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Emergence of supersymmetric quantum electrodynamics SHAO-KAI JIAN, Institute for Advanced Study, Tsinghua University, Beijing 100084, China, CHIEN-HUNG LIN, JOSEPH MACIEJKO, Department of Physics, University of Alberta, Edmonton, Alberta T6G 2E1, Canada, HONG YAO, Institute for Advanced Study, Tsinghua University, Beijing 100084, China — Supersymmetric (SUSY) gauge theories such as the Minimal Supersymmetric Standard Model play a fundamental role in modern particle physics, but have not been verified so far in nature. Here, we show that a SUSY gauge theory with dynamical gauge bosons and fermionic gauginos emerges naturally at the pair-density-wave (PDW) quantum phase transition on the surface of a correlated topological insulator (TI) hosting three Dirac cones, such as the topological Kondo insulator SmB_6. At the quantum tricritical point between the surface Dirac semimetal and nematic PDW phases, three massless bosonic Cooper pair fields emerge as the superpartners of three massless surface Dirac fermions. The resulting low-energy effective theory is the supersymmetric XYZ model, which is dual by mirror symmetry to $\mathcal{N}$=2 supersymmetric quantum electrodynamics (SQED) in 2+1D, providing a first example of emergent supersymmetric gauge theory in condensed matter systems. Supersymmetry allows us to determine exactly certain critical exponents and the optical conductivity of the surface states at the strongly coupled tricritical point, which may be measured in future experiments.

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