The Rayleigh and Raman scattering of light on metastable levels of diatomics: An advanced method and new data

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Laser action on molecules leads to different non-linear processes, including multi-photon ionization, excitation and dissociation, Raman scattering. The elementary two-photon processes are linear coherent and combinational scattering. The intensities and polarization of lines in these spectra are defined by polarizability and derivative on inter-nuclear distance. In this paper we study processes of the Rayleigh and Raman vibration scattering of a light on metastable levels of molecules (H2, HD, D2, Li2, Rb2, Cs2, Fr2). On the example of polarizability of metastable molecules it has been quantitatively studied an effect of nuclear motion in processes of the second order of the perturbation theory. An advanced numerical method for construction of the Green's functions for optical electrons and electron wave functions is developed within the model potential approach in the spheroid coordinates system that allows to take into account non-spherical character of molecular field. We have carried out computing an electron transition moment dependence upon the internuclear distance, molecular polarizability, its derivative on inter-nuclear distance, depolarization degree during the Rayleigh and Raman light scattering on the frequencies of the Rb, Nd lasers. Analysis of results of the calculation of a polarizability, its derivative on inter-nuclear distance, for example, for excited triple metastable c3n, states of the H2, HD, D2 molecules on the frequencies of the Rb (1,78eV) and Nd (1,18eV) lasers shows that the main contribution into polarization of the cited metastable molecules is provided by changing the electron shell under action of the external electromagnetic field. An influence of the nuclear motion effect has been also studied and found to be quite little. It is in a good agreement with simplified models estimates [3]. Relativistic generalization of proposed approach is carried out on the basis of many-body relativistic perturbation theory with account of the polarization and nuclear motion effects and generalized dynamical nuclear model with using the optimized one-quasiparticle representation [1,2].

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