We study the physics in a wide variety of materials, such as superconductors, magnetic materials, and topological insulators, by using nuclear magnetic resonance (NMR) techniques. In these materials, electrons with strong correlation, spin-orbital effect, and lattice coupling, often produce novel phenomena that cannot be predicted by the conventional theories. As material properties are mainly dominated by electrons, an experimental tool, such as NMR that can probe the local electron behavior directly, is required. In the past, we conducted NMR experiments to investigate the role of magnetism in an iron-based superconductor FeSe. We observed exotic magnetism in Na$_{0.825}$CoO$_2$ and solved its superlattice structure. We also probed the bulk electronic states in a newly-discovered topological insulator Bi$_2$Se$_3$. In the future, we plan to develop a new NMR technique so that it can probe the topological surface states of Bi$_2$Se$_3$.

Research highlights:

Cobalt magnetism in a superstructured metallic antiferromagnet Na$_{0.825}$CoO$_2$ [PRB 88, 064418 (2013)]

Probing the bulk electronic states of Bi$_2$Se$_3$ using nuclear magnetic resonance [PRB 86, 075137 (2012)]