Aalto University

Colloquium of mathematics and systems analysis
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"2D Ising model at and near criticality: what we can prove and what we still would like to understand"

The Ising model is one of the most favorite playgrounds for people doing rigorous statistical mechanics in 2D: it is a random assignment of signs to vertices of a planar graph and its remarkably simple definition can be easily explained to a kid playing with a squared sheet of paper. At the same time, it gives rise to very rich mathematical structures, being an archetypical example of a 2D lattice model to which the huge arsenal of theoretical physics methods can be applied. These methods lead to impressive conclusions (scaling exponents, correlation functions, Hausdorff dimensions etc) in a very solid and self-consistent way. From the "theoretical physicists" point of view, the planar Ising model is perfectly understood and the case is (almost) closed. But which part of all that can be derived rigorously by "pure mathematicians"? Or maybe we can do even better and simplify something along the way? This is the game which continues for more than 70 years with several "mathematical" areas being involved and flourished by the underlying "physical" theories. Recently, a yet another round of this interplay started and a number of new results has been obtained. In this talk we will see some pieces of this long story and the current state-of-art, as well as some further goals for those who is trying to (re)develop the whole theory arising in the scaling limit (as the mesh size tends to zero) just starting with the combinatorial definition of the model: no prior knowledge is assumed.