Analysis of the Contribution of Ar Dielectronic Recombination Lines to the Unknown Faint X-Ray Feature Found in the Stacked Spectrum of Galaxy Clusters

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An exciting 2014 study [1] reported a possible dark matter signature at 3.55 keV – 3.57 keV in the stacked spectra of galaxy clusters. To help rule out possible atomic origins, we measured Ar emission from $1s^2 2l$-$1s2l3l'$ satellite transitions near 3.6 keV. The highly charged Ar ions were produced, trapped and excited using the electron beam ion trap (EBIT) at the National Institute of Standards and Technology. The nearly mono-energetic electron beam was scanned in 15 eV increments from 2 keV to 5 keV. X-rays were measured simultaneously with a high count rate Ge detector and a high resolution crystal spectrometer that is able to resolve features that are less than 2 eV apart at 3 keV. The collisional-radiative model NOMAD [2] was used to create synthetic spectra for comparison with both our EBIT measurements and with spectra produced with the AtomDB database/Astrophysical Plasma Emission Code (APEC) [3,4] used in the 2014 work. Excellent agreement was found between the NOMAD and EBIT spectra at each electron beam energy, providing a high level of confidence in the atomic data used. Comparison of the NOMAD and APEC spectra revealed a number of missing lines at 3.56 keV, 3.62 keV, 3.64 keV, and 3.66 keV in the APEC spectra. These features are primarily due to a lack of Be-like Ar DR data in AtomDB. At an electron temperature of T_e = 1.72 keV, inclusion of $1s2l2l'2l''$ and $1s2l2l'3l''$ data in AtomDB increased the total flux in the 3.5 keV to 3.66 keV energy band by a factor of 2. While important, this extra emission is not enough to explain the unidentified line found in the galaxy cluster spectra [5].

References

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