Quantum simulation of polarons in new interaction regimes and Anderson localization with ultracold molecules

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Abstract

I will show that rotational excitations of polar molecules trapped in an optical lattice lead to rotational Frenkel excitons, which, when coupled to the translational motion of molecules, give rise to polarons with tunable properties. The Hamiltonian that describes these quasi-particles is a mixture of the conventional breathing-mode polaron model and the Su-Schrieffer-Heeger model. The tunable combination of these two types of couplings leads to an interesting polaron phase diagram and the formation of mobile polarons in the strongly coupled regimes. I will also show that rotational excitations in an optical lattice *partially* filled with molecules undergo Anderson localization by scattering off of the vacant lattice sites. I will show how this system can be used to study the effects of long-range tunnelling in the Anderson model as well as correlations arising from long-range interactions between the rotational excitations in the process of dynamical localization.