Spin and charge ordering in heterostructures of strongly correlated electron systems

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In strongly correlated heterostructures, a non-uniform potential together with correlation effects can lead to novel electronic properties which are not realized in ordinary bulk systems. For example, it was reported experimentally [1] and theoretically [2] that the interface between the band insulator(BI) $SrTiO_3$ and the Mott insulator(MI) $LaTiO_3$ shows a metallic behavior. In this study, we consider a strongly correlated interface of BI and MI, like $SrTiO_3/LaTiO_3$ [1], with particular emphasis on magnetic properties at the interface. To this end, we investigate the Hubbard model with long-range Coulomb interaction in the Hartree-Fock approximation[2]. We find intriguing magnetic/charge phase transitions at the interface, which are closely related with the non-uniform potential. We elucidate that these transitions are caused by the strong coupling between charge and spin degrees of freedom near the interface. When the MI region has an antiferromagnetic (AF) order, a canted AF order can emerge around the interface, which shows a first-order metamagnetic transition under an external magnetic field. We also find that the strong spin-charge coupling stabilizes a charge order with a checkerboard pattern at the interface.
[1] A. Ohtomo *et al.*, Nature (London) **419**, 378 (2002).
[2] S. Okamoto and A. J. Millis, Phys. Rev. B. **70**, 241104 (2004).