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Emergent space-time supersymmetry in 3D Weyl semimetals and 2D Dirac semimetals SHAO-KAI JIAN, YI-FAN JIANG, HONG YAO, Institute for Advanced Study, Tsinghua University — Supersymmetry (SUSY) interchanges bosons and fermions but no direct evidences of it have been revealed in nature yet. In this paper, we observe that fluctuating pair density waves (PDW) consist of two complex order parameters which can be superpartners of the unavoidably-doubled Weyl fermions in 3+1D lattice models. Using renormalization group, we theoretically show that SUSY emerges at PDW transitions in 3+1D Weyl semimetals (2+1D Dirac semimetals). We construct explicit fermionic lattice models featuring 3+1D Weyl fermions (2+1D Dirac fermions) and show that PDW is the leading instability as short-range interactions exceed a critical value and that the N=2 SUSY emerges at the continuous PDW transitions. We further discuss possible routes to realize these lattice models and experimental signatures of emergent SUSY at the PDW criticality.

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