Ionization by galaxy cluster photons alters the ionization state of the nearby warm-hot intergalactic medium

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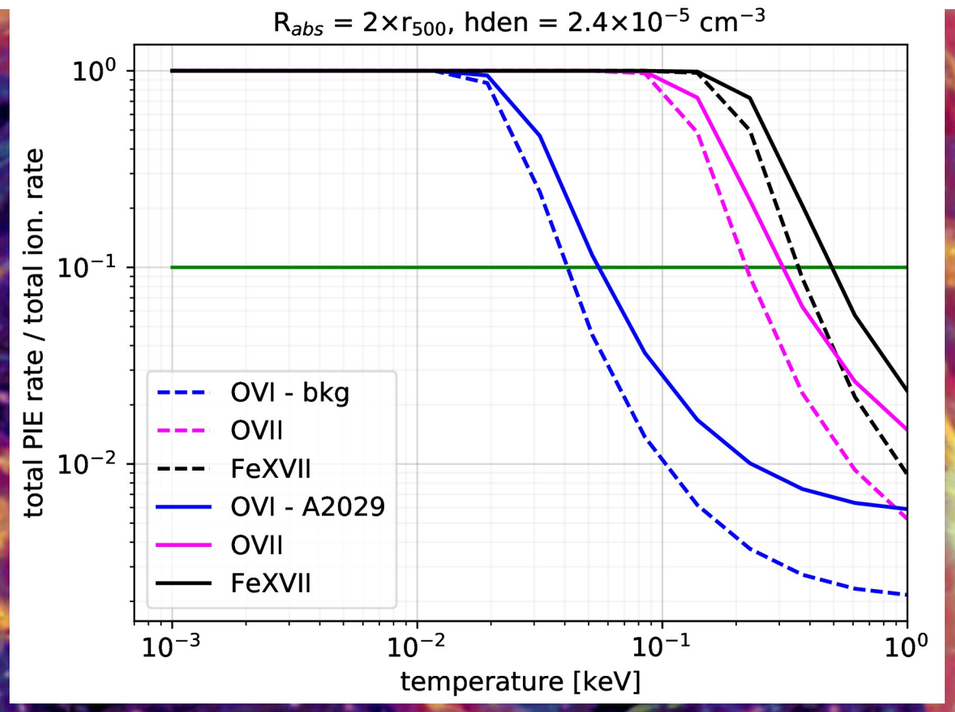
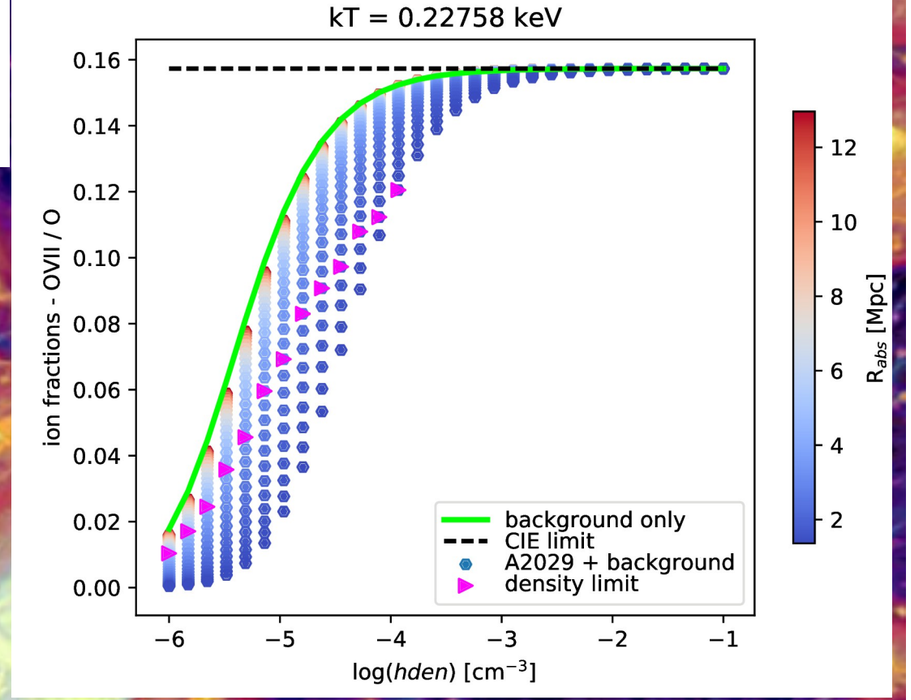
ABSTRACT

The physical properties of the faint and extremely tenuous plasma in the far outskirts of **galaxy clusters**, the **circumgalactic media** of normal galaxies, and **filaments of the cosmic web**, remain one of the biggest unknowns in our story of large-scale structure evolution. Modeling the spectral features due to emission and absorption from this very diffuse plasma poses unique challenges, as both collisional and photo-ionisation processes must be accounted for. In this paper we study the **ionisation by galaxy cluster photons** in addition to the photo-ionisation by the cosmic UV/X-ray background and its impact on the **ionisation balance**. We model realistic spectra by taking into account the cosmic UV/X-ray background together with the emission from three different cool-core galaxy clusters: A262, A1795 and A2029, and illuminate the photo-ionised gas in the galaxy cluster vicinity. We assume the gas has temperatures between 10^{-3}–1 keV ($\approx 10^4$–10^7 K), densities between 10^{-6}–10^{-1} cm^{-3} and can be located between r_{500} and $\sim$ 13 Mpc from the cluster center. We find that depending on the distance from the galaxy cluster and the plasma properties, **the total photo-ionisation rate can be higher than** 10% **or even** 100% **of the total ionization rate**. We show how this affects the **ionisation fractions of O VI, O VII, O VIII, Ne IX, Fe XVII, N VII, C V and C VI** ions and compare it with the ionization fractions with photo-ionization from cosmic background only as well as with plasma that is in collisional ionisation equilibrium. We assume a simplified model of a cosmic web filament and predict **the column densities** for different lines of sight.





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On arXiv this summer.

Credit (background picture): Franco Vazza