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Superparamagnetism at oxide interfaces revealed by scanning SQUID-on-tip microscopy YONATHAN ANAHORY, L. EMBON, Weizmann Institute of Science, C.J. LI, National University of Singapore, S. BANERJEE, A. MELTZER, H. R. NAREN, A. YAKOVENKO, J. CUPPENS, Y. MYASOEDOV, M. L. RAPPAPORT, Weizmann Institute of Science, M. E. HUBER, University of Colorado Denver, K. MICHAELI, Weizmann Institute of Science, T, VENKATESAN, A. ARIANDO, National University of Singapore, E. ZELDOV, Weizmann Institute of Science — Our novel scanning SQUID-on-tip technique[1] is used to study nanoscale magnetism present in systems such as atomically sharp oxide heterostructures. Here we report a new emergent phenomenon at the $LaMnO_3/SrTiO_3$ interface in which an antiferromagnetic insulator abruptly transforms into a magnetic state that exhibits unexpected nanoscale superparamagnetic dynamics. Upon increasing the thickness of $LaMnO_3$ above five unit cells, our scanning nanoSQUID-on-tip microscopy shows spontaneous formation of isolated magnetic islands of 10 to 50 nm diameter, which display random moment reversals by thermal activation or in response to an in-plane magnetic field[2]. Our charge reconstruction model of the polar $LaMnO_3/SrTiO_3$ heterostructure describes the sharp emergence of thermodynamic phase separation leading to nucleation of metallic ferromagnetic islands in an insulating antiferromagnetic matrix. The model further suggests that the nearby superparamagnetic-ferromagnetic transition can be gate tuned, holding potential for applications in magnetic storage and spintronics. [1] D. Vasyukov *et al*, Nature Nanotech. 8, 639 (2013) [2] Y. Anahory *et al*, arXiv:1509.01895

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