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Chemical Doping Induced Ferro- and Antiferro-magnetic States in non-Magnetic Insulating $FeGa_3$ N. HALDOLAARACHCHIGE, J. PRESTIGIACOMO, Y. XIONG, A. PHELAN, J. CHAN, D. SHEEHY, P. ADAMS, J. DITUSA, S. STADLER, D. YOUNG, Louisiana State University — A ferromagnetic quantum critical point (FM-QCP) in Ge-doped $FeGa_3$ was reported very recently (Umeo *et al.* PRB **86** (14), 144421, 2012). We have simultaneously observed the FM-QCP in this system. Furthermore, we analyzed the magnetic properties of $FeGa_3$ in the context of a unique structural feature, where the four Fe atoms in the unit cell exist as two Fe-Fe dimers (Yin and Picket, PRB **82** (15), 155202, 2010). We propose a phenomenological model where the extrinsic electrons from the Ge doping creates a mixed valence Fe-dimer with a net effective spin. Such a model provides a novel mechanism for the (FM-QCP) and is consistent with the system's magnetic and thermal properties. In addition to Ge doping, we have investigated effects of Ru/Mn substitution on the Fe site. Ru substitution produces an unexpected ferromagnetic (FM) insulating phase that develops immediately, and it disappears above an intermediate doping level. This behavior agrees well with our model of spin creation on the transition-metal dimers via conduction electrons, and the enhanced insulating behavior in the electrical resistivity suggests the Ru acquires a 2+ state. Interestingly, Mn-doped $FeGa_3$ shows an apparent antiferromagnetic (AFM) insulating phase, where the magnetic data is consistent with the effective moment coming from Mn(3+). These results provide further evidence of the important role of the Fe-Fe dimer structure in $FeGa_3$ in determining its unique magnetic properties.

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