

MSc Seminar, Panna Kovacs

Names of students *

Szász-Schagrin Dávid

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. We want to observe magnetic monopoles with the use of topological magneto-electric effects.
2. We were introduced to the concept of topological insulators (TI). Charges (mostly electrons) are bound to the surface of TI.
3. Topological magneto-electric effect (TME) originates from quantum Hall-effect (QHE). Hall current causes a magnetic polarization. The Hall conductance is of a form that we can interpret it as we had a magnetic monopole charge as the mirror image of an electric charge. I really like this idea that magnetic monopoles may be bound to electric ones.
4. An idea for measurement of these "monopoles" was suggested.
5. We can introduce dyons as bound states of EM-monopoles. In an Aharonov-Bohm state one can compute the phase of the dyon which is physically observable. (I might not got that right, I don't know about AM effect that much.)
6. The "2D" electron gas becomes a dyon gas with fractional (dyon) statistics.
7. Observation of induced magnetic field (by QHE) as the magnetic field of monopole is possible by experiments.

Ideas to improve on:

1. More text/formulas help. Sentences are okay if not too long.
2. If you have a figure, write a caption! It helps to understand what you want to show.
3. The slides looked good, although seemed a bit empty. If you have free space left in a slide, either fill it in or increase the font.
4. Talk more TO the audience and not to the slides. This is something I am always guilty of as well.
5. Thank you slide is unnecessary.

Overall I really liked your talk, I could see that you understand it very well, you talked well and it wasn't hard to follow. You know your physics very well which is really good to see. You could tell us numerical values by heart. You worked more for this seminar that is necessary, kudos to you.

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Sári Péter, Budai Ákos, Balázs Péter

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1. The talk was about inducing magnetic monopoles in topological insulators.
2. Charge carriers on the surface behave according to the method of image charges.
3. This creates a magnetic field that resembles a magnetic monopole.
4. Some experimental setups were shown.
5. In one case the change of magnetic field was measured using the current in a superconductor ring.

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Borsi Márton, Tamás Gábor

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1. The main idea of the presented paper was the method of mirror images, used widely in electrostatics.
2. The existence of a magnetic monopole is allowed by the laws of nature, but there are no experiments confirming its existence.
3. Near the surface of a topological insulator we can measure an image magnetic monopole due to the topological magneto-electric effect.
4. The bound state of an electron and its image form a so called dyon.
5. For us, it was a bit unclear, what the main result of the paper is.
6. The style of the slides was a bit minimalistic, having a smaller chance to raise attention.
7. Instead of the Thank you!-slide, it would be better to have the Conclusions / Summary slide as the last one.

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Andras Palyi

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. Setup: 3d topological insulator, covered by a ferromagnetic layer, showing quantum anomalous hall effect. A point charge is placed in the vicinity. As a response, 3 image charges are "created" virtually: a magnetic image charge at the position of the electric charge, plus a virtual magnetic and electric monopole at the other side of the topological insulator.
2. Mechanism: Electric charge induces electric field, which induces a circulating current density at the surface of the topological insulator, which in turn induces a magnetic field. That magnetic field looks like a monopole field (or at least it has a component that looks like that.)
3. An experimental setup that could detect this effect is MFM. Another one is a superconducting loop that could pick up the flux created by the magnetic image charges.
4. An interesting aspect is that a charge and its image charges can (do?) form a bound state, and two such bound states can be thought of as "particle". Then, since all this is in 2D, we can ask about the exchange phase ("statistical angle") of two such bound states. It turns out to be nonzero (although rather small). Why? Because the exchange, one electron moves around a flux patch, so naturally there's an Aharonov-Bohm phase picked up.

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László Gyulai, Zsolt Györgypál

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1. In the beginning the lecturer spoke about the method of charge mirroring, which can be used in solid state physics too.
2. For example in topological insulators a magnetic monopole charge is induced as a mirror charge of an electric charge.
3. Using the same method as in classical electrodynamics, the electric and magnetic fields can be derived.
4. The magnetic polarization in the case of a single impurity can be $+1/2$ or $-1/2$.
5. This state can be describe with the hypothetical particle called dyon, which is a bound state of the electric charge and it's mirrored image charge.
6. So in many cases instead of electron gas one can describe a system using a dyon gas.

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Anna Horvath, Bendeguz Sulyok

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1: The presentation has introduced an idea of a magnetic monopole as electron and its mirror image.

2: The method of mirror images is useful for many electrostatical problems, such as Poisson eqn.

3: Topological insulators are special materials with insulator interior while the surface we find nontrivial, symmetry-protected states.

4: Maxwell's equations on the surface yield $q_1=q_2$ and $q_1=-g_2$ where particle "1" is the electron and particle "2" is it's image.

5: When an electron is close to a conducting surface, the surface mirrors the electron and the two particles are to be considered as one with a bound state and named "dyon"; this can be considered a magnetic monopole.

6: Apply voltage on a superconducting ring -- with a metallic island inside -- and the density of surfacial electrons can be finetuned, causing a changing flux; that flux, in turn, induces supercurrent in the superconducting ring, this supercurrent can be measured externally.

7: This is a direct manifestation of the Topological Magneto-Electric Effect.

8: An electron gas forms a dyon gas, which bears fraction statistics.

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Szombathy Dominik

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1. Panna gave a talk about inducing a magnetic monopole within a topological insulator.
2. The presentation consisted a definition of what topological insulators are and what
3. If we apply a magnetic field, the insulator's time reversal symmetry will break which leads to an energy gap in the topological states.
4. This theoretical approach was based on the so called method of images or mirror images.
5. In this picture a magnetic monopole is induced as a mirror charge of an electric charge.
6. These charge and mirror pairs can not be treated as two separate particles thus a quasiparticle introduced, namely a dyon.
7. Panna presented two experimental methods, which can be used to determine the magnetic flux of these particles.

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Réka Szilvási, Zsombor Szilágyi, Zsolt Szabó

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1. The presentation was about inducing a magnetic monopole with topological surface states.
2. The speaker reminded us of the method of images used to solve the Poisson equation.
3. She introduced the concept of topological insulators: the gap in the bulk; the current on the surface.
4. The image method can be used here in topological insulators: a the surface of topological insulator we can see image charges and magnetic monopoles too !
5. She talked about the theoretical background: the physical origin of the topological magneto-electric effect : Hall-current on the surface resulting in magnetic polarization.
6. The speaker mentioned the experimental setup: there is a topological insulator with a superconducting layer on it and a metallic one - gate voltage induces a flux change --> supercurrent.
7. The presentation was neat, the speaker was quite fluent and pleasant to listen to.
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Varga Zoltán, Vízkeleti Áron

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1. The speaker's presentation was based on a paper, which raised the possibility of magnetic monopoles in topological insulators.
2. A hypothetical magnetic monopole charge is induced as an image-charge of an electric charge on a Fermi surface, and these two together are called a "dyon".
3. Topological magneto electric effect comes from the union of Maxwell's equations and the nature of Dirac cones.
4. We failed to fully grasp how a magnetic monopole could exist without the divergence being non-zero.
5. After outlining the theoretical assumptions, the speaker showed a possible measurement method that is suitable to measure this phenomenon.

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