Simulating Variable UV Background Impacts on CGM Metal Column Densities

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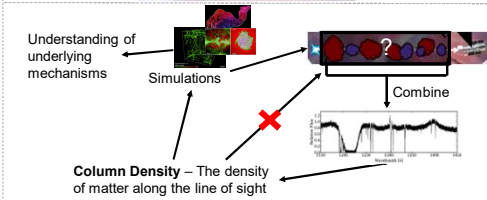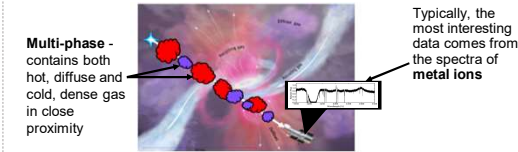
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Background

Circumgalactic Medium – a large mass of gas and dust that surrounds galaxies
- Typically observed via spectral data we receive from quasars

Typically, the most interesting data comes from the spectra of **metal ions**

Multi-phase - contains both hot, diffuse and cold, dense gas in close proximity

Understanding of underlying mechanisms

Simulations

Combine

Column Density – The density of matter along the line of sight

Ultraviolet Background (UVB) – a background radiation that exists everywhere in space that originates from all of the universe's sources of UV radiation
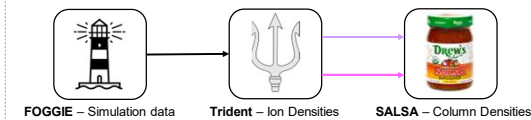- UVB varies from model-to-model depending on the assumptions made
- Most models assume we are very far away from any UV source
- For the case of the CGM this assumption is no longer true
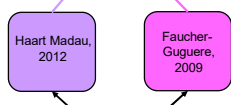
Objectives

1. Evaluate how changing our assumptions of the UVB impact CGM ion column densities

2. Understand how distance from galactic center impacts these metal ion column densities

Methodology

Column Density Pipeline

FOGGIE – Simulation data   **Trident** – Ion Densities   **SALSA** – Column Densities

Varying UVB Model

Haart Madau, 2012   Faucher-Guguere, 2009

Galactic UV Radiation

FSPS

Results

Changing UVB Assumptions

CII Median Column Densities
hm_2012, fg_2009

CIV Median Column Densities
hm_2012, fg_2009

OVI Median Column Densities
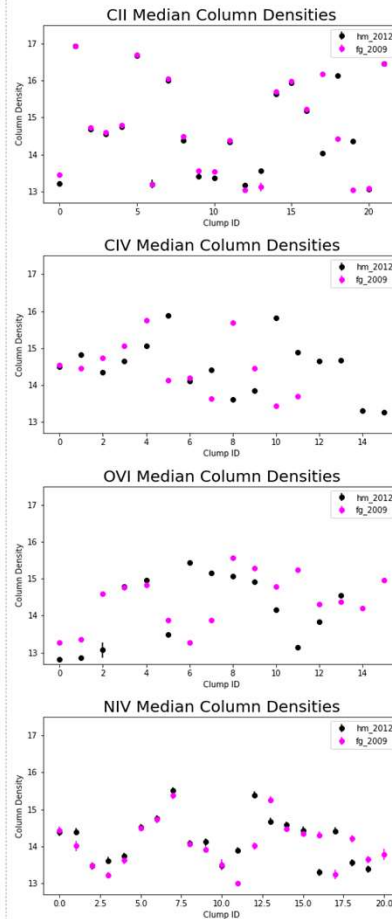hm_2012, fg_2009

NIV Median Column Densities
hm_2012, fg_2009

Fig 1. Plots of the column density of a given element for each individual "clump" of gas that SALSA identifies. The plots feature 3 different metal ions within the CGM. Due to the differences in energy states between each of the ions, they are all found at varying different temperatures and densities. This then causes the UVB, and the changes we make in it to affect the resulting ion column densities that we see
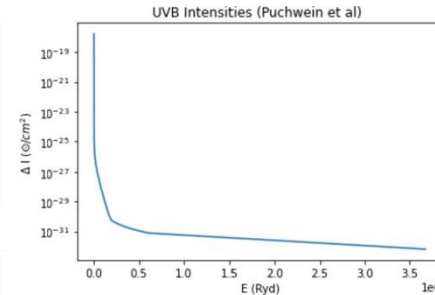
Galactic UVB Contribution

UVB Intensities (Puchwein et al)

Fig 2. Plot of the intensity of radiation emitted by the galaxy ($\frac{\odot}{cm^2}$) as a function of the energy in Rydberg at different radial distances (kpc) from the galactic center. Using the data from the Puchwein et. al. UVB.

Galactic UV Intensities (z = 2.649)
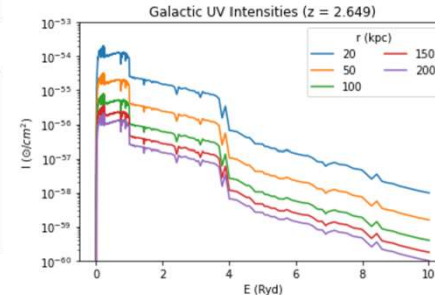r (kpc): 20, 50, 100, 150, 200

Fig 3. Same horizontal and vertical axis as in Fig 2. Now using data from the UV emissions from the simulated galaxy. Each line represents the intensity of the UV radiation emitted by the galaxy.

Galactic UV Intensities (z = 2.649) (with corrected energy scale)
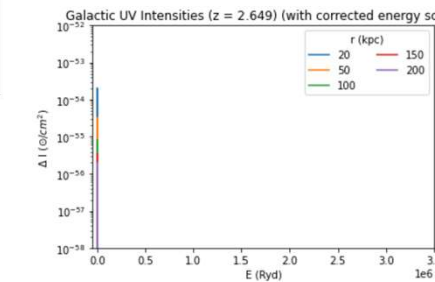r (kpc): 20, 50, 100, 150, 200

Fig 4. Same plot as Fig 3. X-axis has now been corrected to illustrate the difference in scale between the galaxy emission and the UVB model of Which the UV model is significantly larger in both energy range, as well as intensity

Conclusion

Changing the Ultraviolet Background
Changing the UVB mode leads to **statistically significant** changes in resulting metal ion densities

Agrees well with predicted behavior of ions:
- Ions in colder, more dense environments are dominated more by collisional ionization/recombination
- Ions in warmer, more diffuse environments are dominated by photoionization

C II ⟶ Cold-Dense

C IV
O VI ⟶ Hot-Diffuse
N IV
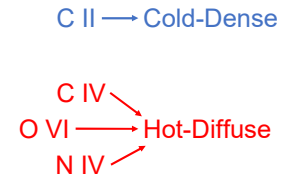
Further analysis is required to fully characterize the impacts of these changes

Galactic Ultraviolet Background
The UV radiation emitted by the galaxies **did not** make any significant contribution to the overall UVB

Indicates that a close proximity to the galactic center **may not** have much of a significant impact on the resulting metal ion column densities.

References

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