Magnetic Fragmentation within an Arctic Circle

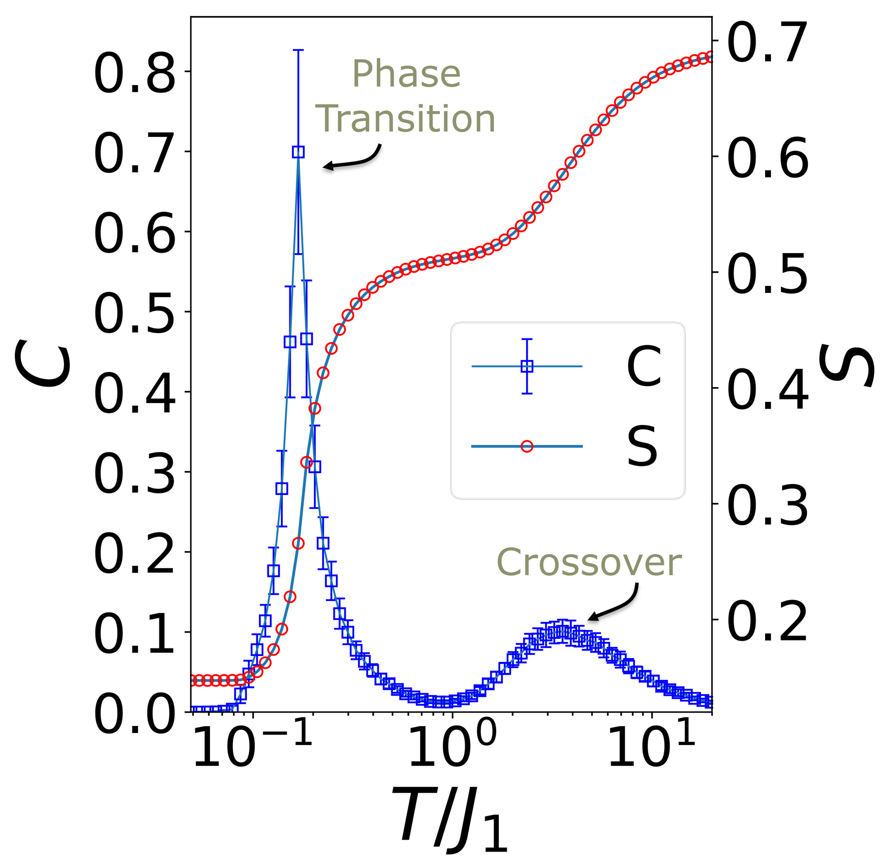
Lucas Reneuve, Nicolas Rougemaille, Benjamin Canals
(Institut Néel, Univ Grenoble Alpes & CNRS, Grenoble, France)

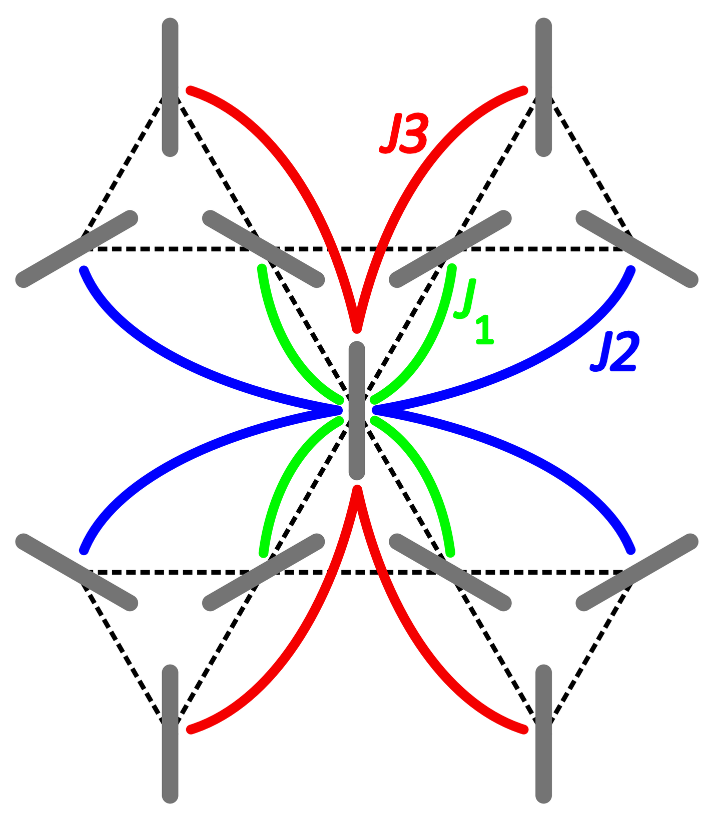
ABSTRACT

Some frustrated spin systems display phases which are characterized by the puzzling coexistence of both magnetic order and liquid-like fluctuations. Those phases can be described using **magnetic fragmentation**[1]: each spin splits into two relatively independent parts, one contributing to the ordered part of the phase and the other to the correlated disordered part (also known as a Coulomb phase [2]).

On the other hand, fixing carefully spins on a frustrated system's edges can modify drastically its behaviour at thermodynamic equilibrium. For instance in 2D systems under so-called **Domain Wall Boundary Conditions**, these constraints result spectacularly in a spontaneous phase separation of the system: an extensive part freezes while another one fluctuates[3]. This phenomenon is known as the **Arctic Circle Phenomenon**[4]**.**

Using a Monte Carlo approach, we show the existence of a phase separation in a Kagomé-based Ising spin system under DWBC. This system displays **arctic circle** within which we find a **fragmented spin-liquid**, reminiscent of the so-called Kagomé spin ice II phase present in the dipolar Kagomé array[5].





Spin Couplings

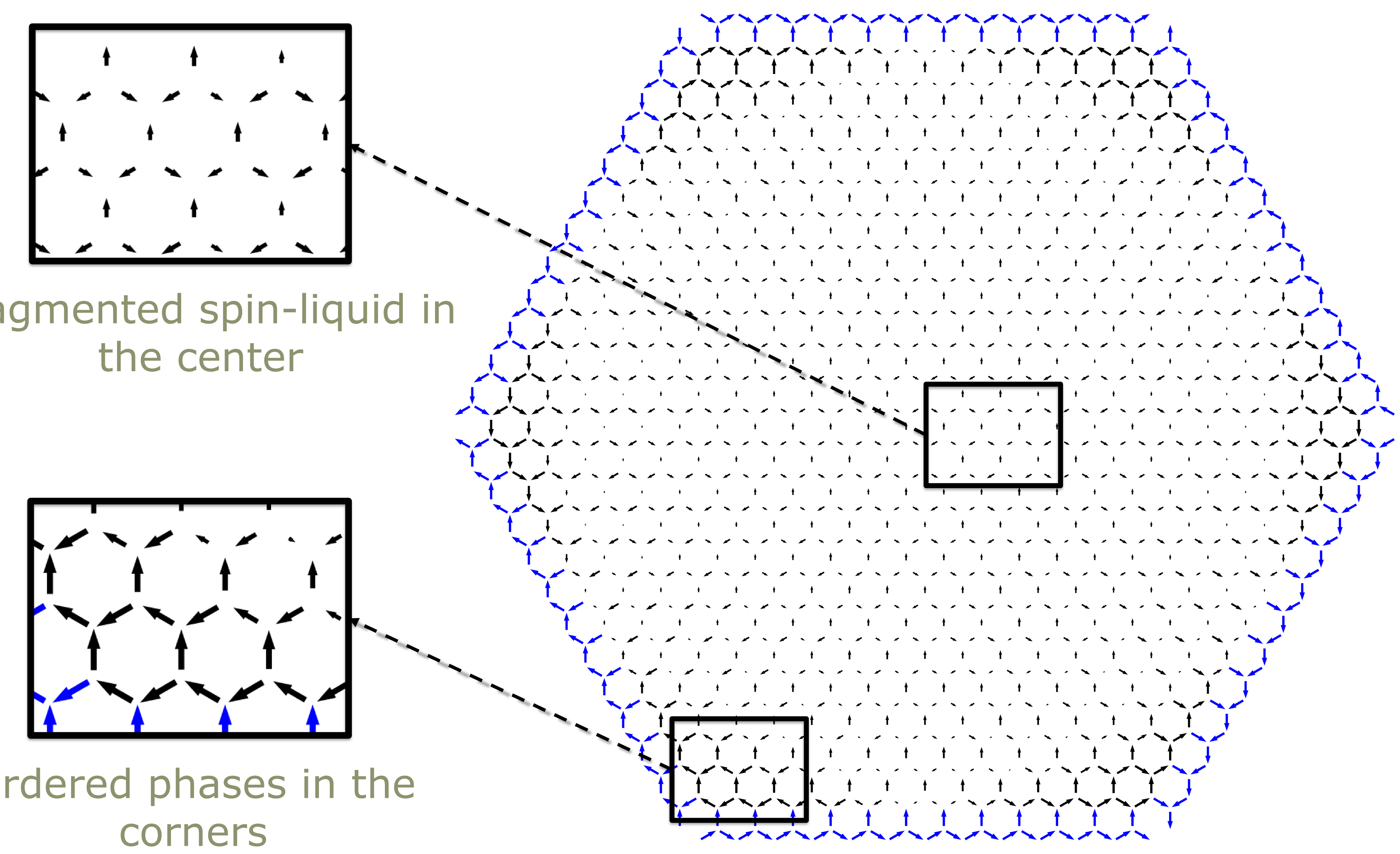
Spins interact ferromagnetically with their first, second and third-neighbours. Dynamics consist of either local updates or global ones.

When J_2=J_3 and $J_1 \gg J_2, J_3$ we observe a **crossover** and a **phase transition** when the system's temperature is lowered. While the intermediate phase displays a fixed-divergence ice rule, the low-temperature one also shows a symmetry-breaking magnetic order. Both phases are highly fluctuating, as shown by their **finite entropy**.

Mean configuration at low temperature shows a **phase separation** : extensive parts of the system freeze (in the corners) while the central part fluctuates.

Spins in the center have non-zero mean values: due to **fragmentation**, a part of each spin remains constant while the rest fluctuates. The ordering portion of each spin which contributes to magnetic order in this phase amounts to a third of its total value.

Spins in the corners align "ferromagnetically", forming **6 frozen zones**. Diametrically opposed phases share the same magnetization.



Fragmented spin-liquid in the center

Ordered phases in the corners

CONCLUSION

By carefully fixing spins on the edges of a Kagome graph, we show that the hamiltonian leads the system to stabilise as a **fragmented spin liquid within an artic circle** at low temperature. Thermodynamics is thoroughly studied with global updates but local dynamics also allows the observation of this exotic phenomenon, which opens the perspective to study experimentally magnetic fragmentation in an arctic circle with finite meta-magnets.

REFERENCES

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