quantify and analyse magnetic structure and origin of superferromagnetism. We discuss some results for a sensor mode application of superferromagnetic reactivity associated with spatially local external fields, e.g., a detection of magnetic particles. Transport of electric charge carriers between superparamagnetic particles is considered as tunneling and the Landau level state dynamics. The tunneling magnetoresistance is predicted to grow up noticeably with decreasing nanomagnet size. The giant magnetoresistance is determined by ratio of respective time of flight and relaxation and can be significant at room temperatures. Favorable designs of superferromagnetic systems for sensor implications are revealed.

[1] V.N. Kondratyev, and V.A. Osipov, Nanomanufacturing. 3, 263 (2023).

On scattering resonances in monolayer and bilayer graphene circular quantum dots

G.G. Krylov

Belarusian State University, Minsk, Belarus

We analyse in detail eigenstates and possible resonance structure for monolayer and bilayer graphene circular quantum dots within the known massless Dirac pseudo-fermion graphene model. Concept and reasonability of the recently introduced quasi-bound states is also discussed.

Collapse of Klein tunneling resonances in pseudo-Majorana-type pn-graphene junctions

H.V. Grushevskaya and G.G. Krylov

Belarusian State University, Minsk, Belarus

Strongly correlated many-electron systems whose quasi-particle excitations are subject to non-Abelian statistics are promising for application in quantum devices. Graphene belongs to such systems. A highly efficient Andreev conversion of incident electrons into electron-hole pairs at the interface between graphene-like materials in quantum Hall-effect and superconducting regimes occurs due to hybridization of the quantum Hall edge modes with the states in superconductor [1]. To remain the topologically nontrivial hybridized modes along the edges of the superconducting sample the local and crossed Andreev states should exist on both sides of the superconducting phase. The topological nontriviality of the hybridized modes disappears due to defects and impurities and intensity of the crossed Andreev states is negligibly small also due to the defects. This impedes to design robust quantum processing based on graphene platform However, the local and crossed nontopological Andreev states reside in a superconductor coupled to the two conventional quantum dots [2-4], resulting in SQUID-like oscillations. In our paper we will study a collapse of Klein-tunneling resonances in pseudo-Majorana graphene p-n junctions which are electrically confined graphene quantum dots (GQDs) without physical termination. The p-n graphene junctions are able to support the supercurrent at the superconducting interface along the edges of the sample under conditions of detuning Klein tunneling. To approach it we will elaborate a mechanism for finely tuning collapse of Klein transmission states.

We suppose that graphene quasi-particle excitations are pseudo-Majorana particles. A graphene band structure determined by the pseudo-Majorana Hamiltonian holds electron and hole flat bands where a pseudo-Majorana force (interaction) confines electron-hole pairs in Majorana configurations. We have used the pseudo-Majorana Hamiltonian to describe collapsing Klein-resonances in the graphene p-n junctions. Figure 1 depicts simulation results. As can see, the wave functions for the Klein-tunneling resonances in the toroidal-and spherical-type Majorana GQDs can narrow and the collapse of these transmission states occurs.

States of this kind are lacking in an electrostatically-confined graphene toroidal p−n junction hosting Dirac-Weyl fermions. Dirac-Weyl fermions in the spheroidal GQD can reside on quasi-zero energy levels at any energies because the centrifugal force due to the curvature of the sphere prevents the electrons (holes) from keeping on resonant trajectories. It means that charge carriers of the spheroidal pn junction can escape into bulk graphene, that leads to the pseudo-Dirac-Weyl GQD collapse

Our simulation results in Fig. 1 testify that the pseudo-Majorana force acts similarly to a centripetal (centrifugal) force in the spherical graphene quantum dot. Since the space of the toroidal graphene quantum dot is curved due to the vorticity of graphene electron density, the collapse of Klein-tunneling resonances occurs.

So, the new method for finely tuning Klein-tunneling in pseudo-Majorana graphene p-n junctions is offered. Using this method, collapse of the toroidal Majorana quantum dots was predicted.

(a)

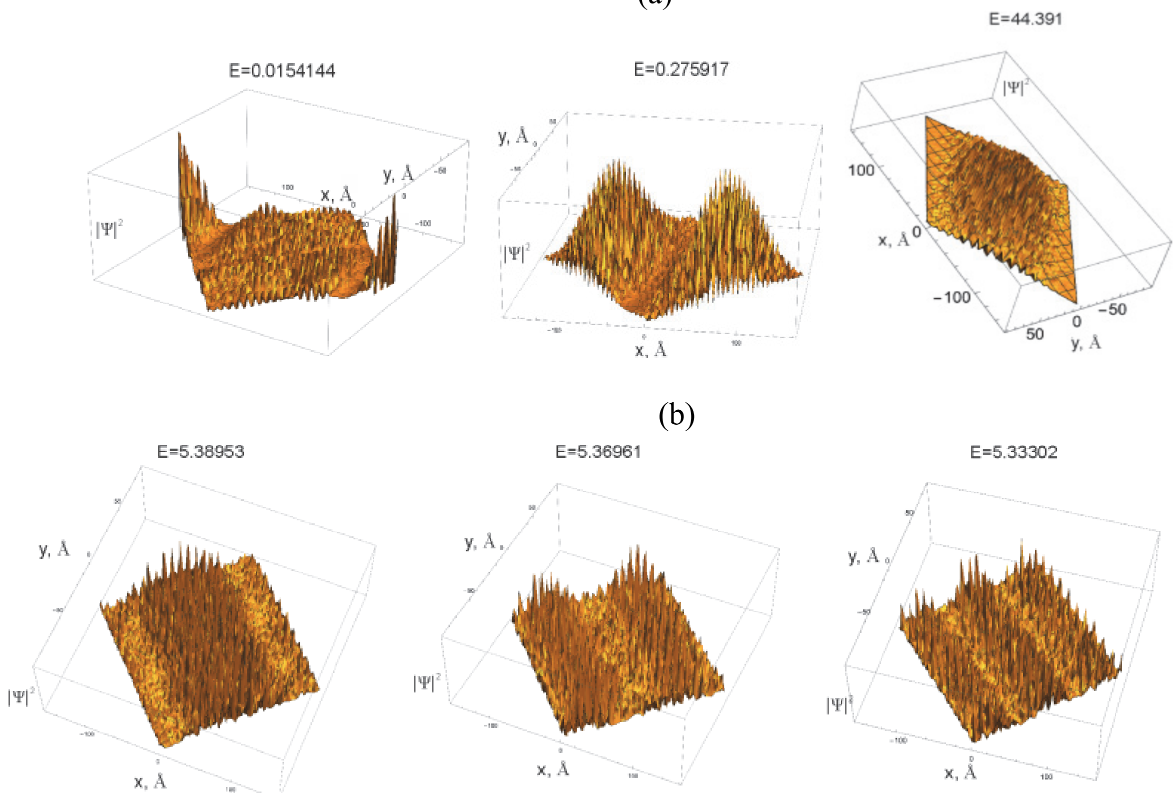

Fig. 1. Collapse of Klein-tunneling resonances in pseudo-Majorana p-n junctions of spherical (a) and toroidal (b) types.

[1] M. Hatefipour et al. Phys. Rev. B. **109**, 035430 (2024).
[2] W. Samuelson et al. Phys.Rev.B. **109**, 035415 (2024).
[3] A. Yazdani et al. Science. **380**, 6651 (2023).
[4] K. Wrzesniewski et al. Scientific Reports. **14**, 7815 (2024).

Hybridization of acoustic tamm states with defective mode of a one-dimensional phononic crystal

A.S.Zuev[1,2], S.Y. Vetrov[1,2], D. P. Fedchenko[1], I.V. Timofeev[1]
[1]Kirensky Institute of Physics, Federal Research Center KSC SB RAS, Krasnoyarsk Russia
[2]Federal Research Center Krasnoyarsk Science Center of the Siberian Branch of the Russian Academy of Sciences, Krasnoyarsk, Russia

Wave propagation in layered media were in the focus of investigated more than fifty years ago, using various mathematical methods to describe propagation of elastic and electromagnetic waves. Currently, a new field of science has been formed to study the properties of photonic crystals and devices based on them. By analogy with the localization of the electronic state near the surface of a solid, it is possible to localize the light wave at the interface of a photonic crystal and the metal or other photonic crystal. This localization is called the optical Tamm state. By analogy with the optical Tamm state, it is also possible to localize an elastic wave at the defect in the phononic crystal. Here we show the results of a study of the spectral properties of a one-dimensional phononic crystal bounded by an air layer. The presence of a defect in a phononic crystal with the air layer leads to a coupling between the defective mode and the acoustic Tamm state. These modes have different nature. The for the spatial distribution manifested mode hybridization, and the repulsions of dips in the reflection spectrum is explained by the avoiding crossing of modes.