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Different Routes to Quantum Criticality in Strongly Correlated Electron Systems[1]

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The vanishing of magnetic order at a quantum critical point (QCP) is a central feature of virtually all classes of correlated electron systems, and may be accompanied by unconventional ordered states such as superconductivity, and by anomalous critical scattering. Some of the most detailed studies have focused on f-electron heavy electron compounds, and here the picture has emerged that magnetic order requires the formation of moments, provided by the divergence of the quasiparticle mass at the QCP. We combine specific heat, magnetization, and electrical resistivity measurements on the new compound Yb_3Pt_4 to argue that alternative routes to quantum criticality are also possible. The weakly first order antiferromagnetic transition in Yb_3Pt_4 can be tuned by field to a critical end point, which is extended to a quantum critical point at 1.62 T. Both the ordered and paramagnetic phases are Fermi liquids at low temperatures, but the quasiparticle mass does not diverge at the QCP. Instead, a divergence of the zero temperature susceptibility and the quasiparticle scattering is observed, controlled by a zero field fixed point and not the nearby QCP. We suggest that like Stoner ferromagnets, and itinerant antiferromagnets, Yb_3Pt_4 is the first example of a heavy electron systems where magnetic order occurs at the QCP due to increasingly strong quasiparticle interactions.

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