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Mach-Zehnder Interference of Boson Flavor States in the Excited Band of a 2D Optical Lattice[1] JOHN CHALLIS, STEVEN GIRVIN, Yale University, LEONID LEVITOV, MIT — Bosons promoted to the first excited Bloch band of an optical lattice have two important properties: they are metastable, having lifetimes long compared to the nearest neighbor hopping rate, and they carry a "flavor" quantum number which controls the direction of highly anisotropic hopping in the lattice [2]. For a 2D optical lattice where the laser beams are not quite perpendicular, there is a small energy which causes the flavors to mix. The two flavor states can be treated as a two-level system with an avoided crossing, with the relative intensity of the two laser beams serving as a tuning parameter controlling the energy difference between the two flavors. When the tuning parameter is varied sinusoidally around some nonzero offset, the avoided crossing acts like a beam splitter in a Mach-Zehnder interferometer [3]. Since this offset is momentum dependent, the rate of flavor change varies throughout the Brillouin Zone. This fact leads to interesting time-dependent momentum distributions which should be readily observable experimentally by free expansion of the bosons.

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[2]A Isacsson and SM Girvin. Phys. Rev. A 72, 053604 (2005)
[3]WD Oliver et al. Science Vol. 310, Issue 5754, pp. 1653-1657(2005)

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