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Numerical Study of a Bosonic Topological Insulator in three dimensions[1] SCOTT GERAEDTS, OLEXEI MOTRUNICH, Department of Physics, California Institute of Technology — We construct a model which realizes a (3+1)-dimensional symmetry-protected topological phase of bosons with $U(1)$ charge conservation and time reversal symmetry, envisioned by A. Vishwanath and T. Senthil [PRX 4 011016]. Our model works by introducing an additional $O(3)$ degree of freedom, and binding its hedgehogs to a species of charged bosons; the continuous symmetry is thus enlarged to $SO(3) \times U(1)$. We study the model using Monte Carlo and determine its bulk phase diagram; the phase where the bound states of hedgehogs and charges condense is the topological phase. We also study surface phase diagram on a (2+1)-dimensional boundary between the topological and trivial insulators. The theory for the surface is the same as for a (2+1)D hedgehog-suppressed non-linear sigma model, which confirms the proposed so-called NCCP[1] field theory. We apply a Zeeman field to the surface, which breaks time reversal on the surface only, and observe a surface Hall conductivity which is half of a quantized value allowed for bosons in strictly (2+1)D, thus establishing topological nature of the (3+1)D bulk phase.

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