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# Near-Threshold Dielectronic Recombination Studies of Si-Like Ions

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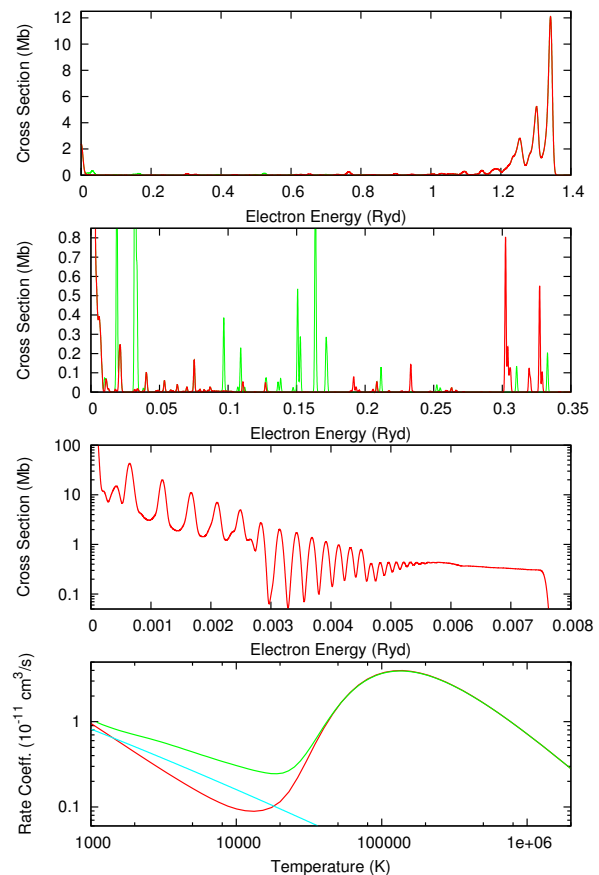
**Synopsis** Dielectronic recombination rate coefficients are computed for the Si-like isoelectronic sequence, focusing on the near-threshold resonances of  $S^{2+}$ .

We present dielectronic recombination (DR) calculations for Si-like ions, and the important  $S^{2+}$  case in particular. This work has been motivated by the astrophysical importance of the  $S^{2+}$  DR rate in determining the sulfur ionization balance in the Orion nebula, a photoionized plasma corresponding to low-energy electrons [1]. All the calculations are performed using the atomic structure and collision code AUTOSTRUCTURE [2], a multi-configuration Breit-Pauli (MCBP) method. Energy levels and transition rates are computed in LS- and IC-coupling approximations. Energy positions of near-threshold bound and resonance states are investigated in particular. Table 1 lists three prominent bound  $(N+1)$ -electron states and one strong resonance state, relative to the  $S^{2+}(3s^23p^2^3P_0)$  threshold. On comparison with available NIST data, the theoretically predicted energies are overestimated by 0.25-0.45 Ryd. There are no NIST or other data available for the given resonance state [3].

Ionic state	Energy (Ryd)	
	Present	NIST
$S^+ 3s3p^4(^2S_{1/2})$	-0.175	-0.623
$S^+ 3s3p^4(^2P_{3/2})$	-0.142	-0.389
$S^+ 3s3p^4(^2P_{1/2})$	-0.137	-0.386
$S^+ 3s3p^33d(^4D_{7/2})$	+0.321	

We conclude from the overestimates observed in the bound energy values that the energy of the resonance is likewise overestimated. It could also mean that low-temperature (characteristic of photoionized plasmas) DR should be enhanced by the resonance position. Fig. 1 shows the computed DR cross-sections and rate coefficients for  $S^{2+}$ , including also the results corresponding to a global shift of low-lying, near-threshold resonances. The uncertainties in these resonances is seen to translate to a large uncertainty in the DR rate coefficient at lower-temperatures such as that of Orion nebula ( $T \sim 10^4$  K). This work

comprises a part of our program to assemble a general DR data base for all ions for modeling dynamic finite plasmas.



**Figure 1.** DR cross section (upper three panels, convolved with FWHM Gaussians convolutions of 0.01 and 0.001 Ryd in descending order) and Maxwellian-averaged rate coefficient (lower panel). *Ab initio* results are in red and those with all  $(N + 1)$ -electron resonances shifted by -0.157 Ryd are in green. The computed RR rate coefficient is the cyan curve in the lower panel.

## References

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- [2] N R Badnell 2011 *Comput. Phys. Commun.* **182** 1528
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