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Topological properties and correlation effects in oxide heterostructures[1]

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Transition-metal oxides (TMOs) have long been one of the main subjects of material science because of their novel functionalities such as high-T_c superconductivity in cuprates and the colossal magnetoresistance effect in manganites. In recent years, we have seen tremendous developments in thin film growth techniques with the atomic precision, resulting in the discovery of a variety of electronic states in TMO heterostructures. These developments motivate us to explore the possibility of novel quantum states of matter such as topological insulators (TIs) in TMO heterostructures. In this talk, I will present our systematic theoretical study on unprecedented electronic states in TMO heterostructures. An extremely simple but crucial observation is that, when grown along the [111] crystallographic axis, bilayers of perovskite TMOs form buckled honeycomb lattices of transition-metal ions, similar to graphene. Thus, with the relativistic spin-orbit coupling and proper band filling, two-dimensional TI states or spin Hall insulators are anticipated. Based on tight-binding modeling and density-functional theory calculations, possible candidate materials for TIs are identified. By means of the dynamical-mean-field theory and a slave-boson mean field theory, correlation effects, characteristics of TMOs, are also examined. I will further discuss future prospects in topological phenomena in TMO heterostructures and related systems.

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