Tunable anomalous diffusion of ultracold Fermi gases in time-dependent disorder: From localization to Fermi-accelerated superdiffusion

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Transport through disorder has been actively studied for the last decades. The majority of these studies, e.g. of Anderson localization, assume a static disorder potential. However, time dependence can strongly accelerate dynamics, and the interplay between localization effects and acceleration could have strong impact on diffusion properties of quantum matter. I will present the results of our experimental investigation of the dynamics of ultracold, spin-polarized fermionic lithium atoms when exposed to an optical speckle potential that can be frozen or continuously varying in both space and time. Depending on the disorder's strength and rate of change, we observe several distinct regimes of tunable anomalous diffusion, ranging from weak localization and subdiffusion to superdiffusion. Especially for strong disorder, where the expansion shows effects of localization, an intermediate regime is present in which quantum interference appears to counteract acceleration. Our system connects the phenomena of Anderson localization with second-order Fermi acceleration and paves the way to experimentally investigate Fermi acceleration when entering the regime of quantum transport.

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