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Escape factors for Paschen 2p-1s lines in Ar, Kr, and Xe plasmas.
XI-MING ZHU, UWE CZARNETZKI, Institute for Plasma and Atomic Physics, Ruhr University Bochum, Bochum 44780, Germany, ZHI-WEN CHENG, YI-KANG PU, Department of Engineering Physics, Tsinghua University, Beijing 100084, Peoples Republic of China — Radiation trapping is often observed when investigating low-temperature plasmas. Photons emitted from an upper state may be reabsorbed by a lower state before they leave the plasmas. To account for this effect, the "escape factor" as a function of optical depth is often adopted. In previous works several simple expressions of the escape factor were proposed for uniform plasmas with emission line profiles dominated by Doppler broadening and without line splitting due to hyperfine structure. These assumptions are valid for atoms e.g. Ar in uniform discharges. However, the excited state density in many low-temperature plasmas is non-uniform and the emission line profile can be influenced by collisional broadening. In this work, we study the escape factors of Paschen 2p-1s lines of Ar, Kr, and Xe in non-uniform plasmas. The collisional broadening and the hyperfine structure for Kr and Xe lines are both included. The calculated escape factor expression is verified particularly by an experiment in a low-pressure discharge. The escape factor equation for high- to atmospheric-pressure discharges is also provided.

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