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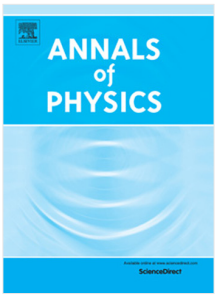

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Constructing superconductors by graphene Chern-Simons wormholes

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We propose a new model which simulates the motion of free electrons in graphene by the evolution of strings on manifolds. In this model, molecules which constitute sheets of graphene are polygonal point-like structures which build $(N+1)$-dimensional manifolds. By breaking the gravitational-analogue symmetry of graphene sheets, we show that two separated child sheets and a Chern-Simons bridge are produced giving rise to a wormhole. In this structure, free electrons are transmitted from one child sheet to the other producing superconductivity. An analogue between "effective gravitons" and "Cooper pairs" is found. In principle, this phenomenology provides the possibility to construct superconductor structures by using the analogue of cosmological models.

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I. INTRODUCTION

Recently much attention has been devoted to graphene, since this material, suitably doped and manufactured, can allow the transition from semiconductivity to superconductivity [1–6]. For example, some authors pointed out that graphene with (effective) vacancy disorder is a physical representative of dirty d-wave superconductors. Moreover, the density of states (DoS) of this system can be numerically derived within the self-consistent T-matrix approximation (SCTMA) considering the existence of vacancies [1]. Furthermore, some authors took into account the quantum size effects in armchair graphene nano-ribbons (AGNR) with hydrogen terminations applying density functional theory (DFT) in Kohn-Sham formulation. They derived the electronic structure of this system and explained a threefold periodicity of the excitation gap with ribbon width [2]. In another work it has been discussed that the best mechanism for constructing the superconductor at room temperature is to build up a wormhole inside a graphene structure [3]. A graphene wormhole contains a short nanotube which behaves like a bridge between two different graphene sheets.

Other authors considered that two properly designed graphene-based nanomaterials can effectively annihilate each other from an electronic point of view, and, similar to a gravitational wormhole, cause the delocalization of the wave-function stationary states [4]. Two layers of graphene joined by a nanotube, a structure that is called "graphene wormhole", is studied in [5]. In this model, the wormhole is a channel for transferring energy from one sheet to another and has the important role to give rise to superconductivity effects [6–8]. Finally, in one of newest scenarios, the authors considered a crystal-motivated gravitational action and showed the presence of topologically non-trivial structures (wormholes) supported by an electromagnetic field [9].

Motivated by these researches, we desire to answer the following question: How can a superconductor graphene wormhole be produced? The approach we will follow here is substantially different from the direct bottom-up approach used in [10] (see also [11–13]). Nonetheless, it shares with that approach the spirit of putting experimental graphene set-ups, on the one hand, and high-energy theoretical speculations, on the other hand, next to each other. However, requiring for real graphene structures to become superconducting is a delicate issue. Here we want to investigate this

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