Dynamics of the Magnetic States in Sr_3NiIrO_6

C. Topping, J. Singleton, J.-W. Kim, E.-D. Mun, V. Zapf (NHMFL-PFF); P. Goddard (Oxford and Warwick Universities); X. Lo (POHANG, Korea); S.-W. Cheong (Rutgers University)

Introduction and Experimental

In work carried out in 2012 at NHMFL-PFF, we showed that Sr_3NiIrO_6 possesses the highest coercive magnetic field at cryogenic temperatures to our knowledge [1]. 2013 saw a systematic study of the effects of sample composition and crystal quality (reported elsewhere in this volume), plus an examination of the sweep-rate dependence of the magnetization. The latter study employed an extraction magnetometer in the 65 T short-pulse and 60 T long-pulse magnets at Los Alamos, plus a SQUID magnetometer at Oxford University; sweep rates from a few Tesla per hour to 6000 T/s were thus spanned.

Results and summary

Figure 1 (top) shows 65 T short-pulse (6000 T/s) magnetization data taken in a Ni-rich off-stoichiometric sample; in the initial field sweep after cooling from 300 K, the coercive field is almost 20 T higher than those for subsequent pulses. In addition, there is some asymmetry in the coercive field between positive and negative field sweeps, determined solely by the direction of the initial field pulse after cooling. It was found that lowering the sweep rate from 6000 T/s to 25 T/s resulted in a ~10% fall in the initial coercive field, but left the subsequent hysteresis loop largely unaffected. Fig. 1 lower (data for a stoichiometric sample) compares first field sweeps after cooling from 100 K carried out at a few T/hour (SQUID) and at 1000 T/s (pulsed field); data were recorded at closely-spaced temperatures in each case. Note the radically different susceptibility. All data suggest that there are at least two timescales/lengthscales involved in the magnetization, a shorter one (<~ms, 100s of units cells) associated with the dynamics of the frustrated groundstate and a longer one (~ s) probably due to domain-wall motion. Further studies and analysis are in progress.

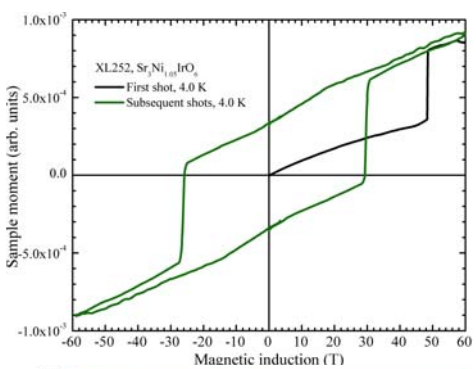
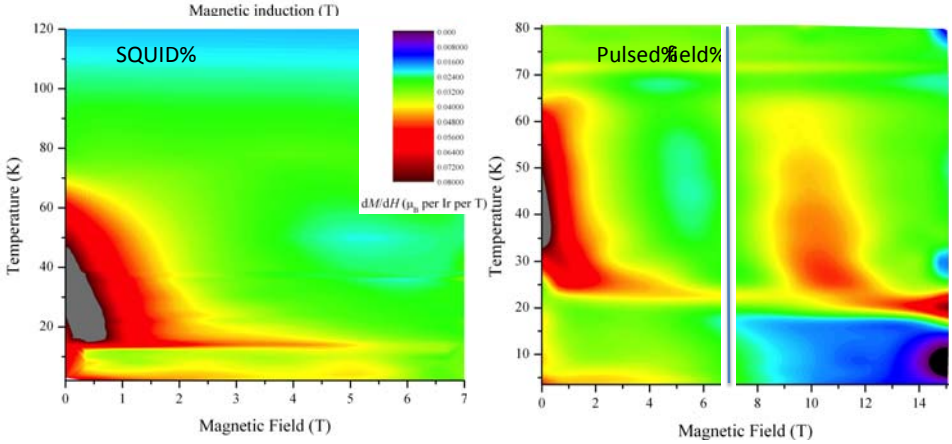


Figure 1. Upper: magnetization at T = 4 K of a single crystal $Sr_3Ni_{2-x}Ir_xO_6$ of grown from a Ni-rich batch with x = 0.95, measured in a short pulse magnet. Lower: first field sweeps after cooling carried out at a few T/hour (SQUID) and at 1000 T/s (pulsed field) on a powder sample with x =1. Data are plotted as susceptibility (color scale) versus temperature and field; owing to hysteresis, only up-sweeps are shown.



Acknowledgements

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Reference

[1] C. Topping, et al, "Giant magnetic hysteresis in Sr_3NiIrO_6," NHMFL Annual report, 2012; and C.V. Topping et al., in preparation.