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Topological order at finite temperature: protected or not protected? CLAUDIO CASTELNOVO, University of Oxford, CLAUDIO CHAMON, Boston University — We investigate the behavior of the entanglement and topological entropy in the two- and three-dimensional toric code at finite temperature. From our results, we infer that quantum topological order is fragile with respect to thermal fluctuations in spite of the presence of a finite energy gap at zero temperature. In two dimensions, all topological order evaporates at any non-vanishing temperature in the thermodynamic limit. On the contrary, in three dimensions not all topological information is lost, although the topologically protected quantum information (qubit) stored in the ground state of the system is immediately degraded to topologically protected classical probabilistic information (pbit) at any infinitesimal temperature, in the thermodynamic limit. All information is eventually lost beyond a finite temperature phase transition. We comment on the implications of our results with respect to braiding operations and topological quantum computing.

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