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

This article has been downloaded from IOPscience. Please scroll down to see the full text article.

(http://iopscience.iop.org/1742-6596/388/6/062035)

View the table of contents for this issue, or go to the journal homepage for more

Download details:
IP Address: 128.59.168.116
The article was downloaded on 07/11/2012 at 21:48

Please note that terms and conditions apply.
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 Ca9+ to Zn19+. 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 ≥ 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 ~10% at temperatures where an ion is predicted to form in collisional ionization equilibrium and up to ~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 Fe15+ forming Mg-like Fe14+ via Δnl = 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 ≥ 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 Ca9+ to Zn19+. This multi-n CI can reduce the DR rate coefficient at CIE (collisional ionization equilibrium) temperatures by up to ~10% and by up to ~15% at higher temperatures.

Figure 1. DR resonance structure of Fe15+ forming Fe14+ via Δnl = 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 ≤ n ≤ 14.

References

1E-mail: lkhwon@kaeri.re.kr
2E-mail: savin@astro.columbia.edu