Highlights

Activity C - Innovative materials with strong interplay of spin, orbital, charge and topological degrees of freedom - 2021

Unveiling unconventional magnetism at the surface of Sr_2RuO_4

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Materials with strongly correlated electrons often exhibit interesting physical properties. An example of these materials is the layered oxide perovskite Sr_2RuO_4, which has been intensively investigated due to its unusual properties. Whilst the debate on the symmetry of the superconducting state in Sr_2RuO_4 is still ongoing, a deeper understanding of the Sr_2RuO_4 normal state appears crucial as this is the background in which electron pairing occurs. By using low-energy muon spin spectroscopy we discover the existence of surface magnetism in Sr_2RuO_4 in its normal state. We detect static weak dipolar fields yet manifesting at an onset temperature higher than 50 K. We ascribe this unconventional magnetism to orbital loop currents forming at the reconstructed Sr_2RuO_4 surface. Our observations set a reference for the discovery of the same magnetic phase in other materials and unveil an electronic ordering mechanism that can influence electron pairing with broken time reversal symmetry.

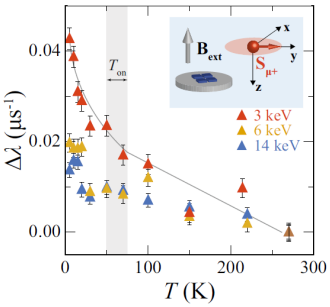

Fig. 1: Temperature dependence of magnetism in Sr_2RuO_4 at different implantation depths. Shift in the muon depolarization rate, $\Delta\lambda$, from the λ value measured at T = 270 K as a function of temperature T measured in a transverse field setup (inset) with applied field amplitude B_{ext}=100G at different implantation energy E values: E=3 keV, E=6 keV and E =16 keV.

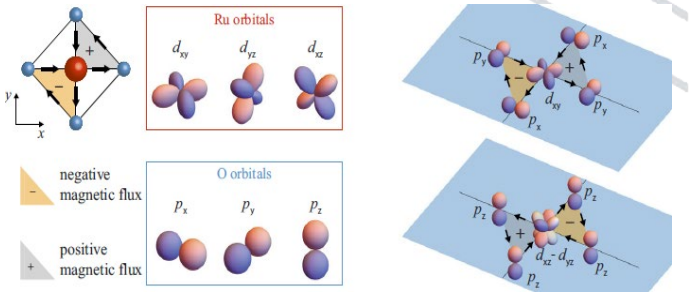

Fig. 2: Magnetism due to orbital loop currents in Sr_2RuO_4. Illustration of the RuO_4 plaquette and of the corresponding d-orbitals for the Ru atoms and p-orbitals for the O atoms (with asymmetric loop current distributions generating magnetic flux pointing inward (yellow triangle) or outward (grey triangle) the RuO_4 plane. Possible orbital loop currents for a given RuO_4 plaquette associated with the Ru–O hybridization of the d_{xy} orbitals and of the (d_{xz}, d_{yz}) orbitals.