Nonequilibrium phenomena in correlated and topological systems

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Nonequilibrium physics is now becoming one of the central interests in condensed-matter physics. This talk will give an overview, covering the following: (i) *Correlated electron systems out of equilibrium:* intense dc electric fields can make a Mott's insulator metallic, where the dielectric breakdown may be regarded as a solid-state analogue of Schwinger's QED vacuum decay. [1] (ii) *Nonequilibrium-induced interaction conversion:* if we illuminate a correlated system with either a continuous laser light or a mono-cycle pulse, we can show that the particle-particle interaction can be changed from repulsive to attractive, which comes from a population inversion (or negative T) and has an obvious implication for nonequilibrium-induced superconductivity. [2] (iii) *Photovoltaic Hall effect*: if we illuminate graphene with a circularly-polarised light, a dc Hall effect can be induced in zero magnetic fields. This comes from a combination of a kind of Berry's phase pumping and a topological property of graphene. [3] So a message here is that nonequilibrium can realise novel phenomena in both correlated and topological systems.

[1] T. Oka and H. Aoki, Phys. Rev. B **81**, 033103 (2010); in *Lecture Notes in Physics* **762**, 251 (Springer, 2009).
[2] T. Oka and H. Aoki, Phys. Rev. B **79**, 081406(R) (2009) [**79**, 169901(E) (2009)]; J. Phys.: Conf. Ser. **334**, 012060 (2011).
[3] N. Tsuji, T. Oka, P. Werner and H. Aoki, Phys. Rev. Lett. **106**, 236401 (2011); Phys. Rev. B **85**, 155124 (2012).