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Ferromagnetic quantum criticality in heavy fermion systems[1]

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Heavy fermion (HF) systems are metals where the weak hybridisation between nearly localized f-electrons and the mobile conduction electrons, i.e. the Kondo effect, leads to a Fermi liquid (FL) ground state with narrow bands and quasiparticles with strongly enhanced effective electronic masses. When the magnetic RKKY interaction becomes comparable to the Kondo interaction, magnetic order can appear, mostly at very low T. The magnetic order can be suppressed by an external parameter, e.g. pressure or magnetic field, inducing a quantum phase transition (QPT) at $T = 0$. If this QPT is continuous, the associated quantum critical point (QCP) is surrounded by a non-FL regime of quantum critical fluctuations where unconventional superconductivity or novel phases of matter may arise [1]. The unambiguous observation of antiferromagnetic (AFM) QCPs in HF systems [2] has led to an increasing number of theoretical and experimental works in order to understand QPTs as deeply as their classical counterpart. Although it has been demonstrated that in antiferromagnets QCPs exist, in ferromagnets there is still no clear evidence. Intensive investigations have shown that metallic ferromagnets are inherently unstable [3,4] and do not exhibit a FM QCP. However, in the recently discovered HF system $YbNi_4P_2$, a quasi-1D ferromagnet with a remarkably-low $T_C = 0.15\,K$ [5], the T-divecgence in the Grüneisen ratio points to the presence of a FM QCP. I will present a general overview of the state of the art of FM quantum criticality in HF systems, discussing in particular the cases of $YbNi_4P_2$, CeFePO, $CePd_{1-x}Rh_x$ as well as the AFM system $YbRh_2Si_2$ where FM order is induced by chemical pressure.

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