Fermi Surface Evolution and Quantum Criticality in $Mn_{1-x}Fe_xSi$

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Different scenarios of non-Fermi liquid behavior in strongly correlated electron systems may be resolved by a study of ordinary Hall effect in quantum critical (QC) regime [1-3]. For the system with localized magnetic moments a collapse of the Fermi surface should occur exactly at the QC point that can result in an abrupt change of the Hall constant at zero temperatures [2]. In contrast, the spin density wave model of quantum criticality in itinerant magnets provides no evidence of the Lifshitz transition at QC point [3].

Here we report the study of Hall effect in $Mn_{1-x}Fe_xSi$ (x<0.3) single crystals carried out in magnetic fields below 8 T at temperatures 2-60 K. Separating between ordinary and anomalous contributions to Hall effect in the paramagnetic phase of $Mn_{1-x}Fe_xSi$ allows to discover a sign inversion of normal Hall coefficient, which is definitely associated with the hidden QC point $x^*\sim0.11$. We show that the increase of Fe content results in effective hole doping. This observation allows us to make some verifiable predictions in the field of fermiology, magnetic interactions, and QC phenomena in this QC system. The discovered redistribution between electron and hole regions of Fermi surface is considered as a main factor, which tunes the QC regime in $Mn_{1-x}Fe_xSi$ by modulating the Ruderman-Kittel-Kasuya-Yosida exchange interaction between the localized magnetic moments of Mn ions.

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References

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