Magnetic-Field-Driven Ising Quantum Criticality of Two-Dimensional Square-Lattice Antiferromagnet Cr(dien)(O$_2$)$_2$.H$_2$O

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— We report on a systematic study of magnetically driven quantum phase transition in a new compound based on Cr(IV). The compound, Cr(dien)(O$_2$)$_2$.H$_2$O, is a low dimensional antiferromagnet with a Neel temperature $T_N$ of 2.55 K in zero field. We have used torque magnetometry, heat capacity and magnetocaloric-effect measurements down to 200 mK, to obtain a complete magnetic phase diagram. A detailed analysis of the dependence of $T_N$ on magnetic field using the power law $T_N \sim (H_c-H)^{\alpha}$ yielded the critical exponent $\alpha = 2.01\pm0.02$, with $H_c = 12.392\pm0.003$ T, indicating that this system behaves like a 3-d Ising magnet at low temperatures.