

Electrical Switching of Altermagnetism

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Using only electricity to detect, generate, and control magnetism is of great potentials in applications but remains challenging. In this talk, I will introduce our theories on using only pure electric approaches to detect, switch, and generate unconventional magnetism, including altermagnetism and nonlinear magnetization.

Altermagnetism is an unconventional collinear antiferromagnetism. Its spin-opposite sublattices cannot be related by inversion or translation. This property gives altermagnetism the advantages of both ferromagnetism and antiferromagnetism thus are promising in applications. I will introduce how to use Coulomb drag and nonlinear Hall effect to detect altermagnetism and how to use only electric current to switch the Neel order of altermagnetism deterministically.

The Christoffel symbol is an essential quantity in Einstein's general theory of relativity. We discover that an electric field can induce a nonlinear magnetization in quantum materials, described by the quantum Christoffel symbol. We identify many 2D material candidates that host this quantum Christoffel nonlinear magnetization. This nonlinear Christoffel magnetization can be probed by optical techniques such as magneto-optical Kerr spectroscopy. More importantly, this quantum Christoffel nonlinear magnetization gives a paradigm of how geometry dictates physics.

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