Berry phase engineering at oxide interfaces

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Three-dimensional strontium ruthenate ($SrRuO_3$) is an itinerant ferromagnet that features Weyl points acting as sources of emergent magnetic fields, anomalous Hall conductivity, and unconventional spin dynamics. Integrating $SrRuO_3$ in oxide heterostructures is potentially a novel route to engineer emergent electrodynamics, but its electronic band topology in the two-dimensional limit remains unknown. Here we show that ultrathin $SrRuO_3$ exhibits spin-polarized topologically nontrivial bands at the Fermi energy. Their band anticrossings show an enhanced Berry curvature and act as competing sources of emergent magnetic fields. We control their balance by designing heterostructures with symmetric ($SrTiO_3/SrRuO_3/SrTiO_3$ and $SrIrO_3/SrRuO_3/SrIrO_3$) and asymmetric interfaces ($SrTiO_3/SrRuO_3/SrIrO_3$). Symmetric structures exhibit an interface-tunable singlechannel anomalous Hall effect, while ultrathin $SrRuO_3$ embedded in asymmetric structures shows humplike features consistent with multiple Hall contributions. The band topology of two-dimensional $SrRuO_3$ proposed here naturally accounts for these observations and harmonizes a large body of experimental results.

References:

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