

Report for ESF HFM Grant

The Kasteleyn Transition on the Spin Ice lattice

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Purpose of the Visit

It has been shown theoretically by Moessner and Sondhi that spin ice materials, under the application of a suitable strength magnetic field in the [111]-direction, can undergo an unusual phase transition known as a Kasteleyn transition.[1][2] This has been observed experimentally however some of the observations were not accounted for by the theoretical model proposed.[3] Motivated by these results we have created a numerical model with which we can produce complementary results to the experimental data and simultaneously hope to understand the theoretical model further. During this visit we hoped to complete the implementation of a non-local loop move algorithm, which is a necessary but difficult component, into our model.

Work Carried Out During the Visit and Main Results Obtained

The majority of this visit was spent working on the code of the numerical model. Immediately prior to the visit we had achieved results which appeared to be correct in all but a small region of the simulation space and we feel that we have understood the error causing this. Specifically we have calculated and implemented 'twisted' periodic boundary conditions that are matched to the direction of the applied field. It is clear now that the onset of the loop excitations within the system depends on the compatibility between the applied field direction and the periodic boundary conditions and further we have understood how the microscopic processes involved in the creation of each loop can strongly influence the system. The refinements to the model we have made as a consequence of this work are significant and should soon allow us to achieve some of the results we are aiming for. In particular, a main result which will be a consequence of work undertaken during this visit is the ability to produce numerically simulated maps of the fourier transform of the spin correlations within the Kagomé plane.

Future Collaborations and Publications

This project is part of an ongoing collaboration and we of course intend to pursue it in future work. Some of the work carried out during this visit will form part of any publication we submit on this project, however there is more work to undertake before we will be in a position to publish these results.

References:

[1] R. Moessner and S. L. Sondhi, *Physical Review B* **68**, 064411 (2003).

[2] P. W. Kasteleyn, *Journal of Mathematical Physics* **4**(2), 287-293 (1963).

[3] T. Fennell, S. T. Bramwell *et al.*, *Nature Physics* **3**(8), 566-572 (2007).