Molecular dynamics simulations of Stark-broadened line shapes of Ar K-shell ions for plasma diagnostics applications

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Analysis of Stark-broadened spectral line profiles is one of the most often used plasma diagnostics techniques, especially to determine the electron density in both laboratory and astrophysical plasmas. The increasing number of applications and the wider availability of spectroscopic measurements under extreme conditions have encouraged studies comparing different computational and analytical methods [1]. In this work we perform numerical simulations to compute Stark-broadened line shapes of several K-shell X-ray line transitions in highly charged Ar ions, i.e. Heα, Heβ and Heγ in He-like Ar and Lyα, Lyβ and Lyγ in H-like Ar, which have been extensively used for spectroscopic diagnosis of implosion cores in indirect- and direct-drive inertial confinement fusion (ICF) experiments [2]. Two different simulations are done: a) within the independent particle approximation using a Debye screened field to account for coupling effects between charges [3] and b) using a molecular dynamics code of interacting particles [4]. Specifically, an effort has been made to include full Stark-mixing of energy levels belonging to manifolds with different principal quantum numbers. Comparisons are made with line shapes calculated in the standard Stark-broadening theory approximation [5, 6]. Observed differences are discussed. Furthermore, we will assess the impact of employing line profiles computed with different methods on the diagnosis of core conditions in implosion experiments performed at OMEGA.

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