Spin-orbital liquid state and liquid-gas metamagnetic transition on a pyrochlore lattice

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In my talk, I present results for the rare-earth pyrochlore material $Pr_2Zr_2O_7$, where orbital degeneracy remains down to the millikelvin range due to an interplay between spins and orbitals. $Pr_2Zr_2O_7$ is a multipolar spin ice with strongly localized 4*f* electrons in an even-number configuration, giving rise to a non-Kramers doublet that carries transverse quadrupolar and longitudinal dipolar moments. Our extensive study of ultrapure single crystals of $Pr_2Zr_2O_7$ finds comprehensive evidence for enhanced spin-orbital quantum dynamics of the non-Kramers doublet. This dynamical Jahn-Teller effect is encapsulated by the liquid-gas metamagnetic transition that is characteristic of spin ice being accompanied by strong lattice softening. This behaviour suggests that a spin-orbital liquid state forms on the pyrochlore lattice at low temperatures and low magnetic fields [1].

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[1] Nan Tang, Y. Gritsenko, K. Kimura, S. Bhattacharjee, A. Sakai, Minguan Fu, H. Takeda, Huiyuan Man, K. Sugawara, Y. Matsumoto, Y. Shimura, J. Wen, C. Broholm, H. Sawa, M. Takigawa, T. Sakakibara, S. Zherlitsyn, J. Wosnitza, R. Moessner, S. Nakatsuji, Nat. Phys. **19**, 92 (2023). https://doi.org/10.1038/s41567-022-01816-4.