The Missing Baryons’ Problem: the COSMIC WEB

~50% of the Baryons are missing at z~2. Hidro-Simulation predict they are in the Warm-Hot IGM (WHIM) (red curve Fig.1).

WHIM is
- Extremely tenuous: n=10^-5-10^2 cm^-3
- Shock-heated to T=10^6-10^7K (high ionized)
- Moderate metallicity: Z~1  (1 + Z/D)
- Small transverse size 0.1-1 Mpc

Difficult to Detect

How to detect the WHIM

Searching for spectral signatures in:
- soft X-ray: high ionized metals (e.g. OVII, CV) → ionization correction
- FUV: broad Lyα (BLA) → metallicity correction

Detection techniques: Absorption wins over Emission
- EW_{abs} ~ n easier way
  A bright enough background source must be found

Here we establish THE optimal FUV-X-ray sample of background ‘beacons’ to be used to detect the WHIM with current and future X-ray and FUV spectrographs. This will determine dN/dz (WHIM) and Ω_b to few %.

FUV-Xray Flux Requirements on Background Sources for WHIM detectability

X-ray needs to be sensitive to EW(OVII) > 1.5 mA (>1 OVII system at z>0.3 at > 99.7% confidence) Assuming n=1 × 10^5 cm^-3, T=5.9 K, Z=0.1 Z_⊙ N_{HI,abs}= 3 × 10^{12} cm^-2

UV needs to be sensitive to EW_{HI} > 20 mA

<~ 500 ks with IXO on targets with F_{0.5-2keV}>0.05 mCrab
<~ 80 orbits with HST-COS on targets with vF_{1600A}>3×10^{-12} cgs

The optimal UV/X-ray Sample

- 2 × 10^4 sources from the ROSAT All-Sky Survey Bright Source Catalogue
- F_{0.5-2keV}>0.05 mCrab (2880 objects)
- Cross-correlations with AGN catalogs: VERONCAT, SDSS DR5, 6dFGS, and BZCAT
- z > 0.3, N_{HI} × 3 × 10^{15} cm^-2
- vF_{1600A}>3×10^{-12} erg s^-1 cm^-2, at 1600 Å (from the GALEX survey)

18 AGNs

X-ray Detectability: Difficult to achieve: large grating areas needed

In its baseline configuration, IXO gratings probe only the 50% central Mass-T distribution of the WHIM.

We can improve detectability with IXO in the 3 temperature regions of Fig. 4.

Need to exploit the whole mirror area (retractable gratings)

Refine the selection with SWIFT

A good X-ray flux estimation is crucial when investing in Ms observations. The historical lightcurves of our sample are still poorly characterized.

SWIFT has the capability to easily refine our knowledge of the sources activity and so our selection of best targets for WHIM detection.

We are therefore actively working on obtaining more reliable measurements by using the monitoring capabilities of SWIFT, especially for the higher X-ray/FUV source of our sample (Fig. 3, red circle).

Conclusion

- The optimal X-ray/FUV sample for WHIM detection is made up of 18 sources at z>0.3
- SWIFT allowed us to evaluate the RASS bias toward high fluxes and therefore to have a better estimate of the quiescent status of our sample.
  - 8.5 Msec total with baseline IXO will detect 60-400 OVII filaments. 510-610 total orbits with HST- COS will detect their HI/BLA counterpart. This will give accurate metallicity and N_{HI} measurements of each filaments and so dN/dz and Ω_b to few %.
  - IXO gratings baseline will only explore the 50% central mass-T distribution of the WHIM. The entire mirror area needed to be exploited to detect the entire Mass-T distribution of WHIM
- SWIFT has the capability to easily improve the characterization of the lightcurves of the sample, in order to refine our knowledge of the sources activity and so our selection of best targets for WHIM detection.