A Perturbative Treatment For the Dielectronic Recombination of the Si-Like Isoelectronic Sequence

J. Kaur,*[1] T. W. Gorczyca,*[2] and N. R. Badnell†

*Department of Physics, Western Michigan University, Kalamazoo, MI 49008-5252, USA
†Department of Physics, University of Strathclyde, Glasgow G4 0NG, United Kingdom

Synopsis A detailed investigation of Si-like dielectronic recombination is performed for the entire Si-like isoelectronic sequence using a perturbative multi-configurational Breit-Pauli method.

We present total and final-state level-resolved DR rate coefficients for the silicon-like ions from P^{+} through Zn^{16+}, relevant to the modelling of astrophysical and laboratory plasmas, and for the ions Kr^{22+}, Mo^{28+} and Xe^{40+} that are important in fusion research. Both $\Delta n_c = 0$ and $\Delta n_c = 1$ core excitations are included in *LS* and *IC* (intermediate coupling) schemes. Our calculations were performed using the atomic structure and collision code AUTOSTRUCTURE [1, 2], a perturbative multi-configurational Breit-Pauli (MCBP) method that relies on the independent proceses, isolated resonance, distorted-wave (IPIRDW) approximation. Energy levels, radiative rates, and autoionization rates are calculated in both *LS* and *IC* approximations, where the latter also include semi-relativistic corrections such as the spin-orbit interaction that gives rise to significant fine-structure effects. The electronic orbitals are obtained using the Thomas-Fermi-Dirac-Amaldi (TFDA) model potential, where the scaling parameters λ_{nl} are optimized so as to reproduce the experimental (NIST) fine-structure splitting for the low-lying levels.

The computed Maxwellian-averaged DR rate coefficients for the entire silicon-like isoelectronic sequence are shown in Fig. 1 and compared with the earlier recommended data of [3, 4], as incorporated in all previous plasma models. Those data were based on crude *LS* calculations, and thus were unable to reproduce the low-temperature DR contributions that are due to fine-structure splitting [5]. This effect becomes more predominant with increase in the effective charge z. At higher temperatures, the more complete IC cross sections instead lie below the non-relativistic LS results, again due to less obvious fine-structure effects [5]. This work is a part of an assembly of a dielectronic recombination database for the modelling of dynamic finite-density plasmas.

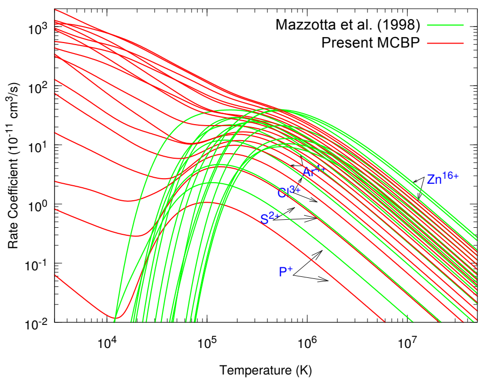

Figure 1. Comparison between present Maxwellian-averaged DR rate coefficients and recommended compilation [3, 4] for the entire silicon-like isoelectronic sequence.

References

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[1]E-mail: fnu.jagjitkaur@wmich.edu
[2]E-mail: Thomas.Gorczyca@wmich.edu