PURCELL EFFECT IN CARBON NANOTUBES

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Purcell effect, spontaneous decay rate variation of an atom located near media interfaces and/or optical inhomogeneities, was investigated for various types of microcavities, optical fibers, photonic crystals, etc.[1]. The effect took on special significance recently in view of rapid progress in physics of low-dimensional nanostructures. The latter ones possess various types of inhomogeneities which may cause considerable manifestations of the Purcell effect.

The present paper analyzes the Purcell effect for the excited atom placed inside or near the surface outside a single-wall carbon nanotube (CN). We model the excited atom by a two-level system with an electric dipole transition allowed. The atomic dipole moment is assumed to be directed along the CN axis. CN optical properties are described by effective boundary conditions of impedance type[2]. The impedance equation accounts for the direct interband transitions of ^-electrons.

Atomic spontaneous decay rate variation factor £,{(H_A) = Γ/Γ_0 (Γ and Γ_0 are the spontaneous decay rates of the atom near CN and in vacuum, respectively, ω_A is the frequency of the atomic dipole transition) has been calculated for infinitely long achiral CNs of different radii. The effect of the nanotube surface has been demonstrated to dramatically increase the atomic spontaneous decay rate - by 6 to 7 orders of magnitude compared with that of the same atom in vacuum (see Figure). Such an increase is associated with the nonradiative decay via surface excitations in the nanotube.

The effect predicted can possess various physical consequences. For example, it may turn out to be of practical importance in problems of the laser control of atomic motion[3], yielding the drastic increase of the ponderomotive force acting on the atom moving inside or near the surface outside CN in a laser field.

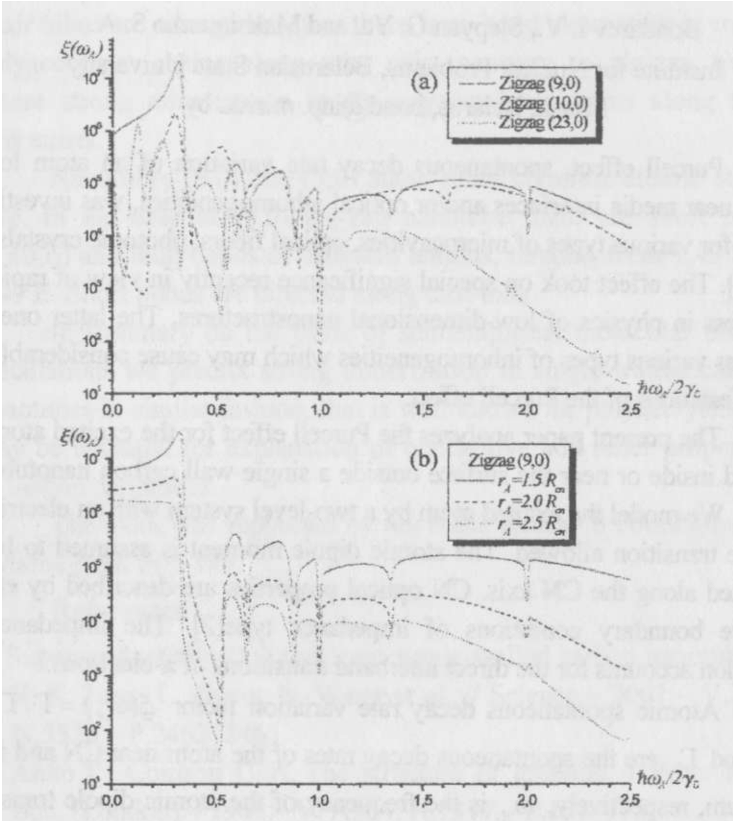

Figure. Factor ^ for the atom on the axis inside CN (a) and near the surface outside CN (b). Constant eV is the carbon overlap integral.

References:

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