Abstract Submitted
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General Analytic Theory for Bragg Atom Interferometry[1] JAN-NICLAS SIEMSS, Institute for Theoretical Physics, Leibniz Universitaet Hannover, FLORIAN FITZEK, SVEN ABEND, ERNST M. RASEL, NACEUR GAALOUL, Institute of Quantum Optics, Leibniz Universitaet Hannover, KLEMENS HAMMERER, Institute for Theoretical Physics, Leibniz Universitaet Hannover — Bragg diffraction is a cornerstone of light-pulse atom interferometry. High-fidelity Bragg pulses operate in the quasi-Bragg regime in which no simple analytic description of the diffraction process exists. We develop an analytic theory for such pulses based on the adiabatic theorem. Indeed, we show that for the widely adapted case of Gaussian temporal pulse shapes Bragg diffraction is an adiabatic process in the sense of the adiabatic theorem. Our model provides an intuitive understanding of the Bragg condition and includes corrections to the adiabatic evolution up to first order. Furthermore, we include the effects of linear Doppler shifts applicable to narrow atomic velocity distributions on the scale of the photon recoil of the optical lattice. We verify our scattering theory by comparing it to an exact numeric integration of the Schroedinger equation for Gaussian pulses diffracting $4, 6, 8$ and 10 photon recoils and show that non-adiabatic processes are accurately described via Landau-Zener physics. Our formalism provides an analytic framework to study systematic effects as well as limitations to the sensitivity of atom interferometers employing Bragg optics that arise due to a non-ideal diffraction process.

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Jan-Niclas Siem
Institute for Theoretical Physics, Leibniz Universitaet Hannover

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