Abstract preparation for Workshop on "Fundamental Methods for Atomic, Molecular and Materials Properties in Plasma Environments"

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Radiative processes like photo-excitation, photoionization, inverse Bremsstrahlung etc., are essential to study the radiation-matter interaction in high energy density (HED) plasma viz. inertial confinement fusion plasma, astrophysical and laboratory plasma etc.These radiative processes depend on atomic properties like excitation energies, oscillator strengths, photoionization cross sections etc., which have explicit dependence on electronic structure of atoms/ions. In a plasma, the potential field and hence electronic structure are altered due to the presence of neighboring ions and plasma free electrons. In plasma where time scale of evolution is longer, one can formulate static plasma potentials. Widely used static plasma potentials are Debye-Huckel (DH) potential (for weakly coupled plasma), ion sphere (IS) potential (for strongly coupled plasma) and quantum plasma (QP) potential (for degenerate plasma). These potential forms represent a short range interaction due to static nuclear charge screening by free electrons and quantum confinement by neighboring ions. The short range behavior of plasma potential alters the energy level and wave functions of bound as well as continuum states. This leads to appearance of many interesting features in bound-bound (photo-excitation) and bound-free (photoionization) transitions.

We studied the electronic properties of atoms/ions in plasma using DH, IS and QP potential by solving the radial Schrodinger equation using adaptive Runge-Kutta method. Bound state solutions were obtained using shooting method and phase amplitude method was used for continuum states. We observed the phenomena of continuum lowering and pressure ionization of bound levels in plasma environment. The effect of screening and quantum confinement were manifested as line shift in photo-excitation ($nl \rightarrow n'l'$) process i.e., blue (red) shift in $\Delta n = 0$ ($\Delta n \neq 0$) transitions [1]. Similar behavior was also exhibited by oscillator strength for ($n\ l \rightarrow n'l'$) transitions. The effect of plasma is also pronounced in photoionization (PI) cross section which depends on the bound-free transition matrix element [2]. It was observed that, DH and QP potential can support quasi-bound states for certain plasma conditions. Bound-free transition to these quasi-bound states lead to appearance of shape resonances in PI cross section . Another important manifestation of plasma environment on PI cross section was appearance of Cooper minimum (mainly due to modification in phase of continuum wave near the nucleus). We observed Cooper minimum in ground state PI cross section of Li like system which does not exhibit this feature in its isolated state. Similar behavior was also observed for atoms/ions embedded in quantum plasma. However, atoms/ions present in IS plasma exhibited oscillations in PI cross section which are termed as 'confinement resonances'. These resonances are manifestation of stronger quantum confinement in strongly coupled high density plasma. Since plasma environment has significant effect on radiative properties of atoms/ions, this study will be useful in estimating the radiative opacity of HED plasma.

[1] M. Das, Phy. Plasmas **19**, 092707 (2012).
[2] M. Das, Phy. Plasmas **21**, 012709 (2014).