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Mott transition controlled by lattice-orbital coupling in double layer ruthenates JIN PENG, Nanjing Univ, GUOQIANG LIU, Ningbo Institute of Material Technology and Engineering, Chinese Academy of Sciences, ZHIQIANG MAO, Tulane University, XIAOSHAN WU, Nanjing Univ, XIANGLIN KE, Michigan state University — We have investigated unusual phase transitions triggered by chemical doping in $Ca_3Ru_2O_7$. Our experiments show a few percent doping of Mn (>4%) can switch the quasi-two-dimensional metallic state with the antiferromagnetic order (AFM-b) comprised of ferromagnetic (FM) bilayers of $Ca_3Ru_2O_7$ to a Mott insulating state with the nearest-neighbor antiferromagnetic order (G-AFM), while Fe doping cannot realize such a Mott transition, but leads to a localized state with the AFM-b order. Combined with first-principles calculations, we find that the lattice-orbital coupling (LOC) plays a critical role in driving the Mott transition caused by Mn doping and the Mott transition temperature T_{MIT} is strikingly dependent on the structural parameter c/a at the temperatures far above T_{MIT}. Such LOC-assisted Mott transition mechanism, which also accounts for the previously-reported Mott transition induced by Ti doping in $Ca_3Ru_2O_7$, forms a clear contrast with the Mott transition mechanism controlled by band filling in $3d$ strongly correlated systems. Our findings advance the understanding of how exotic properties of $4d$ correlated systems are governed by the complex interplay between charge, spin, lattice and orbital degrees of freedom.

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