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# Holographic diod

Alireza Sepehri [a], Umesh Kumar Sharma [b], Anirudh Pradhan [b]

[a] Research Institute for Astronomy and Astrophysics of Maragha (RIAAM), P.O. Box 55134-441, Maragha, Iran
[b] Department of Mathematics, Institute of Applied Sciences and Humanities, GLA University, Mathura 281 406, Uttar Pradesh, India

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ABSTRACT

In a symmetrical manifold with polygonal molecules, free electrons and other charges are absorbed symmetrically by all molecules and these changes tend not to more in a particular direction. Once the manifold is broken the symmetry too, naturally, gets broken and as a resultant the act produces two manifolds. The manifolds unfold such that the number of sides for molecules at boundary of each of the manifolds is different. The sequential events lead to the situation that one of the manifolds absorbs electrons and changes whereas the repel is assorted by the another. This also creates anomaly between the two manifolds. In order to fill the vacuum and to remove the anomaly. Chern–Simons bridge gets emerged that transmits charges between the two manifolds. In such a situation, charges can be paired on the Chern–Simons bridge and a diod is formed. This diod can be used in both solid state and in cosmology.





## 1. Introduction

A diod typically consists of one subsystem with extra electrons which are inspired with extra holes in other subsystem. By applying one external force, these pairs are broken and an electrical current gets emerged. As on date there has not been much research and discussions on polygonal diods like graphene diod. For example – the investigations of the past few years have demonstrated that graphene can form junctions with $3D$ or $2D$ semiconducting materials which have rectifying characteristics which behave as excellent Schottky diodes [1]. The main novelty of these devices is the tunable Schottky barrier height—a feature which makes the graphene/semiconductor junction a great platform for the study of interface transport mechanisms, as well as for applications in photo-detection [2], high-speed communications [3], solar cells [4], chemical and biological sensing [5], etc. Also, realizing an optimal Schottky interface of graphene, on other matters like $Si$, is challenging, as the electrical transport strongly depends on the graphene quality and the temperature. Such interfaces are of increasing research interest for integration in diverse electronic devices as they are thermally and chemically stable in all environments, unlike standard metal/semiconductor interfaces [6].

Previously, we have shown that in a graphene system, heptagonal molecules repel electrons and pentagonal molecules absorb them [7,8]. This is because the angle between atoms in heptagonal molecules with respect to center of it is less than pentagonal molecules and according to the Pauli exclusion principle, parallel electrons become more close to each other and repelled. Also, parallel electrons in pentagonal molecules are much distant and some holes are appear. If one heptagonal molecule is connected to one pentagonal molecule, electrons move from heptagonal, paired with holes in pentagonal and one diod is formed. Now, we extend this consideration to polygonal manifolds and discuss about the role of anomaly in emerging diods. In our model, first there is a big manifold with polygonal molecules. By breaking this manifold, two lower dimensional manifolds are produced. Molecules produced this way are different at boundary. This system is similar to the diods and the differences, between shapes of molecules at boundary, produce the anomaly. In event of happenings this anomaly causes such situation that electrons are transmitted from one manifold to another and are paired with them in the space between two manifolds. This space is called the Chern–Simons bridge.

Now, the question arises that is this only a theoretical idea, or there exists any possibility to verify it through observations? The answer to this question is as follows: In fact, this is a real diod that can be constructed by putting heptagonal and pentagonal molecules among the hexagonal molecules of graphene. We need two graphene sheets which are connected through a bridge. Molecules, at the connected points of one side of the bridge, should have the heptagonal shapes and other molecules are at the connected points of another side of the bridge should have the pentagonal shapes. Electrons are repelled by heptagonal molecules

*E-mail addresses:* alireza.sepehri@uk.ac.ir (A. Sepehri), sharma.umesh@gla.ac.in (U.K. Sharma), pradhan.anirudh@gmail.com (A. Pradhan).

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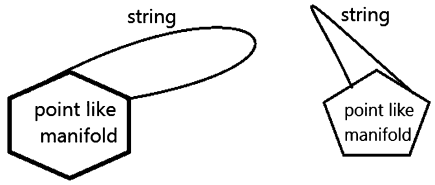


**Fig. 1.** One example of point-like manifolds and attached strings.

and absorbed by pentagonal ones and a current between two sheets appear. This current is very much the same current which has emerged between layers $N$ and $P$ in a real diod. In fact, this current has emerged only from the side with heptagonal molecules towards the side with pentagonal molecules. Also, the current from the side with pentagonal molecules towards the side with heptagonal molecules is zero. This property can also be observed in normal diod.

The outline of the paper is as follows: In section 2, we will obtain the energy of $N$-dimensional polygonal manifolds in terms of gauge fields and curvatures. In section 3, we break this manifold and produce a diod. We also consider its evolution and obtain the current density. The last section is devoted to summary and conclusion.

## 2. The holographic polygonal diod

In this section, first, we introduce the polygonal molecules and construct one $N$-dimensional polygonal manifold by connecting them. We show that at first stage, the molecules do exist (point like polygonal manifolds) in space (see Fig. 1) to which the electrons (strings) are attached. Polygonal manifolds are manifolds with $q$-gonal shape, which are similar to molecules in graphene. These manifolds have only one dimension in direction of time. All interactions between electrons are simulated by interactions between strings, which are done on one polygonal manifold. The potential of these interactions can be given by a delta function and thus, the energy of manifold shrinks to one. We can write:

$$V(\sqrt{C(\tilde{X}^I)}) = \delta(\sqrt{C(\tilde{X}^I)})$$
$$E_{M^0} = 1 = \int_{M^0} d\sqrt{C(\tilde{X}^I)}V(\sqrt{C(\tilde{X}^I)}) = \int_{M^0} d\sqrt{C(\tilde{X}^I)}\delta(\sqrt{C(\tilde{X}^I)})$$
$$= \int_{M^0} d\sqrt{C(\tilde{X}^I)}e^{-\sqrt{C(\tilde{X}^I)}\sqrt{C(\tilde{X}_I)}} \quad (1)$$

where $M^0$ represents the point like manifold, $\tilde{X}^I$'s are strings which attached to them and $y$ is the length of point which shrinks to zero. Also, $C(\tilde{X}^I)$ is the equation of polygonal manifold. The shape of these equations can be as:

$$C(\tilde{X}^I) = \Sigma_{i=1}^{q} \frac{(\tilde{X}_i^I)^2}{2\pi y \tilde{a}_i^2} \quad (2)$$

where $\tilde{a}_i$ is the coefficient of $i$-th side of point like polygonal manifold. For example, for an sphere, we have:

$$C(\tilde{X}^I) = \frac{(\tilde{X}_1^I)^2}{2\pi y R^3} + \frac{(\tilde{X}_2^I)^2}{2\pi y R^3} + \frac{(\tilde{X}_3^I)^2}{2\pi y R^3} \quad (3)$$

With new redefinition of string fields $\tilde{X}^I \longrightarrow \sqrt{2\pi y}X^I$, we obtain:

$$E_{M^0} = 1 = \int_{M^0} d\sqrt{C(X^I)}e^{-\pi\sqrt{C(X^I)}\sqrt{C(X_I)}} \quad (4)$$

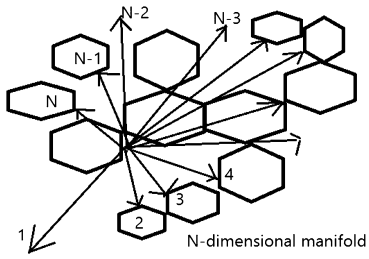


**Fig. 2.** Constructing of $N$-dimensional manifold by joining point like manifolds.

Calculating the integral, we can obtain a solution for strings $(X^I)$:

$$\int_{M^0} d\sqrt{C(X^I)}e^{-\pi\sqrt{C(X^I)}\sqrt{C(X_I)}} = 1 \longrightarrow$$
$$\frac{1}{2}erf(\sqrt{\sqrt{C(X^I)}\sqrt{C(X_I)}\pi}) = 1 \longrightarrow$$
$$C(X^I) \approx I \quad (5)$$

where $I$ is the unitary matrix. This equation shows that at the first stage, there is no interaction between strings and they are the same. In fact, there is a very high symmetry for the early stages of world and all matters have the same origin. For example, for an sphere, above equation yields:

$$\frac{(X_1^I)^2}{R^3} + \frac{(X_2^I)^2}{R^3} + \frac{(X_3^I)^2}{R^3} \approx I \quad (6)$$

Above example shows that initial strings construct an spherical manifold with radius $R$. By changing $\tilde{a}_i$ and number of sides, the shape of point like manifold can be changed.

Now, we can extend this mechanism to $N$-dimensional manifold in space (see Fig. 2). Each $N$-dimensional manifold is similar to $N$-dimensional sheet in graphene. This manifold can be built by coupling $(N+1)$ point like manifolds. The density potential of interactions between strings on the manifolds could be described by delta functions. In fact, all interactions on one point like manifold are concentrated on one point and thus total potential is approximately infinite. This potential which is zero in other points and infinite in one special point can be explained by delta function. Integration over all these potentials, we derive total energy of system:

$$E_{M_i^0} = \int_{M_i^0} dC(\tilde{X}_i^I)V(C(\tilde{X}_i^I)) = \int_{M_i^0} dC(\tilde{X}_i^I)\delta(C(\tilde{X}_i^I)) = 1 \Rightarrow$$
$$E_{M_1^0+\ldots+M_{N+1}^0} = 1$$
$$= \int_{M_1^0+\ldots+M_{N+1}^0} dC(\tilde{X_1}^I)\ldots dC(\tilde{X_{N+1}}^I)$$
$$\times \delta(C(\tilde{X_1}^I))\ldots\delta(C(\tilde{X_{N+1}}^I))$$
$$= \int_{M_1^0+\ldots+M_{N+1}^0} dC(\tilde{X_1}^I)\ldots dC(\tilde{X_{N+1}}^I)$$
$$\times e^{-C(\tilde{X_1}^I)C(\tilde{X}_{1I})}\ldots e^{-C(\tilde{X_{N+1}}^I)C(\tilde{X}_{N+1I})} \quad (7)$$

In above equation, energy of manifold is normalized to one. It is concluded that for $N$-dimensional manifold, there are $N+1$ integrations. Extra dimension is corresponded to time and totality, we have $N+1$-dimensional manifold. By applying new definition of string fields $\tilde{X}^I \longrightarrow \sqrt{2\pi y}X^I$, we obtain: