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Bosonic Dirac materials in two dimensions SAIKAT BANERJEE, Nordic Institute for Theoretical Physics, Sweden, JONAS FRANSSON, ANNICA BLACK-SCHAFFER, Uppsala University, Sweden, HANS GREN, Royal Institute of Technology, Sweden, ALEXANDER BALATSKY, Nordic Institute for Theoretical Physics, Sweden — We examine the low energy effective theory of phase oscillations in a two-dimensional granular superconducting sheet where the grains are arranged in honeycomb lattice structure. Two different types of collective phase oscillations are obtained, which are analogous to the massive Leggett and massless Bogoliubov-Anderson-Gorkov modes in a two-band superconductor. It is shown that the spectra of these collective bosonic modes cross each other at the K and K' points in the Brillouin zone and form a Dirac node. Dirac node dispersion of bosonic excitations is representative of Bosonic Dirac Materials (BDM). We show that the Dirac node is preserved in presence of an inter-grain interaction, despite induced changes of the qualitative features of the two collective modes. Finally, breaking the sublattice symmetry by choosing different on-site potentials for the two sublattices leads to a gap opening near the Dirac node, in analogy with Fermionic Dirac materials.

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