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Berry phase for optical wavepacket propagation in deformed photonic crystals KEI SAWADA, SHUICHI MURAKAMI, NAOTO NAGAOSA, CREST, Department of Applied Physics, the University of Tokyo — We develop a theory for a trajectory of an optical wavepacket propagating through a photonic crystal with a deformation [1]. Naively one might expect that the trajectory of an optical beam is always perpendicular to the wave front, which is expected in a conventional geometrical optics derived from Fermat's principle. We reveal an anomalous behavior of such electromagnetic beams beyond this naive expectation. We derive a set of equations motion which includes multiple scatterings and a geometrical phase called Berry phase associated with the wave dynamics. We find that such a Berry phase correction to geometrical optics gives rise to a shift of the center position of an wavepacket. Remarkably, at the edge of a photonic band gap, such a coordinate shift is enhanced by a factor $\omega/\Delta\omega$, where ω is a frequency of light and $\Delta\omega$ is a size of a photonic band gap. An amount of the enhancement factor is $\omega/\Delta\omega \sim 10$ or $\sim 10^2$ for photonic crystals. Especially, in the case of an x-ray dynamical diffraction, the factor can be $\omega/\Delta\omega \sim 10^6$, which implies that an atomic crystal deformation gives a macroscopic shift of a wavepacket.
[1] K. Sawada, S. Murakami and N. Nagaosa, Phys. Rev. Lett. **96**, 154802 (2006).

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