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From Anderson to Anomalous Localization in Cold Atomic Gases with Effective Spin-Orbit Coupling JOHANNES OTTERBACH, Harvard University, Cambridge, MA, USA, MATTHEW EDMONDS, Heriot-Watt University, Edinburgh, UK, MIKHAIL TITOV, Karlsruhe Institute of Technology, Karlsruhe, Germany, Heriot-Watt University, Edinburgh, UK, PATRICK ÖHBERG, Heriot-Watt University, Edinburgh, UK, RAZMIK UNANYAN, MICHAEL FLEISCHHAUER, TU Kaiserslautern, Kaiserslautern, Germany — The advanced techniques in coherently controlling and manipulating cold atomic gases allow for the formation of, e.g., artificial magnetic fields or the creation of effective Spin-Orbit coupling for neutral atoms. Confining such spin-orbit coupled particles to one dimension gives rise to an effective relativistic Dirac-like dynamics in the limit of small particle momenta. The addition of disorder potentials drastically changes the properties of these systems giving rise to phenomena as, e.g., exponential Anderson localization. Here we study the dynamics of ultracold atoms with an effective Spin-Orbit coupling moving in a one-dimensional random potential. We show that tuning the ratio between spin-orbit coupling and disorder strength leads to a crossover from exponential Anderson-like localization of massive particles to an anomalous power-law behavior. Its origin can be traced back to the emergence of a Dyson-like singularity in the density of states around the zero-energy (mid-gap) state, reminiscent of the so-called Random Mass Dirac model.

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