

Physical Sciences Seminar

Controlling Quantum Materials Using Coherent Optical Driving

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The recent rapid progress in quantum technology has enabled essentially complete control of the quantum-mechanical state of individual atoms and of the interactions between them. Extending this kind of control all the way to entire solids is now moving within reach and provides on-demand access to high-temperature superconductivity or topologically protected transport. A crucial tool for achieving such control is the use of coherent driving with oscillating fields, known as Floquet engineering. I will first illustrate the success of this approach using experiments with ultracold atoms trapped in crystals made of light. Moving on to real materials, the strong fields accessible with pulsed lasers are now starting to enable coherent control of material properties on sub-picosecond time scales. I will show how driving graphene can change the topology of its electronic bands, leading to an ultrafast quantum Hall effect in the absence of a magnetic field. Furthermore, I will present how laser pulses can induce metastable superconducting properties in alkali-doped fullerenes at temperatures approaching room temperature. The process underlying this effect in these organic materials is not well understood, but I will present recent progress based on detecting the presence of superconducting fluctuations in the normal state via the Nernst effect. Pushing this line of research further will be facilitated by new probing and driving technologies, such as ultrafast control and detection of magnetic fields or tailoring the spatial symmetries of laser fields to perform active symmetry breaking in solids. Ultimately, this approach can provide new insights on the fundamental question of how order forms in complex quantum mechanical systems, and unlock ultrafast on-demand control of new functionalities and phenomena ranging from quantum magnetism to topological superconductivity.

Tuesday, July 19, 2022 11:00am - 12:00pm
Heinzel Seminar Room / Office Bldg West (I21.EG.101)



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