# Scientific Report for ESF grant

## Kagomé Ice and the Kasteleyn Transition

**A. Harman-Clarke**[a,b], S. T. Bramwell[a], T. Fennell[a], P. C. W. Holdsworth[b]

[a] *London Center for Nanotechnology, 17-19 Gordon Street, London, WC1H 0AH, England*
[b] *Université de Lyon, Laboratoire de Physique, École Normale Supérieure de Lyon, 46 Allée d'Italie, 69364 Lyon cedex 07, France*

## Purpose of visit

Motivated by recent experiments on spin ice materials [1] we intended to perform analytical and numerical investigations on the Kagomé ice lattice. This topologically constrained system displays an extensive critical phase which can be terminated in a two-dimensional Kasteleyn transition.[2]

## Description of work carried out during the visit

We have written a computational model of a plane of tetrahedra within the spin ice model forming a Kagomé layer. Within this model we have considered the non-local loop algorithm [3, 4] necessary to explore the Kasteleyn transition; specifically, how to implement this procedure within a numerical simulation with regard to transition probabilities between states.[5] From this basis we have made a detailed study of the creation, annihilation and transportation of both topologically closed loops and system-spanning string defects within the lattice.

## Main results obtained

Consideration of the mechanics of the Kasteleyn transition has shown that the loop algorithm proposed by Melko *et al.* [3] will only allow Monte Carlo moves involving loops that are topologically closed on the lattice and will therefore not produce an observable Kasteleyn transition as it prevents the formation of system-spanning strings. As this remains a work in progress we are yet to obtain simulation results and the main results obtained during this visit were of a theoretical nature, as well as some verifications of the model, however we soon expect to be able to simulate Kasteleyn transitions and relate these results directly to experimental evidence obtained from spin ice materials.

## Future collaborations

The work carried out so far on this project has been fruitful and we expect to complete our initial objective in the near future. This will certainly include future collaborations and visits.

## Projected publications

Results from this work are expected to be published upon completion. We also expect to present some of this research at the HFM 2008 Conference.

**References:**

[1] T. Fennell, S. T. Bramwell *et al.*, Nature Physics **3(8)**, 566-572 (2007).
[2] P. W. Kasteleyn, Journal of Mathematical Physics **4(2)**, 287-293 (1963).
[3] R. G. Melko and M. J. P. Gingras, J of Phys: Cond. Mat. **16**, R1277-R1219 (2004).
[4] S. V. Isakov *et al.*, Physical Review B **70**, 104418 (2004).
[5] L. D. C. Jaubert *et al.*, Physical Review Letters **100**, 067207 (2008).