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SURFACE-ENHANCED OPTICAL PROCESSES AND A STRONG QUADRUPOLE LIGHT-MOLECULE, MATTER INTERACTION

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Surface-enhanced optical processes, surface-enhanced Raman scattering (SERS), surface-enhanced hyper Raman scattering (SEHRS) and surface enhanced infrared absorption (SEIRA) are of great interest for physics, chemistry and biology since they allow strongly increased sensitivity of these spectroscopic methods and are caused by a fundamental physical mechanism. It is so-called strong quadrupole light-molecule interaction, arising in surface electromagnetic fields, strongly varying in space near a rough metal surface. Just this interaction is responsible for the enhancement in SERS ~10^6, in SEIRA ~10^3 -10^4 and in SEHRS ~$10^{12}$and significantly higher. Moreover, this interaction is the base for implementation of single molecule detection by SERS, when the enhancement can achieve the value ~10^{14}-10^{15}. This interaction is responsible for appearance of forbidden lines in all these processes on molecules with sufficiently high symmetry. In SEIRA and SEHRS, it is expressed in their belonging to the vibrations with a unit irreducible representation of the molecule symmetry group. In SERS these lines are those, caused by vibrations transforming as the dipole moment component , which is perpendicular to the metal surface. One of the main fundamental properties of this interaction is that it is forbidden in molecules with cubic and icosahedral symmetry groups due to the electrodynamical law div $\mathbf{E=0}$. This forbiddance is named as the electro dynamical forbiddance and was observed in fullerene C_{60}. At present the theory of the above mentioned processes, based on this concept is created and explains the most of the observed phenomena, accompanying SERS, SEHRS and SEIRA.

Biography

Aleksey Mikhailovich Polubotko has graduated from Physical Faculty of Leningrad State University in 1973. He is Radiophysicist in accordance with his education. However, now he works as a Physicist Theorist. He received his Doctor of Science degree in 1983. He worked as a Junior Scientific researcher and Scientific researcher from 1982 till 2013 and Senior Scientific researcher from 2013 till now. He worked abroad in October 1993 as an Associated Professor in Tohoku University, Sendai, Japan, as a Post-doctoral fellow from 1 August till 30 October 1997 in Northwestern University, Evanston, USA and as a Professor from 1 August till 30 November 2000 in Xiamen University, Xiamen, China. Now he is a Senior Scientific researcher of the sector of the Theory of semiconductors and dielectrics, the Department of dielectrics and semiconductors, A F Ioffe Physico-Technical Institute, Saint Petersburg, Russia.

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