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Metallization of atoms and plasmas under high pressure

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Shell-confined condition can serve as an appropriate model to mimic the confined plasma environment. In this scenario, the $r \rightarrow 0$ behavior of plasmas can be explained by placing the mobile electrons inside a shell with inner (Ra) and outer (Rb) radius. Further, the temperature effect can be incorporate by modulating Rb. The influence of effective nuclear charge (Z), plasma screening (λ) and boundary conditions on the metallic plasmas has not yet been understood. Based on Herzfeld criteria here we derive several relations to understand the influence of Z, λ and Ra, Rb on the metallization of elements and ions. Conventional Herzfeld condition indicates the existence of metallic behavior only in l = 0 states. However, employing these newly derived relations we have found metallic character in states. Its applicability is discussed in several potentials including confined H atoms and confined weakly and strongly coupled plasmas etc. Although, these are derived for plasmas but its generality is unimpeachable. In this context, we proposed four independent and generalized scaling concepts for shell-confined systems. The, inter-connection among the original Hamiltonian and four scaled Hamiltonian is also discussed. In this regard, we propose a universal descriptor (χm) to probe the metallic character in atoms, molecules and ions. In general, the selection rule for multipole transition (2k-pole) changes with change in k values. Here, we proposed a uniform selection rule which is ubiquitous in nature. Further, we extract a unique expression for multipole polarizability. This, derived relation is unanimously valid for all possible quantum mechanical systems. Demonstrative calculations of multipole oscillator strength (f(k)) and polarizabilities (α(k), k=1-4) are performed for Debye-Hückel potential (DP), Exponential screened coulomb potential (ECSCP) and Ion-sphere plasmas (SCP) involving some low-lying states.

Biography

Dr. Neetik Mukherjee has completed his PhD in Chemistry from University of Calcutta. He worked as National Post Doctoral Fellow at IISER Kolkata. Presently he is a CSIR Pool Scientist at IISER Kolkata. He has published more than 25 research papers in reputed journals. His research interest is to measure physical and chemical properties of atoms, molecules and plasmas under high pressure.