

Localization and Transport of Vibrons in Trapped-Ion Crystals with Controlled Disorder

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The remarkable degree of control achievable in trapped-ion crystals makes them perfectly suited for exploring the physics of disordered one-dimensional quantum systems. Local vibrations of the ions (vibrons) take the role of particles in an effective tight-binding model. Site-diagonal disorder is naturally introduced into the model by using laser-induced couplings between vibrons and the internal degrees of freedom of the ions. As a specific example, we show that in this way the random binary alloy (RBA) model with fully controlled disorder may be realized. This ion-based implementation makes it possible to induce and directly measure Anderson localization of vibrons. Moreover, we obtain access to the non-equilibrium physics of the system by asymmetric heating of the boundaries of the ion crystal. We demonstrate that the driven RBA model opens an experimental route for exploring the disorder-induced onset of Fourier's law.