Partial cross sections for radiative recombination of bare ions : effects of relativity and radiation multipoles

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Synopsis We derived an original expression for the partial cross sections for radiative recombination (RR) of highly charged bare ions in the nonrelativistic electric-dipole approach. Three sets of cross sections for RR to individual magnetic sublevels of the excited levels of various recombined H-like ions were computed: the first two in the electric-dipole approximation with the nonrelativistic and relativistic electron wavefunctions and the third one in the exact relativistic method including all multipole orders of the radiation field.

We present a systematic study of the relativistic and multipole effects, separately and combined, on the radiative recombination partial cross sections along an isoelectronic sequence and as a function of the incident-electron energy.

We have considered the case of radiative recombination of bare nuclei involving a single-electron system, with colliding electrons assumed to be unidirectional and monoenergetic. We have treated the radiative recombination process in the framework of the nonrelativistic electric-dipole approach and derived an original expression for the partial RR cross sections to a particular magnetic sublevel of H-like recombined ions [1].

The calculations have been performed for various recombined H-like ions with atomic numbers in the range $10 \le Z \le 92$. Several incident-electron kinetic energies ranging from 0.01 to 10 times the electron binding energy in the $1s_{1/2}$ ground state were considered and the radiative cascades following recombination into states with principal quantum number up to $n = 6$ were included. In order to stress the relative importance of relativistic and multipole effects as Z or the electron energy increases, three distinct calculations of the radiative recombination cross sections to individual magnetic sublevels of the recombined H-like ions were performed. The first two were made in the electric-dipole approximation with the nonrelativistic and relativistic Coulomb wavefunctions for both the continuum and bound states, and the third calculation was made using the exact relativistic treatment with all multipoles of the radiation field [2].

Comparing the results for the partial RR cross sections obtained in the three different treatments, we have shown how relativistic and multipole effects change with atomic number and with electron energy.

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References

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