Ultrathin quantum materials present a unique platform for the control of electronic, magnetic, and topological properties. A commonly observed phenomenon in many ultrathin quantum materials is that an undesired crossover from a metallic to an insulating state occurs below a critical thickness. This presents a potential challenge for realizing ultrathin heterostructures of quantum materials when metallic properties are desired.

Here, members of PARADIM’s In-House Research group use angle-resolved photoemission spectroscopy (ARPES) and molecular-beam epitaxy (MBE) to reveal the electronic structure, charge transfer, doping profile, and carrier effective masses in a layer-by-layer fashion for the interface between the Dirac nodal-line semimetal SrIrO$_3$ and the correlated metallic Weyl ferromagnet SrRuO$_3$.

It is shown here that metallicity can be preserved even down to a single SrIrO$_3$ layer, due to the structural similarities between SrIrO$_3$ and SrRuO$_3$, and the overlapping Ir and Ru $d$ orbitals. In addition, ARPES reveals that electrons are transferred from the SrIrO$_3$ layer into the SrRuO$_3$, with an estimated screening length of $\lambda = 3.2 \pm 0.1$ Å.