Changing Elemental Abundance Assumptions Does Not Change Simulated Observations of the CGM

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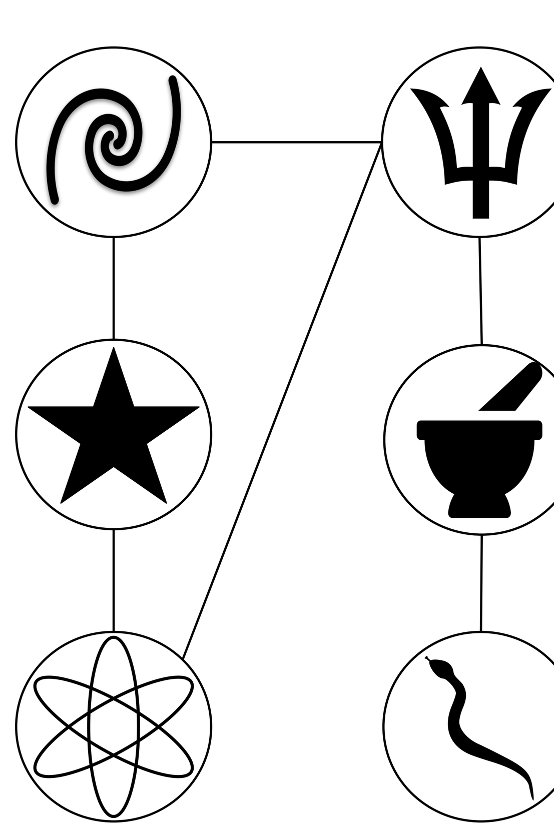
Background

The Circumgalactic Medium (CGM) is the gas around a galaxy. This gas is multiphase (has a broad range of temperatures and densities) so we use metal ions to "trace" what the gas is doing. Studying the CGM is essential to understanding the quenching of galaxies [1]. Quenching means shutting off star formation. Because we cannot observe over large spans of time, we turn to simulations to find out how this material developed and how it affects the rest of the galaxy [1]. In connecting simulations to observation, we must make many assumptions about the nature of this gas. One of these assumptions is the abundances of different elements in the gas. This is affected by and affects the stellar evolution of the galaxy. We often use the Solar abundance pattern because it is well measured. However, observations of other stars give different abundance patterns so it is highly unlikely that the CGM is truly characterized by the Solar abundance.

Objectives

The main objective of this project is to determine how changing the assumed chemical abundance of the CGM changes the synthetic observations. With this, we will be able to know if it is viable to assume Solar abundances of the gas in the CGM or if a more sophisticated model is necessary to account for the abundances of different ions. We would also like to quantify how sensitive the column density is to changes in the abundance pattern.

Method



FOGGIE [2]
Ideal for understanding how the CGM behaves due to its high resolution [6].

Trident [3]
Built on yt analysis framework, outputs ion densities

SFR
Star Formation Rate is output by FOGGIE

SALSA [5]
Finds absorbers and outputs data tables

OMEGA+ [4]
Chemical evolution model, outputs abundance tables

Sal the Super Snake
What I (mostly) wrote, outputs statistics on the gas clumps within the halo via the "super clumps" method

Results

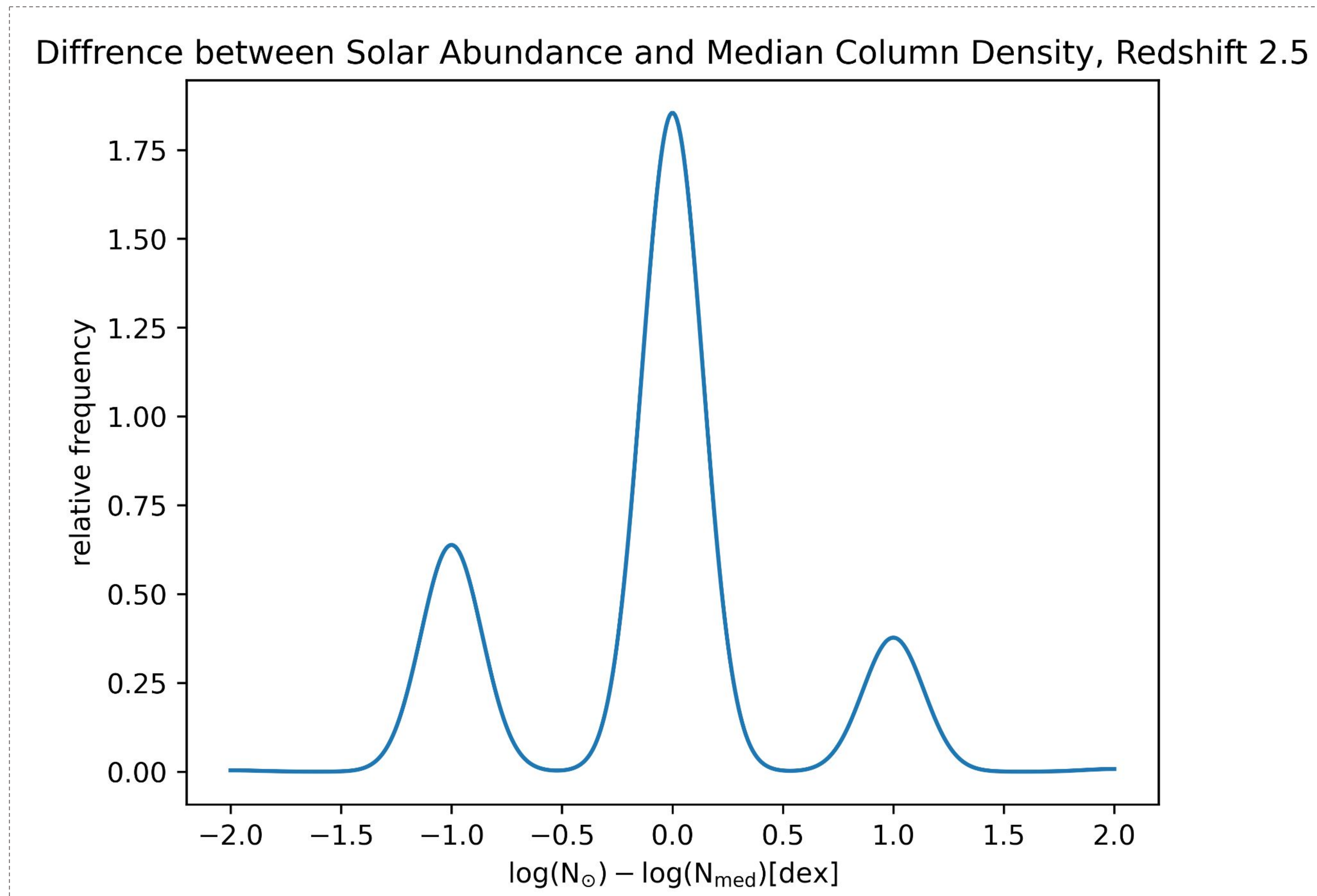


Fig. 1: $N_\odot$ is the column density when Solar abundance patterns are assumed. N_{med} is the median of the column density when other abundance patterns are assumed. A Gaussian kde was performed to show how frequent different differences are. From this plot, we can say that there is very little difference between the column densities when we assume Solar abundance and when we assume another model of chemical evolution.

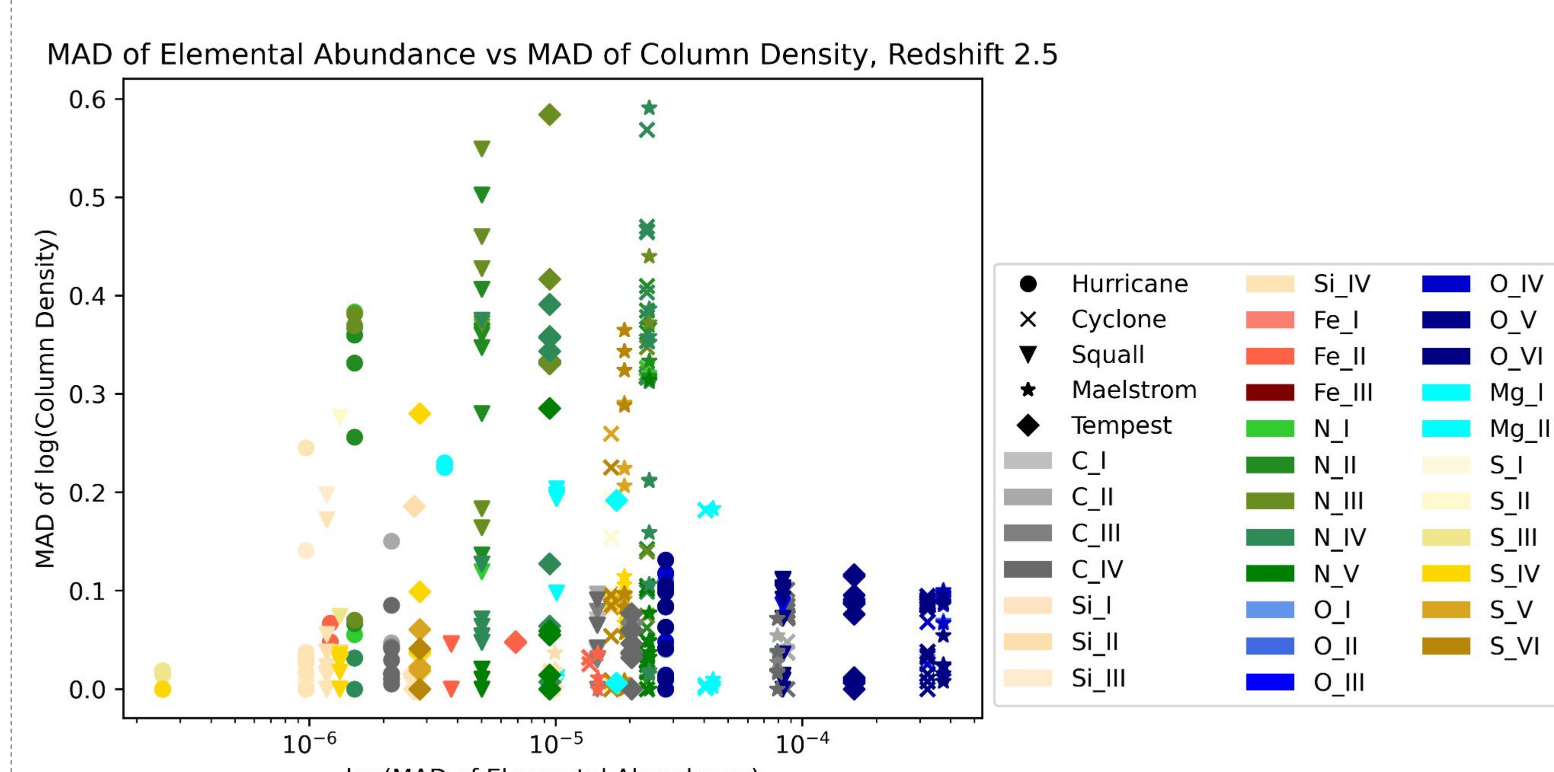


Fig. 2: MAD is the Median Absolute Deviation (like standard deviation, but for median instead of mean). We looked at the MAD for different models of chemical evolution and the MAD of the column densities for with those models. This plot shows that there is no dependance between these two quantities.

Conclusion

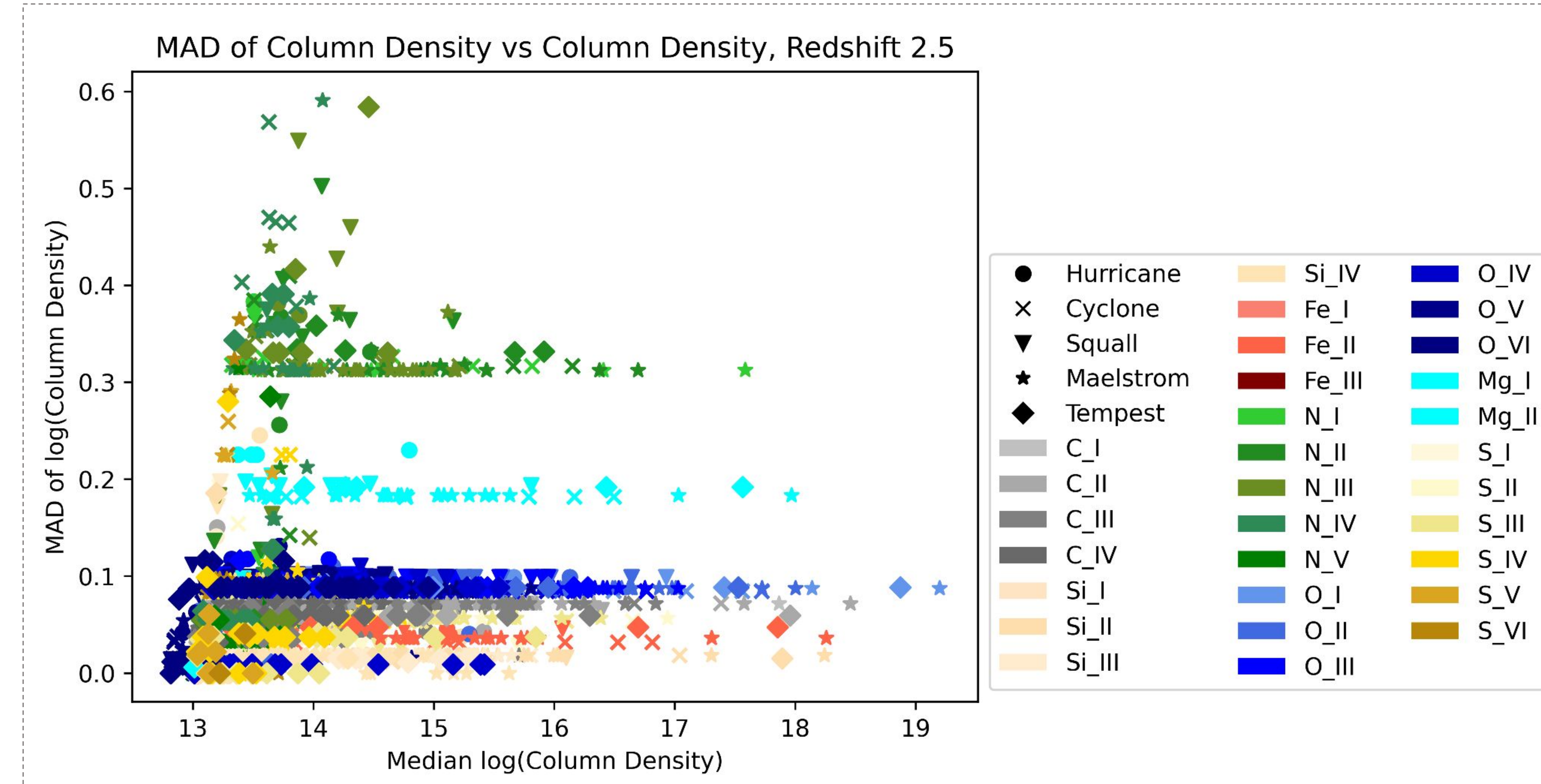


Fig. 3: MAD and Median of column density for each clump found. The prevalence of horizontal lines denotes that the spread of column densities does not depend of the column density itself.

There is generally little dependance between the spread of the column density and any the median of the column density. There is very little difference between the column densities themselves whether or not we assume a Solar abundance pattern. The spread of column densities also does not depend on the spread of the abundance of elements. Therefore, since there is a similar level of uncertainty whether or not we use the Solar abundance pattern, we suggest that it is variable to use the Solar abundance pattern in the FOGGIE simulations.

References

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