Zero Point Energy Module proposed principle and open hardware prototype

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Abstract:

There is currently no practical way to extract energy from the lowest quantum state of a system, the zero-point energy. A thought experiment is proposed here to define the principles of a current generator that would extract energy from this state. To improve the clarity of the concept, an open hardware prototype is also discussed. This thought experiment may help better understand the quantum fluctuations, the practical limitations involved in extracting zero-point energy, and the interaction of virtual particles with matter. If the concept has any practical applications, there are implications to have an alternative energy source based on matter/anti-matter interactions. Beyond the ideas discussed here, there are charged particles in most places in the universe (plasma, solar winds, cosmic rays), and the concept discussed here can be applied to measure the flux of particles in these environments.

Introduction

The concept relevant to this thought experiment is the hypothetical generation of particles and antiparticles. This is supposed to occur everywhere and all the time. The original thought experiment to explain black hole radiation was that next to the event horizon, this constant creation/destruction, which is typically unnoticeable, manifests itself as an emission of radiation (Fig. 1, Hawking, S., 1988). The event horizon separates particles and antiparticles.

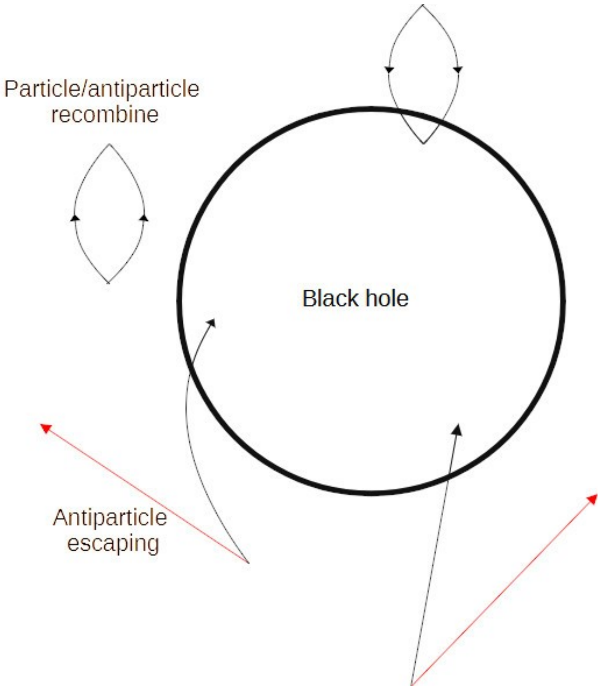

Fig. 1. The presence of the event horizon considerably affects the particle-antiparticle pairs and, for some space-time geometry, selectively removes one from the universe outside of the black hole (Hawkins, 1988).

The presented thought experiment uses a magnetic field gradient to separate charged pairs of particles and antiparticles. Electric charges of different signs statistically move in different directions in a magnetic field gradient. The novelty of the idea is to realize that if particles and antiparticles are constantly created, then a magnetic field gradient would have the immediate effect of statistically moving the particles and antiparticles in different directions. An electric field would work as well, but focusing on magnetic fields leads to a simple prototype.

In most system configurations, the particle/antiparticles would recombine together or with other atoms, and the charge, mass, and momentum would not vary. However, suppose we set up two conductive plates in a specific geometrical configuration. In that case, the positive and negative charges will move in opposite directions and towards these plates. This will lead to the generation of an electric current between the plates when an electric wire connects them.

Simulations:

For illustration purposes, I simulated the drift of a pair of electrons/antielectrons in the vacuum in the presence of a magnetic field gradient. I used a publicly available Python code based on the Lorentz equations. The parameters used are in Appendix 1. In most initial configurations, irrespective of the initial velocity, when a magnetic field in the z direction increases as x increases, the charged particles drift following the y axis. The electrons drift in the positive, and the antielectrons drift towards the negative. This is shown in Fig. 2, for two initial sets of velocity. The velocity in the z direction is not affected. However, the y axis drift tends to dominate where the particles go.

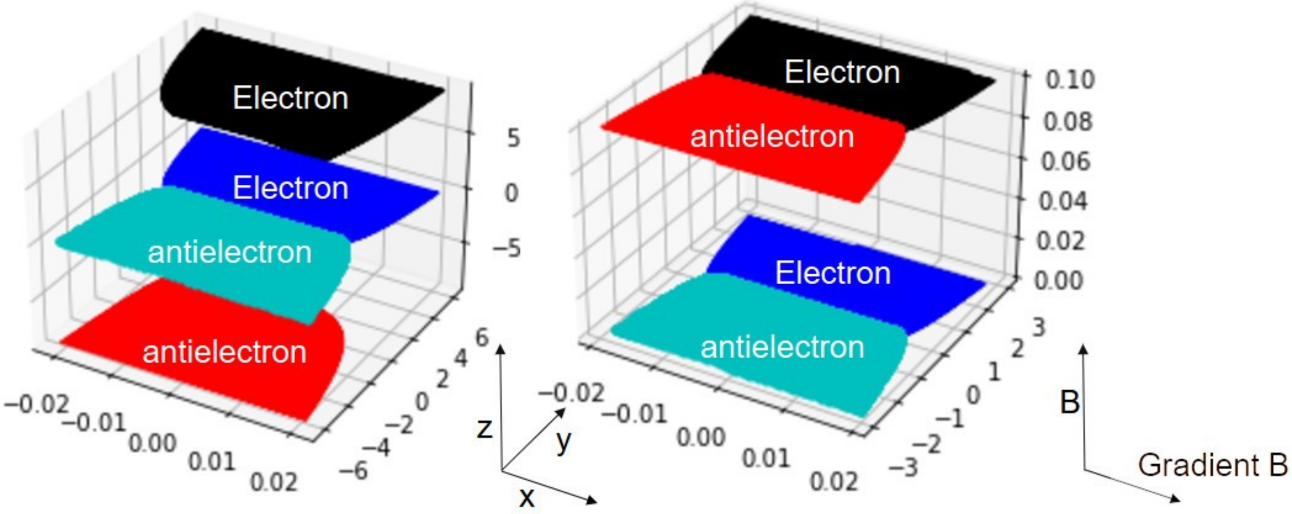

Fig. 2 Illustration of charged particles drifts in a magnetic field gradient. The magnetic field is in the z direction. The gradient is in the x direction. The drift is in the y direction. The two pairs of particles and antiparticles have slightly different starting velocities or starting points.

Fig. 3 shows a close-up of Fig. 2 for one anti-electron with an initial position of x, y, z = (0.01, 0, 0) and the initial velocity is vx, vy, vz= (0, 1, 0 - see Appendix 1). The units are m and m.s-1, respectively.

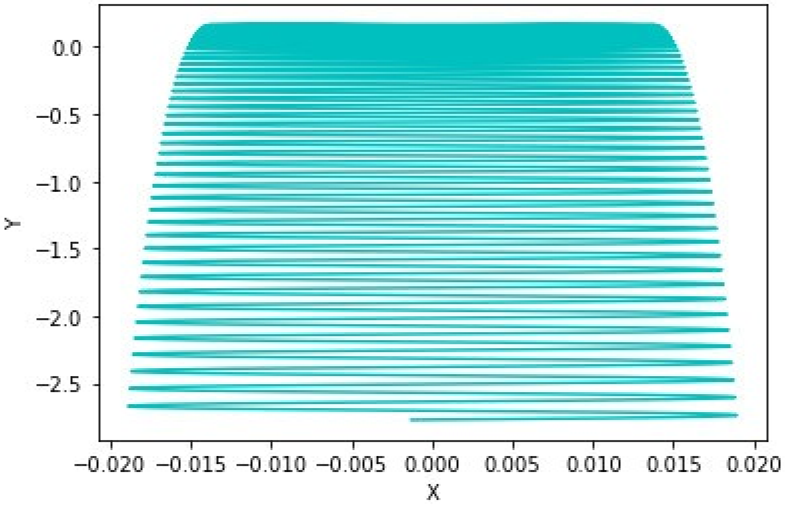

Fig. 3. Trajectory of one simulated antielectron in the x-y plane. The particle drifts towards y negative values as it oscillates in the x direction.

This simulation is based on the Lorentz force on charge particles of a specific mass. Except for the electromagnetic force, no relativistic or quantum effects are included. I also neglected the attraction between the two charged particles and the electromagnetic field generated by the particles. It seems like a reasonable assumption for electrons as the accelerations and velocity are such that the magnetic force will be the primary driver of the particles' movement. Suppose the analogy I used with black hole radiation is correct. In that case, a pair of particles and antiparticles can move to some extent before the Coulomb force brings them back together. To give some order of magnitudes, considering an electron moving at 1 $m.s^{-1}$, in a magnetic field of 0.01 T, the Coulomb force will have the same order of magnitude as the magnetic force when the electron and antielectrons are 1 centimeter apart. However, the magnitude of the electron acceleration in the same conditions will be 10^9 $m.s^{-2}$. The magnitude of the magnetic force will increase significantly at the nanosecond scale. This statement may still hold true for other pairs of particles, like the protons and antiprotons, but this matter was not investigated specifically.

In this simulation, the charged particles move in the vacuum. If they would move in the Earth's atmosphere, collisions would occur. The conservation of charge would keep the general drift in the same direction. However, the mass and velocity will be closer to the proton/antiproton pairs previously mentioned. This would require specific calculations to understand if and to what extent a low-pressure environment is necessary for the particles to reach the conductive plates.

Prototype

A relatively simple prototype can be built to test the validity of previously discussed principles. In the example discussed here, the prototype requires a magnetic field in the direction z, with a magnetic field gradient in the direction x. In this configuration, having two plates in opposite directions (± y) and linking the plates with an electric wire will result in the generation of an electric current. When the antielectron reaches the metallic plate, it will positively charge the plate, as it destroys one valence electron. The electron reaching the opposite plate will negatively charge the plate, and through an electric wire, a flow of electrons will go from the negatively charged plate to the positively charged plate. The interaction of other particles/antiparticles pair with the plates is more complex and would require more discussion. Antiprotons that can reach the atoms' plate nuclei will negatively charge the plate, and the charge will need to be transferred to the valence electrons before a current can be created. This could happen, for example, if the resulting nucleus is unstable and an electron or antielectron (beta particle) is created through a nuclear reaction. This would require further investigation.

Fig. 4 shows a possible prototype based on permanent magnets (Blümler, 2016). The flow of electrons is shown with the red arrow. Appendix 2 provides a possible list of materials for this open hardware (license in Appendix 3)

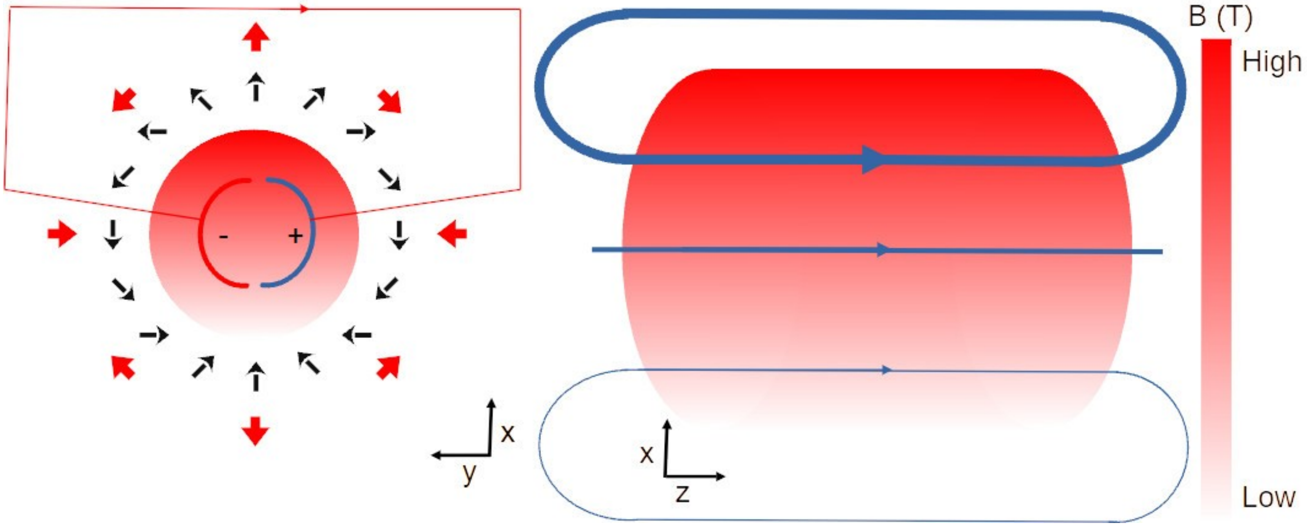

Fig. 4. Left: Gradient of the magnetic field created with an inner Halbach dipole created with 16 magnets (black arrows indicate the positive pole). The external quadrupole is made of eight magnets (red arrows show the positive pole). The white-red scale image shows the magnitude of the gradient field. In (Blümler, 2016), the magnetic field for such a system was from 0.44 to 0.448 T (gradient equal to 0.026 T/cm). Right: The figure on the left needs to be understood in 3 dimensions, with a specific length so that the magnetic field is in the z direction (blue arrows), with a gradient in the x direction. It is similar to a simplified magnetic resonance imaging device built here with permanent magnets.

Conclusion:

A thought experiment was presented, and a possible prototype for a current generator. If the prototype generates currents, some questions will help to optimize the design. What is the typical probability distribution of the velocity of the electron/antielectron pairs? How do other pairs of particles/antiparticles interact with the magnetic field gradient and the conductive plates? Is low pressure inside the enclosure necessary? What magnetic field and system geometry increase the current generation?

If the current generator does not work, it also raises interesting questions. Is there a constant creation of particles/antiparticles? If yes, is the lack of current generation related to an engineering difficulty, or is a more fundamental issue preventing the concept from having practical applications? Is there a fundamental reason why energy cannot be extracted from the lowest quantum state of a system?

References:

Blümler, P., 2016, Proposal for a permanent magnet system with a constant gradient mechanically adjustable in direction and strength. Concepts Magn. Reson., 46: 41 48. https://doi.org/10.1002/cmr.b.21320)

Hawking, S. A Brief History of Time, 1988

Acknowledgement:
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Open hardware:

Appendix 1: code used for Fig. 2 and Fig. 3. See (https://github.com/catherinemoresco/lorentz-force) for the full code, the key modifications are:

```
#  B field definition
def b(x, y, z):
  ''' What the B field evaluates to at a given x, y, z, location.
  Returns B as a vector. '''
  b = np.array([0, 0, 0.01*x])
  return b

#Particles used for Fig. 2 (left)
masses = [9.1093837e-31, 9.1093837e-31, 9.1093837e-31 , 9.1093837e-31]
positions = [[0.01, 0., 0.], [0.01, 0., 0.], [0.01,  -0.,  0.] , [0.01, -0., 0.]]
velocities = [[0.01e2, -0.01e2, 0.1], [-0.01e2, 0.01e2, -0.1], [0.01e2, 0.01e2, 0.], [-0.01e2, -0.01e2, 0.]]
charges = [-1.60217663e-19, 1.60217663e-19, -1.60217663e-19, 1.60217663e-19]

#Particles used for Fig. 2 (right)
#masses = [9.1093837e-31, 9.1093837e-31, 9.1093837e-31 , 9.1093837e-31]
#positions = [[0.01, 0., 0.1], [0.01, 0., 0.1], [0.01,  -0.,  0.] , [0.01, -0., 0.]]
#velocities = [[0.01e2, -0.0, 0.], [-0.01e2, 0.0, -0.], [0.0, -0.01e2, 0.], [-0.0, 0.01e2, 0.]]
#charges = [-1.60217663e-19, 1.60217663e-19, -1.60217663e-19, 1.60217663e-19]
```

Appendix 2:

This list of materials is to focus the discussion on a possible build. The final list of material for a working prototype may end up different from this list. I encourage reader to think about dimension and materials.

The way I am considering the next step for the prototype build is:
- Attach the conductive plates inside the chamber, add the conductor outside the chamber
- Seal the chamber
- Attach the magnets
- Test that a magnetic gradient exist, test if a current is generated
- Pump air out of the chamber
- Measure pressure and electric current output

1) **Magnets**: The dimensions of the magnets I used are:

- 3’’ X ½’’ X 1/8’’
- 60 X 10 X 5 mm

2) Chamber material:

- (Quantity 3, to hold the magnets) Multipurpose 6061 Aluminum Round Tube, 1/4" Wall Thickness, 6" OD, 1" Long
- The chamber itself - Pressure-Rated Borosilicate Glass Tube, 5-1/2" OD, 5" ID, 7" Long
- (Quantity 2, to seal the end of the chamber) Multipurpose 6061 Aluminum, 5-1/2" Diameter, 1/2" Long

3) Vacuum system

- Brass Threaded Fitting, High-Pressure, Through-Wall Connector, 1/8 NPT Female, Packs of 1
- Universal-Thread Push-to-Connect Tube Fitting, Nickel-Plated Brass, Straight, 3/8" OD x 3/8 Pipe Size, Packs of 5
- Vacuum Gauge with Steel Case, Dual Scale, 1-1/2" Dial, 1/8 NPT Male Bottom Connection

4) Plates:

- Aluminum or copper (foil, thin plates)

5) Conductor:

- Copper wire. Note that placement can be important. I suggest the wire start in the z direction with enough length to close the loop 5-10 inches from the chamber.

6) Seal made with Faraday wax

- 1 pt. yellow beeswax
- 5 pt. colophony (Rosin)
- 1 pt. Venetian red

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