Photo-induced nonequilibrium steady state of correlated electron systems
- Floquet + DMFT analysis

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We theoretically study photo-induced phase transitions in correlated electron systems where physical properties abruptly change when irradiated with intense laser fields. Especially we focus on a photo-induced nonequilibrium steady state emerging from a Mott insulator during irradiation of pump light, where a key issue is: what is characteristic to a photo-induced phase transition, i.e. how it is different from conventional filling- or temperature-driven phase transitions in equilibrium, and how the difference appears in observable quantities.

In order to analyze photo-excited states, we have proposed a theoretical method (Floquet + DMFT) [1] that combines Floquet technique for an ac electric field and the dynamical mean-field theory for the electron correlation. With this approach one can simultaneously treat electron correlation and electric-field effects, both of which are expected to be crucial in the transition.

Here we apply Floquet + DMFT to two lattice models of correlated electrons driven by pump light: Falicov-Kimball (FK) model [2] and Hubbard model. The former is solved exactly, while the latter is solved within iterated perturbation theory. The figure shows the optical conductivity spectrum $\sigma(\nu)$ against the frequency ν of the probe light for FK model.

When the pump light is absent, the system is insulating and $\sigma(\nu)$ has an optical gap. As one increases the amplitude E of the pump light, the gap disappears and a Drude-like peak grows in the low energy region, which suggests that the system is optically driven into a metallic state. We will discuss the nature of the photo-induced state in terms of $\sigma(\nu)$ and the nonequilibrium distribution function.

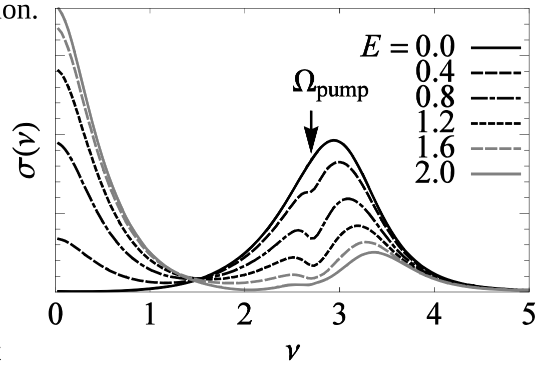

Figure: The optical conductivity against ν, the frequency of the probe light, for a given frequency, Ω_{pump}, of the pump.

It is of particular interest to study PIPTs in organic materials, which have been widely observed in recent pump-probe experiments.

[1] N. Tsuji, T. Oka, and H. Aoki, Phys. Rev. B **78** (2008) 235124.
[2] N. Tsuji, T. Oka, and H. Aoki, arXiv:0903.2332.