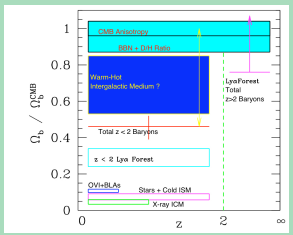
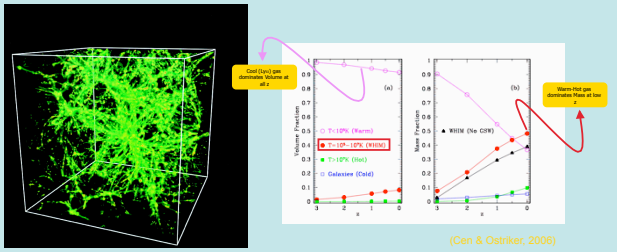
IXO and the Missing Baryons: The Need for High Resolution Spectroscopy

(Nicastro, F., Conciatore, M.L., Elvis, M., Krongold, Y.,)

The *Missing Baryon* Problem



The *Warm-Hot Intergalactic Medium Solution*



(Cen & Ostriker, 2006)

Relevance of WHIM Studies

- Complete Inventory of Baryons (Ω_b and $d\mathcal{N}/dz$): necessary condition to validate SCM
- Heating history of the Universe (dT/dz): Role of Shocks in LSS formation + Study of non-equilib. post-shocked gas + Role of meta-galactic photoionization contribution
- Ecology of the Universe: Relative and Absolute metallicity (dZ/dz) + Feedback (galaxy/IGM vs AGN/IGM) + Nucleosynthesis studies
- Cosmology: Cosmological parameters from density fluctuations of WHIM filaments

IXO Gratings and Calorimeter Spectral Simulations

- We extracted 30 random z<0.5 lines of sight from the latest Cen & Ostriker simulations and selected the poorest in number of WHIM filaments (a -3σ CV fluctuation)
- Only 6 WHIM intervening filaments with N_{OVII} >= 10^{14} cm^{-2}, two of which multiphase and extended in velocity (i.e. z) and physical (T and N_H) space.
- We folded this line of sight through our hybrid-ionization spectral code, which 'translates' the density, temperature and metallicity fluctuations into ion opacities
- We simulated 200 ks IXO gratings (R3K-A3K) order 1-5 and IXO-calorimeter spectra of this line of sight, using a background source at z=0.5, with $F_{0.1\text{-}2.5\ keV}$ = 10^{-11} cgs
- We first searched these spectra for OVII Kα absorption and then, to securely identify a system, for associated CV, NVI, NeIX Kα; CVI, NVII, OVIII, NeX Lyα or OVII Kβ
- Fig. 1-5 show the residuals in velocity space for the 6 WHIM systems independently identified in the grating spectra (residuals from the calorimeter spectra are also shown for for comparison)

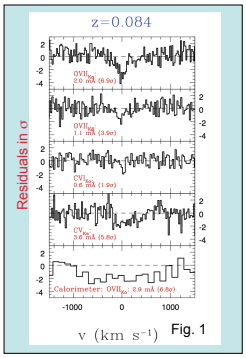


Fig. 1

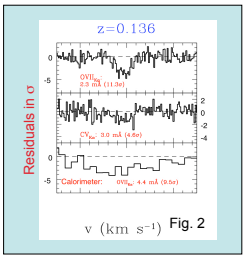


Fig. 2

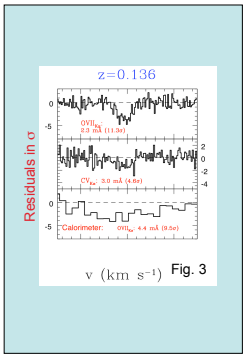


Fig. 3

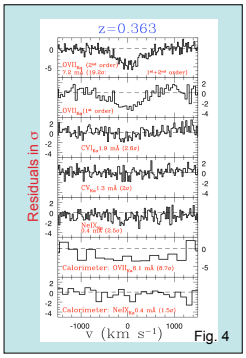


Fig. 4

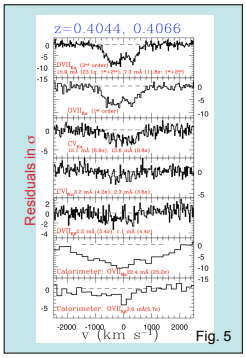


Fig. 5

Conclusions

- 6 out of the 8 WHIM systems (75%) were securely (I.e. >=2 lbsorption lines per system) identified in the IXO grating spectra
- NONE of the 8 WHIM systems was identified in the IXO calorimeter spectrum
- Turbulence velocities in the simulations range between 100-300 km/sec, and are clearly resolved in the IXO R3K-A3K grating configuration spectra (Fig. 1-5)
- Multiphase WHIM filaments are resolved with the IXO gratings (Fig. 5), but not with the IXO calorimeter
- WHIM line profiles are almost invariably complex, with gradients of density and temperature along the absorber (see, particularly the blue extension of the system at z=0.136, as well as the reddish component detected in OVII K-alpha and CV K-alpha in the system at z=0.084). This information is missing in the calorimeter spectrum.
- Metallicities along this line of sight span the range (3-19)% Solar and can only be measured in association with HI Ly-alpha EW measurements (HST-COS)
- IXO gratings enables not only the detections and identifications of WHIM filaments (even along the WHIM-poorest lines of sight) but also deep studies of the physics of the WHIM (velocities, turbulence, density and temperature phases, Omega_b, etc)

References

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