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Effects of configuration interaction for dielectronic recombination of Na-like ions forming Mg-like ions

Duck-Hee Kwon[*] [1] **and Daniel Wolf Savin**[†] [2]

[*]Laboratory for Quantum Optics, Korea Atomic Energy Research Institute, Daejeon 305-600, Republic of Korea

[†]Columbia Astrophysics Laboratory, Columbia University, New York, NY 10027, USA

Synopsis Dielectronic recombination (DR) of Na-like ions forming Mg-like ions via excitation of a $2l$ core electron has been investigated for selected ions from Ca^{9+} to Zn^{19+}. We find that configuration interaction (CI) between DR resonances with different captured electron principal quantum numbers n can lead to a significant reduction in resonance strengths for $n \gtrsim 5$. We also explored the effect of this multi-n CI for the total DR rate coefficient. DR rate coefficients can be reduced by up to $\sim 10\%$ at temperatures where an ion is predicted to form in collisional ionization equilibrium and up to $\sim 15\%$ at higher temperatures.

Dielectronic recombination (DR) is the dominant electron-ion recombination process for most photoionized or collisionally ionized atomic ions in cosmic plasmas. Reliable DR data are critical for the analysis, modeling, and interpretation of astrophysical spectra. To meet this need atomic physicists have been and continue to carry out theoretical and experimental DR studies.

DR is a two-step recombination process which begins when a free electron collides with an ion. The incident electron excites a core electron of the ion and is simultaneously captured forming an intermediate system. The energy of the intermediate system lies in the continuum and it may autoionize. Recombination occurs when the system radiatively decays to a bound state.

We have investigated the cause for the discrepancy between theory [1, 2] and experiment [3] for the simple M-shell ion Na-like Fe^{15+} forming Mg-like Fe^{14+} via $\Delta n_c = 1$ core excitation of a $2l$ electron. We have used the flexible atomic code (FAC) [4] to calculate the required atomic parameters for the DR process and demonstrated the importance of configuration interaction (CI) between resonances with different captured electron principal quantum number n. This multi-n CI can lead to a significant reduction in DR resonance strength for resonances where $n \geq 5$ as shown in Figure 1. Including multi-n CI accounts for most of the discrepancy between previous theoretical and experimental results as we report in [5].

We have also investigated the effects on DR rate coefficients due to this multi-n CI for selected Na-like ions from Ca^{9+} to Zn^{19+}. This multi-n CI can reduce the DR rate coefficient at CIE (collisional ionization equilibrium) temperatures by up to $\sim 10\%$ and by up to $\sim 15\%$ at higher temperatures.

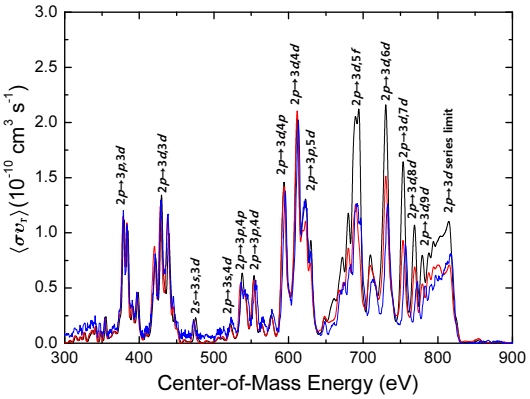

Figure 1. DR resonance structure of Fe^{15+} forming Fe^{14+} via $\Delta n_c = 1$ core excitation of a $2l$ electron. The green line shows the experimental results of [3]. The black line shows our results including CI only within the same n resonance complex. The red line shows our results including CI between different n resonance complexes for $3 \leq n \leq 14$.

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[1]E-mail: hkwon@kaeri.re.kr
[2]E-mail: savin@astro.columbia.edu