Abstract Submitted
for the DAMOP09 Meeting of
The American Physical Society

Quantum gates between atoms coupled by surface plasmons of a nanowire DAVID DZSOTJAN, Universitaet Kaiserslautern, Germany; RMKI-KFKI, Budapest, Hungary, MICHAEL FLEISCHHAUER, Universitaet Kaiserslautern, Germany — We investigate the long-range coupling of single atoms placed close to the surface of a metallic nanowire. Putting the emitter close to the surface of the wire, a strong Purcell effect can be observed: the emitter will decay into the guided surface plasmon modes of the wire, with a rate exceeding that of free space by a large factor. The strength of the coupling originates from the extremely small mode volume of the surface plasmon modes, because they are tightly confined near the wire surface. We find furthermore that there is an optimal, sub-wavelength emitter-wire distance where the coupling is maximal, due to the losses originating from circulating currents. Placing two emitters along the wire, we observe a strong, wire-mediated long-range interaction between them. As a result, super- and subradiance can occur over distances large compared to the resonant wavelength. Using this effect, one can construct quantum gates and induce entanglement among qubits along the wire. As a specific application, we propose a scheme for constructing a phase gate by a wire-mediated interaction of two lambda atoms.

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Date submitted: 22 Jan 2009 Electronic form version 1.4