Thesis Summary

Orbital and Spin Dependent Electronic Structures of Non-symmorphic Dirac Nodal Line Semimetals
(非共型ディラック線ノード半金属の軌道およびスピンに依存した電子構造)

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HfSiS and ZrSiS have been mostly studied as a proto-typical NLDS with a great expectation on the emergence of exotic fundamental physics and the suitability for a number of potential applications. The involved orbital degree of freedom plays a crucial role in modulating the bulk and surface electronic structures. Orbital characteristics of the spin-split SSs in HfSiS have been confirmed by angle-resolved photoelectron spectroscopy (ARPES) with variable light polarization. Moreover, we have also studied a possible influence of orbital arrangement on the bulk Dirac node line (along the $\bar{\Gamma}\bar{M}$-line) in $Hf_{1-x}Zr_xSiS$ systems. We have identified an important change of the orbital character for the linearly dispersing Dirac bands near E_F with varying the light polarization, which is of significance in explaining the microscopic mechanism for transport properties in Dirac nodal line semimetal systems.

We present the first observation of exotic unidirectional spin texture in the Dirac nodal line semimetal HfSiS by the state-of-the-art spin-resolved ARPES. More importantly, we have already verified that the unidirectional spin texture in HfSiS is strongly correlated with the orbital symmetry switch through light-polarization dependent measurement, which is also well reproduced by the ab-initio theoretical calculations and the $\boldsymbol{k}\cdot\boldsymbol{p}$ model Hamiltonian. Our finding suggests that orbital symmetry is crucially important for the formation mechanism of the persistent spin texture and will eventually open an avenue to a new quality of low-loss spintronics. We demonstrate the presence of the SOC effects within the surface and bulk states of $Hf_{1-x}Zr_xSiS$ (x=0, 0.6, 1). Spin degeneracy in both bulk and surface states are found to be lifted with different magnitudes by varying the Zr content (x) in $Hf_{1-x}Zr_xSiS$. We demonstrate a crucial role in the regulation of Zr composition in $Hf_{1-x}Zr_xSiS$ in quantitatively controlling the strength of the SOC, an important step towards the realization of spintronic devices.