**Magnetic Criticality Controlled by Magnetic Field Sweep in La1-xSrxCoO3**

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**Introduction**

Ordinary magnetic exchange interactions are modeled as static quantities. However, when spins interact via propagating objects such as magnons, then time becomes a factor. Here we show that in such a system, magnetic field sweep rate can tune the interaction strength and the existence of phase transitions. La1-xSrxCoO3 is a cluster magnet in which local ferromagnetic regions seeded by Co4+ ions exist in an antiferromagnetic or non-magnetic background of Co+3. For x < 0.17, the system behaves like an insulating cluster glass, while for x > 0.17 a percolation to ferromagnetic metallic behavior takes place. [1, 2] In similar systems, particularly the analogous manganites, magnetic avalanches have been observed, resulting in sharp random steps in the magnetization with a power-law distribution. [3] Here we find that we can tune magnetic avalanche behavior effectively inducing criticality for an intermediate regime of field sweep rate.

**Experimental**

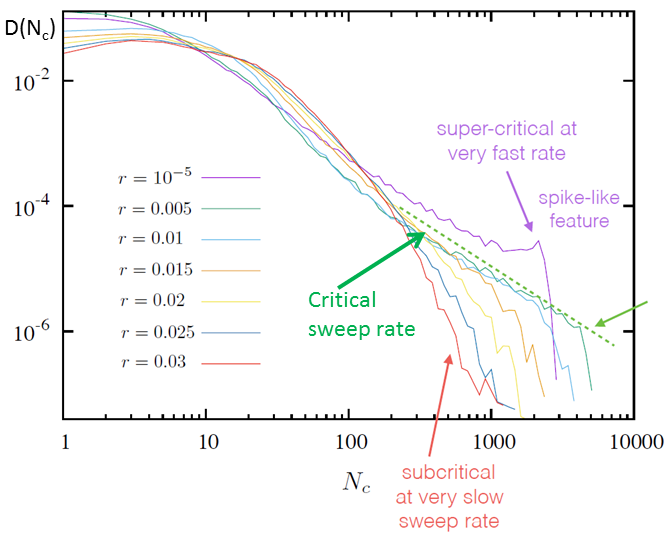
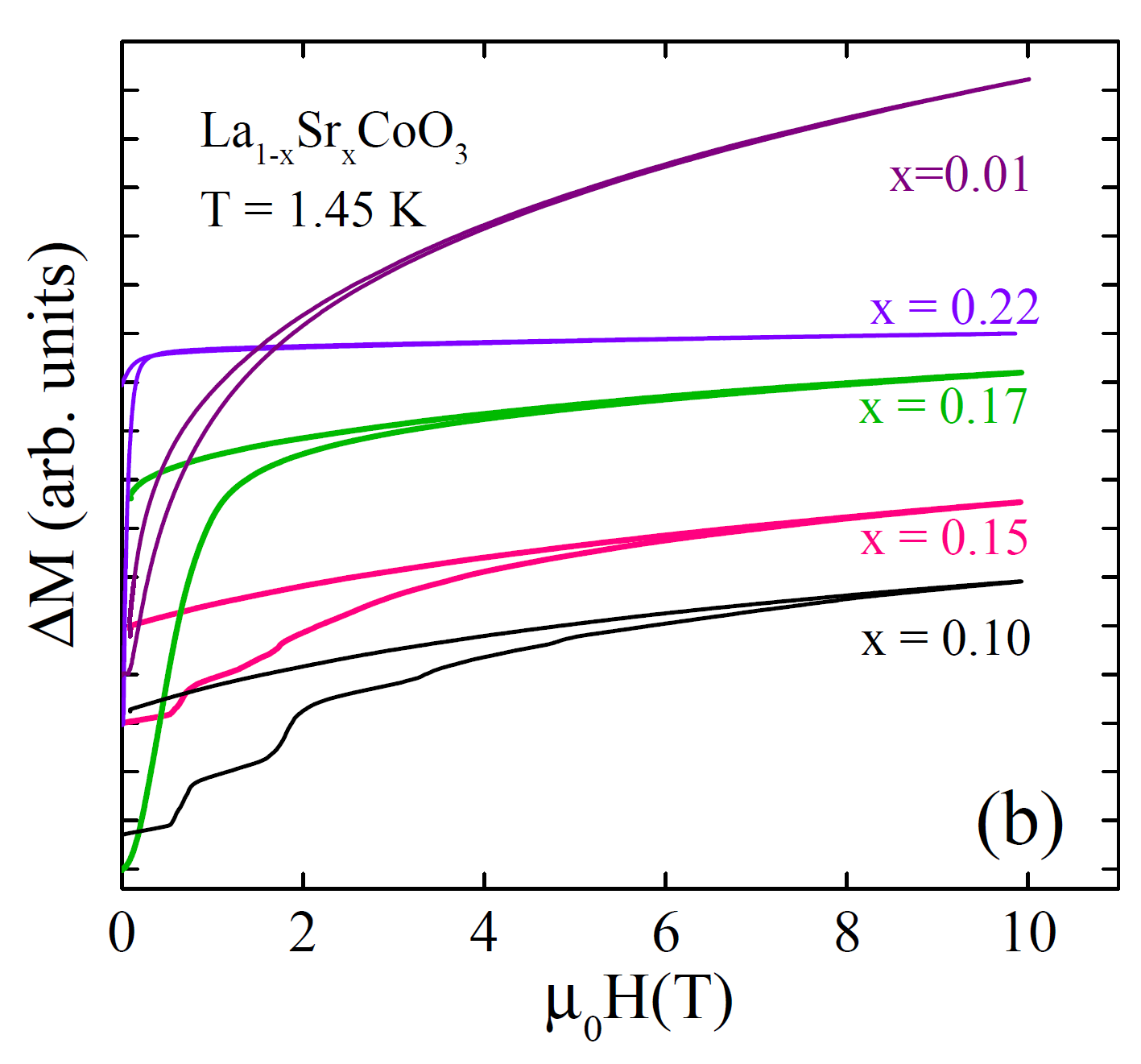
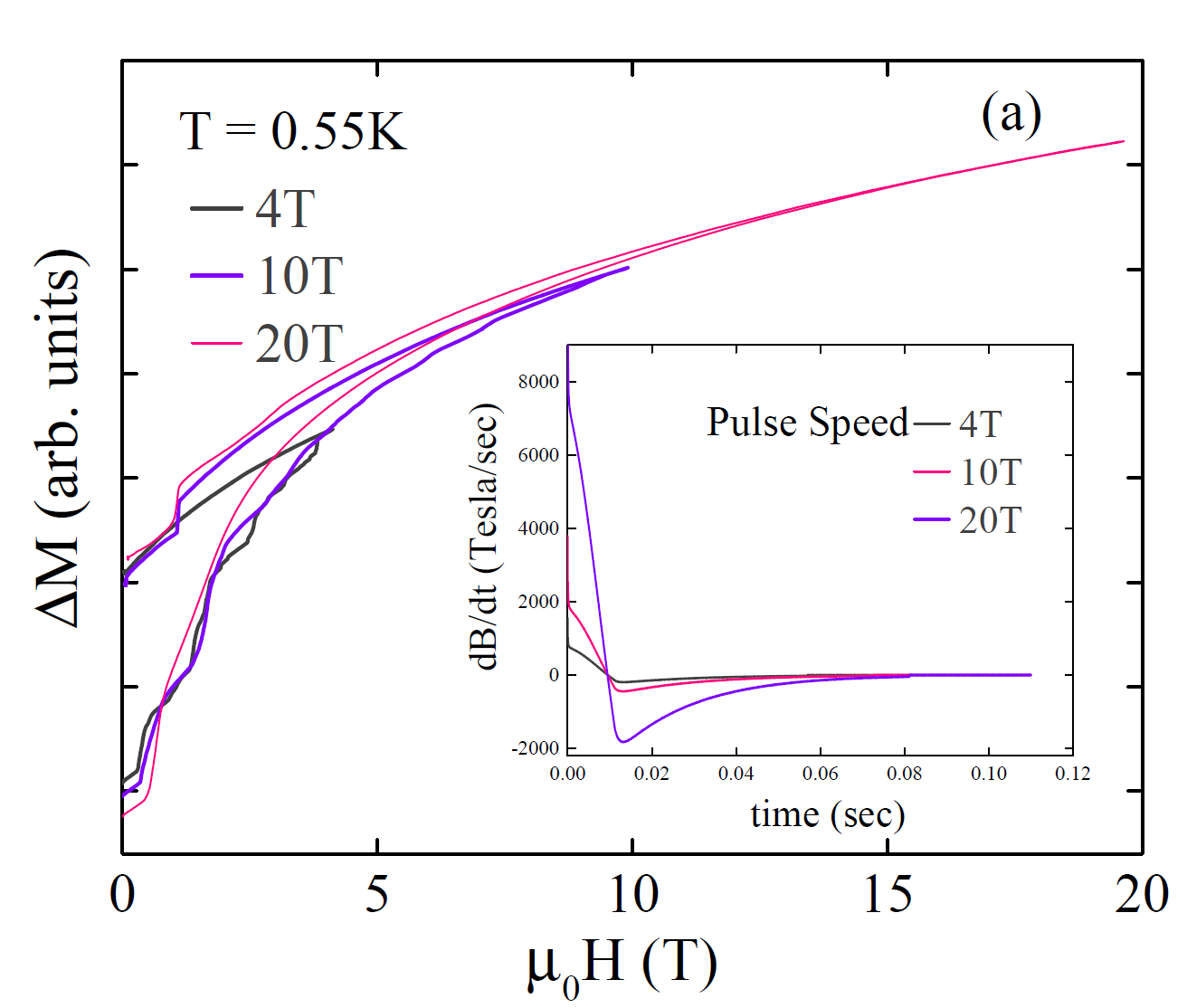
Magnetization change (M) was measured as a function of magnetic field H at the NHMFL-PFF to 65 Tesla in pulsed and DC superconducting magnets. [4] Polycrystalline La1-xSrxCoO3 (0.01 ≤x≤0.22) was studied at different magnetic field sweep rates dH/dt by varying the peak field of the pulse.

**Results and Discussion**

Fig. 1 depicts M(H) after reversal of the magnetic field. Fig 1(a) demonstrates step-like behavior for x =0.10 at 4 and 10 T peak fields (dH/dt < 2 kT/s) but not 20 T (dH/dt < 8kT/s). No steps occur in superconducting magnets with dH/dt = 5e-3 T/s (not shown). In Fig 1(b), the magnetization steps can be seen for x = 0.1 and 0.15 but not x = 0.01, 0.17 or 0.22. Fig 1(c) shows simulation results for a magnetic cluster glass where clusters interact via magnon propagation with the power law distribution of the number of simultaneously flipped clusters.

**Fig.1** (a) Magnetization change M with field H for different pulse speeds (peak field) for x=0.10 (b) M(H) for samples with different x for a 10 T pulse. (c) Distribution D(Nc) of the number of simultaneously flipped clusters Nc for different sweep rates r.

(c)



**Conclusions**

We have observed magnetic avalanche behavior in La1-xSrxCoO3 with x = 0.1 to 0.15 due to competing dynamic time and energy scales. Phase transitions are induced for a window of magnetic field sweep rates, reflecting magnetic interactions that propagate at finite speeds. Simulations confirm that avalanches can be induced by intermediate sweep rates, and also show power-law distributions of cluster flips when approaching the phase transition (sweep-rate-induced criticality).

**Acknowledgements**

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