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Quantum walk and localization dynamics of rotational excitations in disordered ensembles of polar molecules TIANRUI XU, ROMAN V. KREMS, The University of British Columbia — We consider the dynamics of rotational excitations placed on a single molecule in a spatially disordered 1D, 2D and 3D molecular ensembles trapped in optical lattices. The disorder arises from incomplete populations of optical lattices with molecules. We show that for realistic experimental parameters this type of disorder leads to disorder-induced localization in 1D and 2D on a time scale $t \sim 1$ s. For 3D lattices with 55 sites in each dimension and vacancy concentrations $\leq 90\%$, the rotational excitations diffuse to the edges of the lattice. We observe that the diffusion has three distinct time scales. At short times, the rotational excitations diffuse as quantum particles expanding ballistically. At later times, the diffusion character changes to be the same as for the classical particles in Brownian motion. At still later times, the rotational excitations transition to a sub-diffusive regime. The Brownian-motion-like regime can last as long as 200-300 ms. We also examine the role of the long-range tunnelling amplitudes and find that it has little consequences for the dynamics of quantum particles in the diffusive regime but affects significantly the localization length of strongly localized particles. Reference: arXiv:1501.05063.

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