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# Understanding Reentrance in Frustrated Magnets: the case of $Er_2Sn_2O_7$ pyrochlore


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Reentrance is a recurring theme found in disparate physical systems, from condensed matter to black holes. While diverse in its many incarnations and generally unsuspected, the cause of reentrance at the microscopic level is often not investigated thoroughly. Here, through detailed characterisation and theoretical modelling, we uncover the microscopic mechanism behind reentrance in the frustrated antiferromagnet $Er_2Sn_2O_7$ [1], where strong spin-orbit coupling confers highly anisotropic spin-spin interactions, as parametrised in Ref. [2]. Taking advantage of the recent advance in the synthesis of rare-earth stannate single crystal, we use heat capacity measurements to expose that $Er_2Sn_2O_7$ exhibits multiple instances of reentrance for magnetic fields along three cubic high symmetry directions. Through classical Monte Carlo simulations, mean field theory and classical linear spin-wave expansions, we argue that the origins of the multiple occurrences of reentrance observed in $Er_2Sn_2O_7$ are linked to soft modes. The multi-phase competition enhances thermal fluctuations which entropically stabilise a specific magnetic order. This results in an increased transition temperature for certain field values and thus the reentrant behaviour. Our work represents a detailed examination into the mechanisms responsible for reentrance in a frustrated magnet and may serve as a template for the interpretation of reentrant phenomena in other physical systems.


[1] D. R. Yahne *et al*, arXiv:2101.08361 | [2] S. Petit *et al*, Phys. Rev. Lett. **119**, 187202 (2017)


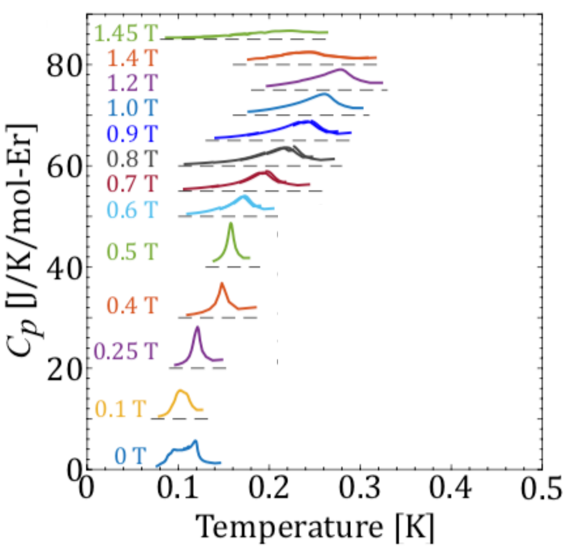


**Figure 1 :** Reentrance as observed in the specific heat of $Er_2Sn_2O_7$, measured for different values of an external magnetic field along the [001] cubic axis.