Continuity of the phase transition of the Ising Model in 3 dimensions via random currents

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This poster reviews the focus article of my Master's dissertation.

The Ising Model dates back to 1920 and was introduced in Ernst Ising's PhD Thesis to study phase transitions of ferromagnets in the context of Statistical Mechanics. Ising proved in his thesis that the model does not present phase transition in dimension 1 and conjectured that the same would happen for every dimension $d \geq 2$. Due to this belief, the model was abandoned for almost ten years before Peierls proved that this conjecture was wrong for every dimension.

Once the phase transition was proved, the attention shifted to exactly how it occurred. In 1944, Onsager managed to explicitly calculate the pressure of the Ising Model in dimension 2. With this in hand, he succeeded in proving the continuity of its phase transition.

In 1982, Aizenman proved the continuity of the phase transition of the Ising Model for dimensions $d \geq 4$ using a technique called Random Current Representation. This representation was first introduced in 1970, when it was applied to prove the famous Griffiths-Hurst-Sherman (GHS) Inequality. But Aizenman managed to extract much more information using this technique, that proved to be more powerful than originally thought.

The most important dimension for physical purposes is $d = 3$, where the problem of the continuity of phase transition remained a mystery until 2016. Using yet the same representation, but applying new methods Aizenman, Duminil-Copin and Sidoravicius proved the phase transition is continuous in dimension 3. In this poster, we aim is to explain the main ingredients of this proof and to provide the reader with some insight into the matter.