From Quantum Matter to Quantum Computers

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Quantum materials exhibit non-universal properties that are the result of strong interactions between their constituents, defying a theoretical description in terms of free electrons. Their physical phenomena, such as superconductivity, long-range entanglement and topologically protected currents, are exotic and absent in simple metals or insulator. Tailoring these intrinsic electronic interactions through the application of electromagnetic fields makes them promising candidates for future quantum devices.
Pushing the theoretical understanding of non-equilibrium excitations in such complex many-body systems is a key challenge arising for many different materials. In this talk I will focus on the physics of light-matter interactions in unconventional superconductors and heavy-fermion systems as paradigmatic examples for quantum matter with strong correlations. I will show, that quantum quenches can induce superconducting Higgs oscillations [1] and how light-induced superconductivity can be efficiently detected using photo-electron pair spectroscopy [2]. Next, I will discuss, how charge and spin order can be dynamically controlled in photoinduced phase transitions of Kondo lattice systems [3-5]. Finally, we will build the bride towards modern noisy intermediate scale quantum (NISQ) computers and investigate the potential impact of novel quantum algorithms to describe correlated quantum materials in- and out-of-equilibrium [6,7].

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