Confined ^{4}He Near T_λ: Scaling, Coupling and Proximity Effects

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When ^{4}He is confined to a small uniform dimension L, its thermodynamic behavior near the superfluid transition is modified as the correlation length ξ becomes comparable to L. This can be described by crossover functions from three dimensions to a lower dimension. These functions depend only on the ratio ξ/L. This has been verified most extensively for the case where L represents the thickness of a film and the crossover dimension is two.[1] A more complex situation where two regions of ^{4}He are in contact, each characterized by a different L, allows one to study proximity effects and the coupling of one region with another through a 'weak link'. Recent measurements have shown that these effects are governed by the finite-size correlation length $\xi(t, L)$, where $t = |1 - T/T_\lambda|$; and, quite surprisingly, that the effects extend to distances over an order of magnitude larger than ξ.[2,3] This cannot be understood in terms of a mean field approach and must be due to the role of fluctuations at the superfluid transition. The long range of this effect is not understood at present. This behavior distinguishes ^{4}He from analogous behavior in the case of low temperature superconductors where such effects are on the scale of ξ/L.

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