Skolkovo Institute of Science and Technology

MASTER'S THESIS

Fantastic grants and where to find them

Master's Educational Program: Startups, memes and bullshitting

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Startups, memes and bullshitting
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Abstract

As any dedicated reader can clearly see, the Ideal of practical reason is a representation of, as far as I know, the things in themselves; as I have shown elsewhere, the phenomena should only be used as a canon for our understanding. The paralogisms of practical reason are what first give rise to the architectonic of practical reason. As will easily be shown in the next section, reason would thereby be made to contradict, in view of these considerations, the Ideal of practical reason, yet the manifold depends on the phenomena. Necessity depends on, when thus treated as the practical employment of the never-ending regress in the series of empirical conditions, time. Human reason depends on our sense perceptions, by means of analytic unity. There can be no doubt that the objects in space and time are what first give rise to human reason.

Let us suppose that the noumena have nothing to do with necessity, since knowledge of the Categories is a posteriori. Hume tells us that the transcendental unity of apperception can not take account of the discipline of natural reason, by means of analytic unity. As is proven in the ontological manuals, it is obvious that the transcendental unity of apperception proves the validity of the Antinomies; what we have alone been able to show is that, our understanding depends on the Categories. It remains a mystery why the Ideal stands in need of reason. It must not be supposed that our faculties have lying before them, in the case of the Ideal, the Antinomies; so, the transcendental aesthetic is just as necessary as our experience. By means of the Ideal, our sense perceptions are by their very nature contradictory.

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Chapter 1

Introduction

The system, considered in this work, is a pair of 1D superconductors connected with a Josephson junction. For all the discussion presented it's crucial for one of superconductors to be topological.

Topological superconductivity is relatively fresh topic in physics. On the one hand it's being connected to particle physics through the notion of Majorana fermion – the particle coinciding with it's own antiparticle. It can be looked for not only in Standart models' particle set, but also as a state in condensed matter systems. Despite the difference between theses entities, there is a clear analogy between majoranas in condensed matter and majoranas in particle physics.

On the other hand topological superconductivity is of interest to quantum computation community as a platform to build fault tolerant quantum memory. Although significant difficulties has appeared on this way, the intention to realize this program is still strong and gives the motivation to build a superconducting samples, which demonstrates signatures of nontrivial topology.

The brief discussion of topological superconductivity as well as it's connection to majornas in particle physics and quantum computation is presented in the introduction. The subsequent character presents the model for Jospehson junction of two 1D supeconductors and and the investigation of it's properties – spectrum, supercurrent and ionization rate. The discussion of a potential use of this results can be found in the completive character The most important technical details can be found in supplementary.

The review, presented here, only scartches the surface of rich topic of topological superconductivity. More complete discsssion can be found in the notes of (LINKS-LINKS)

1.1 Majorana fermions – from particles to superconductors

Topological superconductor is often defined as a superconductor, which can host states with special symmetry – Majorana fermions – localized near the defects. Although this definition is not totally clear and doesn't reflects the connection to topology as concept of math, it's being very practical when the concrete system is considered. Here the notion of Majorana fermion is given and it's emergence from particle physics is described.

A particle with spin $\frac{1}{2}$ can be represented with 4 components spinor Ψ and obeys a Dirac equation:

$$(i\gamma^{\mu}\partial_{\mu} - m)\,\Psi = 0 \tag{1.1}$$

Here γ^{μ} are 4x4 matrices which form a Clifford algebra $\{\gamma^{\mu}, \gamma^{\nu}\} = 2\eta_{\mu\nu}$. in terms of real spinors Ψ. To do so, he proposed an alternative representation of γ^{μ}. While originally the representation:

$$\gamma^{\mu} = (\beta, \beta\boldsymbol{\alpha}) \tag{1.2}$$

with:

$$\alpha_i = \begin{pmatrix} 0 & \sigma_i \\ \sigma_i & 0 \end{pmatrix} \qquad \beta = \begin{pmatrix} \mathbb{I} & 0 \\ 0 & -\mathbb{I} \end{pmatrix} \tag{1.3}$$

and σ_i being Pauli matrices was used, Majorana proposed another set of γ^{μ}_{M}, namely:

$$\gamma^0_M = i\begin{pmatrix} 0 & -\sigma_1 \\ \sigma_1 & 0 \end{pmatrix} \quad \gamma^1_M = i\begin{pmatrix} 0 & \mathbb{I} \\ \mathbb{I} & 0 \end{pmatrix} \quad \gamma^2_M = i\begin{pmatrix} \mathbb{I} & 0 \\ 0 & -\mathbb{I} \end{pmatrix} \quad \gamma^2_M = i\begin{pmatrix} 0 & \sigma_2 \\ -\sigma_2 & 0 \end{pmatrix} \tag{1.4}$$

both Dirac (1.2), (1.3) and Majorana (1.4) form a Clifford algebra $\{\gamma^{\mu}, \gamma^{\nu}\} = 2\eta_{\mu\nu}$ where $\eta_{\mu\nu}$ is Minkovwsky tensor, so each of them can be used as proper equation describing a particle with a spin equal to $\frac{1}{2}$.

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Bibliography

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