Radius Dependent Shift of Surface Plasmon Frequency in Metallic Nanospheres: Theory and Experiment

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The theoretical description of oscillations of an electron liquid in metallic nanosphere is formulated within random-phase-approximation semiclassical scheme. The spectrum of plasmons in metallic nanospheres is determined including both surface and volume type excitations. The Lorentz friction of electrons due to irradiation of electro-magnetic (e-m) energy by plasmon oscillations is analyzed with respect to the sphere dimension. The resulting red-shift of resonance frequency due to plasmon damping turns out to be strongly sensitive to the sphere radius. The form of e-m response of the system of metallic nanospheres embedded in the dielectric medium is found. The theoretical predictions are verified by the measurements of light excitation in nanosphere colloidal water solutions, for Au and Ag with the radius of metallic components from 10 to 75 nm. Theoretical predictions and experiment data clearly agree in the radius dependence of the resonance red-shift and in the emergence of the first volume plasmon resonance in the e-m response of the system for big nanosphere radii.