

PHOTOIONIZATION AND RECOMBINATION OF NA IX, NA X, MG X, AND MG XI

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Detailed study on the inverse processes of photoionization and electron-ion recombination for (Na IX + $h\nu \leftrightarrow$ Na X + e), (Na X + $h\nu \leftrightarrow$ Na XI + e), (Mg X + $h\nu \leftrightarrow$ Mg XI + e), and (Mg XI + $h\nu \leftrightarrow$ Mg XII + e) is reported. The unified method for the total electron-ion recombination is used for the self-consistent results of total and level-specific recombination rate coefficients α_R and $\alpha_R(i)$, subsuming both radiative and dielectronic recombination (RR and DR), total recombination cross sections, σ_{RC} , the total and partial level-specific photoionization cross sections σ_{PI} and $\sigma_{PI}(g)$ of these He- and Li-like ions. The total recombination spectrum of cross sections and recombination rates versus photoelectron energy are presented for experimental applications. The unified method employs close coupling approximation in the relativistic Breit-Pauli R-matrix (BPRM) method. The coupled channel wavefunction expansions for Li-like Na IX and Mg X consist of 17 levels and for He-like Na X and Mg XI consist of 16 levels of the core, respectively.

The results are presented for all fine structure levels of the ions going up to $n \leq 10$ which correspond to 98 levels with $1/2 \leq J \leq 17/2$ for Li-like Na IX and Mg X, 182 and 185 levels with $0 \leq J \leq 10$ for He-like Na X and Mg XI respectively. The single-valued total $\alpha_R(T)$ is presented over an extended temperature range for astrophysical and laboratory plasma applications. The total unified $\alpha_R(T)$ for all ions agree very well with the available published (RR+DR) rates. The results are expected to be accurate within 10-15% from considerations of important atomic effects such as radiation damping, channel couplings, and interference of DR and RR. The comprehensive datasets are applicable for ionization balance and recombination-cascade models for UV and X-ray lines.