

Observation of warm-hot intergalactic medium in OVII and OVIII absorption against diffuse extended sources with Athena and LEM

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Large Scale Structure

The EAGLE project (Schaye+15)

Large Scale Structure



Cosmic web filaments:

- diffuse low density gas
- $n_e \sim 10^{-6} - 10^{-4} \text{ cm}^{-3}$
- $T = 10^5 - 10^7 \text{ K}$
- lower density – WHIM
- higher density – CGM

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Observations:

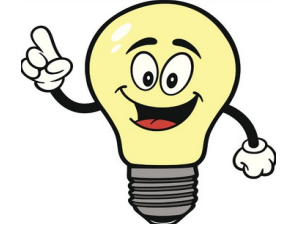
- A) emission (Wang & McCray 1993, Kaastra+2003, Werner+2008, Eckert+2015, Akamatsu+2017, Reiprich+2021)
- B) absorption

X-ray absorption studies

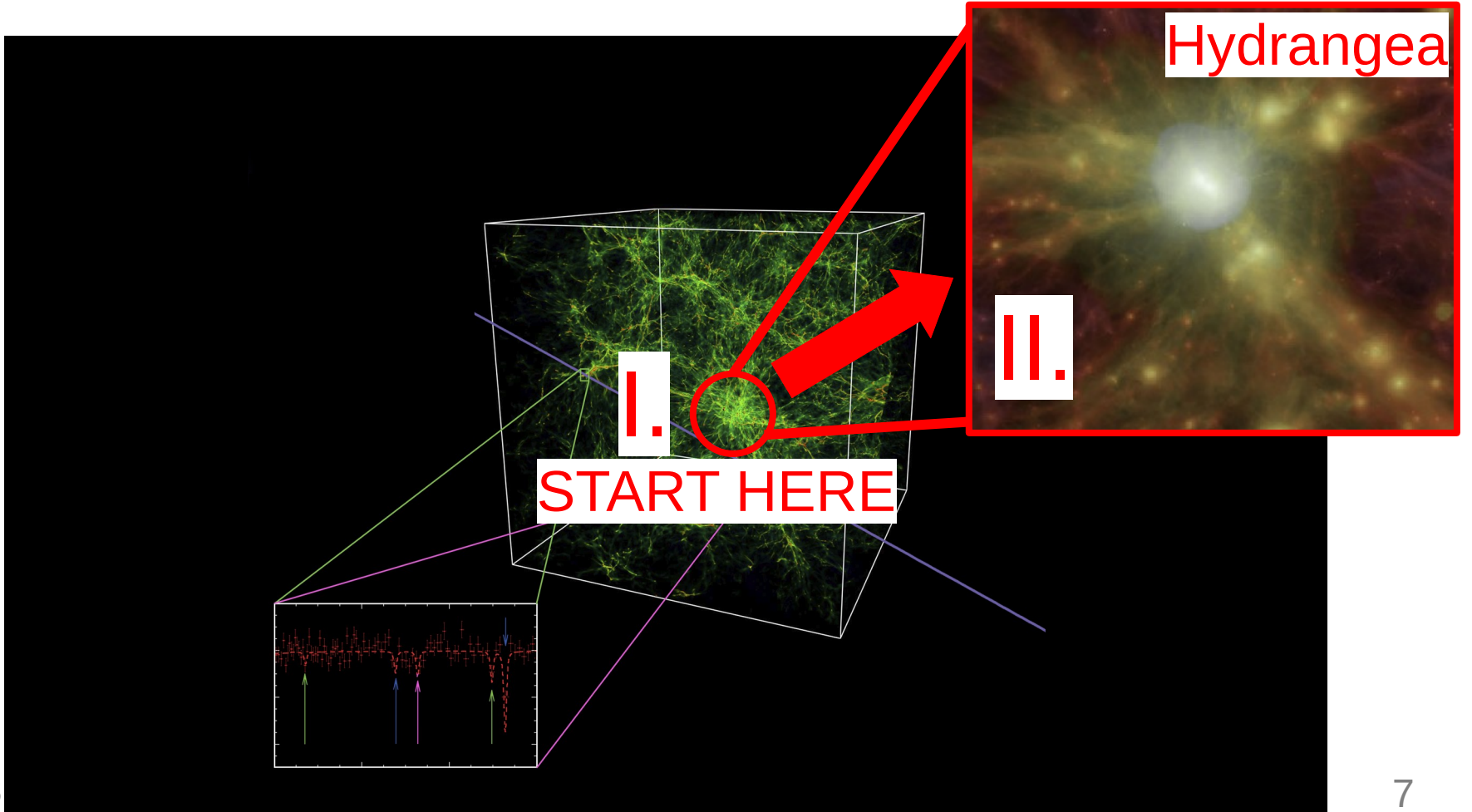
- point-like sources (blazars, quasars)
 - review by Nicastro, Fang & Mathur 2022

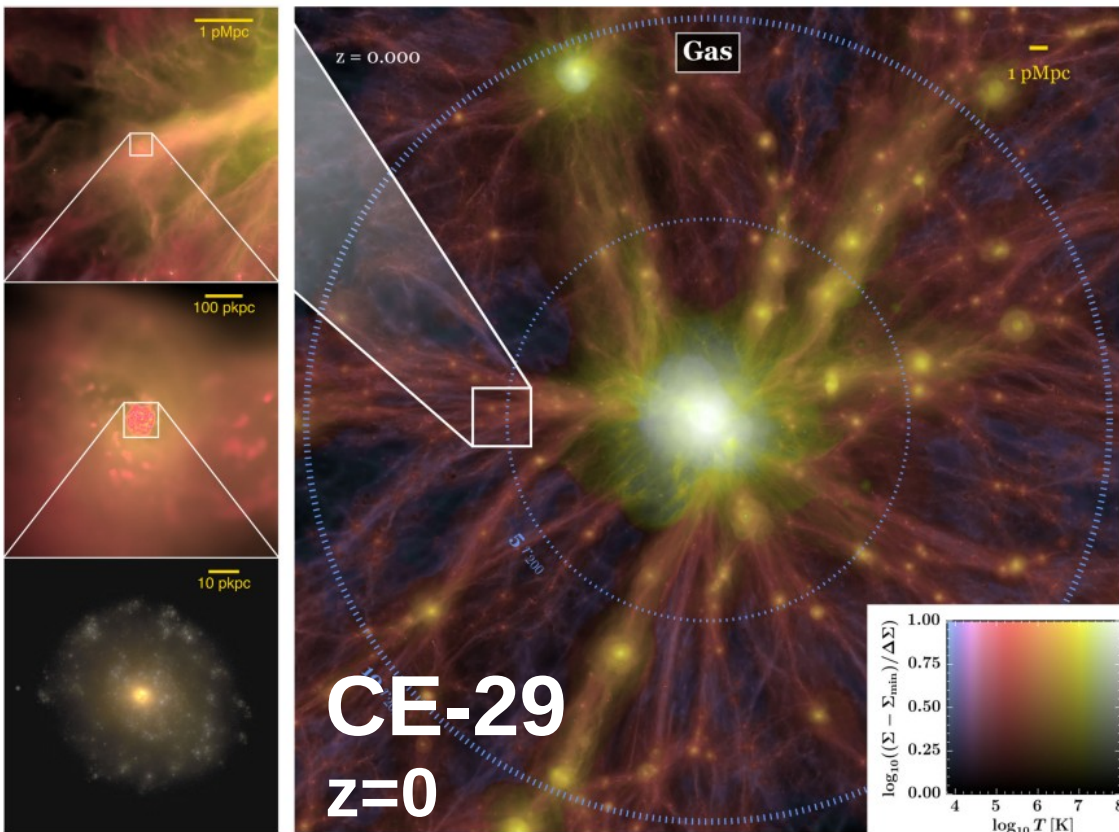
X-ray absorption studies

- point-like sources (blazars, quasars)
 - review by Nicastro, Fang & Mathur 2022
- extended bright sources (galaxy cluster cores)
 - Markevitch et al. 1999, 2009
 - Simionescu et al 2021 (Voyage 2050)



X-ray absorption studies



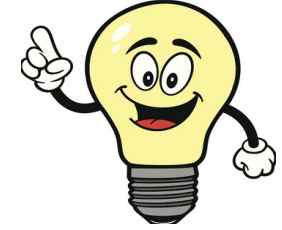


Hydrangea cosmological hydrodynamical simulations:

- zoom-in (EAGLE)
- 30 candidates
- simulated up to $10 r_{200c}$
- $M_{200c} = 10^{14-15.4} M_{\text{solar}}$

- color bar:
gas surface density vs.
gas temperature

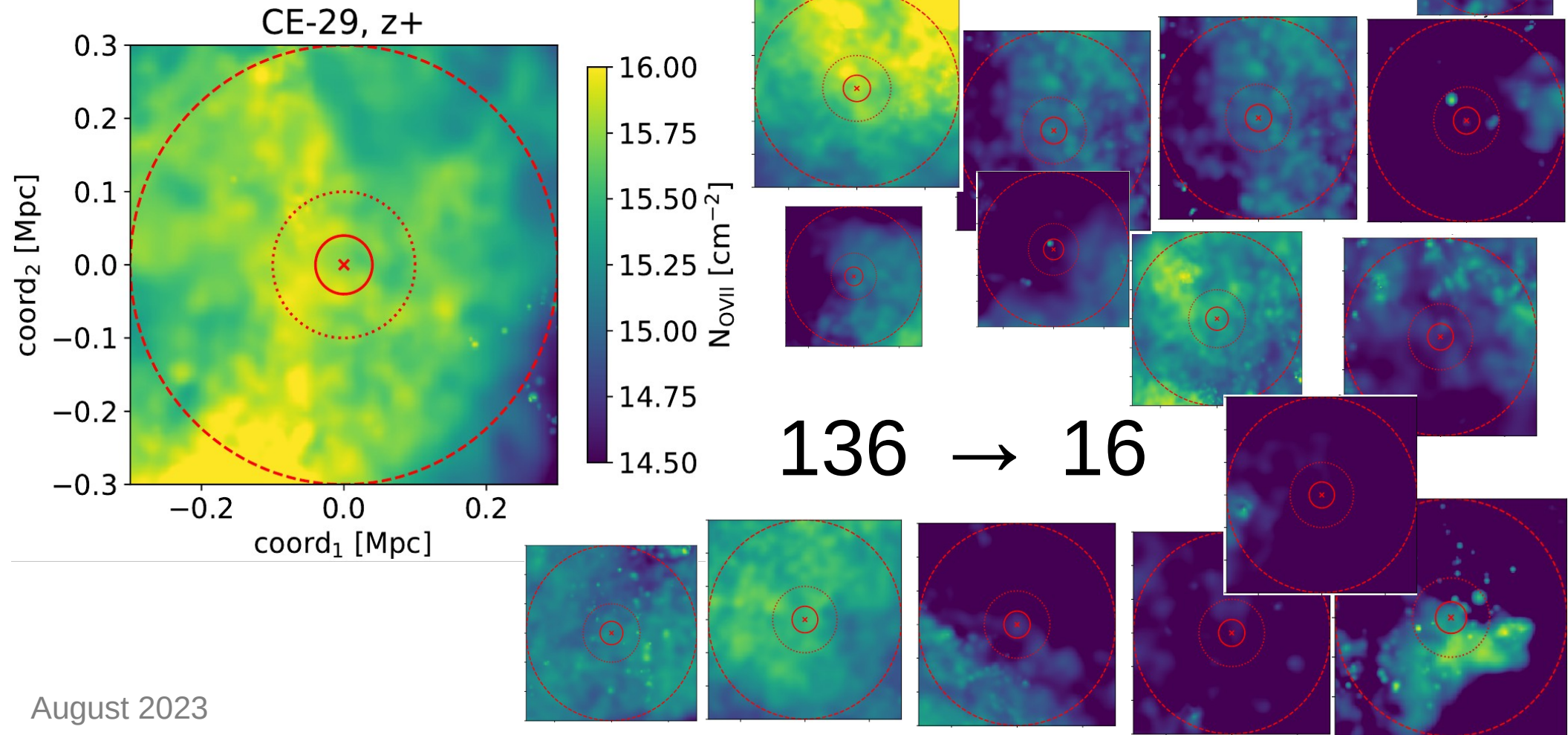
Schaye+15, Bahé+2017

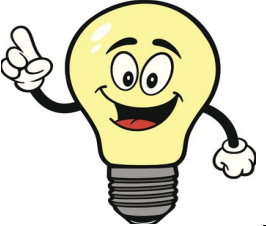


X-ray absorption studies



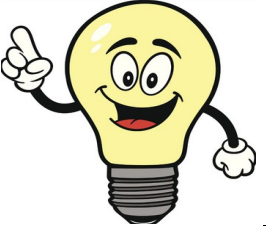
OVII column density maps



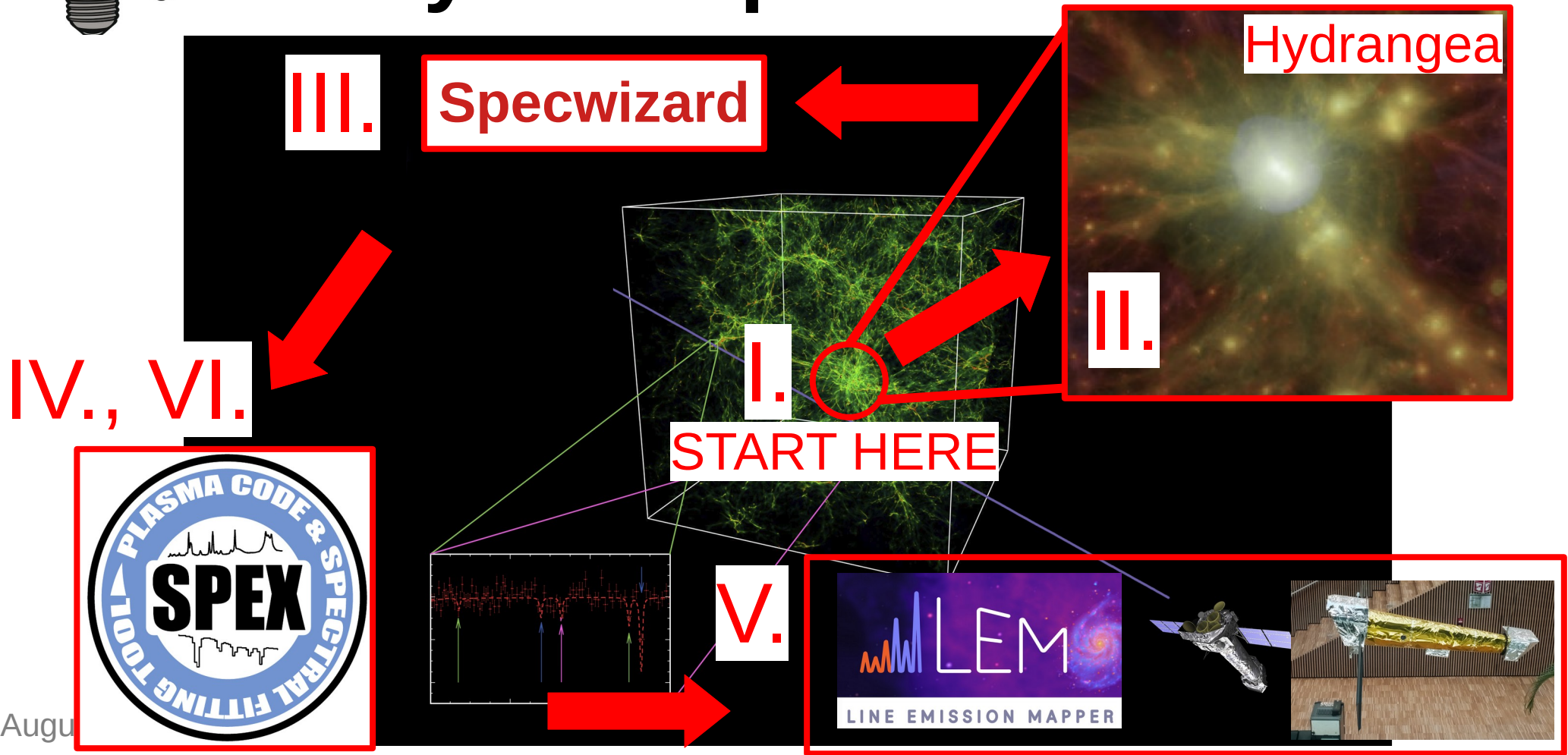


X-ray absorption studies





X-ray absorption studies





Athena & LEM micro-calorimeters

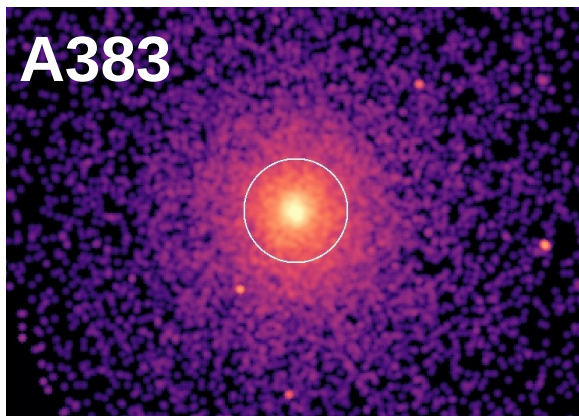


	Energy band [keV]	Angular resolution [arcsec]	Spectral resolution @ 0.5 keV [eV]	Effective area @ 0.5 keV [cm ²]	FoV [arcmin ²]	Grasp @ 0.5 keV
Athena X-IFU	0.2 – 12	5	2.5 (4)	5900	5 (4) x 5 (4)	0.12
LEM IFU	0.2 – 2	15	0.9 - 2	1500	30 x 30	1.3

Grasp [10⁶ arcmin² cm²] = effective area * FoV

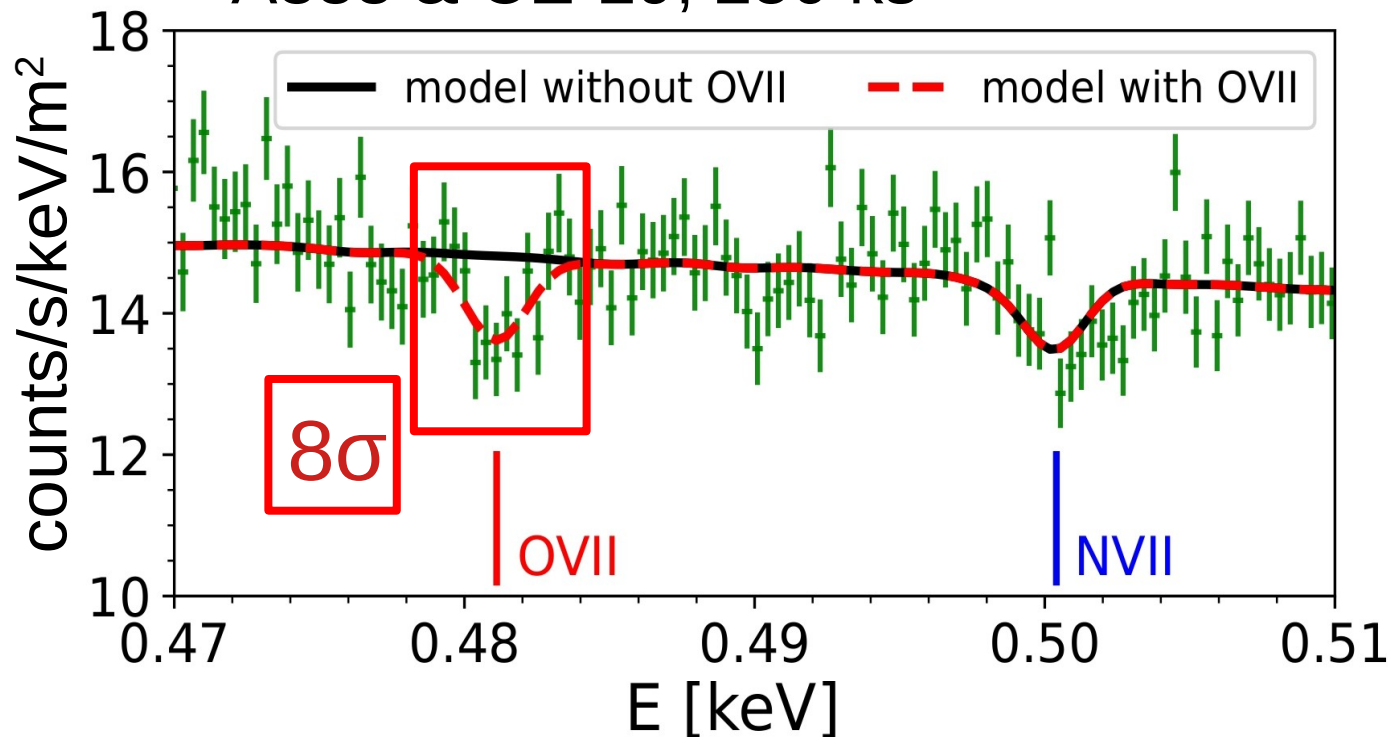
Athena X-IFU

5 σ in ~ 100 ks



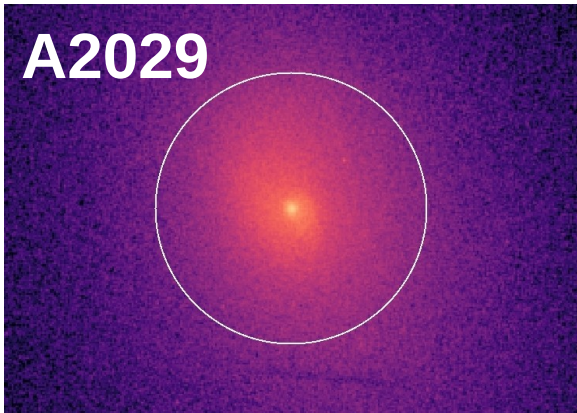
Chandra (ID 2321)

A383 & CE-29, 250 ks



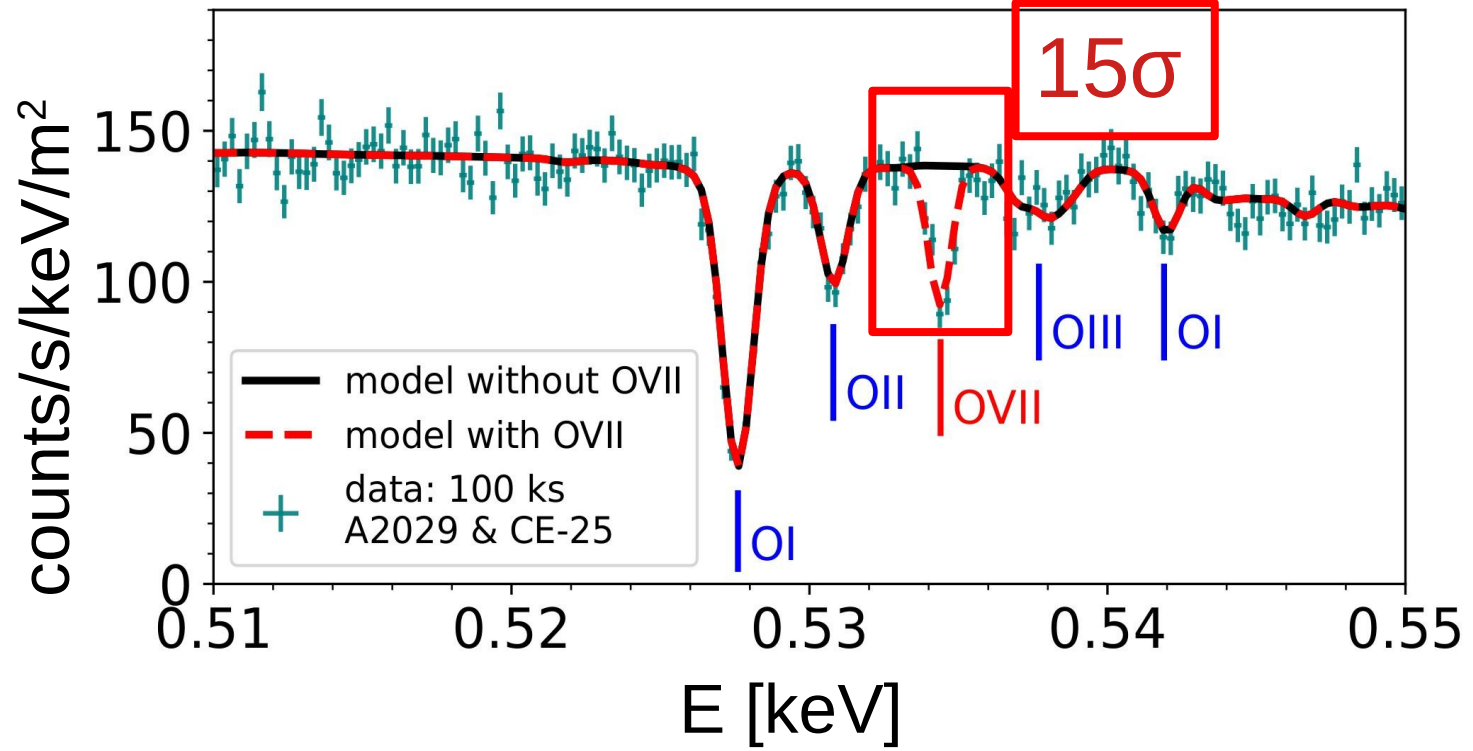
LEM

5 σ in ~12 ks



Chandra (ID 4977)

A2029 & CE-25, 100 ks



Conclusions

OVII

possible with Athena & LEM towards multiple galaxy clusters, as e.g. A2390, A383, A1413, A2029, A262

OVIII

Stay tuned for **Štofanová et al.** (almost submitted) or catch me at a coffee break ;)

BUT depending on properties of absorbers and the galaxy cluster redshift – possible contamination by Milky way!