Summer School Couse Topic:
Color-Center Based Quantum Sensing

Hao Wu [1], *

[1] Center for Quantum Technology Research and Key Laboratory of Advanced Optoelectronic Quantum Architecture and Measurements (MOE), School of Physics, Beijing Institute of Technology, Beijing 100081, China

*email: hao.wu@bit.edu.cn

Quantum sensing harnesses the principles of quantum mechanics—such as superposition, entanglement, and coherence—to achieve measurement sensitivities beyond the limits of classical approaches. Among various solid-state platforms, color centers in diamond, in particular the nitrogen-vacancy (NV) center, have emerged as versatile quantum sensors owing to their unique optical addressability, long spin coherence times, and operation under ambient conditions. This course introduces the foundations of quantum sensing, highlighting how quantum states can be exploited to probe physical quantities with high precision. We will discuss the fundamental properties of diamond color centers, including their electronic and spin structure, coherence characteristics, and methods for optical initialization and readout. Finally, the course will explore key applications of diamond-based quantum sensors in magnetometry, thermometry, and electric field detection, as well as their potential roles in biology, materials science, and quantum technologies.