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Cubic Rashba effect and 2D-ferromagnetism at the iridium-silicide surfaces of antiferromagnetic GdIr2Si2 and mixed-valent EuIr2Si2

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Cubic Rashba effect and 2D-ferromagnetism at the iridium-silicide surfaces of antiferromagnetic GdIr2Si2 and mixed-valent EuIr2Si2

Two-dimensional (2D) electron states at the surface of RT2Si2 compounds (R = lanthanide, T = transition metal) with ThCr2Si2 structure have proven to be ideal model systems for studying the joint action of spin-orbit (SOI) and exchange interactions on itinerant electrons [1-5]. Those surface states are predominantly situated in the Si-T-Si-R surface block and subject to Rashba-type spin splittings which can be manipulated by ordered 4f moments.

Here, we present our combined angle-resolved photoelectron spectroscopy (ARPES) and density functional theory (DFT) studies on the Si-terminated surface of compounds with T = Ir, which are of particular interest because Ir leads to a large SOI. We found that in the paramagnetic phase the surface states are characterised by a huge energy splitting of the highly spin-polarised bands and an exotic triple-winding spin structure along the constant-energy contours induced by the so-called cubic Rashba effect [4]. Upon ordering of the 4f moments below the Si-terminated surface, the emerging exchange coupling of the surface-state spins to the localised lanthanide moments modifies the spin structure, leading to pronounced asymmetries in the band dispersion. Surprisingly, these asymmetries were not only found for the antiferromagnet GdIr2Si2 [5], but for the valence-fluctuating EuIr2Si2, too [3]. The latter allowed us to unveil unusual 2D ferromagnetic properties and related temperature scales of the iridium-silicide surface of EuIr2Si2, which is non-magnetic in the bulk. Moreover, a short overview on additional results from complementary experimental techniques like photoelectron diffraction and magnetic dichroism experiments on the 4f shell is given [6].

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[4] D. Yu. Usachov et al., Phys. Rev. Lett. 124, 237202 (2020)
[5] S. Schulz et al., Phys. Rev. B 103, 035123 (2021)
[6] D. Yu. Usachov et al., Phys. Rev. B 102, 205102 (2020)

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