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A practical scheme for a light-induced gauge field in an atomic Bose gas

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Cold atoms can be used to simulate a wide range of pending problems known from condensed matter systems. This should give important insight into phenomena such as high-temperature superconductivity or the fractional quantum Hall effect. Since there the main actors are electrons coupling to electromagnetic fields, it is highly desirable to implement orbital electromagnetism also for neutral alkali atoms. A promising approach is to prepare the atoms in a position-dependent internal state. If the atoms follow this state adiabatically, a geometric (Berry) phase is acquired, corresponding to a gauge field. We will first give a semi-classical interpretation of the emerging Lorentz force and the scalar potential in terms of the quantum-optical radiative forces. We will then discuss a practical scheme to generate a light-induced gauge, which has been designed to minimise losses due to spontaneous emission. We will present results of simulations of the many-body dynamics at the mean field level that validate the adiabatic approximation. In particular we will show that it is possible to attain the Lowest Landau Level regime, and compare the promises of this system with those of a rotating gas.

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