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The Γ_1–Γ_4 quasi-quartet model of $PrFe_4P_{12}$

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We discuss a localized f-electron model for the bulk properties of $PrFe_4P_{12}$ [1]. $PrFe_4P_{12}$ undergoes AFQ ordering at $T_Q = 6.5$K. The transition is gradually suppressed by a magnetic field H, vanishing at $H_{\rm cr} = 4.2$T. The details depend on the field direction.

The Pr^{3+} level scheme has been debated for years. In contrast to an earlier suggestion of Γ_3 ground state, we argued that the magnetic and thermal properties are satisfactorily described by a low-lying Γ_1–Γ_4 quasi-quartet [1]. We used O_h symmetry as an approximation. Assuming Γ_3-type O_2^2 ordering and $H \parallel (100)$, we found good agreement with the measured phase boundary including the tricritical point, the metamagnetic transition, the susceptibility cusp, and specific heat.

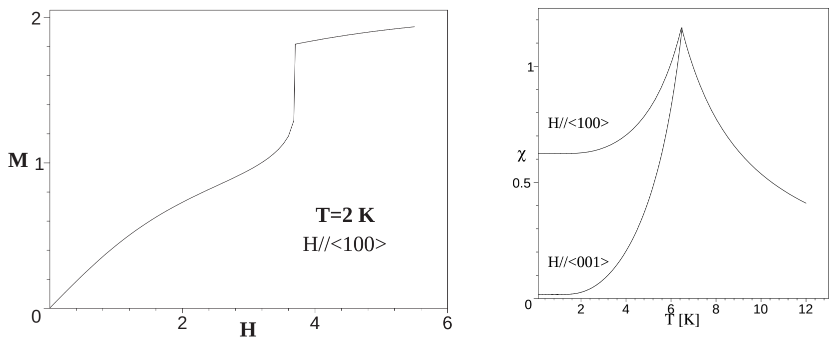

Figure 1: Metamagnetic transition (left), and susceptibility (right) from the mean field approximation.

The high-field magnetization $M(H)$ differs for fields lying in the (100), (110), and (111) directions, while for $H < 2$T, M is essentially isotropic, which is natural in the Γ_1–Γ_4 scheme. The high-field anisotropy may be ascribed to the interaction of field-induced quadrupoles. In principle, the measured anisotropy can be used to choose between possible quadrupolar order parameters. Allowing for both Γ_3 and Γ_5 quadrupoles, we found that the explanation of the magnetization anisotropy requires the consideration of the tetrahedral crystal field component [2].

[1] A. Kiss, P. Fazekas, J. Phys: Condens. Matter **15** (2003) S2109.
[2] A. Kiss, P. Fazekas, in preparation.