Quantum control of the dynamics of a semiconductor quantum well

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In recent years the quantum control of semiconductor quantum wells is a topic of increasing interest due to the significant potential applications of those structures. One of the most important problems in this area is the potential for controlled population transfer and Rabi oscillations in a two-subband semiconductor quantum well (QW). In a QW the many-body effects arising due to the macroscopic carrier density play a significant role and make the system behaving quite differently from a simple atomic-like two-level system.[1]

In this work we study the potential for quantum control of electron dynamics in a symmetric double QW that is coupled by a strong electric field. We consider only the first two subbands. The system dynamics when the electron-electron interactions are taken into account is described by using the effective nonlinear Bloch equations derived recently by Olaya-Castro *et al.*[2] We first simplify the nonlinear Bloch equations by using the rotating wave approximation and present analytical solutions in cases that the two-subband system interacts with pulsed and continuous wave (cw) electric fields. Conditions that lead to complete inversion of the electronic population in the two-subband system are also presented. In addition, strongly modified Rabi oscillations are found in the case that the QW structure interacts with a cw electric field. We finally compare our analytic findings with numerical solutions of the effective nonlinear Bloch equations for a realistic semiconductor QW. In all the cases, significant population inversion is found in the presence of dephasing.

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2. A. Olaya-Castro, M. Korkusinski, P. Hawrylak, and M. Yu. Ivanov, *Phys. Rev. B* **68**, 155305 (2003).