The challenge of highly frustrated quantum magnets at finite temperatures

J. Richter[a,b]

[a] *Institut für Physik, Otto-von-Guericke-Universität Magdeburg, P.O. Box 4120, 39016 Magdeburg, Germany*

[b] *Max-Planck-Institut für Physik komplexer Systeme, 38 Nöthnitzer Str., 01187 Dresden, Germany, E–mail: Johannes.Richter@Physik.Uni-Magdeburg.DE*

Frustrated quantum spin systems are prominent and at the same time challenging quantum many-body models. The first challenge concerns the nature of the ground state that might be semi-classically ordered or magnetically disordered (valence-bond crystals, quantum spin-liquids etc.). The second challenge is given by the magnetization process of these systems, which may exhibit plateaus and jumps. Last but not least, the third challenge concerns their thermodynamic properties on which far less studies exist than for the ground state. Here we focus on the thermodynamics of highly frustrated quantum spin systems with flat excitation bands, in particular on frustrated bilayer [1] and kagome antiferromagnets [2]. The frustrated bilayer antiferromagnet is realized in $Ba_2CoSi_2O_6Cl_2$ [3] and the magnetization curve of this compound is characterized by well-pronounced plateaus and jumps. The specific flat-band physics allows a comprehensive description of the thermodynamic properties of $Ba_2CoSi_2O_6Cl_2$ and the prediction of a finite-temperature order-disorder transition in high magnetic fields [1]. For the kagome quantum antiferromagnet the description of low-temperature physics is particularly demanding, because there are several competing states on the low-energy scale. Based on large-scale finite-temperature Lanczos simulations we discuss the specific heat, the susceptibility as well as the magnetization process. We find a strong influence of frustration on thermodynamic properties not only at low but also at moderate temperatures. Moreover, we find indications for an ordered magnon-crystal phase slightly below the saturation field.

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