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Dynamics of mobile impurities in one-dimensional quantum liquids[1] MICHAEL SCHECTER, University of Minnesota, School of Physics and Astronomy, ALEX KAMENEV, University of Minnesota, School of Physics and Astronomy and Fine Institute for Theoretical Physics, DIMITRI GANGARDT, University of Birmingham, United Kingdom, AUSTEN LAMACRAFT, University of Virginia — We consider the dynamics of mobile impurities immersed in one-dimensional (1d) quantum liquids. Such systems have been realized experimentally in the context of ultracold atomic gases in optical lattices. We show that, on very general grounds, the dispersion relation of the impurity dressed by the liquid is a periodic function of momentum with period $2\pi\hbar n$, n being the 1d density. An impurity subject to a small external force thus exhibits the phenomenon of Bloch oscillations about a fixed point in real space, in the absence of a periodic potential. To compare with experiments,we set out to address the consequences of both finite temperature and finite force on the Bloch oscillation sequence. Our main results are as follows: (i) There exists a finite window of parameters where Bloch oscillations exist $F_{\min}(T) < F < F_{\max}$ (ii) The lower bound is fixed by thermal friction depending on temperature T, and interaction parameters. In particular, we show that $F_{\min} = 0$ for integrable impurity models. (iii) The upper bound $F_{\max}$ is set by friction associated with dipole radiation of phonons due to the accelerating impurity. The ensuing energy loss results in the uniform drift of the oscillation center.

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