Massachusetts Institute of Technology
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SPECIAL CONDENSED MATTER PHYSICS SEMINAR

"Floquet Theory of Photo-induced Topological Phase Transitions"

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Abstract: The effect of strong laser on the topology of many-electron systems is becoming a hot topic [1,2,3]. Recently, a theoretical proposal was made in two dimensional Dirac systems where an application of circularly polarized light was shown to turn the system into a quantum Hall state with a non-trivial photo-induced Chern number and an emergence of edge channels [1,2]. One can see this as a dynamical realization of the Haldane model of a quantum Hall state without Landau levels [4]. This effect can be understood with the help of the Floquet theory of driven quantum systems, where the circularly polarized light plays the role similar to the "next nearest hopping with a nontrivial phase factor" in the Haldane model. This proposal applies to a broad class of multi-band systems including graphene, graphite and surface states of topological insulators as well as cold atoms in optical lattices with synthetic gauge fields.

Another interesting application of circularly polarized light is the magnetization process in quantum spin systems[5]. If the magnetic component is applied to a spin 1 antiferromagnetic Heisenberg system, one can break the topological groundstate, i.e., the Haldane state, and coherently introduce net magnetization. This is a pure quantum effect which cannot be addressed by phenomenological treatments. We have obtained a systematic understanding of this effect using a many-body extension of the Floquet theory. In these examples of light induced phenomena, the necessary strength of laser is below or within reach of the current state of the art laser techniques.

This work was done in collaboration with T. Kitagawa, S. Takayoshi, H. Aoki, T. A. Brataas, L. Fu and E. Demler.

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