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Two-Qubit Atomic Entanglement in Metallic Carbon Nanotubes[1]

MISTY GREEN, IGOR BONDAREV, North Carolina Central University — Recent progress in the growth techniques of centimeter-long single-walled carbon nanotubes (CNs) [1], as well as the experiments on the controlled encapsulation of single atoms into CNs [2], stimulate theoretical studies of the potential applications of hybrid atomically doped CN systems in quantum information science. We analyze the conditions for two spatially separated atomic qubits (two-level atoms, or ions) encapsulated in a CN, or located close to the CN surface, to be strongly coupled to a common high-finesse surface photonic mode of the nanotube, and thus to be entangled via the virtual surface photon exchange [3]. We show that metallic CNs of ∼1 nm diameter can be very efficient, even at room temperatures, to entangle a pair of the spatially separated atomic qubits. We discuss how to employ the rear-earth Eu3+ ions to test our predictions as they are known to be excellent probes to study quantum optical effects in spatially confined systems [4], owing to the dominant 5D0–>7F2 electric dipole transition that essentially creates a qubit system.

[1] L.X.Zheng, et al., Nature Mat. 3, 673 (2004). [2] G.-H.Jeong, et al., Phys. Rev. B. 68, 075410 (2003). [3] I.V.Bondarev, J. Electron. Mat. 36, 1579 (2007). [4] S.V.Gaponenko, et al., J. Lightwave Technol. 17, 2128 (1999).

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