Nonlocal Optical Properties of Spherical Nanomatryoshkas

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We investigate nonlocal optical properties of spherical nanomatryoshka (NM) structures with sub-nanometer core-shell spacing [1] by using quantum hydrodynamic theory (QHT). We consider several plasmonic systems of Na metal with dimensions SF × (R_1, R_2, R_3) where SF is the scaling factor and R_i are the NM radii as shown in Fig. 1(a). We apply state-of-the-art QHT, which is a unique method to study near- and far-field optical properties of multiscale plasmonic systems [2, 3]. We study the effect of gap spacing and particle size on the optical properties of these core-shell structures. Absorption efficiency spectra for five Na core-shell structures, with SF taking an integer value from 5 to 1, computed within the QHT are shown in Fig. 1(b).

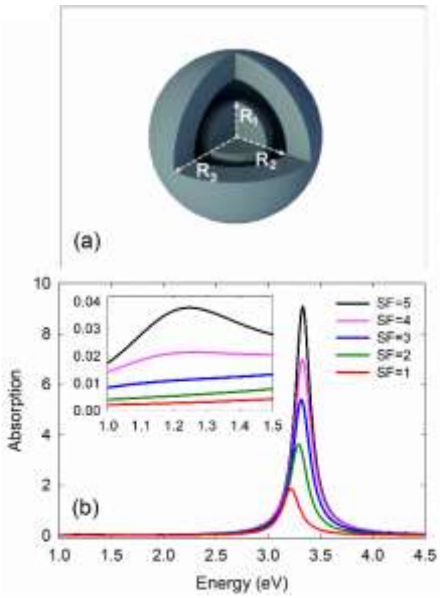

Figure 1. (a) Geometry of the problem (b) Absorption efficiency for Na NMs computed within QHT method. The scaling factor (SF) takes an integer value from 5 to 1.

We compute results using different theories and find that the results calculated within QHT method are in excellent agreement with the Density functional theory (DFT) computations [4], performed using an in-house developed code. To show the potential of QHT as compared to the other methods, we also include in our analysis the results calculated using local response approximation (LRA) and Thomas-Fermi hydrodynamic theory (TF-HT). Figure 2 presents a comparison for absorption spectra and induced polarization density, computed using different methods, for SF=4.

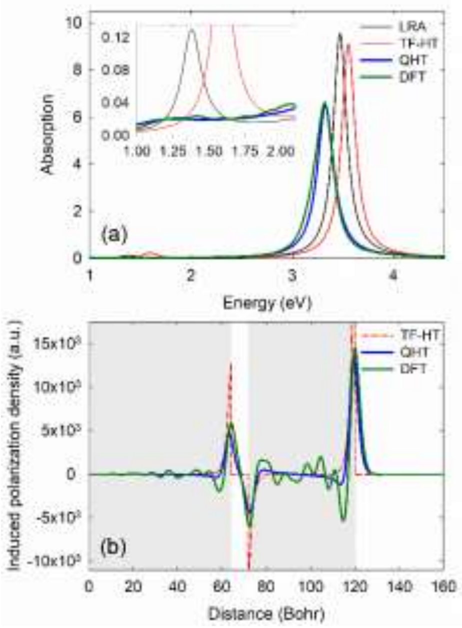

Figure 2. (a) Absorption spectra (b) induced polarization density for Na NM for SF=4 computed using different methods.

References

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