On the origin of steep emissivity profiles in AGN accretion discs

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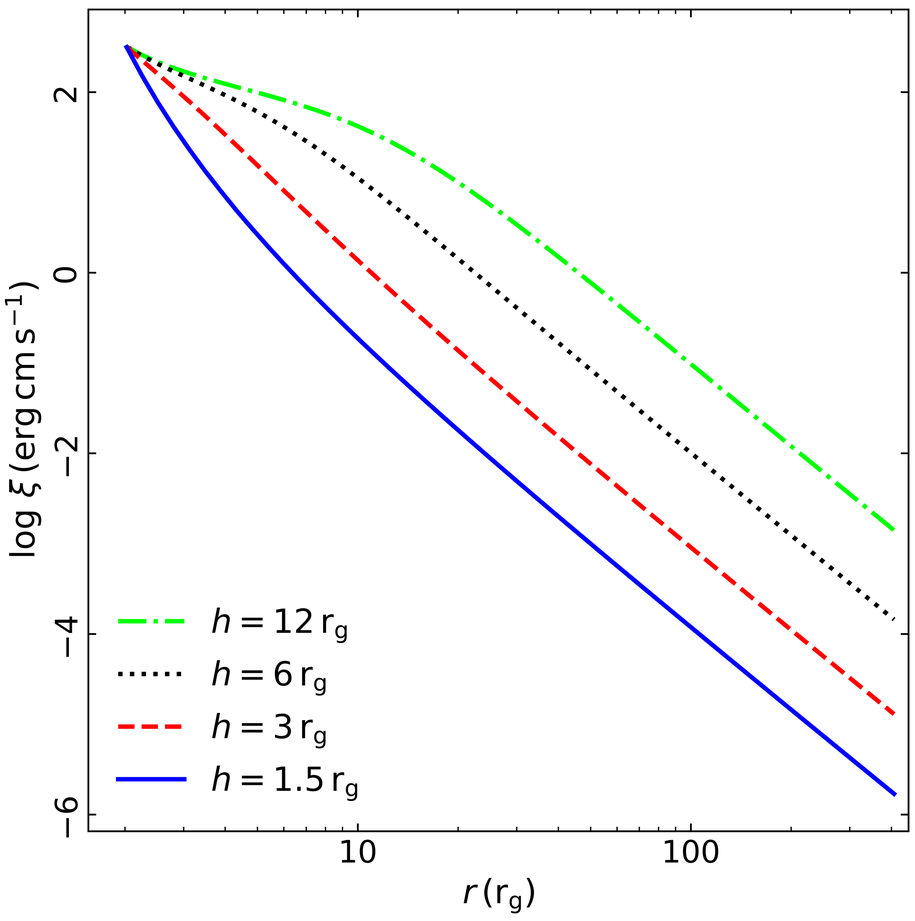
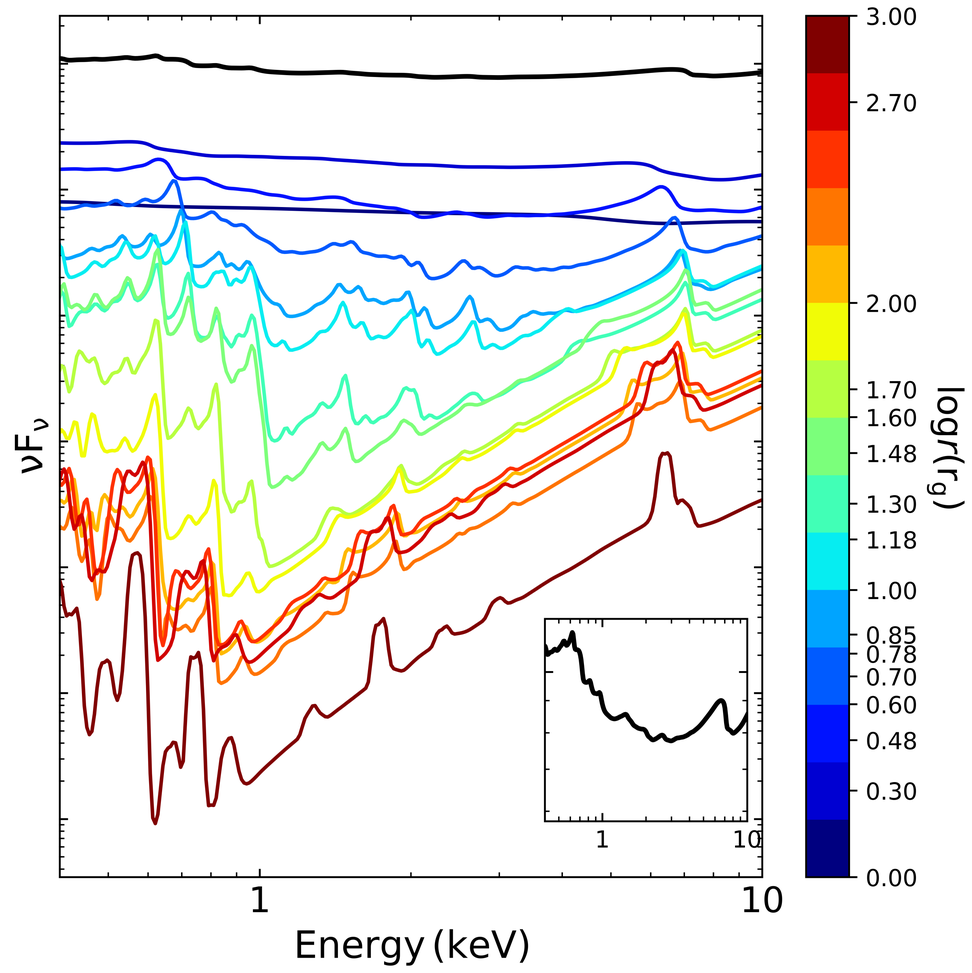
(Kammoun et al. 2019, MNRAS, 485)

Objective

X-ray observations suggest high compactness of coronæ in active galactic nuclei as well as in X-ray binaries. The compactness of the source implies a strong radial dependence in the illumination of the accretion disc. This will, for any reasonable radial profile of the density, lead to a radial profile of the disc ionization. Svoboda et al. (2012) showed on a single example that assuming a radially structured ionization profile of the disc can cause an artificial increase of the radial emissivity parameter. We further investigate how the X-ray spectra are modified and quantify this effect for a wide range of parameters.

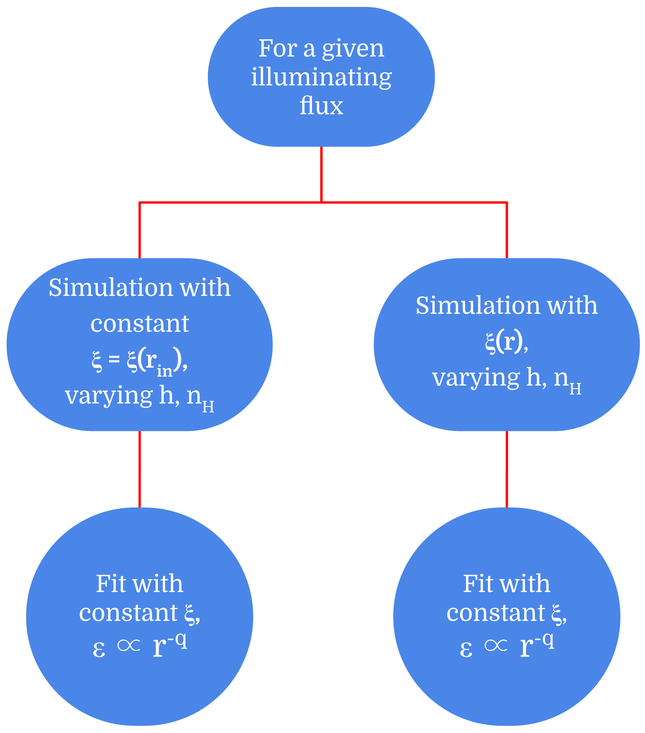


The radial ionization profile $\xi(r)$, for various lamp-post heights. We assume the same inner ionization parameter ($\log \xi_{\rm in} = 2.5$) for all the cases.

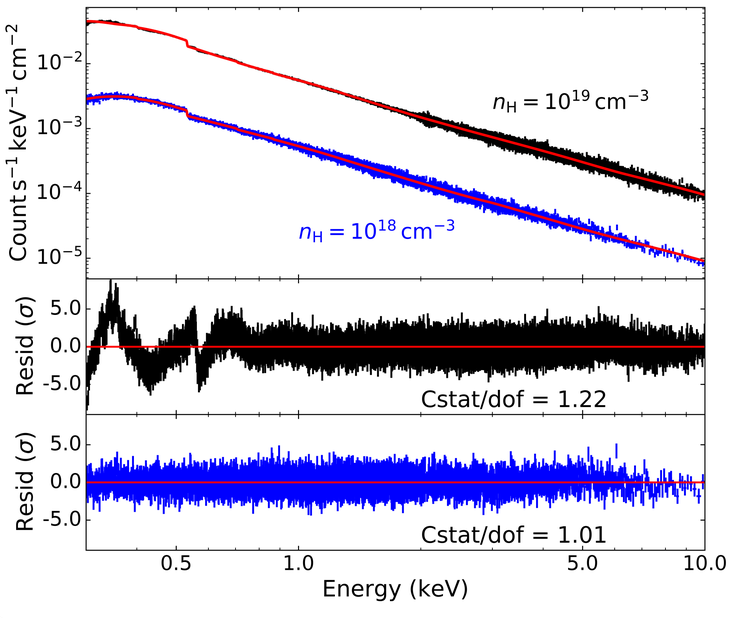


The innermost regions are highly ionized. The outer regions are neutral ⇒ The resulting spectrum is the sum of the contributions from each radius and might affect the radial emissivity parameter.

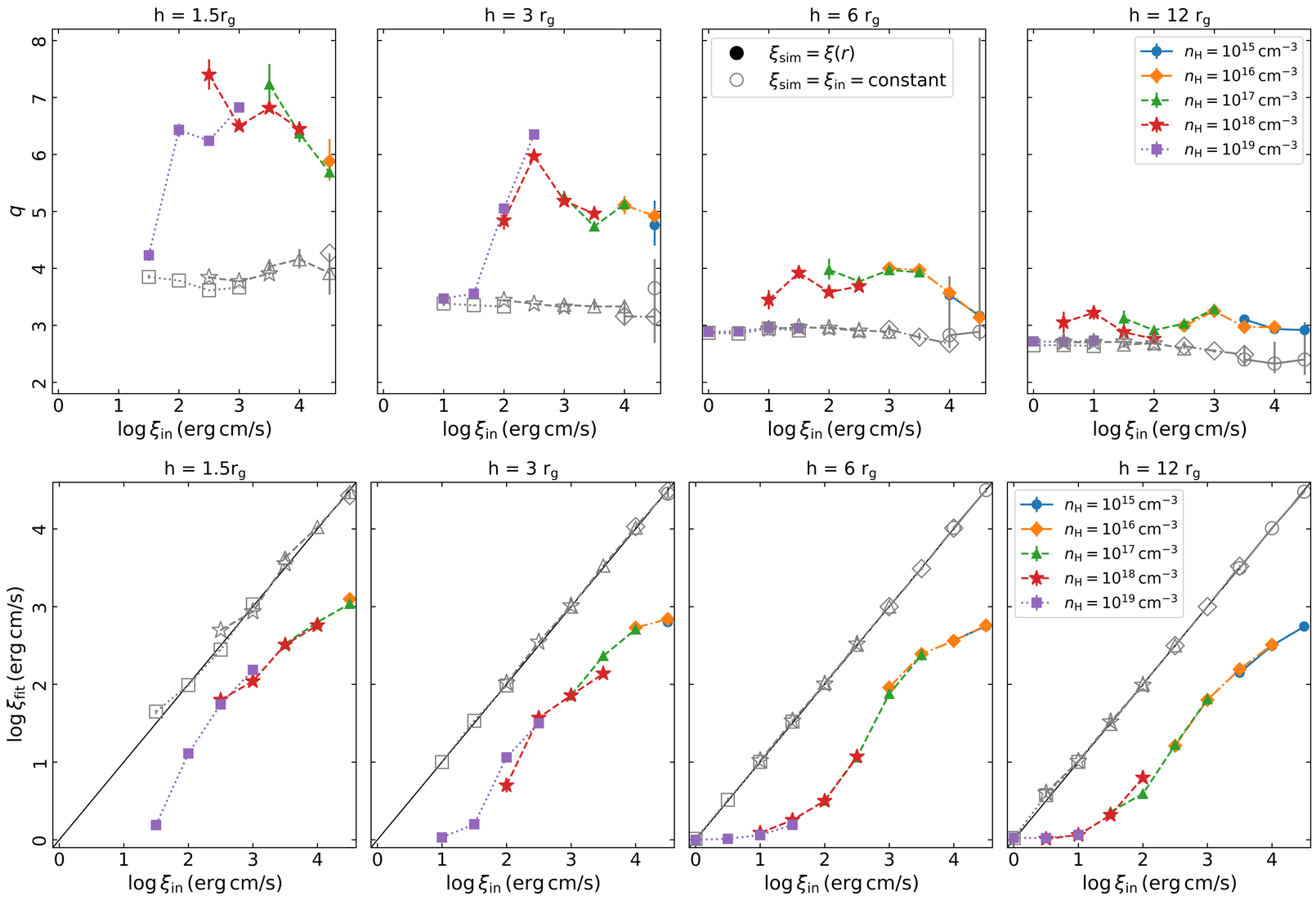
Method



The simulations are performed assuming a 'lamp-post' geometry, using `KYNXillver` and the *Athena*/XIFU response (for an exposure time of 100 ks).



Results



- For low and large values of $\xi_{\rm in}$, the parts of the disc contributing the most to the observed spectrum would be either neutral or highly ionized ⇒ a small gradient of ionization would be expected in these parts of the disc ⇒ constant-ionization approximation holds ⇒ lower values of q.
- For the intermediate values of $\xi_{\rm in}$, the gradient of ionization is more important. The innermost regions will be more ionized and will have softer reflection spectra. The outer regions of the disc are less ionized ⇒ model assuming a single ionization parameter of the disc will underestimate the ionization from the innermost regions by assuming an average ionization. ⇒ This effect will then be compensated by requiring a steep emissivity profile.