Graphene and supersymmetry

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Abstract

We discuss a 2+1 dimensional model holographically realized as the boundary theory of a four-dimensional gravity model in Anti de Sitter (AdS) spacetime. The result is achieved through suitable boundary conditions for the D=4 fields, and an effective model for massive spin-1/2 fields on a curved background is obtained [1,2].
The (unconventional) supersymmetry of the boundary model allows to introduce extra internal degrees of freedom, which can provide an application of the model to the description of the charge carriers properties of graphene-like 2D materials at the Dirac points **K** and **K'**. In particular, the two valleys correspond to the two independent sectors of the boundary model, connected by a parity transformation. The fermion masses entering the corresponding Dirac equations are related to the torsion parameters of the substrate in the three-dimensional model: the parity-even and odd components of the corresponding masses are identified with Semenoff and Haldane-type mass contributions, respectively [2].
We emphasize that the construction follows a top-down approach, in that the effective 2+1 dimensional theory for a condensed matter system at the boundary originates from a well-defined supersymmetric effective supergravity in the bulk [2,3].

References

[1] Alvarez, Valenzuela, Zanelli, JHEP 04 (2012) 058
[2] Andrianopoli, Cerchiai, D'Auria, Gallerati, Noris, Trigiante , Zanelli, JHEP 01 (2020) 084
[3] Andrianopoli, Cerchiai, D'Auria, Trigiante, JHEP 04 (2018) 007

Figures

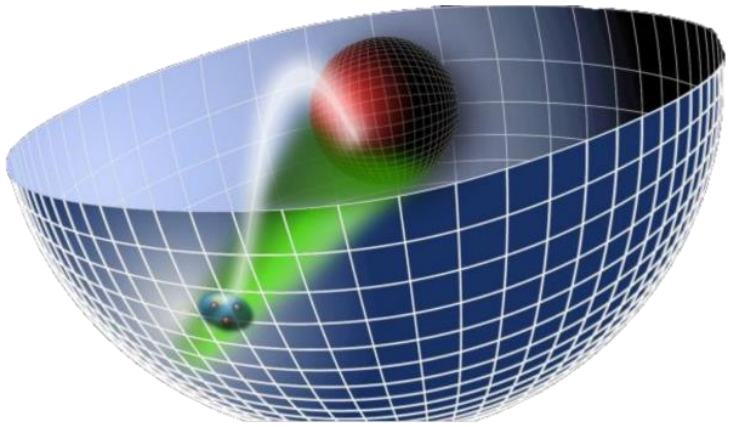

Figure 1: Pictorial (holographic) realization of a 2+1 model for a condensed matter system, living on the boundary of a 3+1 supergravity theory defined in the bulk.