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Analysis of the antiferromagnetic phase transitions of the 2D Kondo lattice

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The Kondo lattice continues to present an interesting and relevant challenge, with its interactions between Kondo, RKKY, and coherent order. We present our study[1] of the antiferromagnetic quantum phase transitions of a 2D Kondo-Heisenberg square lattice. Starting from the nonlinear sigma model as a model of antiferromagnetism, we carry out a renormalization group analysis of the competing Kondo-RKKY interaction to one-loop order in an ε-expansion. We find a new quantum critical point (QCP) strongly affected by Kondo fluctuations. Near this QCP, there is a breakdown of hydrodynamic behavior, and the spin waves are logarithmically frozen out. The renormalization group results allow us to propose a new phase diagram near the antiferromagnetic fixed point of this 2D Kondo lattice model. The T=0 phase diagram contains four phases separated by a tetracritical point, the new QCP. For small spin fluctuations, we find a stable local magnetic moment antiferromagnet. For stronger coupling, region II is a metallic quantum disordered paramagnet. We find in region III a paramagnetic phase driven by Kondo interactions, with possible ground states of a heavy fermion liquid or a Kondo driven spin-liquid. The fourth phase is a spiral phase, or a large-Fermi-surface antiferromagnetic phase. We will describe these phases in more detail, including possible experimental confirmation of the spiral phase. The existence of the tetracritical point found here would be expected to affect the phase diagram at finite temperatures as well. In addition, It is hoped that these results, and particularly the Kondo interaction paramagnetic phase, will serve to bridge to solutions starting from the opposite limit, of a Kondo effect leading to a heavy fermion ground state. Work in collaboration with T. Tzen Ong.

[1] T. Ong and B. A. Jones, Phys. Rev. Lett. **103**, 066405 (2009).