MAR12-2011-001167

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Similarities and differences between spin and water ice models

IVAN RYZHKIN, Institute of Solid State Physics RAS

In the present contribution we provide a brief survey of the amazing analogy between spin and water ice basically from the water ice physics point of view. Special attention is paid to the following question: which of the theoretical concepts developed in ice physics could be applied to the study of spin ice and other frustrated systems. We show that the analogy between ground states of these systems can be extended other properties. In Section 1 we outline the history and present state of the analogy, and thoroughly investigate the similarity between quasi-particle excitations in ordinary ice (point defects in the ice proton system) and in spin ice (magnetic monopoles). The magnetic monopole concentration is shown to have a break in its temperature dependence arising due the magnetic Coulomb interaction (melting of the Coulomb phase). In Section 2 we develop a theory of magnetic charge transport, study the magnetic relaxation as well as the screening of magnetic field in spin ice. The transport analogy between spin and water ice is shown to be of limited nature: it is impossible to produce a stationary magnetic current in the commonly accepted model of spin ice. An extended spin ice model is suggested which is free from this disadvantage. In Section 3 we discuss the problem of how the magnetic ordering is modified near the free surface of spin ice or near its interface with other magnets. The study is based on the concepts previously used in water ice physics. In concluding Section 4 we discuss the differences between water and spin ice models (differences in numerical relations between appropriate constants, limited nature of transport analogy) and indicate some other problems which are not considered in this contribution (thermal effects of charge currents, quantum properties of the models, effect of frustrations on electron energy spectrum).