Dielectronic recombination for aluminum-like iron peak elements

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Synopsis Dielectronic recombination (DR) and radiative recombination (RR) rate coefficients for aluminum-like ions forming silicon-like ions have been calculated. Here we only present the calculations for iron peak elements. Calculations have been performed from both ground and metastable initial states.

DR is an atomic physics process important for accurately modeling astrophysical plasmas. DR is the dominant electron-ion recombination process for most ions in both photoionized and collisionally-ionized plasmas and plays a central role in determining the charge state balance and spectra of these plasmas. Over the past few years, our group has computed DR and RR data for H through Zn for all isoelectronic sequences up through Mg-like ions. We use a state-of-the-art multiconfiguration Breit-Pauli (MCBP) approach. Recently, we have focused our work on the complex third-row M-shell isoelectronic sequences, especially Al-like. Although there are some pre-existing DR calculations (e.g., S^{3+}), they were performed within a nonrelativistic LS-coupling approximation and only for the high temperatures characteristic of electronionized gas. No data exist for the low temperatures characteristic of photoionized gas. Using the level resolved distorted-wave AUTOSTRUCTURE program, we have carried out DR cross section and rate coefficient calculations for the iron peak elements. The effect of ground-state fine structure on the DR rate coefficients will be discussed.

For Fe^{13+}, we have tested our work against results from the Heidelberg TSR ion storage ring [1] (see Fig. 1). Our calculations include final-state-resolved partial DR and RR rate coefficients from the initial ground and metastable levels spanning a temperature range of $(10 - 10^7)z^2$ K, where z is the initial ionic charge. More details about the theoretical calculations can be found in [2]. Also, we present the Maxwellian rate coefficients for these iron peak elements in Fig. 2. We have fitted our computed Maxwellian DR rate coefficients using a simple formula for efficient dissemination of data and ease of use in plasma modeling codes. Comparisons to existing data will also be shown.

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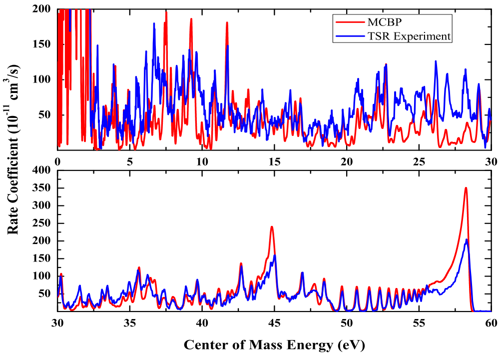

Fig. 1. Velocity-convoluted DR cross sections for Fe^{13+} from TSR measurements [1] and our MCBP calculations. Note: The experiment is quenched at the Rydberg limits due to external field ionization.

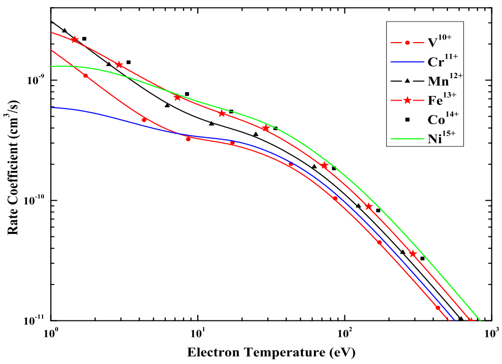

Fig. 2. MCBP calculations for the Maxwellian rate coefficients of iron peak elements.

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References

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[2] Badnell N R 2006 *J. Phys.* B **39** 4825.

