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Electronic Correlations and Magnetic Frustration in the Iron Pnictides[1]

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An important question about the high Tc iron pnictides is the extent to which they are strongly correlated. Based on the fact that they are "bad metals," we propose that these materials are in proximity to a Mott insulator [1,2]. In other words, the degree of the electronic correlations here is closer to that of intermediately-coupled metallic systems like V2O3, which lies near the Mott transition, rather than that of simple antiferromagnetic metals such as Cr. Consequently, we model the incoherent electronic excitations in terms of localized moments, whose superexchange interactions contain the competing nearest-neighbor (J1) and next-nearest-neighbor (J2) components [1]. The magnetic frustration of the J1-J2 model in the relevant parameter range leads to a (pi,0) antiferromagnet and a reduced ordered moment. The model also features an Ising transition that naturally yields a structural phase transition. All these are consistent with the neutron scattering results. With the coupling of the local moments to the coherent electronic excitations, the strength of the antiferromagnetic order is tuned, leading to a magnetic quantum critical point [2]. The ordered moment should therefore vary across the undoped iron arsenides. In addition, the magnetic quantum criticality can be probed by P doping for As in the parent iron pnictides, where the disruption to the quantum criticality caused by superconductivity is likely to be less compared to the electron or hole doped cases. Finally, the implications of the electronic correlations and magnetic frustration on the multi-band superconductivity will be briefly discussed.

[1] Q. Si and E. Abrahams, PRL 101, 076401 (2008);
[2] J. Dai, Q. Si, J-X Zhu and E. Abrahams, arXiv:0808.0305.

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