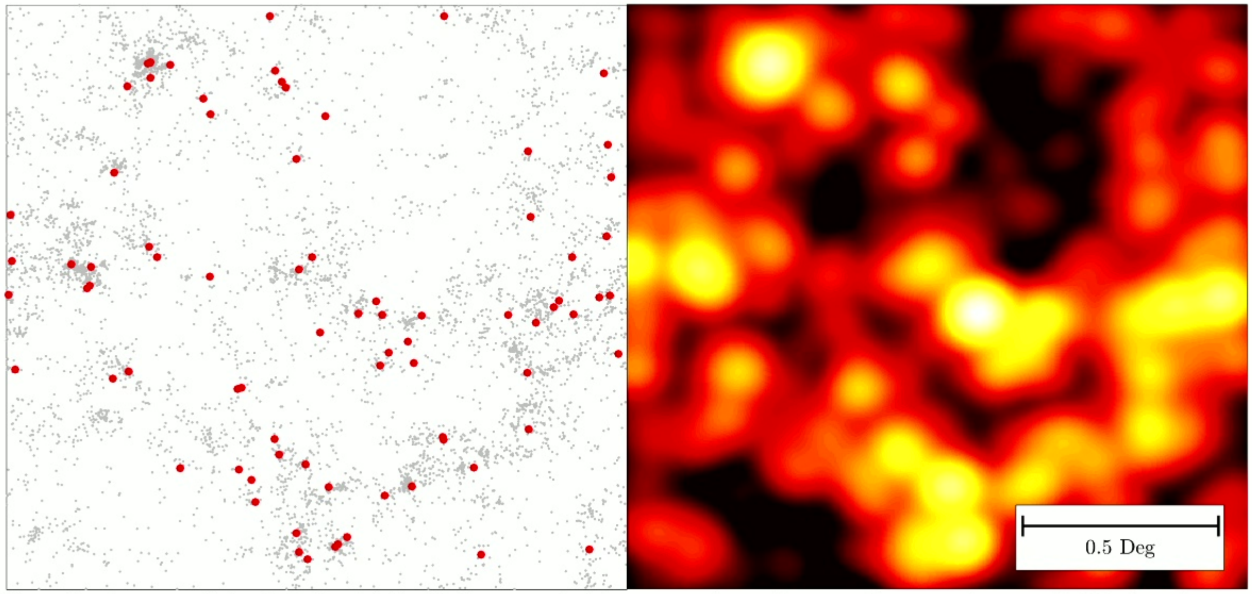


Figure retrieved from Kovetz et al., 2017

LIM can attain the information that is previously hidden from the galaxy surveys

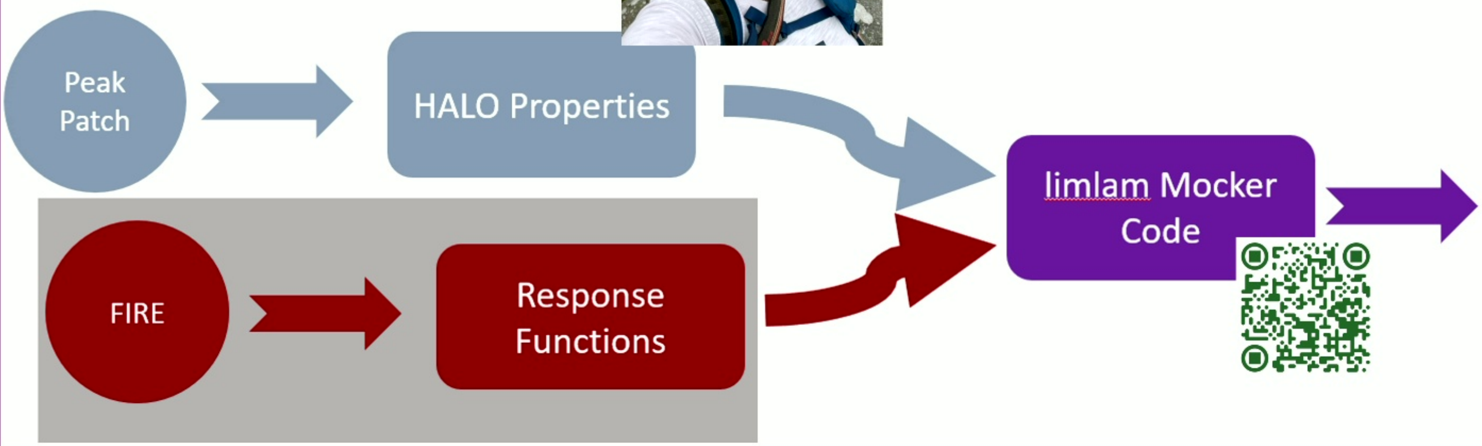
With the three times longer observation time VLA could only measure ~%1 of CO-emitting galaxies, while COMAP could produce a map of intensity fluctuations.

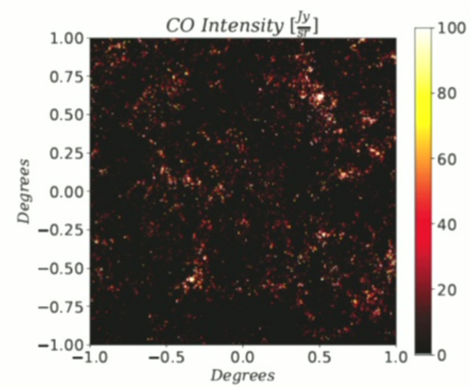


Simualted map of the 2.5 deg^2 field. Sources bright enough to detect after one hour of VLA time is marked with red. Figure taken from Kovetz et al., 2017, and created by Patrick Breysses

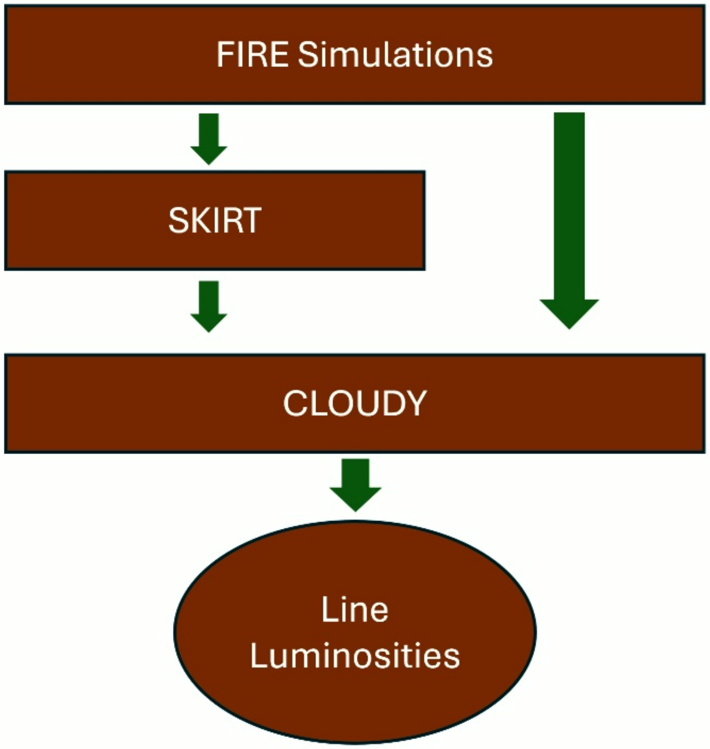
In the absence of confirmed detections mocks are powerful tools to study universe statistically

Nathan Carlson
Ph.D. Candidate at CITA / UofT





Post-processing of the FIRE outputs is required to compute the line luminosities of galaxies.



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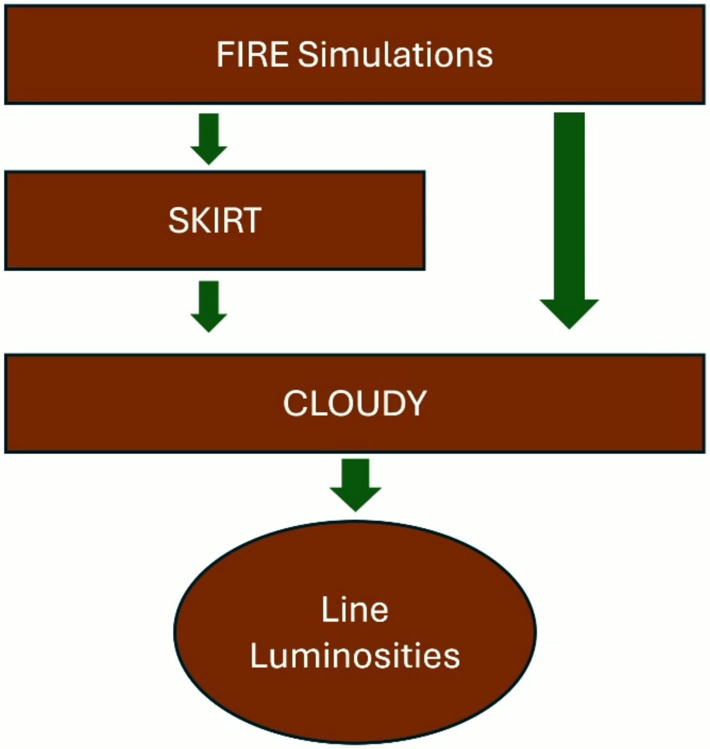
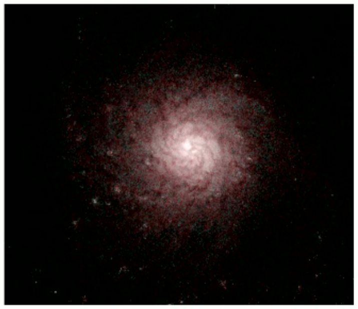
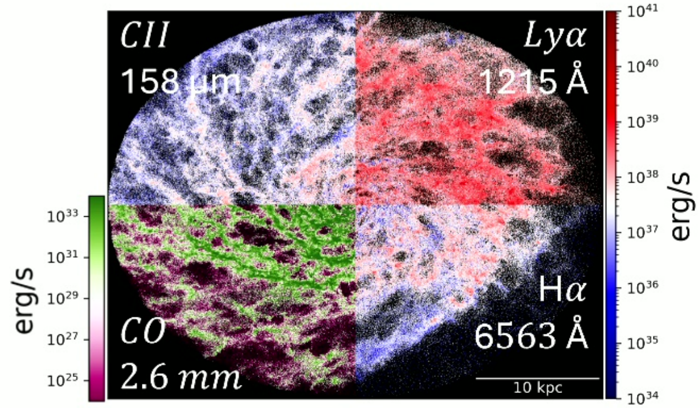


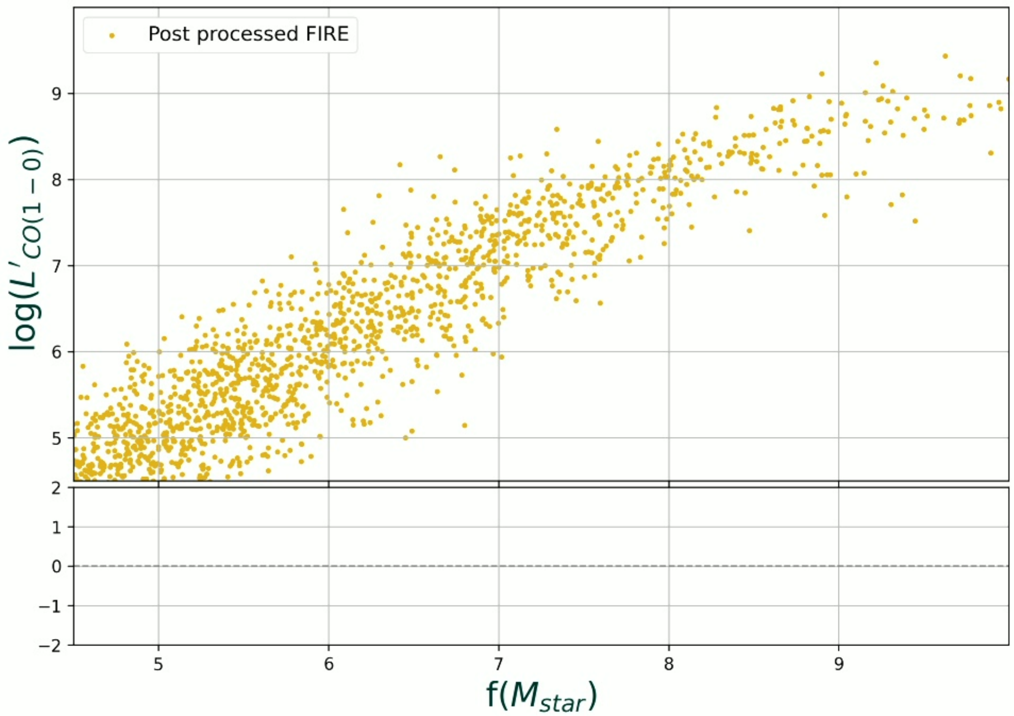




Both ML and statistical approaches produce similar outcomes

Random Forest Tree with Feature Importance	Non-linear Correlations Causations as well as correlations
Symbolic Regression	Machine learning technique that aims to discover mathematical expressions that best fit a given dataset
Power Law relation with least scatter	Basic statistical method Easy to interpret

Response function formalism presented



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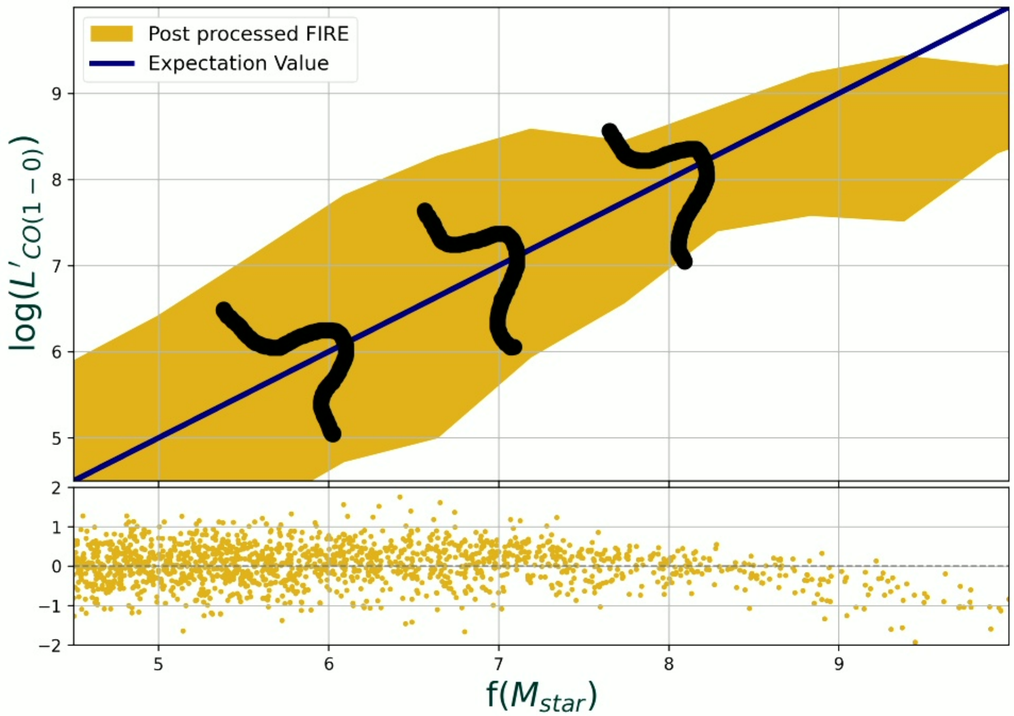
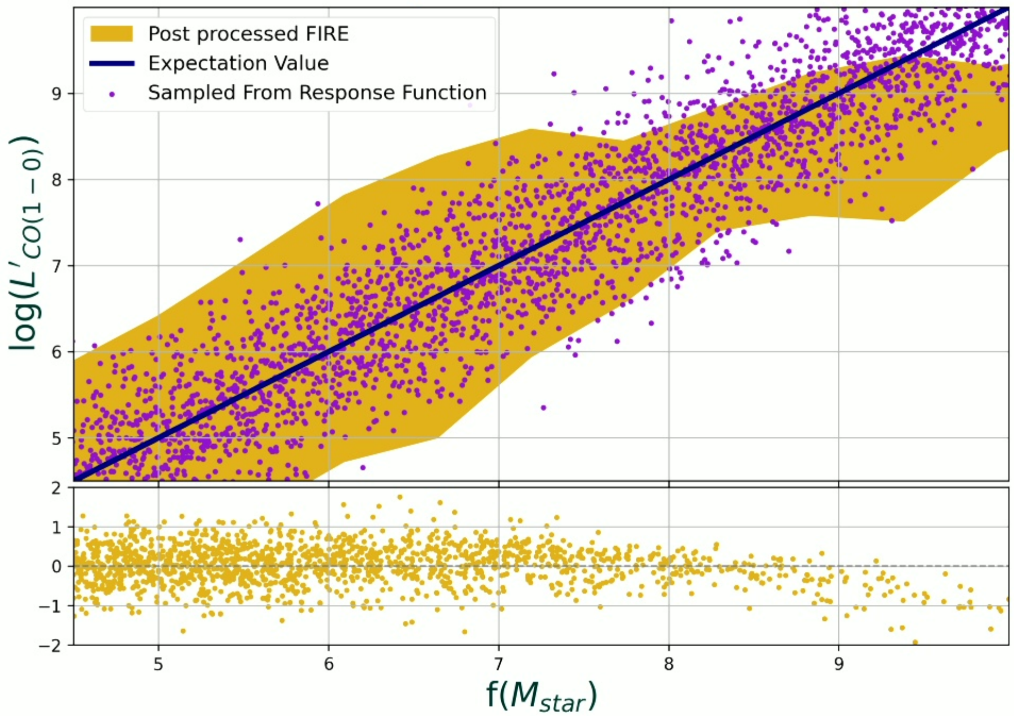
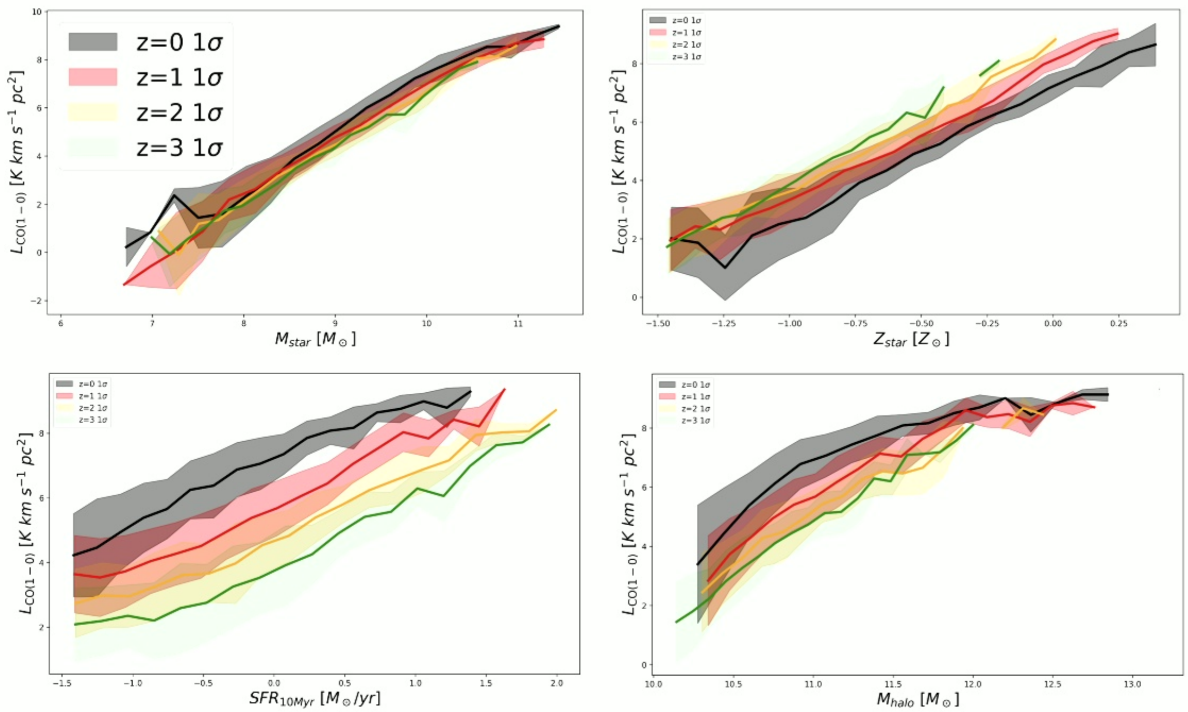


Identifying the variable that exhibits the least scatter is of critical importance



Metallicity information is critical for accurate estimation of CO emission, independent of redshift



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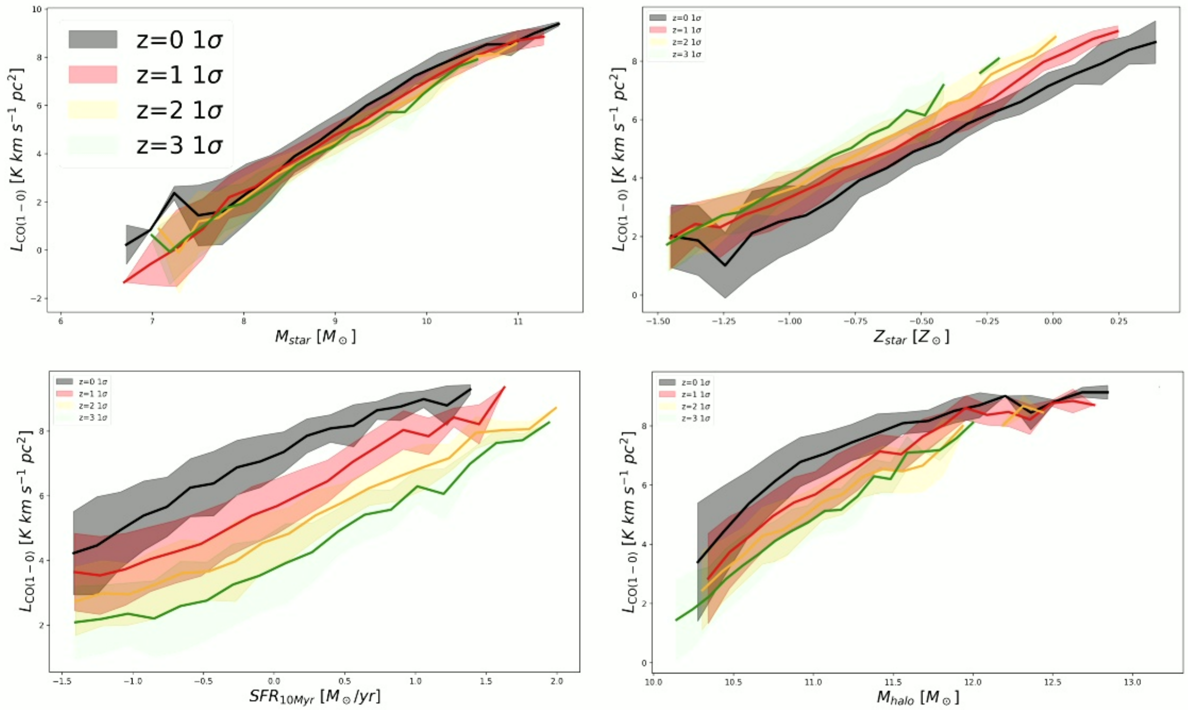


In the absence of metallicity information different response functions can be used at each redshifts to model the emission

Review

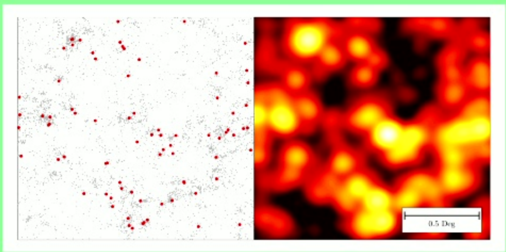
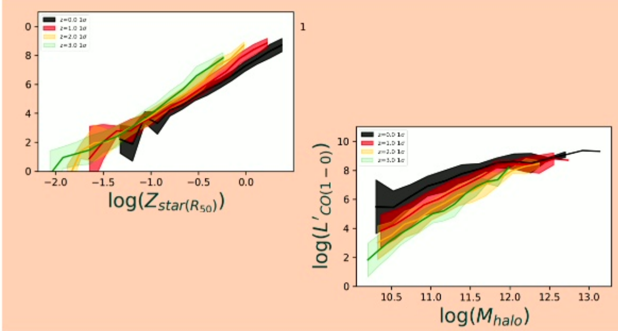
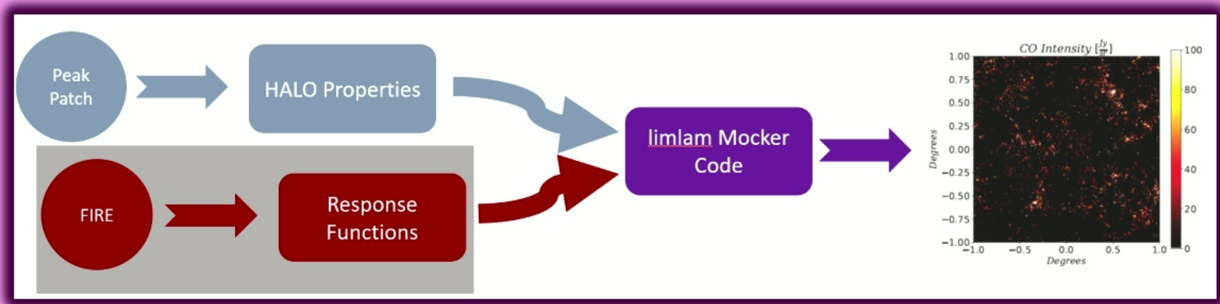


Figure retrieved from Kovetz et al., 2017





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