HELIUM ATOMS LOCALIZATION AROUND THE IMPURITY ATOMS EMBEDDED TO LUIQUID HELIUM ON OPTICAL AND ESR SPECTRA

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Two limiting types of helium shell formed around impurity atoms in liquid helium have been shown to exist: (i) repulsing structure (RS) for alkali atoms and, (ii) attracting one (AS) for more strongly interacting species as heavy rare gases and nitrogen atoms. RS is characterized by delocalized (liquid) compressible helium shell at any pressure, whereas AS displays localized (solid) rigid shell especially at high pressure. These cases manifest significantly different shapes of optical and ESR spectra. For RS the atomic optical transitions represent broad and shifted bands with their position strongly dependent on pressure, whereas ESR spectra are very narrow and weakly disturbed. Meanwhile in AS the optical spectra have molecular-like structure with narrow line belonged to 0-0 transition, whereas ESR spectra are rather broad. The analysis shows that all experimental data available may be reasonably explained by above concept. Moreover on the base of the model simple relationships were elaborated which make it possible to connect the observables with fundamental features of the system. Some interesting predictions can be made as well. For example in ^{3}He - ^{4}He liquid mixtures AS has to be consisted mainly of ^{4}He atoms whereas RS of ^{3}He atoms - it can be easily confirmed by optical spectroscopy means. Besides the ”magic numbers” of He atoms in the shell may exist having their reflections in a spectrum, and some phase transitions in an ensemble of He atoms belonged to the shell could proceed under the change of outer pressure.