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Weak Localization In Periodical Structures Without Disorders[1]

CHUSHUN TIAN, ANATOLY LARKIN, William I. Fine Theoretical Physics Institute, University of Minnesota — he dynamics of a moving particle in some periodic structures exhibits (normal) diffusion at the classical level [1]. We find weak localization phenomena in such structures. Remarkably, no random quantum potentials are introduced so that the analytical treatments do not involve calculations with the regularizer. In periodic structures, an additional random quantum potential does not affect the perturbative regime of localization phenomena (loop expansion). In sharp contrast, in the quantum limit, it leads to strong localization (in the 1D and 2D cases), but quantum diffractions result in the (extended) Bloch state due to spatial periodicity. At the semiclassical level, we find the one loop (frequency- dependent) quantum correction to the diffusion constant has the same functional form as chaotic systems [2]. However, the Ehrenfest time, which signals the crossover between a classical and quantum picture is found without any random quantum potentials. The predicted classical-to-quantum crossover may be studied experimentally in periodic quantum dot systems. The results may be helpful for understanding the crossover between ray and wave optics in photonic crystals. [1] P. Gaspard, Phys. Rev. E **53**, 4379 (1995). [2] I. Aleiner and A. Larkin, Phys. Rev. B **54**, 14423 (1996).

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