Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

Fractalisation drives crystalline states in the frustrated spin system $SrCu_2(BO_3)_2$ SUCHITRA SEBASTIAN, Cambridge University, N. HARRISON, P. SENGUPTA, C.D. BATISTA, S. FRANCOUAL, NHMFL, Los Alamos National Laboratory, E. PALM, T. MURPHY, NHMFL, Tallahassee, H.A. DABKOWSKA, B.D. GAULIN, McMaster University — Geometrical frustration in the spin dimer material $SrCu_2(BO_3)_2$ leads to a singlet Shastry-Sutherland ground-state at low magnetic fields, but complex spin superstructures at higher fields. Our magnetisation measurements reveal a fine substructure of quantum Hall-like plateaux at all $1/q$ ratios $2 < q < 9$ and $p/q = 2/9$ in magnetic fields up to 85 T and temperatures down to 29 mK, within the sequence of previously identified plateaux at 1/8, 1/4, and 1/3 of the saturated magnetisation. We identify this hierarchy of plateaux as a consequence of confined bosons in $SrCu_2(BO_3)_2$ mimicking the high magnetic field fractalisation predicted by the Hofstadter butterfly for fermionic systems. Such an experimental realisation of the Hofstadter butterfly has not been previously achieved in real interacting materials, given the unachievably high magnetic flux densities or large lattice periods required. By a theoretical treatment that includes short-range repulsion in the Hofstadter treatment, stripe-like spin density-modulated phases are revealed in $SrCu_2(BO_3)_2$ as emergent from a fluidic fractal spectrum.

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Date submitted: 28 Nov 2007 Electronic form version 1.4