

PHYSICS DEPARTMENT COLLOQUIUM

" ELECTRON TRANSPORT IN GRANULAR ARRAYS"

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Electron-electron interactions in low-dimensional systems have attracted a great deal of attention in recent years. We show that arrays of large, strongly coupled quantum dots present an analytically tractable, yet non-trivial model of such systems.

A single dot strongly coupled to leads exhibits almost no Coulomb blockade (save for corrections that are exponentially small in the dot-lead conductance). In the array geometry with large inter-grain conductance $g \gg 1$, however, the interactions drive the system into an insulating state with a charge gap $\Delta \propto \exp^{-\#g}$. The latter reflects the energy cost to create a large-size, unit-charge soliton -- the only charged excitation the system supports. In 2d, such solitons bring about a Berezinskii-Kosterlitz-Thouless crossover at a certain (g-dependent) critical temperature.

Upon changing the charge imbalance (e.g., by a gate voltage), the array undergoes a phase transition into the pinned Wigner crystal state. The model, thus, allows one to follow the system from a good metal (at high temperature) all the way to the Wigner crystal insulator (at low temperature) within a single framework.

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