Detection of filament of warm intergalactic baryons

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Recovering the local baryons

- Mismatch between abundances of high-redshift baryons (*Rauch et al. 1997; Burles and Tytler 1998*) and local baryons (*Fukugita et al. 1998*)

$\Omega_b^{z=0} \sim 1/4\ \Omega_b^{high\text{-}z}$

- Cosmological simulations (e.g. *Cen & Ostriker 1999*) predict the formation at low redshift of filamentary baryonic structures with temperatures 10^5-10^7K and low overdensities. That phase could constitute the main reservoir of missing baryons.

Warm/Hot Intergalactic Medium (WHIM)

- soft X-ray emission, but difficult to detect

low brightness, lot of foreground and background

- so far only a few temptative detection in emission

Scharf et al. 2000, Bagchi et al. 2002, Soltan et al. 2002

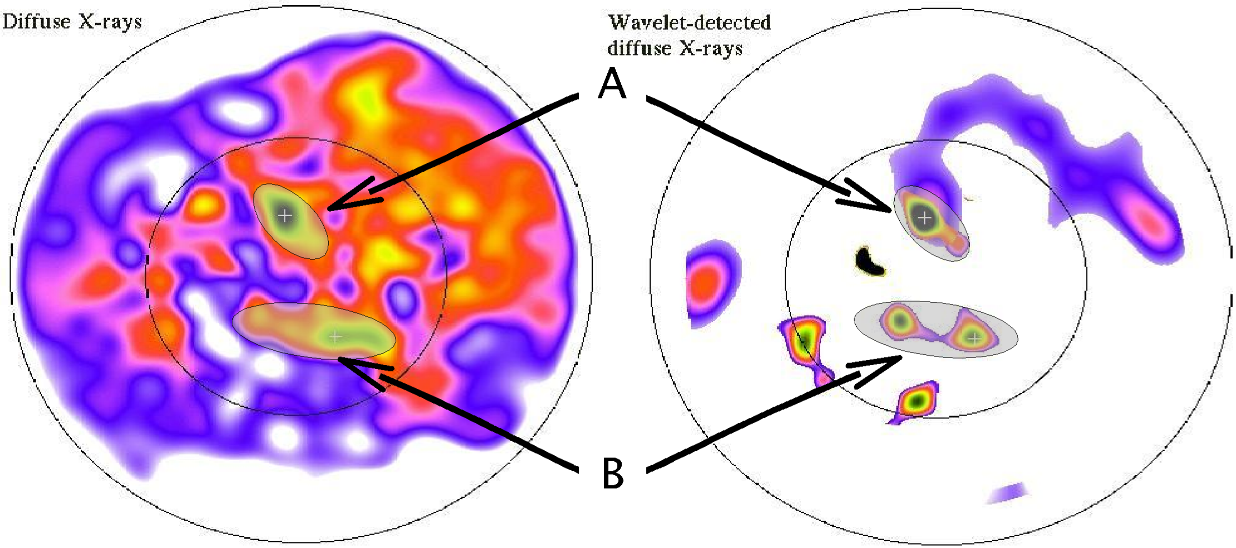
Our Project

Field with low N_H ($<10^{20}cm^{-2}$) where *Warwick et al. 1998* detected diffuse filamentary structures on several partially overlapping ROSAT PSPC pointings.

Goals:

- detection of diffuse emission
- measure of the spectral shape
- correlation with galaxy overdensity
- photometric redshift of the correlated structures

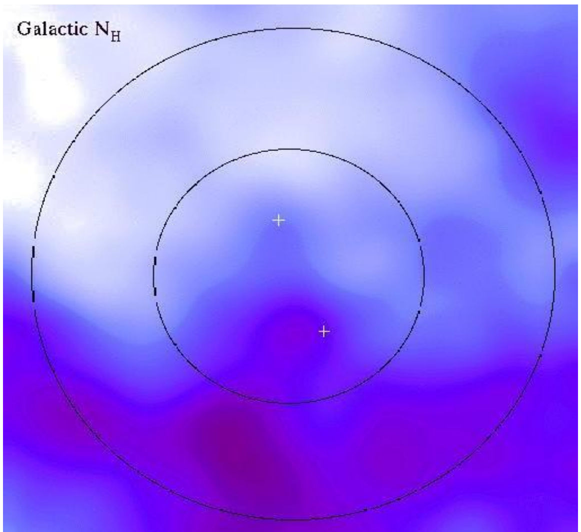
Rosat Maps



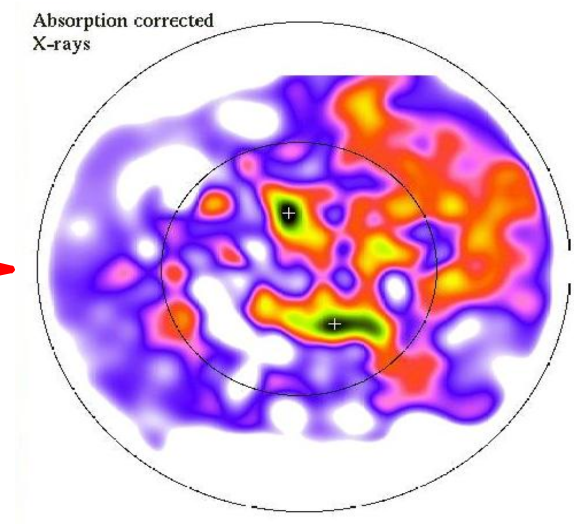
- Structures found on a 20 ksec ROSAT pointing after the point source removal
- 2 different detection methods
- the 2 main structures will be taken in consideration

Structures in common are significant at 5σ

HI Map

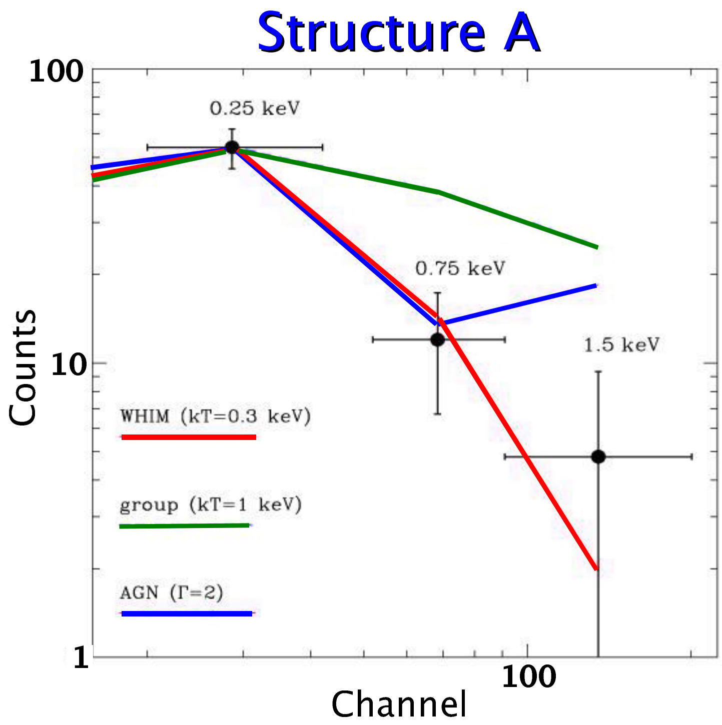


- Obtained at Effelsberg 100m radiotelescope
- Low N_H
- No anticorrelation with x-ray structures
- the correction changes only the relative intensities of the structures



Correction for hydrogen absorption

Spectral Shape and flux



- spectrum consistent with a WHIM emission ($T \sim 3 \cdot 10^6$ K)
- group and clusters are too hot ($T > 10^7$K)
- unresolved type I AGNs are 3σ inconsistent ($\Gamma = 2$)
- structure B shows a softer spectrum

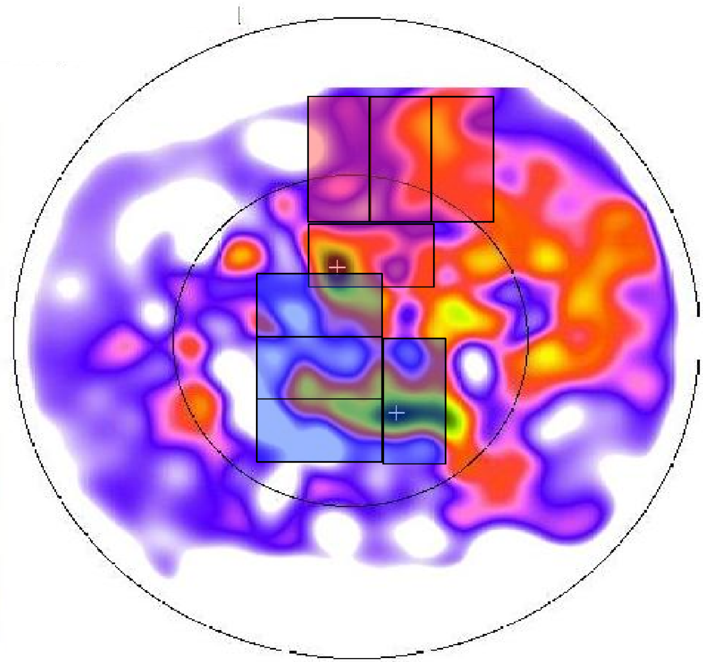
The 0.2-0.3 keV flux is in good agreement with the simulations (*Croft et al. 2001*).

Optical Data

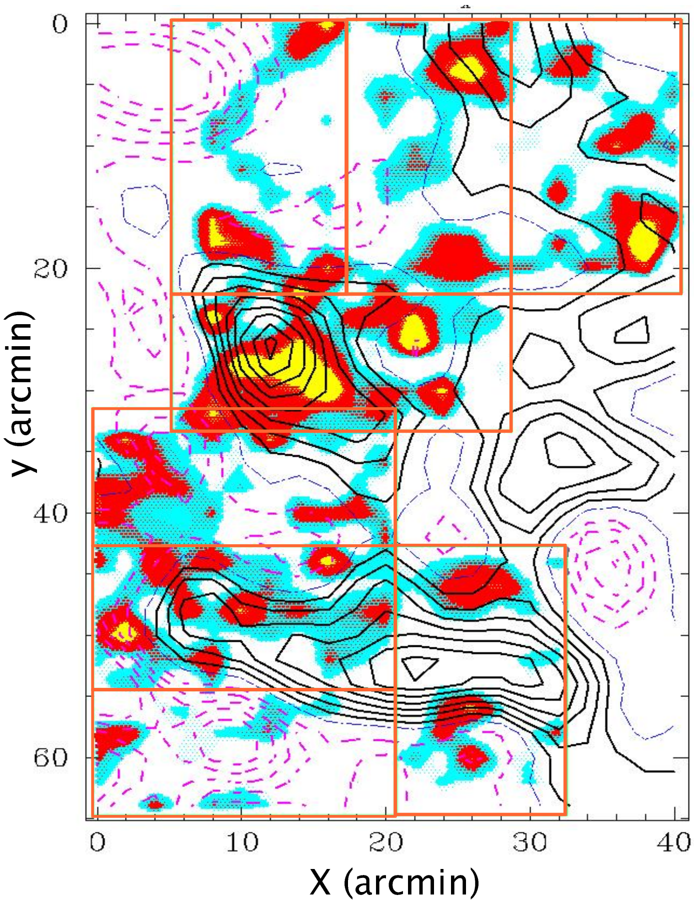
- observations with the Wide Field Camera at Isaac Newton Telescope

- 2 slightly overlapping pointings covering the main structures

- images in 5 photometric bands



Overdensity



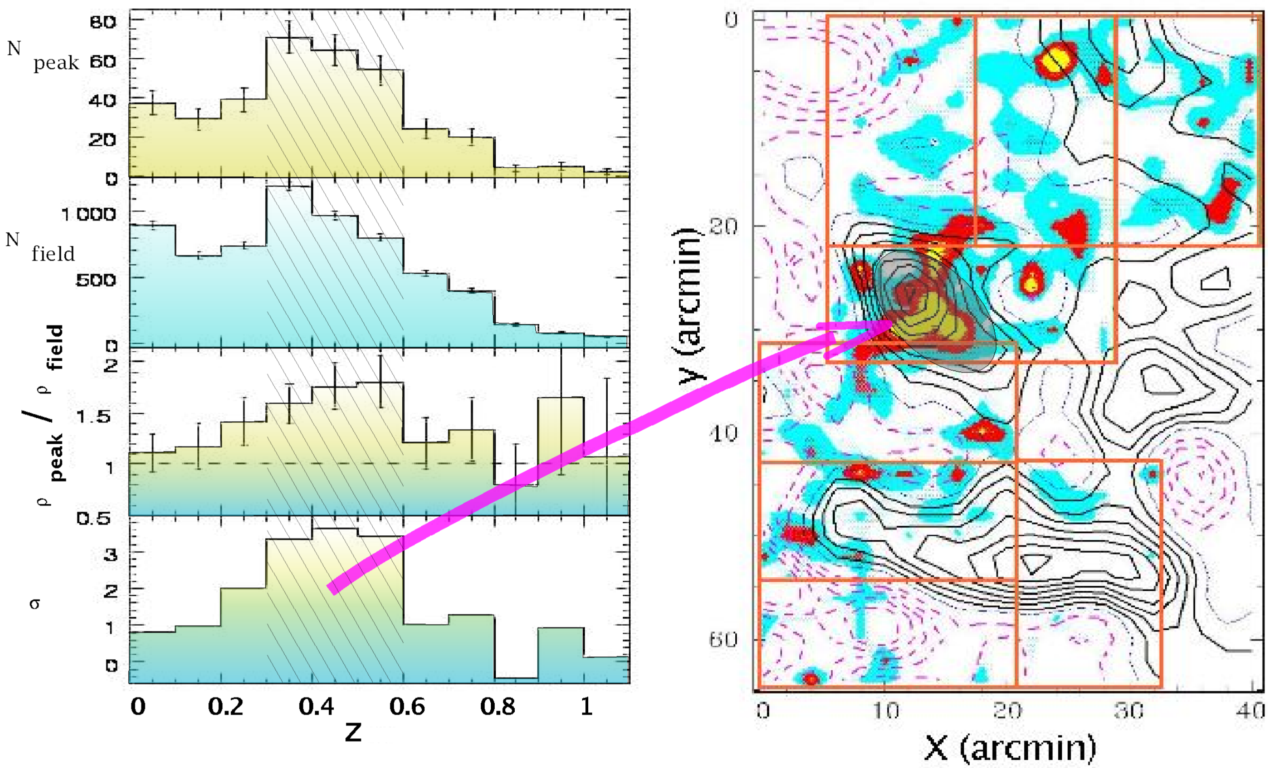
x-ray/optical comparison

- contours: x-ray intensity
  - ➔mean: blue dot-dashed ($6x10^{-3}$ counts s^{-1} $arcmin^{-2}$)
- colors: projected density of galaxies
  - ➔mean: cyan (4.7 galaxy $arcmin^{-2}$)
- boxes: Wide field ccd arrays

The central x-ray structure is traced by a galaxy overdensity

(probability of random coincidence <1%)

Photometric redshifts



The overdensity is 6σ significant in the range 0.3<z<0.6

Conclusions

- detection of a diffuse non virialized structure
- spectral shape consistent with the WHIM predicted by cosmological simulations
- soft X-ray intensity consistent with models
- correlation with galaxy overdensity at a redshift ~0.45

One of the first detections of WHIM at intermediate redshift

Future plans

- Better optical data:
  - spectroscopic redshift → TNG, WHT
- Better x-ray detection:
  - accurate temperature estimation
  - morphology informations

  → XMM
  Chandra

- Absorptions in QSO spectra of oxygen ions:

  UV OVI (1032,1038)Å

  X OVII 0.574 keV, OVIII 0.653 keV
  - alternative determination of the absorber's redshift
  - estimation of other physical properties