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Dielectronic recombination of boronlike Si^{9+} ions at the heavy-ion storage ring TSR

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Synopsis Absolute electron-ion recombination rate coefficients of B-like Si^{9+} have been measured employing the merged-beams method at the storage ring TSR. Center-of-mass energies were studied over the range 0 – 50 eV, covering all dielectronic recombination (DR) resonances associated with electron excitations within the L-shell.

Within our research collaboration on laboratory astrophysics we have measured absolute merged beam recombination rate coefficients (MBRRC) for Si^{9+} forming Si^{8+}. Theoretical calculations of rate coefficients for the recombination of open shell ions are strongly affected by only small uncertainties of DR-resonances at lowest energies [1]. For Si^{9+} the uncertainty of the rate coefficient was estimated as +70% and -0% [2]. In the experiment, an electron-ion merged-beam arrangement was used at the heavy-ion storage ring TSR of the Max-Planck-Institute for Nuclear Physics in Heidelberg, Germany. The MBRRC was measured for electron-ion collision energies from 0 to 50 eV. This range contains all DR resonances associated with electron excitations within the L-shell. Figure 1 shows the MBRRC spectrum and calculated resonance positions. For energies above 1 eV the spectrum is dominated by three DR resonance series: $Si^{9+}(2s^2\,2p) + e^- \rightarrow Si^{8+}\ (2s\,2p^2\ ^2D_J)n$, $(2s\,2p^2\ ^2S_{1/2})n$ and $(2s\,2p^2\ ^2P_J)n$. DR resonances associated with $2s^2\,2p\ ^2P_{1/2} \rightarrow 2s\,2p^2\ ^4P_J$ excitations only play a minor role. For energies below 1 eV, high Rydberg resonances associated with a $2s^2\ 2p\ ^2P_{1/2} \rightarrow 2s^2\ 2p\ ^2P_{3/2}$ core excitation are found. In addition, the influence of $(2s^2\,2p\ ^2P_{1/2}) + e^- \rightarrow (2p^3\ ^2P_J)\ n$ and $(2p^3\ ^2D_J)\ n$ trielectronic recombination (TR) [3] resonances (marked by open and filled triangles in figure 1) is investigated. The resonance positions that are indicated in figure 1 were estimated from theoretical excitation energies [4] and hydrogenic Rydberg binding energies for the captured electron.

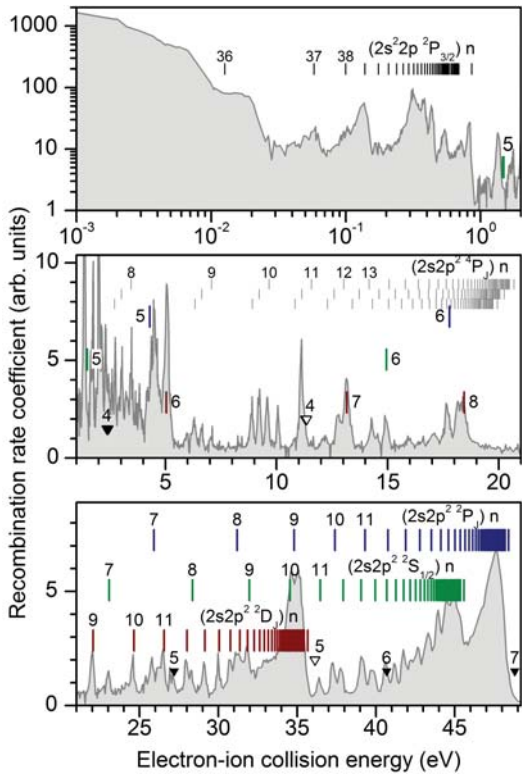

Figure 1. The measured Si^{9+} MBRRC is displayed as gray shaded curve. DR resonance energies associated with $2s^2 2p\ ^2P_{1/2} \rightarrow 2s^2 2p\ ^2P_{3/2}$, $2s2p^2\ ^4P_J$ and $2s2p^2\ ^2L_J$ excitations are represented as small black, small gray and large (colored) vertical bars.

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