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

Sameer Patidar[1†], Vikram Khaire[1,2], Anand Narayanan[1]

[1] Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala

[2] University of California, Santa Barbara, CA, USA

[†] Email : itssameer.patidar@gmail.com

Introduction

- More than 90% of baryons reside in IGM and CGM at $z \sim 0$.
- Out of these 90% baryons, more than 30% are still unaccounted for in observations (Shull et al. 2012).
- Structure formation simulations show that these missing baryons reside in Warm Hot phase of Intergalactic Medium (WHIM).
- WHIM : Difficult to observe - low density and high temperature
- Broad Lyman-α Absorbers (BLAs) are expected to be large reservoirs of baryons.
- We probe WHIM using BLAs and estimate their contribution in the total baryonic energy density of universe.

Objectives

- Comprehensive survey of BLAs
- To estimate contribution of BLAs to the total cosmic baryon inventory

Observations

- HST/COS data in FUV channel : 1130-1790 Å
- High S/N > 15 per resolution element
- $\lambda/\Delta\lambda \sim$ 17,000 (17 km s^{-1})

Studying an Absorber system : Methods

- Voigt profile fitting - VPFIT
  - Gives positions, widths and column densities of ions
- Ionization Modelling – CLOUDY
  - To infer ionization state of the absorber cloud
  - To determine physical conditions prevailing in the absorber system
- Galaxy neighborhood
  - To deduce origins of the absorber system

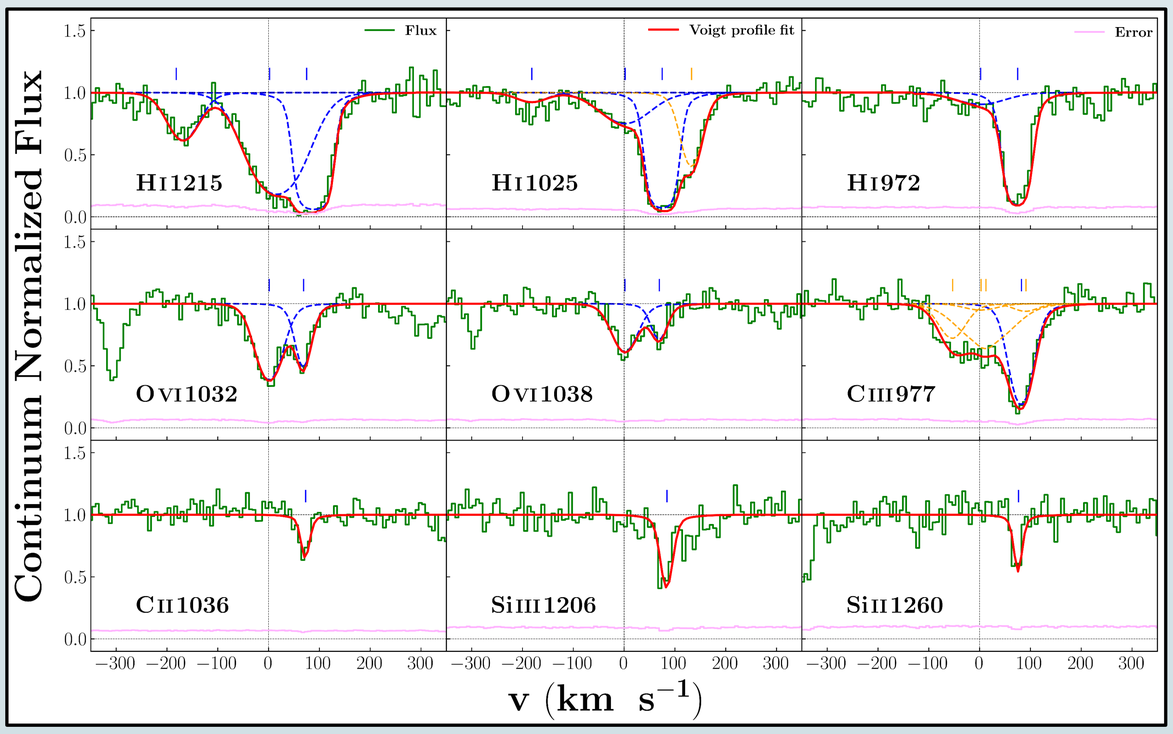

Fig. 1 : System plot of an absorber at $z \sim 0.347$ towards the line of sight of quasar PG0003+158 ($v = 0$ at $z = 0.347579$)

Absorber towards PG 0003+158 : Results

- **Voigt profile analysis (fig. 1)**
  - 3 component system at $z \sim 0.347$
  - Component I : Lyα and Lyβ at $v \sim -180\ km\ s^{-1}$
  - Component II : Lyα - Lyδ, O VI at $v = 0\ km\ s^{-1}$; T~$10^{5.3}$ K **(BLA)**
  - Component III : H I 1215-914, O VI, C II, C III, Si II, Si III at $v \sim 70\ km\ s^{-1}$
- **Ionization Modelling**
  - All ions in component III can be explained using photoionization models **except O VI. (fig. 2)**
  - So, **O VI** could be tracing **collisionally ionized gas phase.**

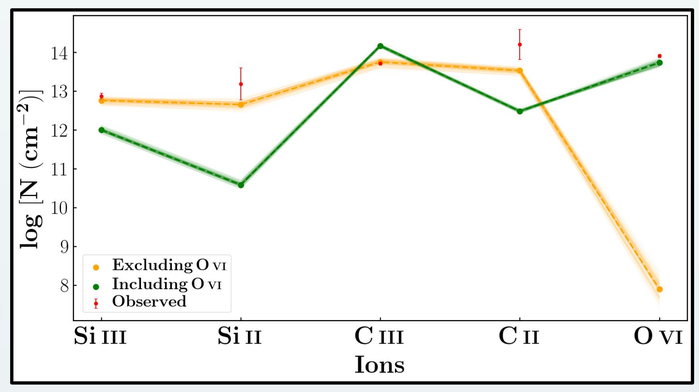

Fig. 2 : Observed and modelled column densities of ions in component III

- **Galaxy Environment**
  - VIMOS : 5 galaxies identified in the field - $L \lesssim 0.07\ L^*$ **(fig. 3)**
  - Absorber residing in galaxy under -dense region, could be tracing a large scale filamentary structure in the cosmic web or CGM of galaxy fainter than $0.07\ L^*$

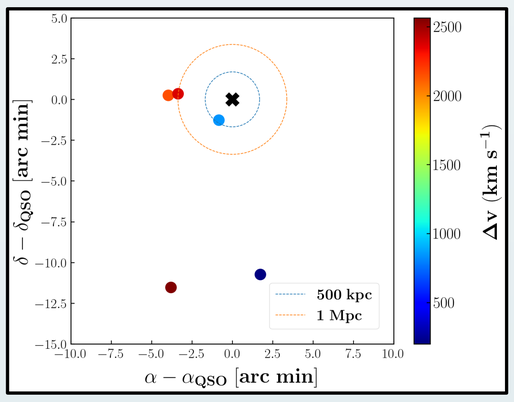

Fig. 3 : Galaxy environment around the absorber LOS color-coded with velocity separation from the absorber

BLA Survey : Ongoing work

- Presented results are part of our ongoing large survey of BLAs
- Identified 28 more BLA candidates for the survey
- Methods described currently are being carried out on these 28 BLA candidates.
- Results from these 28 systems will be used to estimate contribution of BLAs in the total cosmic baryon inventory.

Conclusion

- Addressed uncertainties in Baryon census in WHIM using BLAs
- Studied an interesting absorber system, possibly tracing a large scale filamentary structure or a CGM of sub- L^* galaxy.
- Results are awaited from the whole survey of additional 28 absorbers.

References

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