Theoretical study of Ba^+ ion in superfluid helium

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Charged dopants (electrons, ions) trapped by applying a static electric field at the surface of liquid helium can be used as probes to study properties of the liquid helium surface [1]. A probe particle (atomic ion) that has electronic transitions in the visible range is typically studied by means of optical spectroscopy [2]. The interpretation of available spectroscopic data requires a detailed knowledge of the trapping site structure and of impurity-helium interaction.

Ba^+ ion in liquid helium forms a nanometer-sized cavity called atomic bubble. We use pair potentials provided by modern quantum chemistry methods [3] to take into account interaction between Ba^+ ion and a He atom. The standard bubble model is used to calculate the bubble parameters and absorption and fluorescence spectra of 6s $^2S_{1/2}$- 6p $^2P_{1/2}$ transition of Ba^+ (λ_0=493.4 nm in vacuum). Calculated spectra are compared with existing experimental data [4]. We obtain $\Delta\lambda_{theory} = \lambda_{calc} - \lambda_0 =$ -8.5 nm in absorption (experiment: $\Delta\lambda_{exp} = -11.4$ nm) and $\Delta\lambda_{theory} = -3.2$ nm in fluorescence (experiment: $\Delta\lambda_{exp} = -2.3$ nm). We discuss further development of the model that should improve the agreement with experimental and theoretical data. The experiments on Ba^+ spectra in superfluid helium are currently in progress.

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