Translation invariant Gibbs measures and continuity for φ_d^4 via random tangled currents

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We prove that the set of translation invariant Gibbs measures for the φ_d^4 model on $\mathbb{Z}^d$ has at most two extremal measures at all temperature. We also give a sufficient condition to ensure that the set of all Gibbs measures is a singleton. As an application, we show that the spontaneous magnetisation of the nearest-neighbour φ_d^4 model on $\mathbb{Z}^d$ vanishes at criticality for $d \geq 3$. The analogous results were established for the Ising model in the seminal works of Aizenman, Duminil-Copin, and Sidoravicius (Comm. Math. Phys., 2015), and Raoufi (Ann. Prob., 2020) using the so-called random current representation introduced by Aizenman (Comm. Math. Phys., 1982). Our proof relies on a new corresponding geometric representation for the φ_d^4 model called the random tangled current representation.

Joint work with Trishen Gunaratnam, Christoforos Panagiotis and Franco Severo.