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

D. Bernhardt*[1], A. Becker‡, M. Grieser‡, M. Hahn◇, C. Krantz‡, M. Lestinsky§, A. Müller*, O. Novotný◇, R. Repnow‡, D. W. Savin◇, S. Schippers*, K. Spruck*,‡, A. Wolf‡

* Institut für Atom- und Molekülphysik, Justus-Liebig-Universität, D-35392 Giessen, Germany
‡ Max-Planck-Institut für Kernphysik, D-69117 Heidelberg, Germany
◇ Columbia Astrophysics Laboratory, Columbia University, New York, NY 10027, USA
§GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany

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.

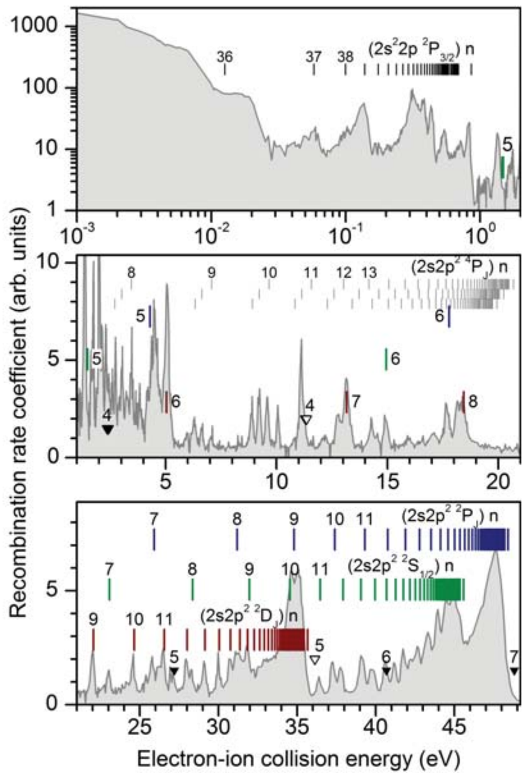

Figure 1. The measured Si^{9+} MBRRC is displayed as gray shaded curve. DR resonance energies associated with $2s^22p\;^2P_{1/2} \rightarrow 2s^22p\;^2P_{3/2}$, $2s2p^2\;^4P_J$ and $2s2p^2\;^2L_J$ excitations are represented as small black, small gray and large (colored) vertical bars.

References

[1] S. Schippers 2009 *J. Phys. Conf. Ser.* **163** 012001

[2] D. W. Savin and J. M. Laming 2002 *Astrophy. J.* **566** 1166

[3] M. Schnell *et al.* 2003 Phys. Rev. Lett. **91** 043001

[4] M. J. Vilkas *et al.* 2005 Phys. Scr. **72** 181

[1]E-mail: Dietrich.Bernhardt@iamp.physik.uni-giessen.de