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Light induced Abelian and non-Abelian gauge fields for ultra-cold atoms MICHAEL FLEISCHHAUER, Technical University of Kaiserslautern, Germany, JULIUS RUSECKAS, GEDIMINAS JUZELIUNAS, Vilnius University, Lithuania, PATRIK OEHBERG, University of Strathclyde, UK — The adiabatic motion of ultra-cold, multi-level atoms in spatially varying laser fields creating a dark state can give rise to effective gauge potentials. We show that these potentials lead to effective magnetic fields if the light fields possess a relative orbital angular momentum. This allows to study quantum-Hall like effects in ultra-cold atomic gases in various geometries. If the atom-light interaction creates several degenerate adiabatic eigenstates, the associated gauge potentials are non-Abelian. A pair of such degenerate dark states emerges e.g. if laser fields couple three internal states of an atom to a fourth common one under pairwise two–photon-resonance conditions. For this so-called tripod scheme we derive general conditions for truly non-Abelian gauge potentials and discuss special examples. In particular we show that using orthogonal laser beams with orbital angular momentum an effective magnetic field can be generated that has a monopole component.

Michael Fleischhauer
Technical University of Kaiserslautern

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