Tracing Baryons in the Warm Hot Intergalactic Medium using Broad Lyman-α Absorbers

Thesis Phase-II

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Thesis Phase I : Recap

Recap

- **The missing baryon problem**
- BLAs : Way to probe WHIM
- Absorber towards PG 0003+158
- BLA survey : 28 BLA candidates

Ref. : Shull et al. (2012)

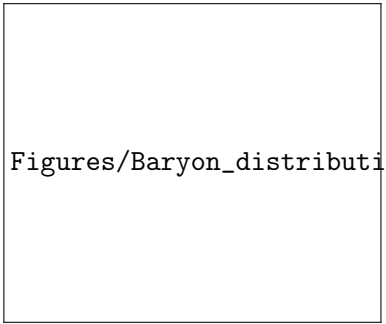

Figure 1: Baryon budget at $z \sim 0$.
Shull et al. (2012)

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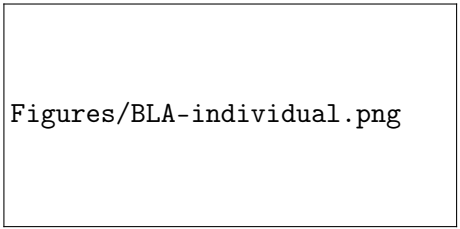

Figure 2: A BLA towards the LOS of quasar H 1821+643. Philipp Richter (2005)

Ref. : Shull et al. (2012)

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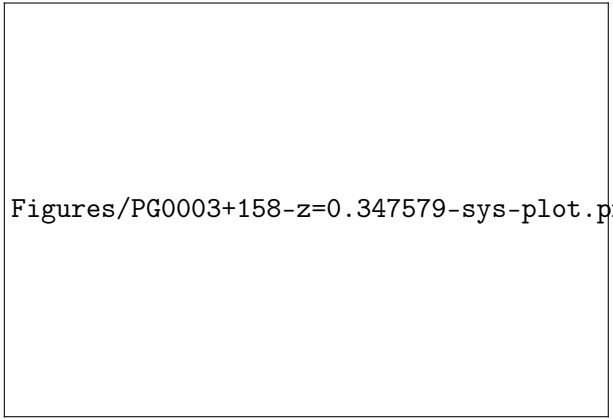

Figure 3: System plot of the absorber system towards PG 0003+158. Velocity is taken zero at z = 0.347579

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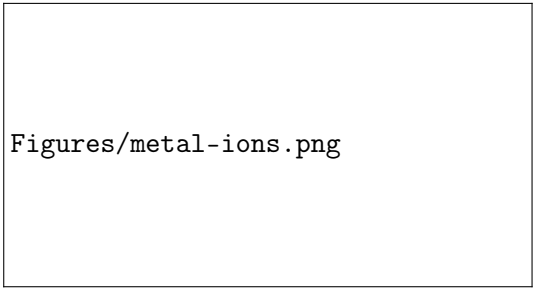

Figure 4: Distribution of metal ions in all 28 candidate BLAs

Ref. : Shull et al. (2012)
Danforth et al. (2016)

The BLA Survey

Survey so far...

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- Voigt profile fitting : 16 (O VI) + **6**

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- Voigt profile fitting : 16 (O VI) + **6**
- Ionisation Modelling : **16 (O VI)**

Insights

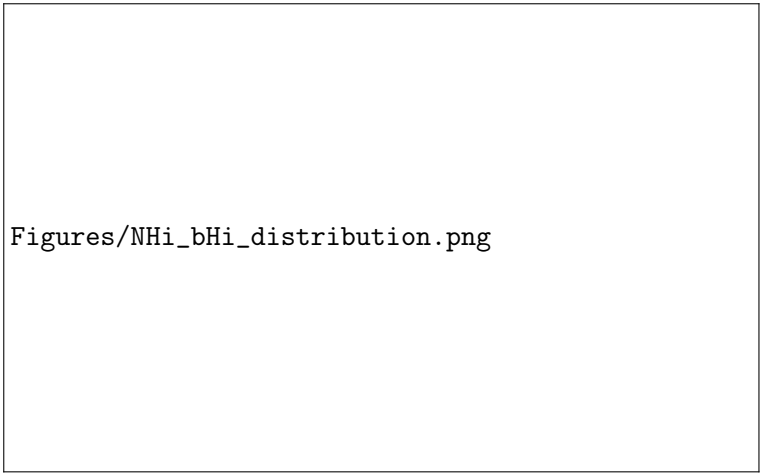


Figure 5: Distribution of H I column densities and Doppler parameters.

Insights

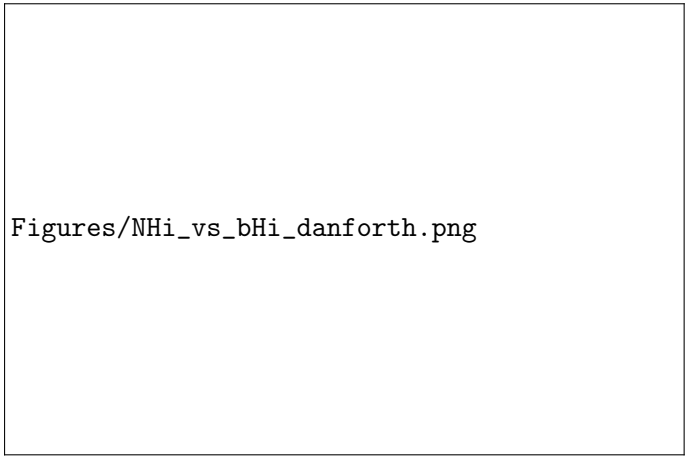
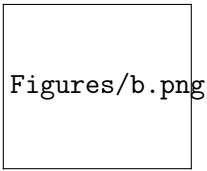


Figure 6: H I column density vs. Doppler parameter

Insights



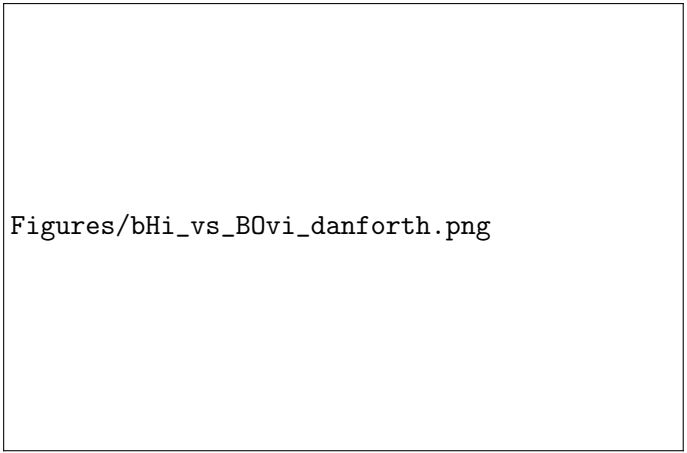


Figure 7: b(O VI) vs. b(H I). Grey filled circles are measurements from Danforth et al. (2016).

Insights

Figures/T.png

Figures/T_histogram.png

Figure 8: Distribution of temperature calculated from Doppler parameters of H I and O VI lines.

Ionisation Modelling

Method

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- Grid of PI CLOUDY models : Density and Metallicity

Ref. : Acharya and Khaire (2021)

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Method

- Grid of PI CLOUDY models : Density and Metallicity
- log (n_H/cm^{-3}) : -5 to 1 in steps of 0.02
- log $(Z/Z\odot)$: -3 to 2 in steps of 0.05
- Solution : Model that best predicts the observed column densities

Ref. : Acharya and Khaire (2021)

Results

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- 16 O VI absorbers

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- 26 components

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- 26 components
- Origin of O VI

Solutions

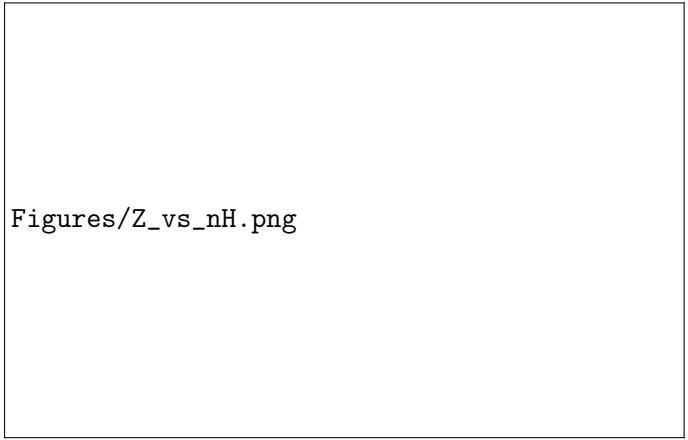

Figure 9: Ionisation modelling solutions (n_H, Z) for all 26 components.

+ve correlation

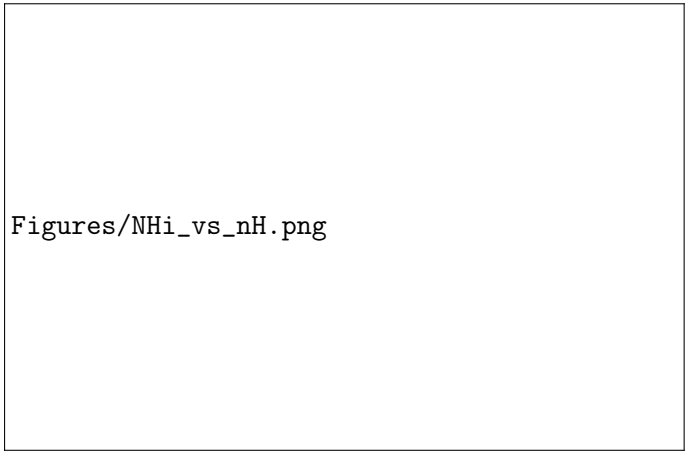

Figure 10: Variation of N(H I) with n_H

O VI cases

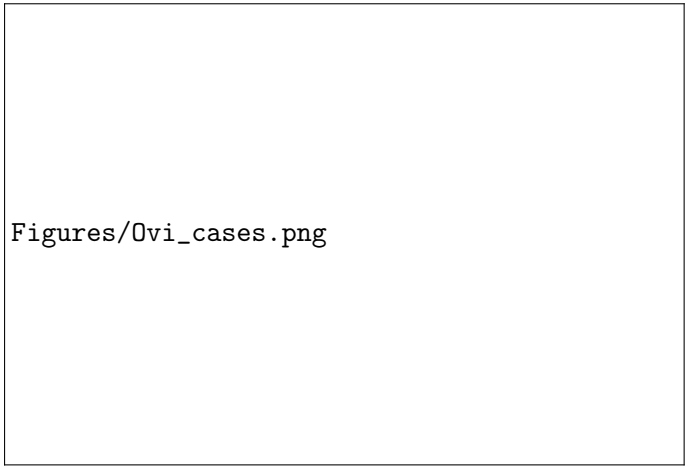

Figure 11: O VI column density predictions.

Ex : Unexplained

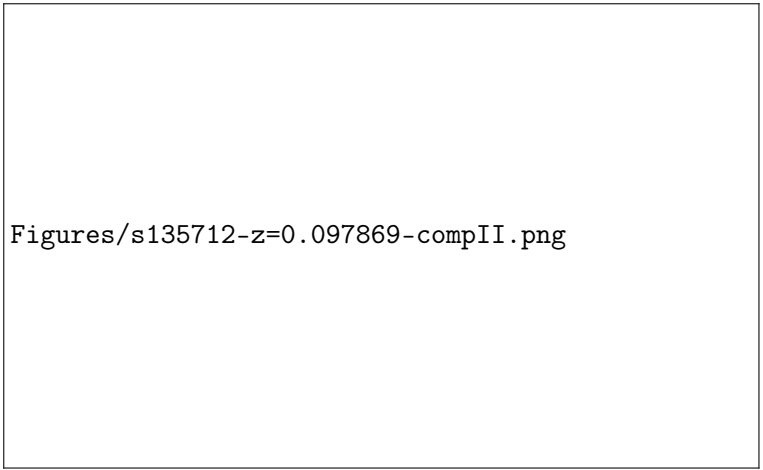

Figure 12: N(H I)=16.49 cm^{-2}

Ex : Explained

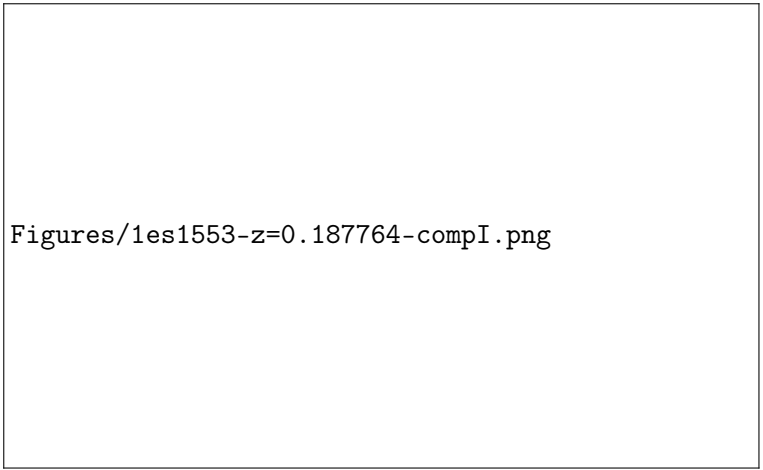

Figure 13: N(H I)=12.76 cm^{-2}

Ex : Uncertain

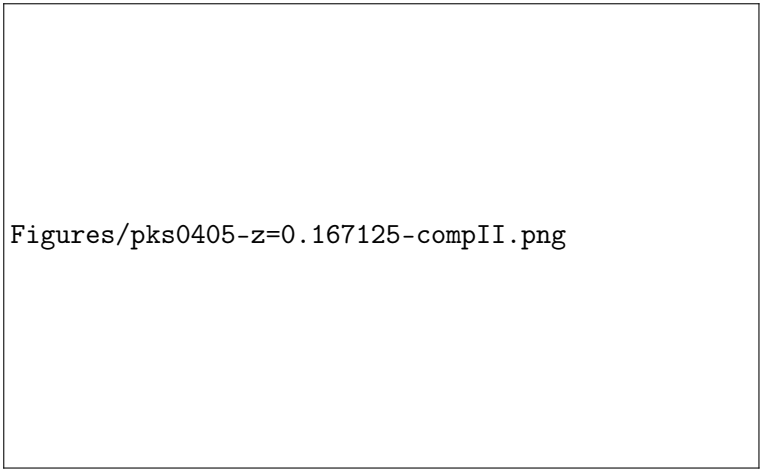

Figure 14: N(H I)=13.46 cm^{-2}

Towards *the end*

Ongoing and Future Work

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- Voigt profile fitting : 6

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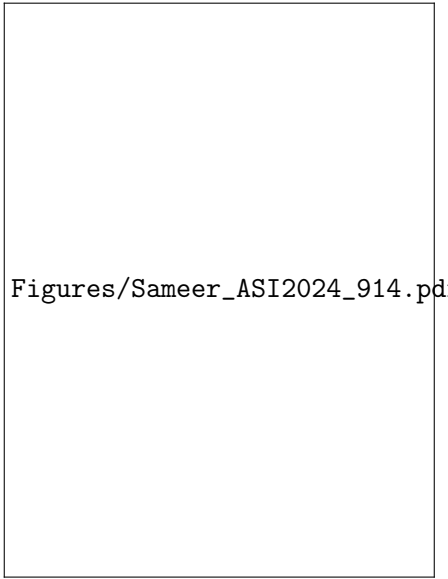
Ongoing and Future Work

- Voigt profile fitting : 6
- Ionisation modelling : 12
- Exploring the survey results
- *Finally*, calculating $\Omega_b(BLA)$

Outcomes

- Poster presentation at ASI-2024 meet titled "Tracing Baryons in WHIM using BLAs"



Summary

- Voigt profile fitting : 22 absorbers - 231 Voigt profiles
- Ionisation modelling : 16 absorbers - 26 components
- O VI couldn't be explained with photoionization models
- BLA survey towards completion

References

Acharya A., Khaire V., 2021, MNRAS, 509, 5559

Danforth C. W., et al., 2016, ApJ, 817, 111

Lehner N., Savage B. D., Richter P., Sembach K. R., Tripp T. M., Wakker B. P., 2007, ApJ, 658, 680

Richter P., Savage B. D., Sembach K. R., Tripp T. M., 2006, A&A, 445, 827

Savage B. D., Kim T. S., Wakker B. P., Keeney B., Shull J. M., Stocke J. T., Green J. C., 2014, ApJS, 212, 8

So much universe, and so little time...

Appendix

- Outlier b(O VI)

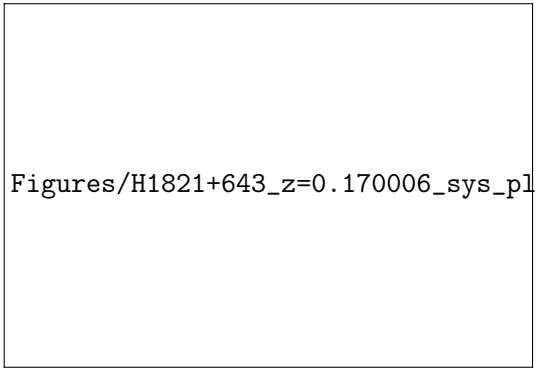


Figure 15: Voigt profile fit of O VI 1032 line in absorber system towards H1821+643 at $z_{abs} = 0.170006$