The XMM-Newton View of the z<0.5 Warm-Hot Intergalactic Medium

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Outline

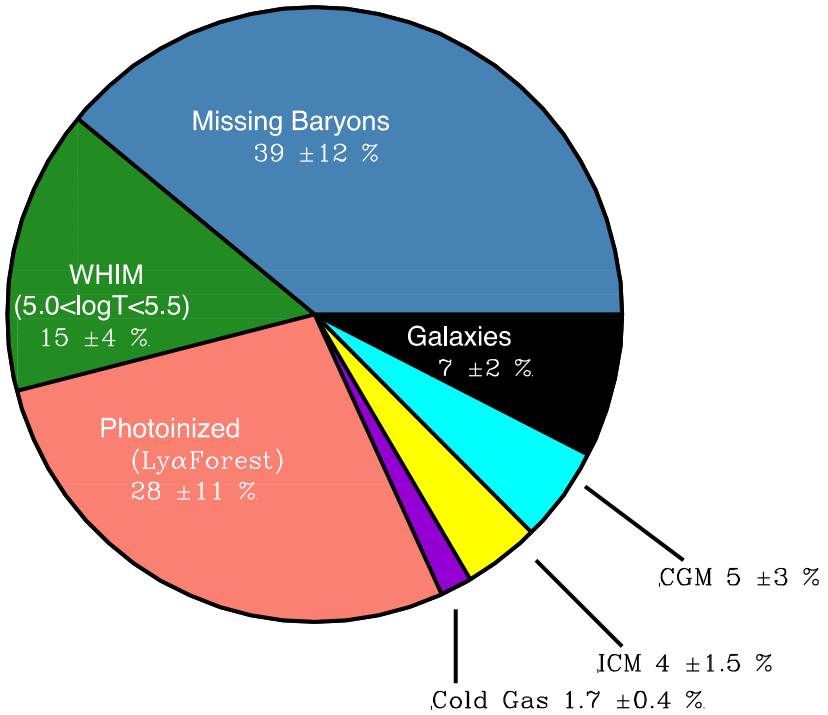
- The Missing Baryon Problem
- Preliminary Results from the XMM-Newton VLP on 1ES 1553+113
- From XMM/Chandra to Athena/Lynx

The Missing Baryons Problem

Nicastro+16

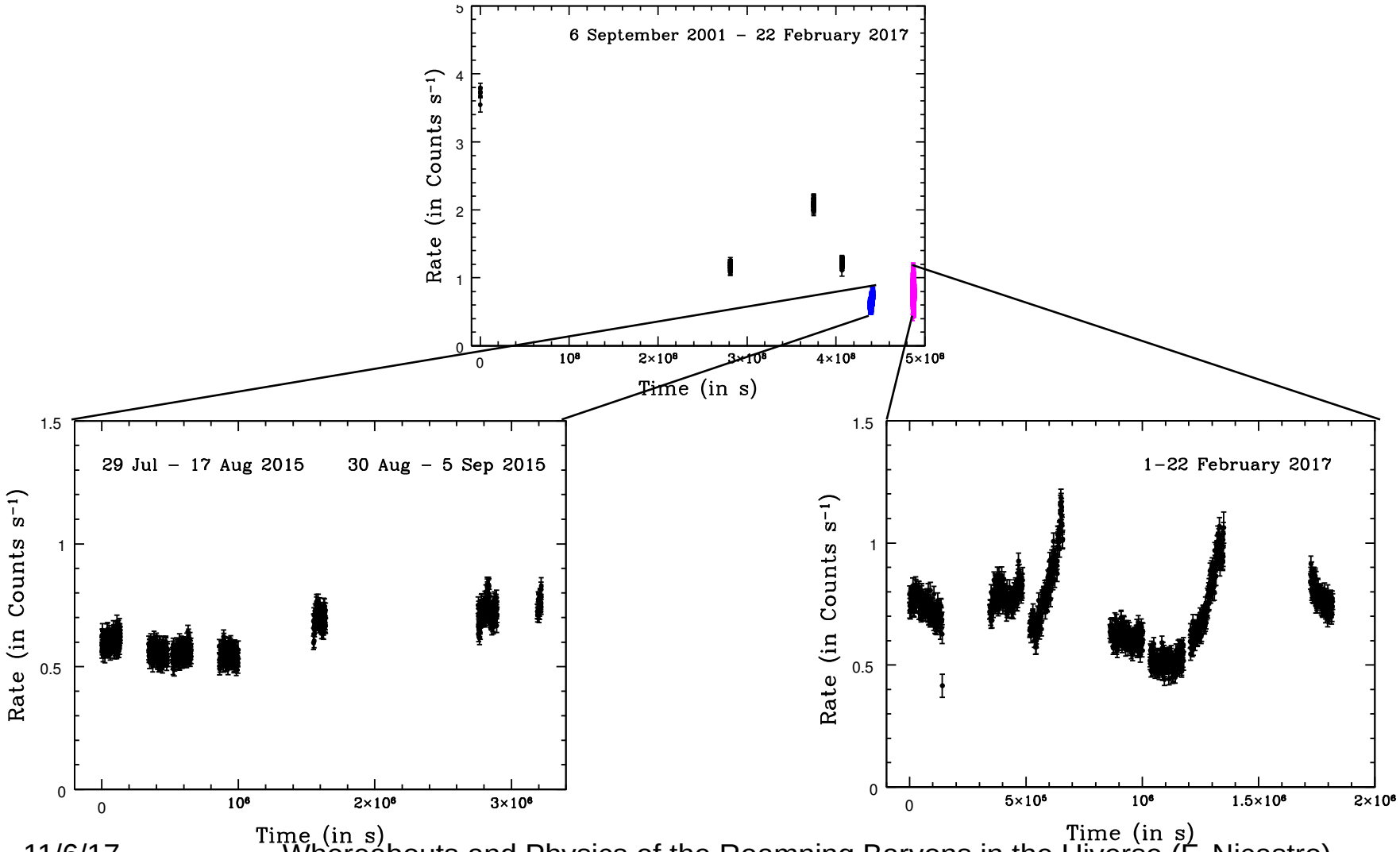
$\Omega_b^{WMAP} h^{-2} = 0.0226\ h^{-2} = 0.0456 \sim 5\%$

HST-COS Obs of BLA+OVI & Chandra Obs of CV



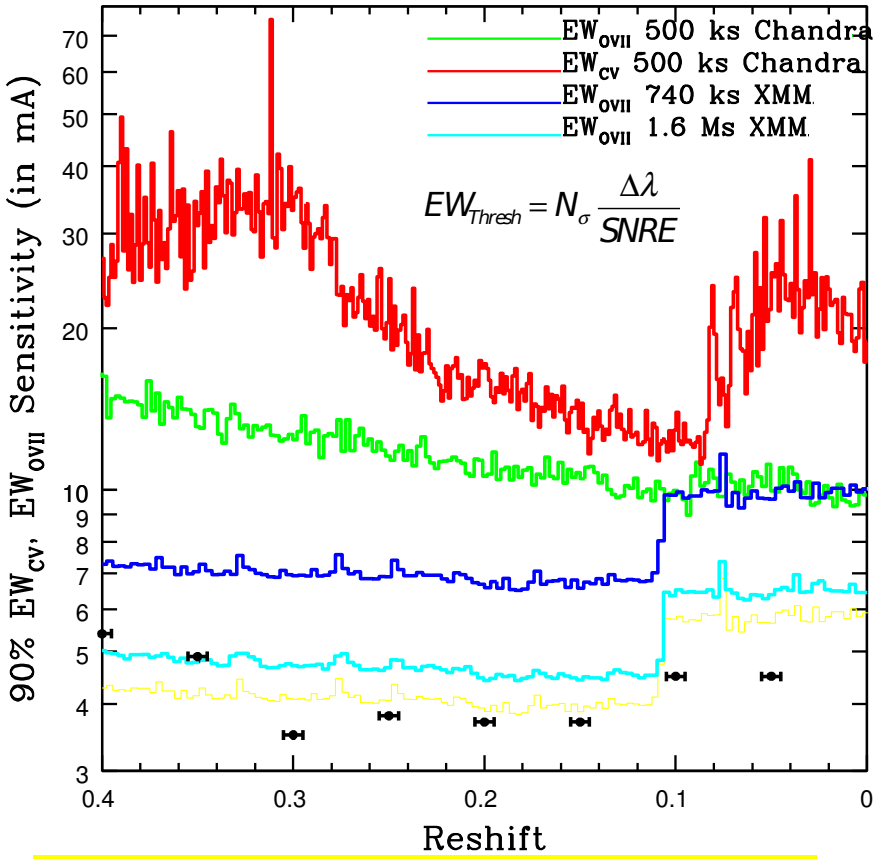
~ 30-50% (or more) of Baryons Still Missing at z~0

The XMM-Newton VLP on 1ES 1553+113

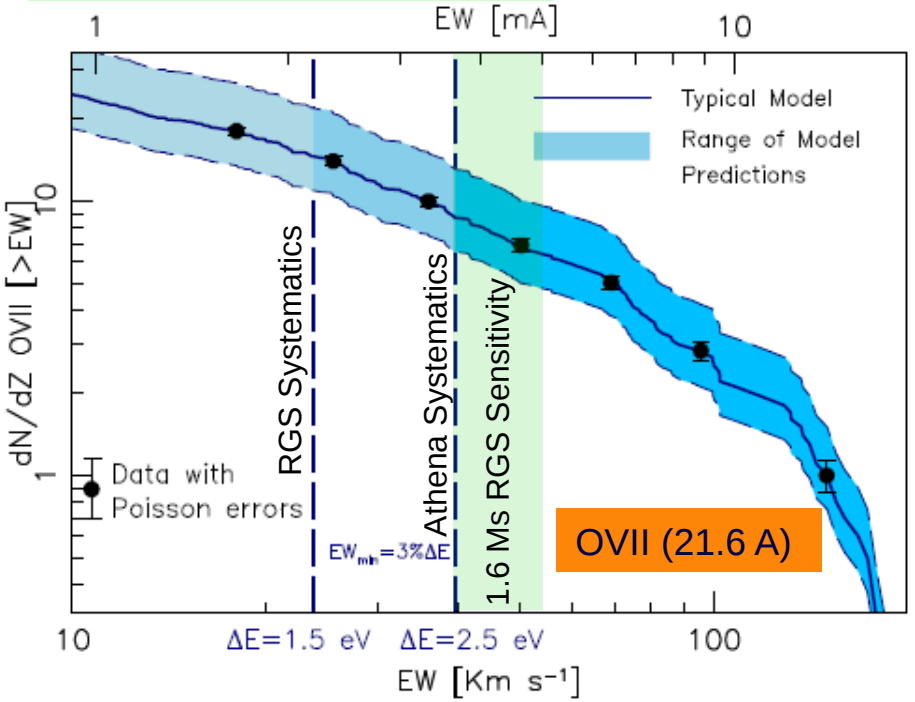


The Warm-Hot (OVII) IGM
XMM-Newton RGS Spectrum of 1ES 1553+113

X-Ray Spectra of 1ES 1553+113
(z≈0.49 ± 0.04)



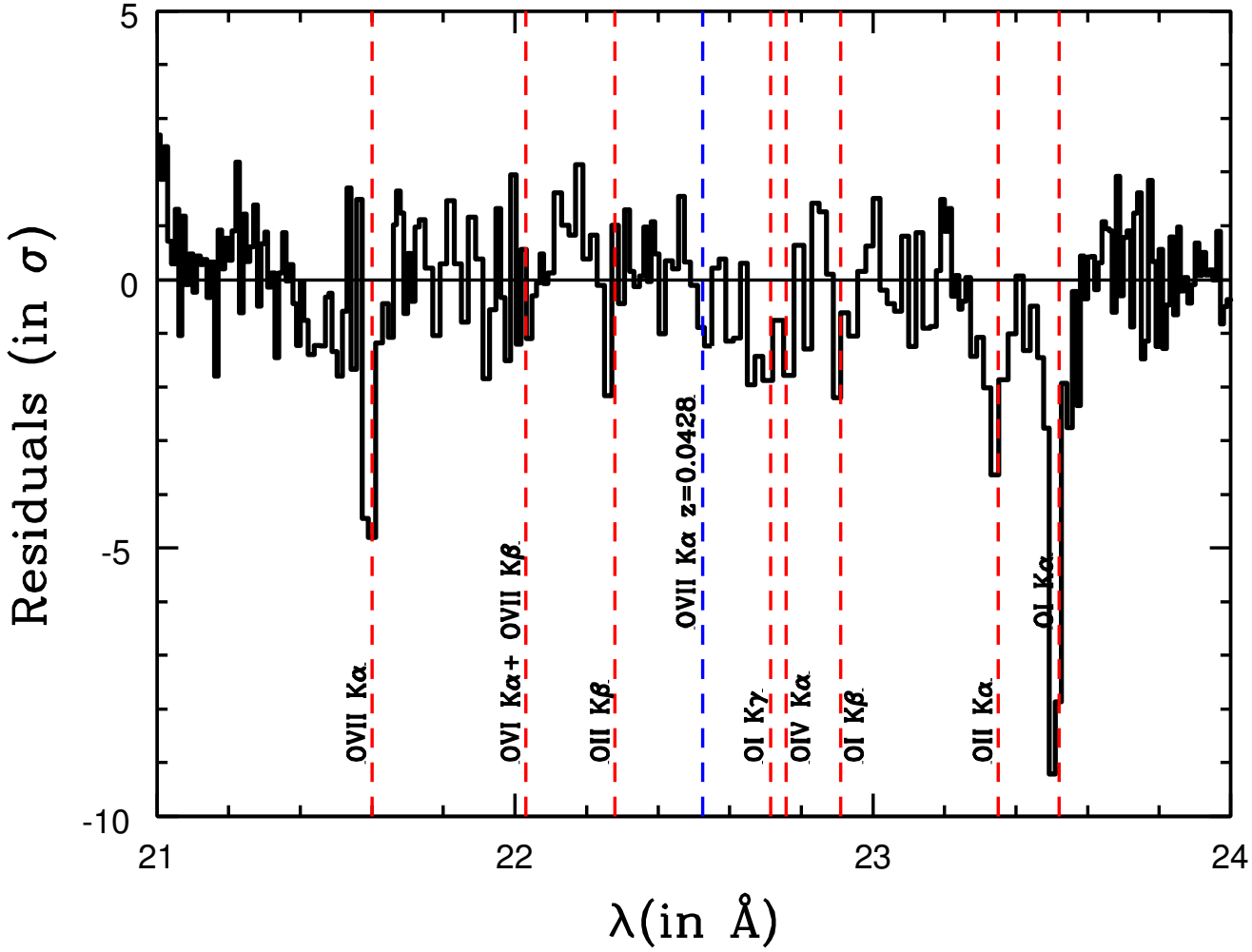
Athena WHIM White Paper (Kaastra+13)



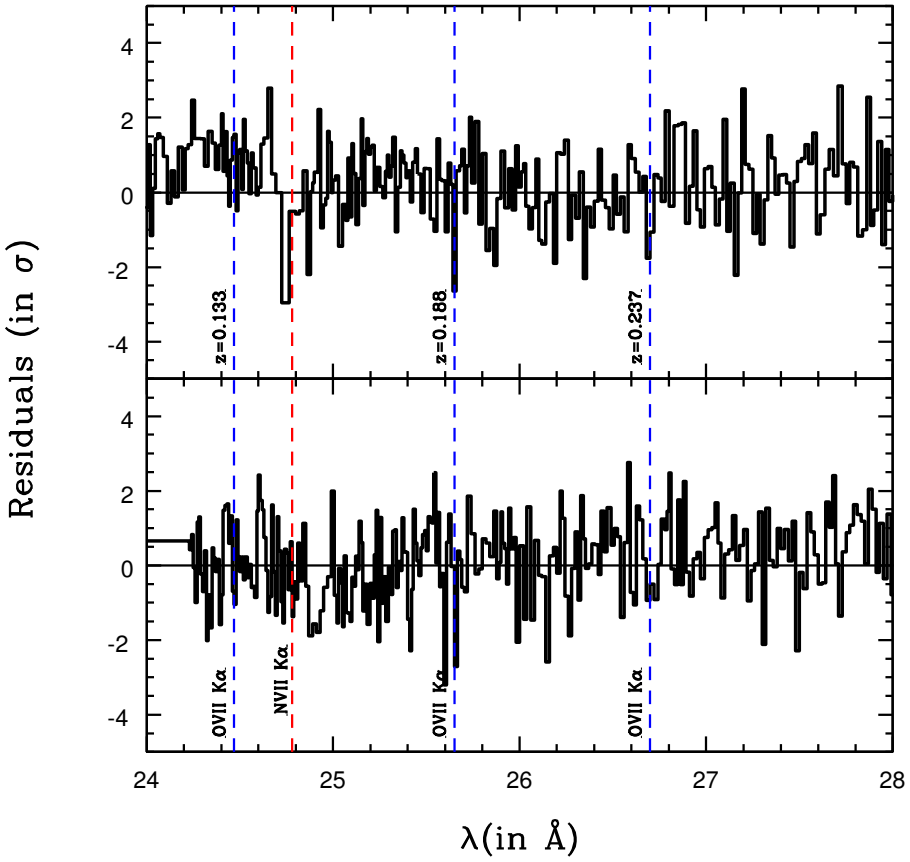
1.6 Ms RGS: EW>4-5 mA @ >90%
i.e. ~1200 cts per R.E.

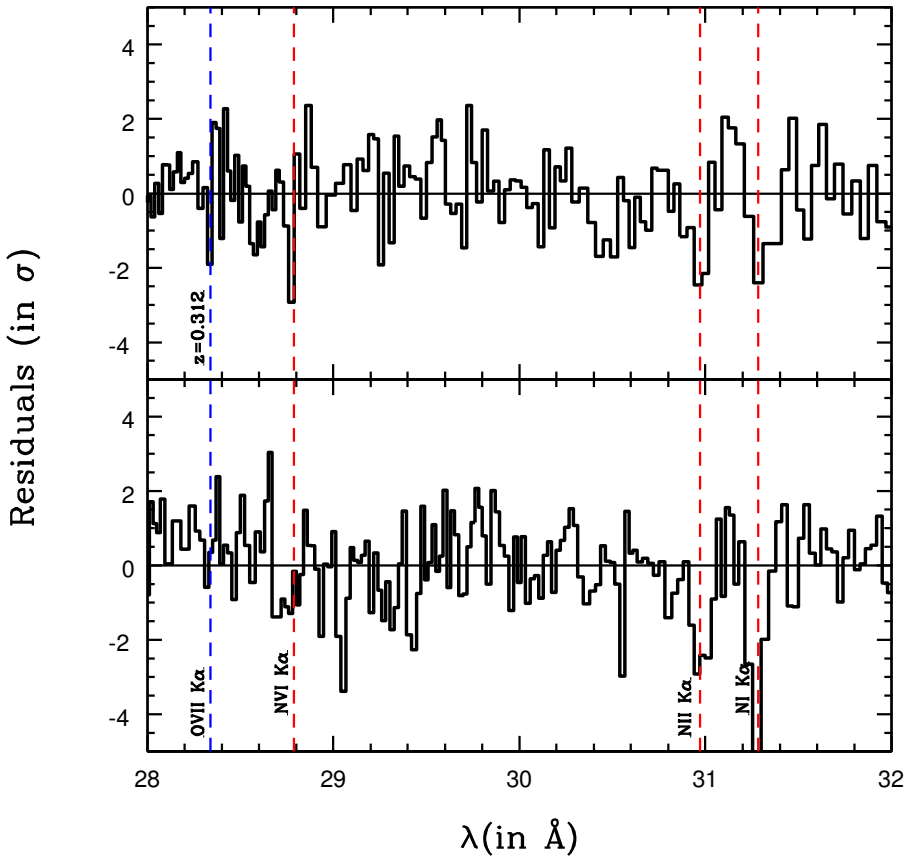
Expected:
3.1-6.2 down to 90% RGS sensitivity &
up to z<0.53
P(>0) = [1-P(3.1-6.2 | 0)] = 99.56-99.98%
□□ 2.85-3.75 σ

Galactic Oxygen Absorption

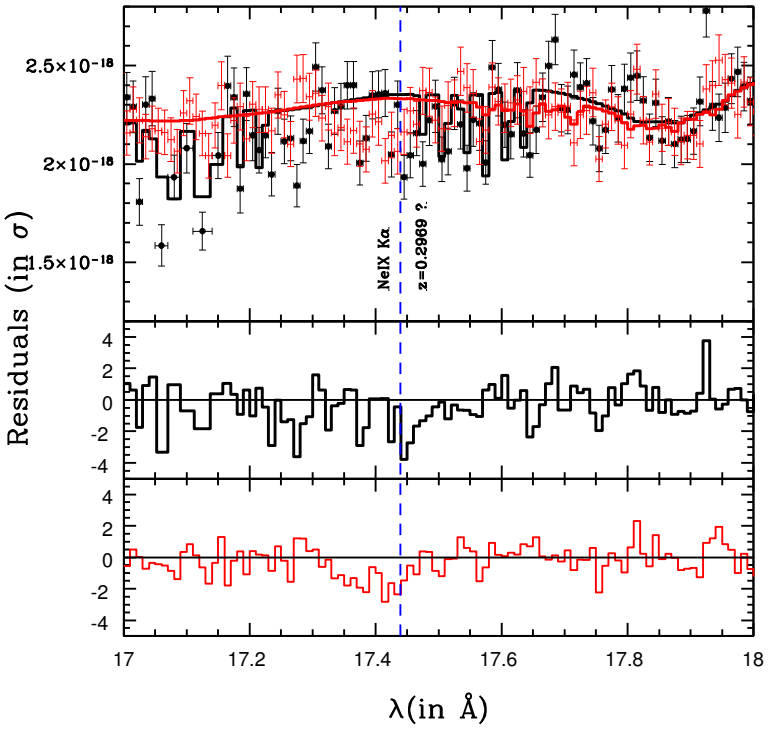


Galactic Nitrogen Absorption

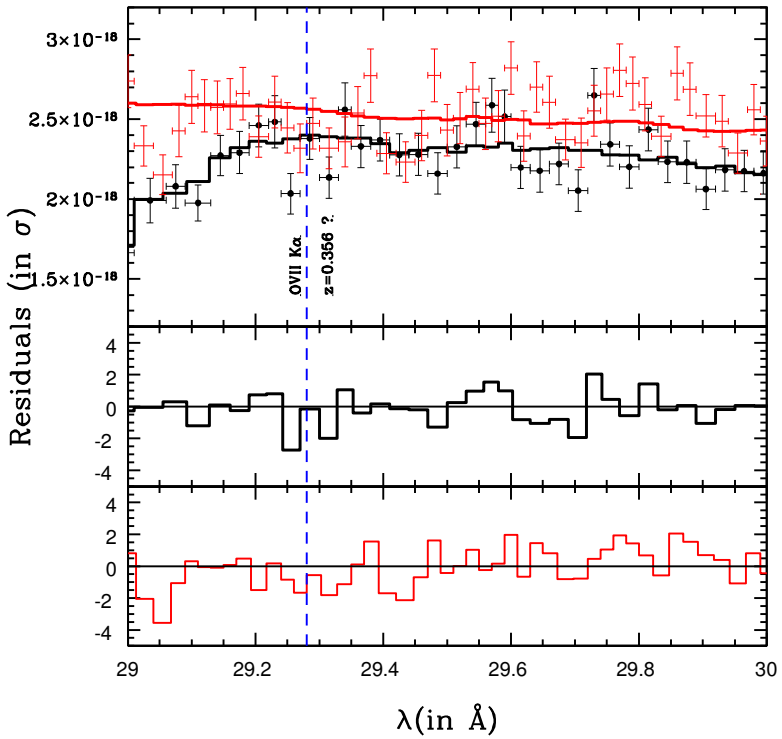




Serendipitous Abs. Lines at λ =12-38 Å (in clean effective area regions)

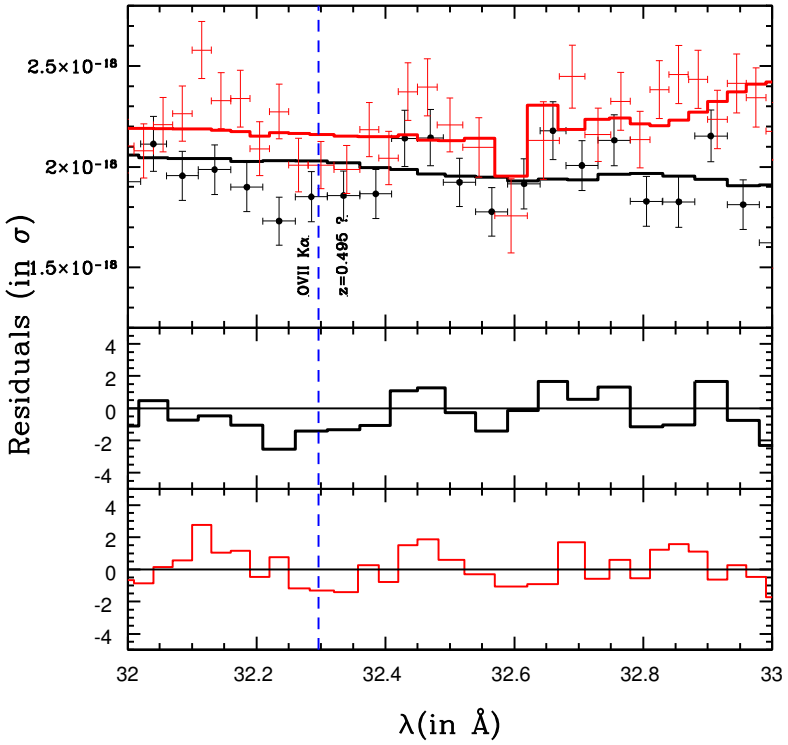


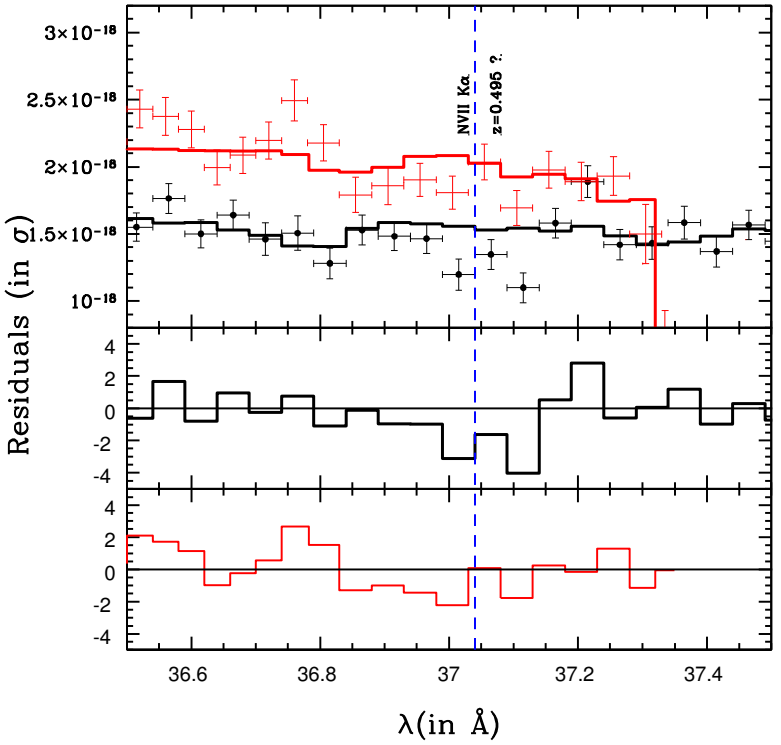
λ=17.439(+0.006,-0.010) Å
EW=12.0±1.7 mÅ (≈ 7σ)
If NeIX Kα ⇒ z=0.2969
If NeX Kα ⇒ z=0.4371
If FeXVII L ⇒ z=0.1614



λ=29.28±0.02 Å
EW=9.0(+3.9,-2.0) mÅ (≈ 4.5σ)
If OVII Kα ⇒ z=0.356
If NVII Kα ⇒ z=0.182
If NVI Kα ⇒ z=0.017

Serendipitous Abs. Lines at λ =12-38 Å (in clean effective are regions)

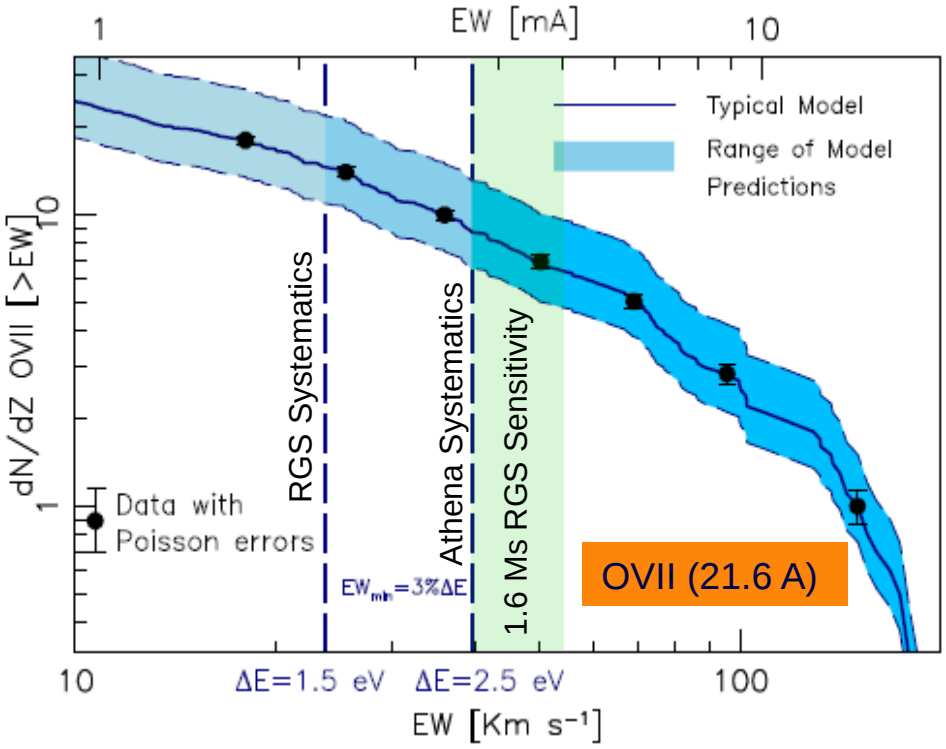




λ=32.296(+0.009,-0.032) Å
EW=11.8±3.7 mÅ (□ 3.2σ)
If OVII Kα □ z=0.495
If NVI Kα □ z=0.122
If NVII Kα □ z=0.303
If NI Kα □ z=0.032

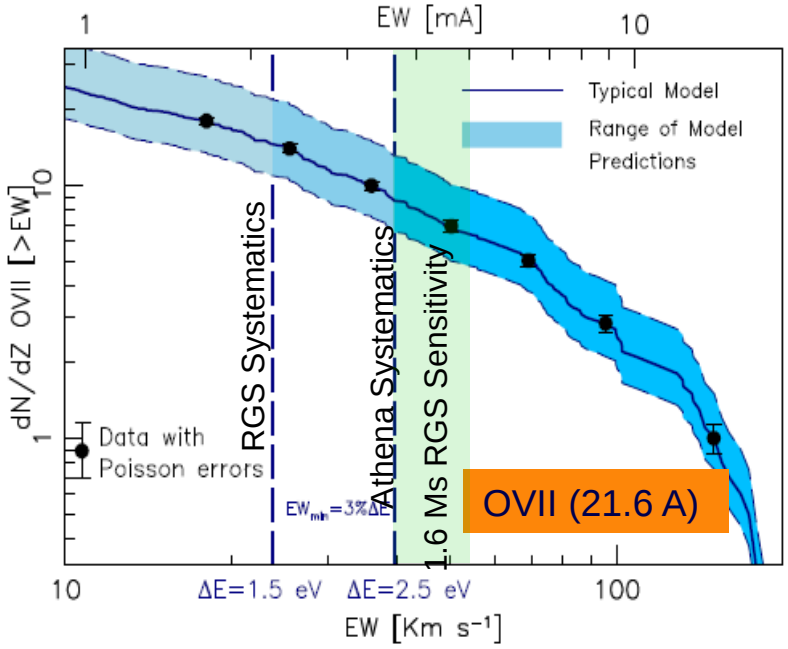
λ=37.04(+0.01,-0.03) Å
EW=21.0±4.6 mÅ (□ 4.6σ)
If NVII Kα □ z=0.495
If NVI Kα □ z=0.287
If NI Kα □ z=0.184

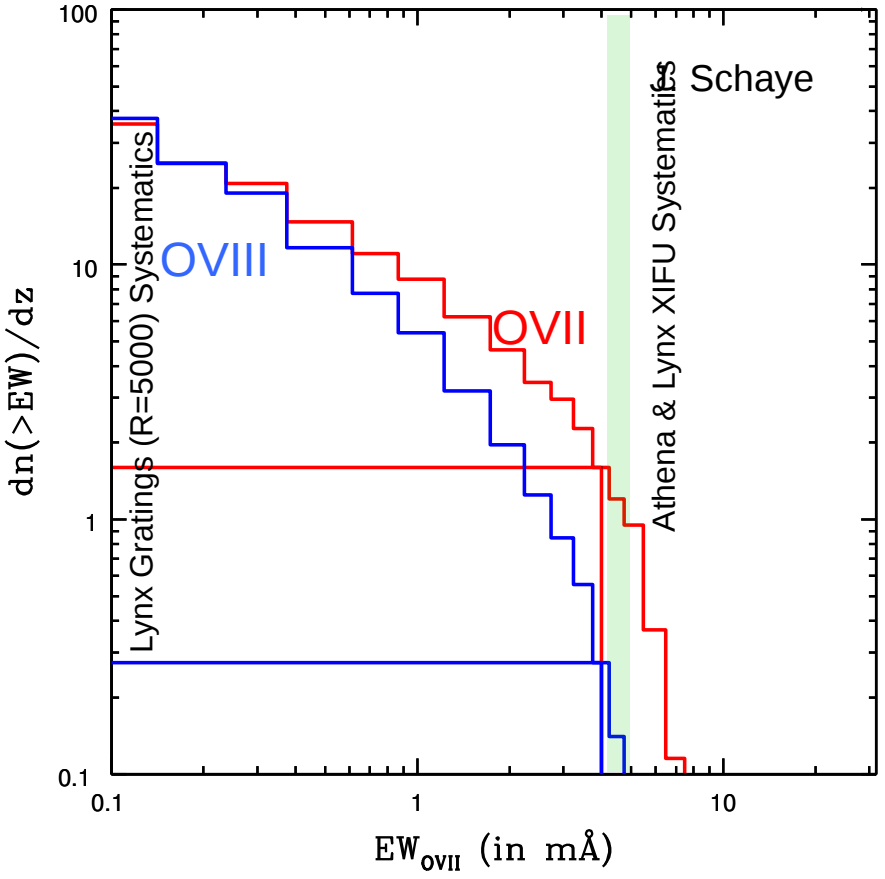
The Future:
from XMM/Chandra to Athena/Lynx



- 1-3 logT>5.5 IGM systems (1-2 in OVII Kα) have possibly been seen thanks to the deepest XMM observation of a blazar (that hits the predicted Athena systematics)
- This is (still) barely consistent with the most conservative HDS predictions, and certainly challenges optimistic predictions
- But a single line of sight! Cosmic Variance needs to be addressed: going deeper would not pay
- Shallower (EW≥8 mA at 90%) observations of a number (5-10) properly selected high-z targets are needed and would greatly benefit feasibility studies for Athena.

Which Predictions are Correct?





Our Line of Sight seems to Suggest Eagle Simulations give right predictions