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Ultrafast adiabatic rapid passage in single InAs quantum dots

REUBLE MATHEW, ERIC DILCHER, ANGELA GAMOURAS, Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia, Canada, SABINE FREISEM, DENNIS DEPPE, The College of Optics and Photonics, University of Central Florida, Orlando, Florida, USA, KIMBERLEY HALL, Department of Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia, Canada — Fast quantum gates are important in quantum information processing because operations must be performed within the coherence time of the qubit. Faster single-qubit operations are also important for specific applications such as decoherence control via dynamical decoupling [1], entanglement operations to generate cluster states [2], and probabilistic gates [3]. Here we report an experimental demonstration of optical state inversion of the p-shell exciton in a single InGaAs quantum dot via adiabatic rapid passage (ARP) using a 1.1 ps optical pulse. Population inversion via ARP using frequency swept pulses is robust against experimental instabilities associated with the control pulse and variations in the light-matter coupling parameters. In contrast to previous work [4], shorter optical control pulses provide a 13.5 fold improvement in operation speed and a 200 fold reduction in the required chirp. We find that a chirp of $55,000 \text{ fs}^2$, corresponding to a pulse width of 1.1 ps, is sufficient to achieve ARP. [1] Viola *et al.*, PRA 58, 2733 (1998), [2] Barrett *et al.*, PRA 71, 060310(R) (2005), [3] Olmschenk *et al.*, Science 323, 486 (2009), [4] Wu *et al.*, PRL 106, 067401 (2011), Simon *et al.*, PRL 106, 1666801 (2011)

Reuble Mathew
Department of Physics and Atmospheric Science,
Dalhousie University, Halifax, Nova Scotia, Canada

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