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Bi-layer ^{3}He: a simple two dimensional heavy fermion system with quantum criticality[1]

JOHN SAUNDERS, Royal Holloway University of London

Two dimensional helium films provide simple model systems for the investigation of quantum phase transitions in two dimensions. Monolayer ^{3}He absorbed on graphite, with various pre-platings, behaves as a two dimensional Mott-Hubbard system, complete with a density driven "metal-insulator" transition [1, 2] into what appears to be a gapless spin-liquid. In two dimensions the corrections to the temperature dependence of the fluid heat capacity, beyond the term linear in T, are anomalous and attributed to quasi-1D scattering [3]. On the other hand, bi-layer ^{3}He films adsorbed on the surface of graphite show evidence of two-band heavy-fermion behavior and quantum criticality [4, 5]. The relevant control parameter is the total density of the ^{3}He film. The ^{3}He bilayer system can be driven toward a quantum critical point (QCP) at which the effective mass appears to diverge, the effective inter-band hybridization vanishes, and a local moment state appears. A theoretical model in terms of a "Kondo breakdown selective Mott transition" has recently been suggested [6]. * In collaboration with: A Casey, M Neumann, J Nyeki, B Cowan. [1] Evidence for a Mott-Hubbard Transition in a Two-Dimensional ^{3}He Fluid Monolayer, A. Casey, H. Patel, J. Nyéki, B. P. Cowan, and J. Saunders Phys. Rev. Lett. **90**, 115301 (2003) [2] D Tsuji et al. J. Low Temp. Phys. 134, 31 (2004) [3] A V Chubukov et al. Phys. Rev. **B71**, 205112 (2005) [4] Bilayer ^{3}He; a simple two dimensional heavy fermion system with quantum criticality, Michael Neumann, Jan Nyeki, Brian Cowan, John Saunders. Science **317**, 1356 (2007) [5] Heavy fermions in the original Fermi liquid. Christopher A Hooley and Andrew P Mackenzie. Science **317**, 1332 (2007) [6] C Pepin, Phys. Rev. Lett. **98**, 206401 (2007) and A Benlagra and C Pepin, arXiv: 0709.0354

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