Designing spin and orbital sources of Berry curvature at oxide interfaces

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Quantum materials can display physical phenomena rooted in the geometry of electronic wavefunctions. The corresponding geometric tensor is characterized by an emergent field known as Berry curvature (BC). Large BCs typically arise when electronic states with different spin, orbital or sublattice quantum numbers hybridize at finite crystal momentum. In all materials known to date, the BC is triggered by the hybridization of a single type of quantum number. In this talk I will discuss the finding [1] of the first material system having both spin and orbital-sourced BC: $LaAlO_3/SrTiO_3$ interfaces grown along the [111] direction. The BC associated to the spin quantum number are probed through measurements of the recently proposed anomalous planar Hall effect [2]. I will also discuss how the observation of a nonlinear Hall effect with time-reversal symmetry [3] - a phenomenon observed so far in Dirac materials such as graphene [4,5] - signals large orbital-mediated BC dipoles [6].

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[3] C. Ortix, Advanced Quantum Technologies 4, 2100056 (2021)

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[6] M.-T. Mercaldo, C. Noce, A. Caviglia, M. Cuoco, C. Ortix, npj Quantum Materials (2023) in press