[QMS2020 Invited talk]

Terahertz Spectroscopy of Quantum Materials

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Terahertz time-domain spectroscopy (THz-TDS) is introduced as an effective tool to probe the charge and spin dynamics of quantum materials. The high-sensitivity, low-energy, and phase-sensitive character of the time-domain technique in the terahertz range brings in unique advantages in elucidating novel electronic processes. Here, a general introduction to the experimental technique is given along with a standard method of extracting the frequency-dependent dynamical conductivity of a given electronic system. Next, three prime examples of quantum materials are presented for case studies: superconductors [1], topological insulators [2], and two-dimensional (2D) antiferromagnets. Experimental data and theoretical analyses of the superconducting gap, the London penetration depth, topological surface states, and antiferromagnetic resonance absorption and emission will be given. The talk concludes with an outlook on the use of THz-TDS in an expanding list of newly emerging materials.

[1] Sim, K.I., Jo, Y.C., Ha, T. et al. Journal of the Korean Physical Society (2017) 71: 571. https://doi.org/10.3938/jkps.71.571

[2] Park, B., Kim, T., Sim, K. et al. Terahertz single conductance quantum and topological phase transitions in topological insulator Bi2Se3 ultrathin films. Nat Commun 6, 6552 (2015). https://doi.org/10.1038/ncomms7552