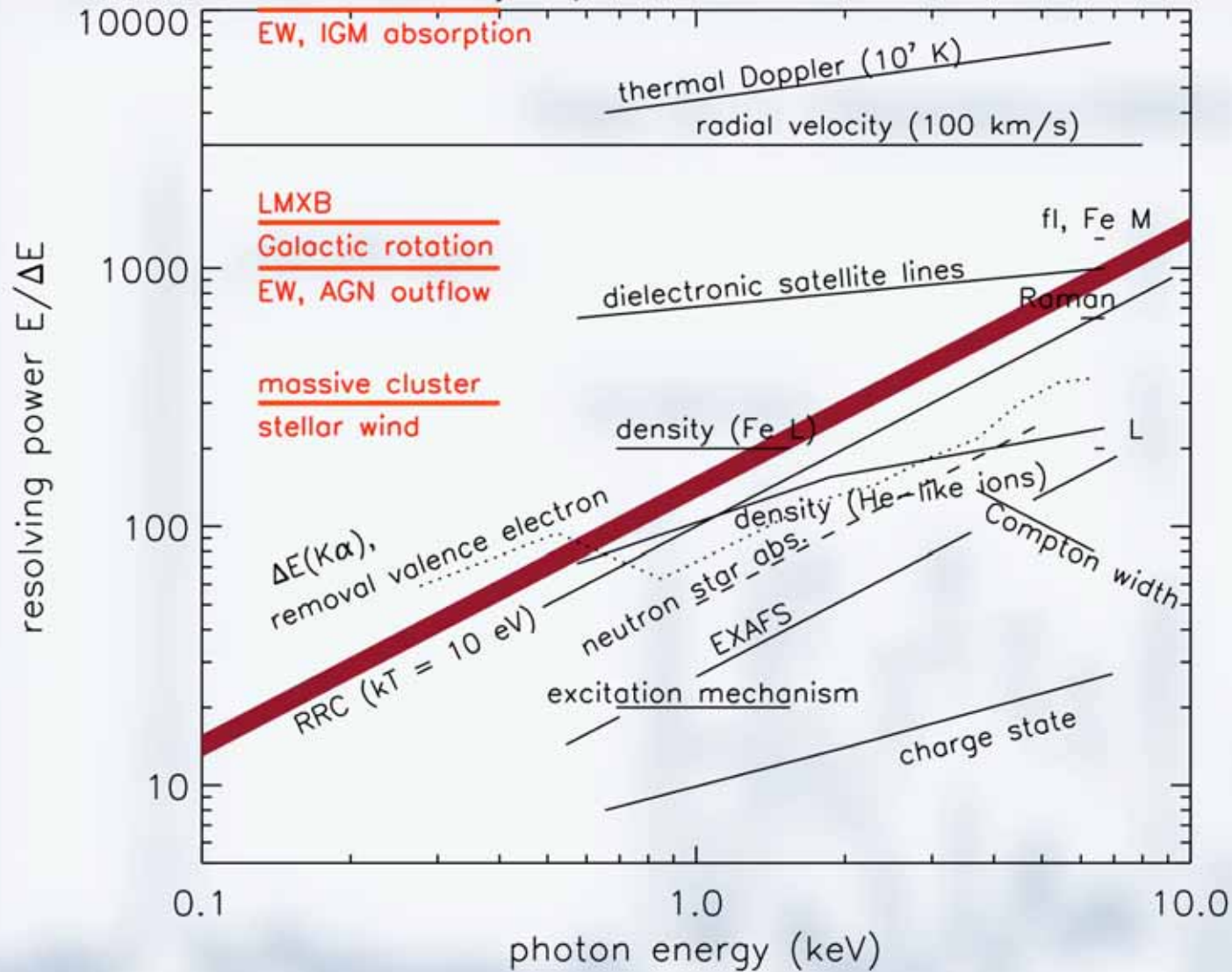


HIGH RESOLUTION SPECTROSCOPY WITH ASTRO-H

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Discovery Space for Astro-H XCS



1. Some Predictable 'Surprises'

Physics of photoionized accretion flows

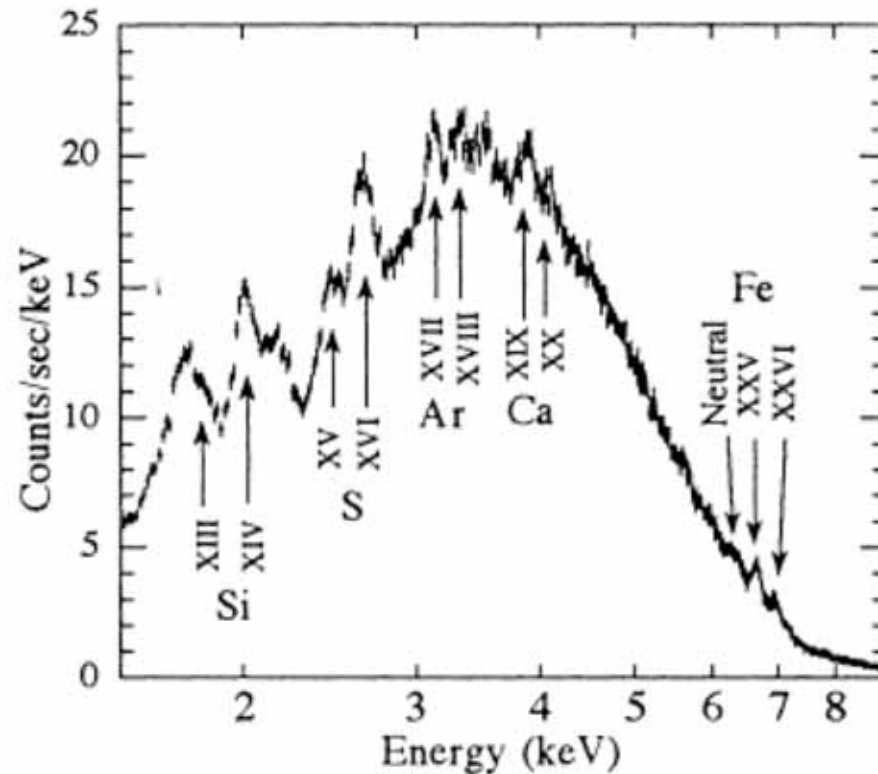


Fig. 1. Energy spectrum of **Cyg X-3** obtained by SIS. Identifications for prominent lines are also indicated by arrows.

Diagnostics:

He-like triplets, RRC's

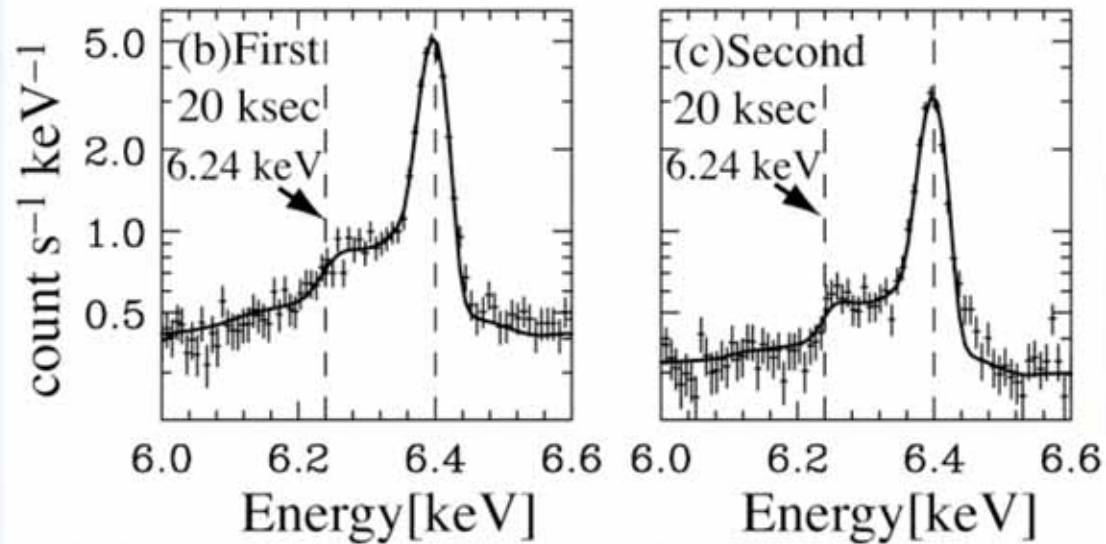
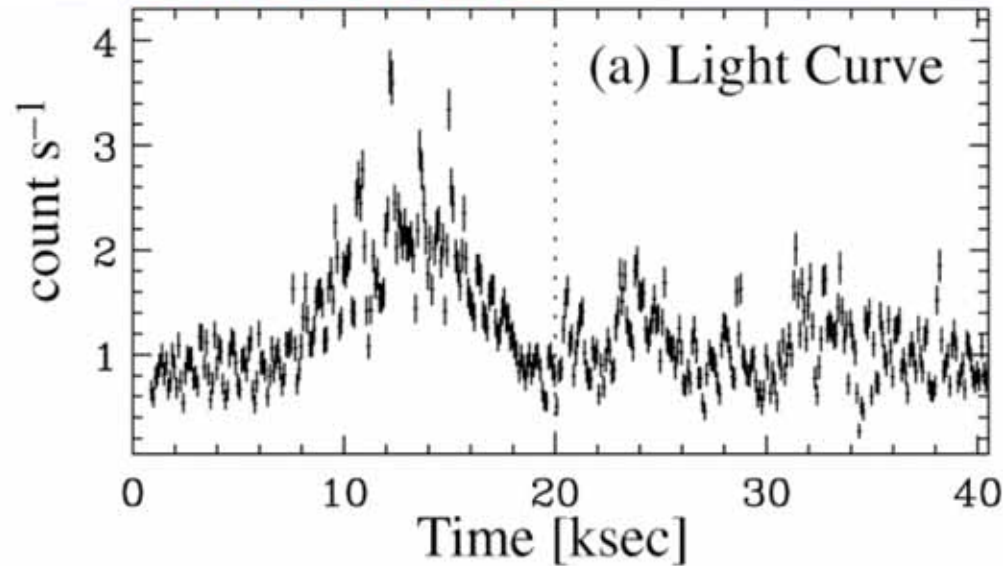
Easily resolved

(width RRC $\sim kT \sim 10$ eV)

Relevant to XRB, AGN (Seyfert 2)

Cold Compton scattering; maybe Raman scattering

GX301 Chandra HETGS



Watanabe et al., 2003, *ApJ*, **597**, L37

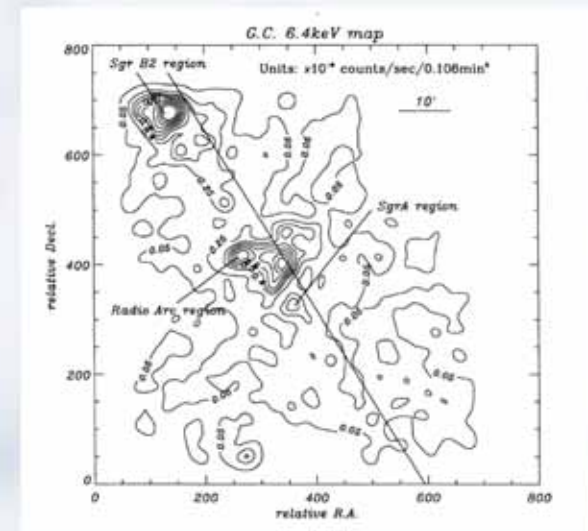
Diagnostic: Fe K α

Easily resolved:

e^- Compton width at Fe K = ...

Raman: H, $\Delta E = 10.2$ eV

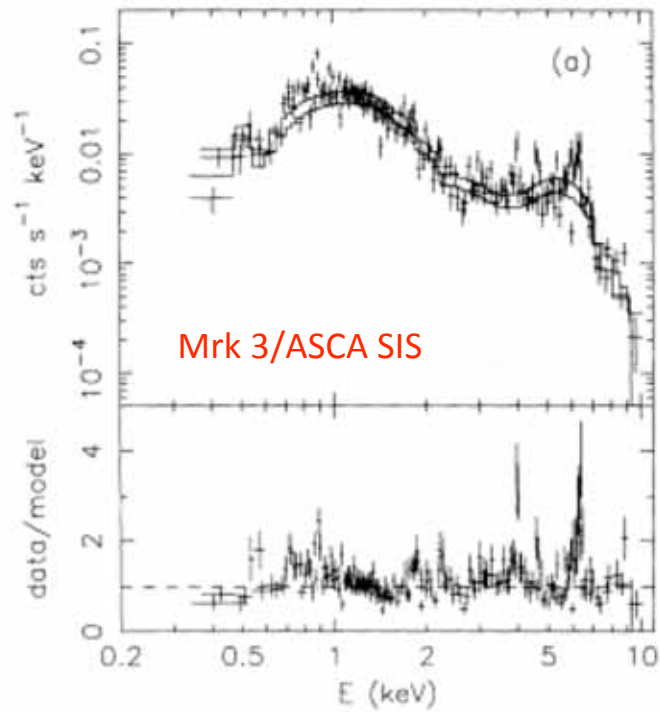
Relevant to XRB, AGN, GC



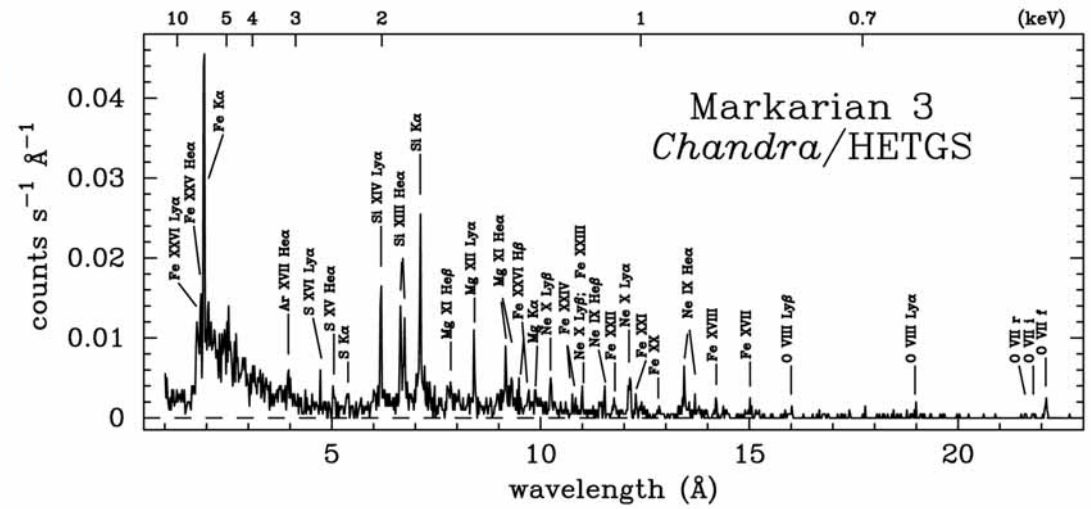
Koyama et al., 1996, *PASJ*, **48**, 249

Fe K Absorption in Obscured AGN; Dust Torus (?)

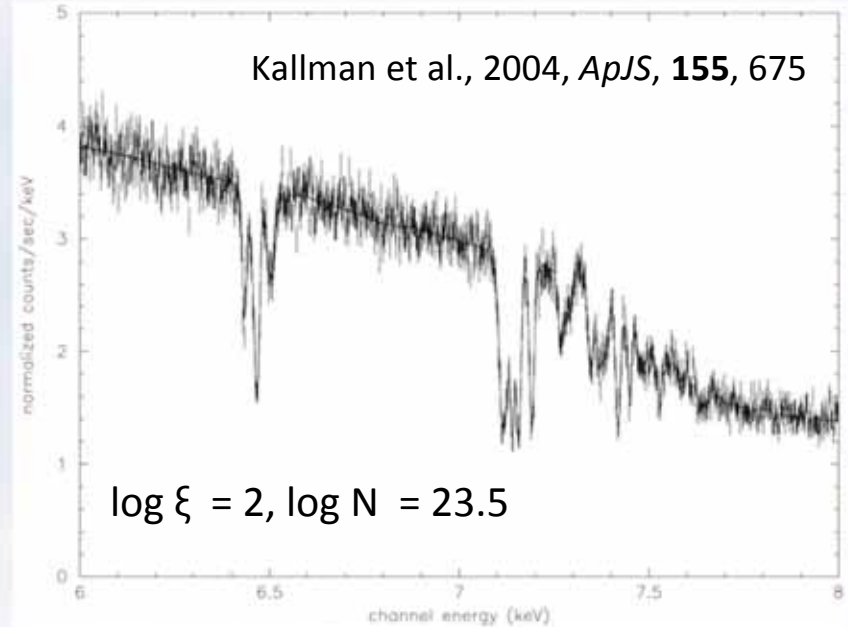
Sako et al., 2000, *ApJ*, **543**, L115



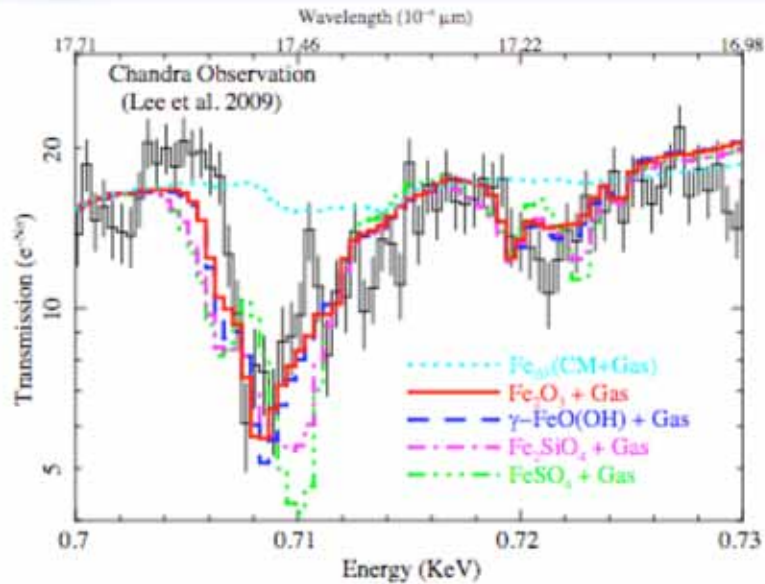
Iwasawa et al., 1994, *PASJ*, **46**, L167



Kallman et al., 2004, *ApJS*, **155**, 675



EXAFS: Solid State Astrophysics



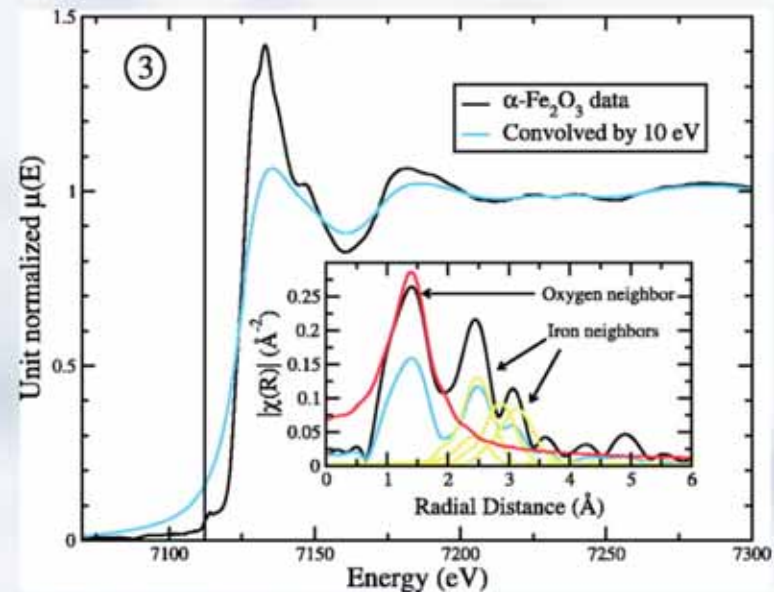
First examples:
 Cyg X-1, Fe L (Lee et al. 2009)
 Sco X-1, O K (de Vries & Costantini 2009)

(NB: physical chemistry ISM in light elts.
 difficult with XCS-
 absorption edge/line spectroscopy $\Delta E \sim 1$ eV)

Crystallography of absorbing dust

Diagnostic: K edge continuum structure
 $Z > 12$: easily resolved

Targets: Galactic ISM (XRB);
 Absorbing material in AGN

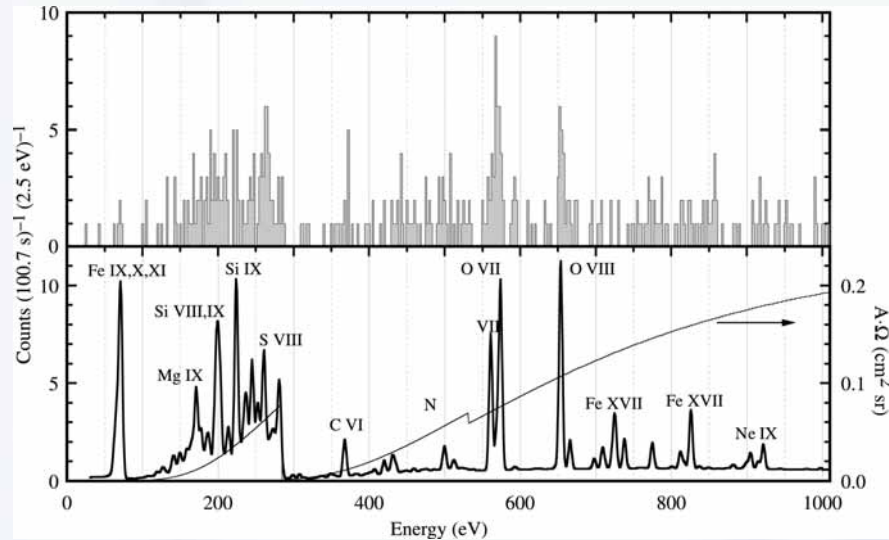


Plea for an ambitious Science Demonstration Program:

- Early demonstration of capabilities, based on easy to explain, easy to appreciate spectroscopy
- Should appeal to anyone in astrophysics
- Stimulates interest among astronomers, propaganda for Astro-H and X-ray astronomy
- Partly predictable, but worth taking risks

2. Spectroscopy of Diffuse Sources

Galactic Halo/ISM, Local Group hot gas (all-sky)



Finite fraction (? most) of the
OVII/VIII emission extragalactic!

McCammon et al., 2002, *ApJ*, **576**, 188

Limits on $z > 0$ extragalactic O line emission from full archive?
(requires careful modeling of [t-variable] background)

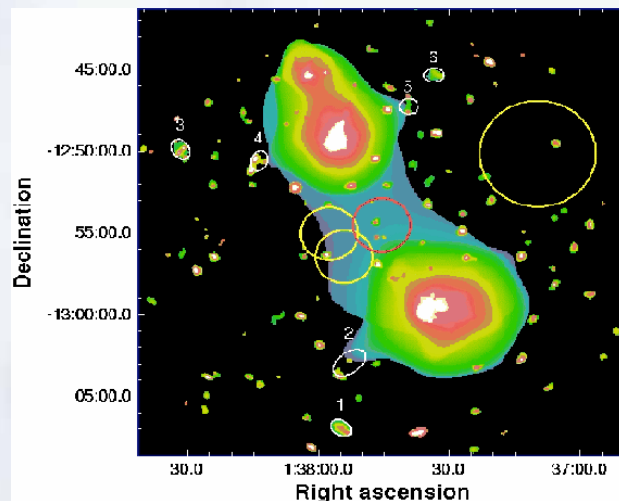
Conditions in outskirts of galaxy clusters

for $n_e t < 10^{12} \text{ cm}^{-3} \text{ s}$, ionization balance not yet in equilibrium
 $t = 1 \text{ Gyr} \rightarrow n_e < 3 \times 10^{-5} \text{ cm}^{-3}$

Will be very difficult...but potentially very interesting

Diagnostics:

He, H-like ionization balance + measured T_e
ratio of forbidden/resonance line in He-like triplets, + T_e



Feasible?

Lowest density medium ever seen:

$$n_e \sim 3 \times 10^{-5} \text{ cm}^{-3}$$
$$kT_e \sim 0.9 \text{ keV (hot)}$$

