Laboratory measurements compellingly support a charge-exchange mechanism for the "Dark matter" ∼3.5 keV X-ray line

Chintan Shah*[1], Sven Bernitt†[1,2,3], Stepan Dobrodey[1], René Steinbrügge[1], Liyi Gu[4], Jelle Kaastra[4,5], and José R. Crespo López-Urrutia[1]

1. Max–Planck–Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany
2. Friedrich-Schiller-Universität Jena, Fürstengraben 1, 07743 Jena, Germany
3. Helmholtz-Institut Jena, Fröbelstieg 3, 07743 Jena, Germany
4. SRON Netherlands Institute for Space Research, Utrecht, The Netherlands
5. Leiden Observatory, Leiden University, 2300 RA Leiden, The Netherlands

A mysterious X-ray signal at 3.5 keV from nearby galaxies and galaxy clusters [1] recently sparked tremendous interest in the scientific community and has given rise to a tide of publications attempting to explain the origin of this line. It has been hypothesized that the signal is the result of decaying sterile neutrinos – a potential dark matter particle candidate – presumably based on the fact that this X-ray line is not available in the standard spectral databases and models for thermal plasmas. Cautiously, Gu *et al.* [2] have pointed out an alternative explanation for this phenomenon: charge exchange between bare ions of sulfur and atomic hydrogen. Their model shows that X-rays should be emitted at 3.5 keV by a set of S^{15+} transitions from $n \geq 9$ to the ground states, where n is the principle quantum number.

We tested this hypothesis in the laboratory by measuring K-shell X-ray spectra of highly ionized sulfur ions following charge exchange with gaseous molecules in an electron beam ion trap. We produced bare S^{16+} and H-like S^{15+} ions and let them capture electrons in collisions with molecules, while recording X-ray spectra. The 3.5 keV transition clearly shows up in the charge-exchange induced spectrum under a broad range of conditions. The inferred X-ray energy of 3.47 ± 0.06 keV is in full accord with both the astrophysical observations and theoretical calculations, and confirms the novel scenario proposed by Gu [2][3]. Taking the experimental uncertainties and inaccuracies of the astrophysical measurements into account, we conclude that the charge exchange between bare sulfur and hydrogen atoms can outstandingly explain the mysterious signal at around 3.5 keV [3].

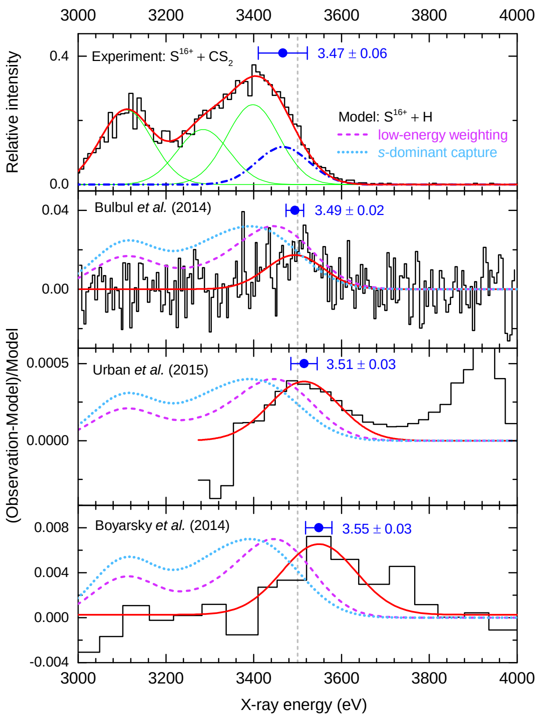

Fig. 1: Charge-exchange-induced X-ray spectrum in comparison with recently reported astrophysical observations. The experimental data and observations are compared with the charge exchange model of Gu.

References

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*Corresponding author: chintan@mpi-hd.mpg.de
†Corresponding author: bernitt@mpi-hd.mpg.de