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Dielectronic Recombination Rates for L-Shell Iron Ions (Fe XVII - Fe XXIV) in Collisionally Ionized Plasmas

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Abstract. Perhaps the greatest uncertainty remaining in our understanding of iron L-shell ions in collisionally-ionized cosmic plasmas is in the dielectronic recombination (DR) rate coefficients. Here we discuss the astrophysical importance of these rates and present preliminary results for our recent measurements of DR onto Fe XIX.

1. Introduction

Dielectronic recombination (DR) of the iron L-shell ions (Fe XVIII-XXIV) is one of the most important atomic processes occuring in collisionally-ionized, X-ray emitting cosmic plasmas. Reliable DR rates are needed to predict the ionization structure and resulting line emission from such plasmas and to interpret spectral observations of these sources. These observations can be used to derive chemical abundances and differential emission measures of stellar coronae, galaxies, clusters of galaxies, and supernova remnants. However, at the relevant formation temperatures, published theoretical DR rates for the these ions can differ by factors of $\sim 2-5$ (Arnaud & Raymond 1992; Savin & Laming 2001). These uncertainties in the DR rates for the iron L-shell ions hinders our ability to infer reliably the properties of many cosmic X-ray sources.

2. Measurements

In order to address the need of the astrophysics community, we have undertaken a series of DR measurements on the iron L-shell ions. The experiments are carried out using the heavy-ion Test Storage Ring (TSR) located at the Max

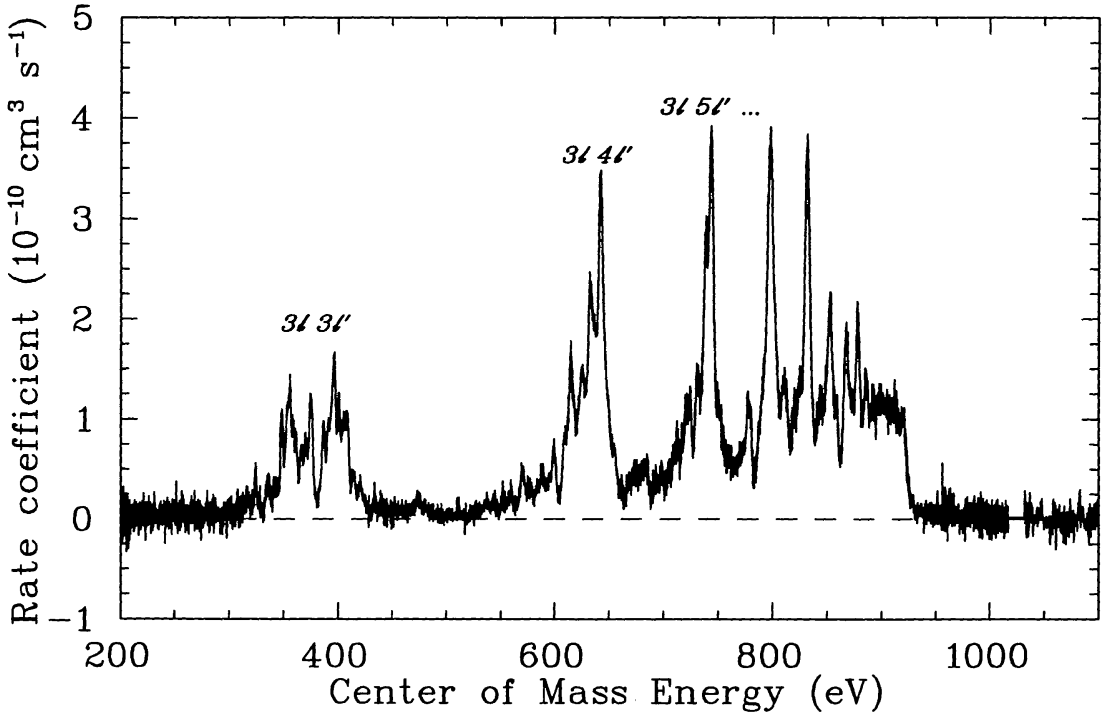

Figure 1. TSR measurements of DR onto Fe XIX via $N = 2 \rightarrow N = 3$ core excitations. DR resonances are labeled for capture into the $n = 3$, 4, and 5 levels (Savin et al., in preparation).

Planck Institute for Nuclear Physics in Heidelberg, Germany (Müller 1999, Wolf et al. 2000).

Our preliminary results for DR onto Fe XIX via $N = 2 \rightarrow N = 3$ core excitations are shown in Figure 1. The data represent the DR cross section multiplied by the relative electron velocity and then convolved with the experimental energy spread. Using these results and those of Savin et al. (1999) for DR onto Fe XIX via $N = 2 \rightarrow N = 2$ core excitations, we will be able to produce experimentally-derived Maxwellian rate coefficients for plasma modeling with an estimated uncertainty of less than 20% (Savin et al., in preparation).

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