THE CHINESE UNIVERSITY OF HONG KONG

Department of Physics

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Beyond the Symmetric Magnetic-Dipole Picture: Experimental Signatures in Ferromagnets and Altermagnets

by

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Place: Rm LG23, Science Centre North Block, CUHK

ALL INTERESTED ARE WELCOME
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Abstract

Conventional phenomenological descriptions of transverse transport and magneto-optical effects in magnetic materials are commonly formulated in terms of a symmetric magnetic-dipole contribution associated with the magnetization. Recent advances in antiferromagnetic materials, however, have demonstrated that their transport and optical responses cannot always be understood within this conventional dipolar picture. Whether similarly unconventional physical contributions are also relevant to ordinary ferromagnets has received far less attention. In this talk, I will present our recent measurements of transport and magneto-optical effects in 3d transition-metal ferromagnets, van der Waals ferromagnets, and altermagnetic materials. Our results lead to three main conclusions. First, even in uniformly magnetized ferromagnets, magnetic octupoles in magnetization space can make substantial and widespread contributions to the anomalous Hall and magneto-optical responses. Second, by selecting low-symmetry crystal-surface orientations, anomalous Hall, anomalous Nernst, and magneto-optical effects driven by in-plane magnetic moments can be realized even in materials with relatively high bulk symmetry. Phenomenologically, these responses can be attributed to toroidal magnetic-dipole or magnetic-octupole contributions. Third, the strong magneto-optical signals observed in antiferromagnetic insulators such as α-Fe_2O_3 and $YFeO_3$ originate predominantly from their staggered magnetic order and can be described in terms of an antisymmetric magnetic-dipole contribution. These findings demonstrate that higher-order magnetic multipoles and toroidal magnetic-dipole terms beyond the conventional symmetric-dipole picture are broadly relevant across magnetic systems. They deepen our understanding of the microscopic origins of anomalous transport and magneto-optical phenomena and provide a new route for designing magnetic transport and optical functionalities through crystal-symmetry engineering. If time is permitted, I will be also glad to introduce my progress in the domestic EFA equipment development.

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