Bi-layer $^3$He: a simple two dimensional heavy fermion system with quantum criticality

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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. 


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