Synthetic magnetic fields in cold atom systems

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Cold atoms can be made to experience synthetic magnetic fields through suitable ac driving. Some methods rely on the properties of the atom internal structure. Shaking is a particular type of driving that couples only to the atom center of mass. By modulating the location of lattice sites periodically in time, shaking provides a powerful method to create effective magnetic fields in engineered quantum systems such as cold gases trapped in optical lattices. However, such schemes are typically associated with space-dependent effective masses (tunneling amplitudes) and non-uniform flux patterns. We compute the effective Hamiltonians and quasienergy spectra associated with several kinds of lattice-shaking protocols. Comparison is made with the method of moving lattices. This study allows the identification of novel shaking schemes, which simultaneously provide uniform effective mass and magnetic flux, with direct implications for cold-atom experiments and photonics.

[1] C E Creffield, F Sols, Europhys. Lett. 101 (2013) 40001. C E Creffield, F Sols, Phys. Rev. A90 (2014) 023636. C E Creffield, G Pieplow, F Sols, N Goldman, New J. Phys. 18 (2016) 093013.