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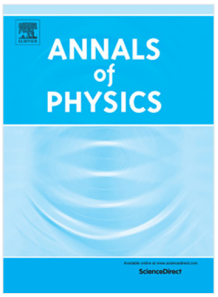

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Lattice field theory simulations of Dirac semimetals

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Abstract

In this paper the observed Dirac semimetals Na_3Bi and Cd_3As_2 are studied within lattice simulation. We formulate lattice field theory with rooted staggered fermions on anisotropic lattice. It is shown that in the limit of zero temporal lattice spacing this theory reproduces low energy effective theory of Dirac semimetals. Using this lattice theory we study the phase diagram of Dirac semimetals in the plane effective coupling constant–Fermi velocity anisotropy. Within the formulated theory the results are practically volume independent in contrast with our previous study. Our results confirm our previous finding that within the Dirac model with bare Coulomb interaction both Na_3Bi and Cd_3As_2 lie deep in the insulator phase.

Keywords: semimetal, insulator, Coulomb interaction, Monte Carlo simulations
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1. Introduction

Recent years are marked with the discovery of numerous materials with interesting properties. Considerable interest is attracted by the materials which low-energy fermionic excitations can be described by massless fermions. Among well-known examples is graphene[1, 2] - two-dimensional material with two effective massless Dirac fermions[3, 4, 5, 6, 7]. Its three-dimensional analogues include Dirac(Na_3Bi[8], Cd_3As_2[9, 10]) and Weyl semimetals[11, 12]. Such materials provide a perfect opportunity for detailed study of quantum field theory phenomena, which were previously related to high-energy physics.

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