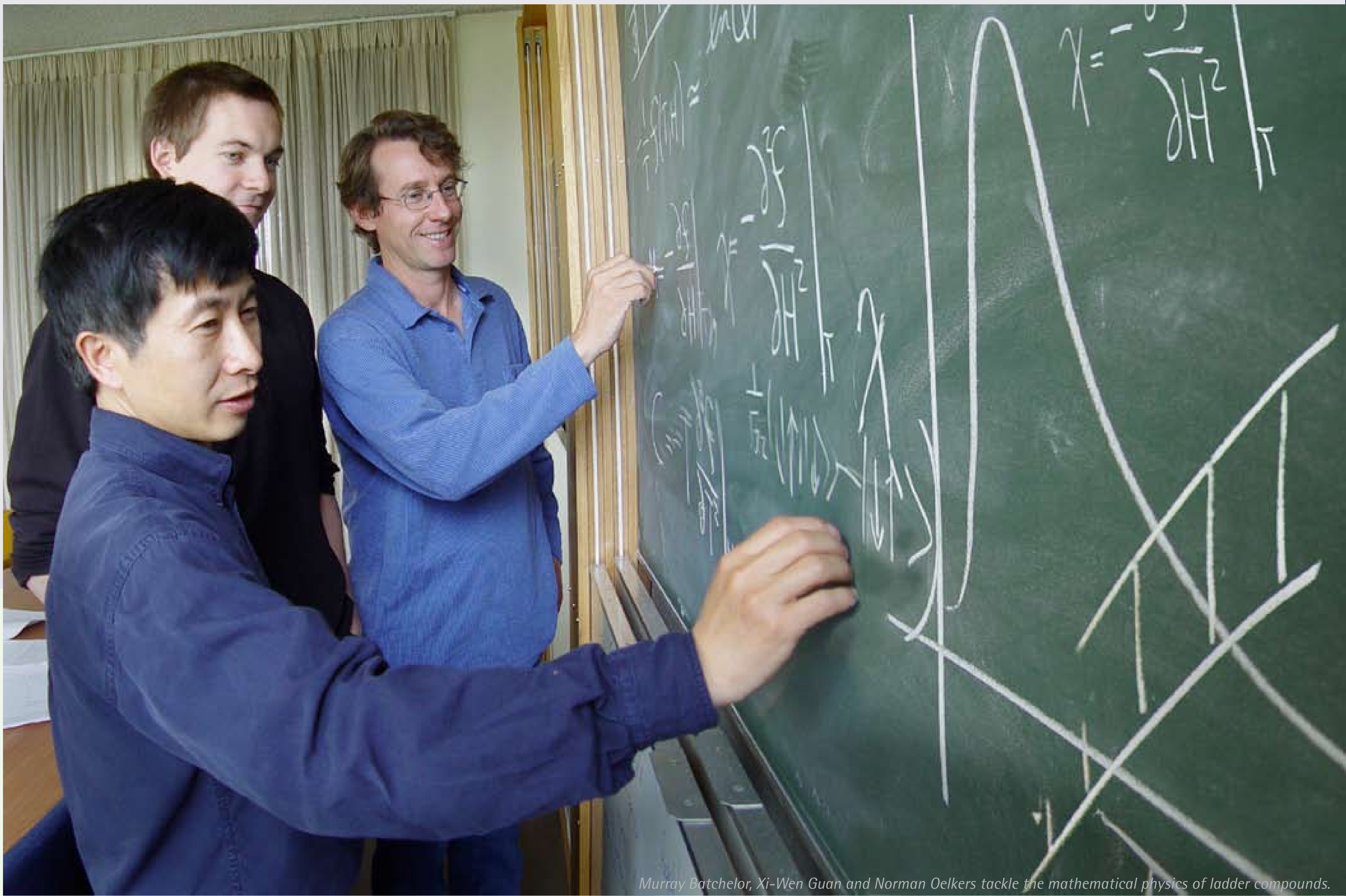
THE AUSTRALIAN NATIONAL UNIVERSITY

Research School of Physical Sciences and Engineering

Climbing Quantum Ladders

Murray Batchelor, Xi-Wen Guan and Norman Oelkers



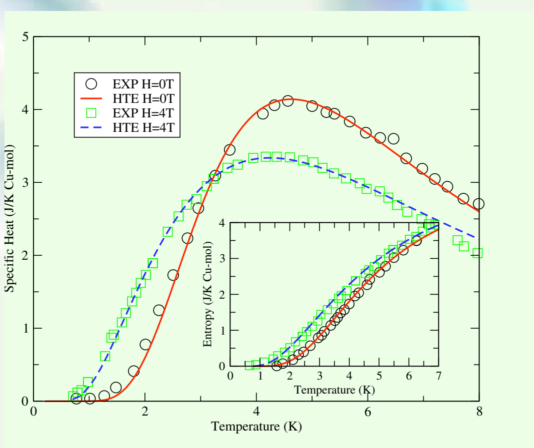
Murray Batchelor, Xi-Wen Guan and Norman Oelkers tackle the mathematical physics of ladder compounds.

The experimental realisation of novel materials with a ladder-like structure is contributing to the intense interest in low-dimensional quantum systems, which are made up of fundamental arrays of interacting quantum spins. The calculation and understanding of their physical properties provides a key challenge to theorists.

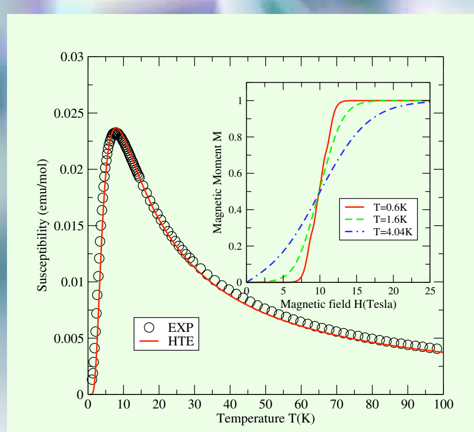
Physicists at the ANU are leading the application of integrable models to the physical description of the ladder compounds. Their work brings over 40 years of mathematical development of the theory of integrable models into direct contact with experiment. Integrable models are unique in that their physical properties can be calculated exactly, thus being far superior to numerical and perturbative approaches.

Excellent agreement between the theoretical curves calculated from the integrable ladder model and the experimental data has been found for a number of ladder compounds. Shown here are results for the spin-1/2 compound $Cu_2(C_5H_{12}N_2)_2Cl_4$, also known as CuHpCl. The calculations include the magnetic susceptibility and the specific heat as functions of magnetic field and temperature. The critical magnetic fields, defining quantum phase transitions, also follow from this approach.

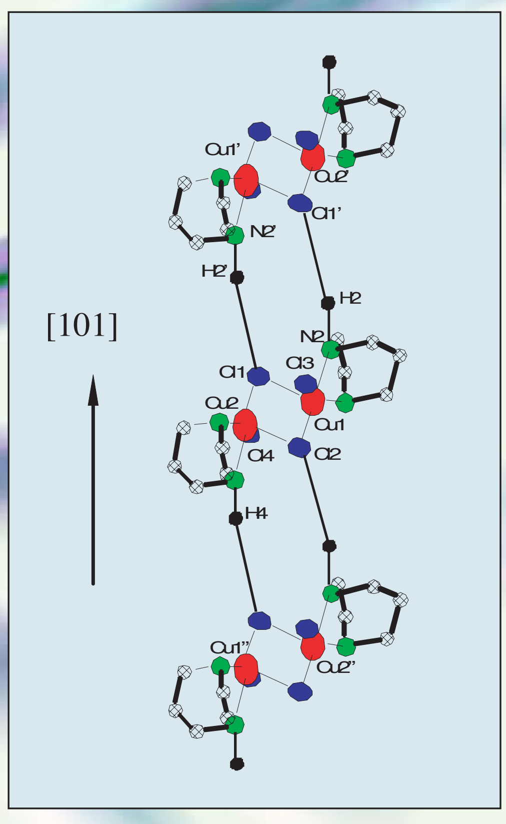
There is a strong expectation that the mathematical physics of integrable models will play a crucial role in understanding low-dimensional quantum effects, where they are most pronounced.



Comparison between theory and experiment for the specific heat and entropy of CuHpCl.



Comparison between theory and experiment for the susceptibility and magnetisation of CuHpCl.



The physics of novel materials like the spin-1/2 ladder compound CuHpCl [Chaboussant et al.] can be described by the integrable model based approach developed in the RSPhysSE group.