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The internal magnetic field in a ferromagnetic compound $Y_2Co_{12}P_7$

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Various μ^+SR techniques have been widely used for studying internal magnetic fields in assorted materials [1], such as, antiferromagnets, spin-glasses, paramagnets, and superconductors. However, for ferromagnetic (FM) materials, μ^+SR faces a difficulty in determining the correct dipole field at the muon site ($\mathbf{H}_{\rm dip}$) because the internal magnetic field at the muon site in ferromagnets is expressed by; $\mathbf{H}_\mu = \mathbf{H}_{\rm dip} + \mathbf{H}_{\rm L} + \mathbf{H}_{\rm hf}$, where $\mathbf{H}_{\rm L}$ is the Lorentz field and $\mathbf{H}_{\rm hf}$ is the hyperfine field at the muon site. Therefore, the muon sites and the magnetic structure need to be apprehended for evaluating $\mathbf{H}_{\rm dip}$ but also the saturation magnetization for evaluating $\mathbf{H}_{\rm L}$ and the local spin density at the muon site for evaluating $\mathbf{H}_{\rm hf}$.

Considering the three contributions to $\mathbf{H}_\mu$ in the above equation, a combined work with μ^+SR and DFT calculations are needed to provide a reasonable estimate for the ordered magnetic moment of rare earth (R) ions in $\rm Nd_2Fe_{14}B$ and related magnets [2]. Following upon this work, we attempt to estimate the ordered magnetic moments of R ions in cobalt-based FM materials, $R_2\rm Co_{12}P_7$ with such combined work. As a first step, a powder sample of $R_2\rm Co_{12}P_7$ with $R = \rm Y$ was measured with μ^+SR and three clear muon spin precession signals below its Curie temperature ($T_{\rm C} = 151$ K) were found.

[1] A. Yaouanc and P. D. de Réotier, "Muon Spin Rotation, Relaxation, and Resonance, Application to Condensed Matter" (Oxford, New York, 2011).

[2] J. Sugiyama et al., Phys. Rev. Material **3**, 064402 (2019).

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