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Scaling behaviors at discontinuous quantum transitions JACOPO NESPOLO, MASSIMO CAMPOSTRINI, Dipartimento di Fisica dell'Università di Pisa and INFN, Sez. di Pisa, ANDREA PELISSETTO, Dipartimento di Fisica di 'Sapienza' Università di Roma and INFN, Sez. di Roma I, ETTORE VICARI, Dipartimento di Fisica dell'Università di Pisa and INFN, Sez. di Pisa — First-order (or discontinuous) quantum phase transitions (FOQTs) are characterized by a vanishing energy gap and jumps in the values of some observables across the critical point in the thermodynamic limit. Unlike what happens at continuous transitions, the correlation lengths remain finite at FOQTs. Nevertheless, finite systems at FOQTs exhibit finite-size effects, in the form of a rounding and smoothing of the discontinuities. We show that a scaling theory, similar to the usual finite-size scaling, can be formulated at FOQTs, and that the relevant scaling variable is extremely sensitive to the choice of boundary conditions. We further consider the scaling effects due to the presence of spatial inhomogeneities, in analogy with trap-size scaling at continuous transitions. Our results are supported by numerical simulations on the ferromagnetic quantum Ising chain and on the q-state quantum Potts chain with $q > 4$. We provide FSS predictions for the energy gap and the magnetization of finite quantum chains, which can be relevant for quantum computation applications.

Jacopo Nespolo
Dipartimento di Fisica dell'Università di Pisa and INFN, Sez. di Pisa

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