

# Repulsive gravity as an alternative to dark energy (Part 2: In the quantum vacuum)

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(PhysOrg.com) -- During the past few years, CERN physicist Dragan Hajdukovic has been investigating what he thinks may be a widely overlooked part of the cosmos: the quantum vacuum. He suggests that the quantum vacuum has a gravitational charge stemming from the gravitational repulsion of virtual particles and antiparticles. [Previously](#), he has theoretically shown that this repulsive gravity can explain several observations, including effects usually attributed to dark matter. Additionally, this additional gravity suggests that we live in a cyclic Universe (with no Big Bang) and may provide insight into the nature of black holes and an estimate of the neutrino mass. In his most recent paper, published in *Astrophysics and Space Science*, he shows that the quantum vacuum could explain one more observation: the Universe's accelerating expansion, without the need for dark energy.

“The [quantum vacuum](#) was predicted theoretically more than 60 years ago,” Hajdukovic told *PhysOrg.com*. “Today, there is significant experimental evidence that the quantum vacuum exists. I have decided to combine one reality (the quantum vacuum) with one hypothesis (the negative gravitational charge of antiparticles) and to study the consequences. The hypothesis of the gravitational repulsion between matter and antimatter is older than half a century, but before me no one has used it in the combination with the quantum vacuum. ... The results are surprising; there is potential to explain [the Universe's accelerating expansion] in the framework of the quantum vacuum enriched with the gravitational repulsion between matter and antimatter.”

According to Hajdukovic, [gravity](#) in the quantum vacuum arises from the gravitational [repulsion](#) between the positive gravitational charge of matter and the (hypothetical) negative gravitational charge of antimatter. While matter and antimatter are gravitationally self-attractive, they are mutually repulsive. (This part is similar to Massimo Villata's theory from part 1, in which negatively charged antimatter exists in voids rather than in the quantum vacuum.) Although the quantum vacuum does not contain real matter and antimatter, short-lived [virtual particles](#) and virtual antiparticles could momentarily appear and form pairs, becoming gravitational dipoles.

“If particles and antiparticles have gravitational charges of the opposite sign, a sufficiently strong gravitational field can convert a virtual pair into a real one,” Hajdukovic explained. “It is not a new hypothesis but a consequence of the Schwinger mechanism, well known in quantum field theories.”

In the new paper, Hajdukovic calculates that the energy density of the gravitational dipoles in the quantum vacuum is the correct order of magnitude to act as the cosmological constant, or the force causing the Universe's accelerating expansion. While this agreement may not seem that remarkable at first, it becomes impressive in the context of the much less agreeable predictions of quantum field theory, which predicts the energy density of the quantum vacuum to be at least 30 - and up to 120 - orders of magnitude larger than the observed [dark energy](#) density. Hajdukovic's calculations also estimate that the Universe's expansion began accelerating when the Universe was about half of its present size, which is only slightly earlier than the prediction of standard cosmology.

Interestingly, one significant difference between Hajdukovic's quantum vacuum model and standard cosmology is that the former predicts that the acceleration is decreasing, while the latter predicts it is increasing. Very different predictions for the fate of the Universe result from these

differences.

“The series of publications shows that the quantum vacuum, enriched with the hypothesis of the negative gravitational charge for [antiparticles](#), has the potential to explain the observed phenomena in astrophysics and cosmology without invoking [dark matter](#) and dark energy and mysterious mechanisms for inflation and matter-antimatter asymmetry,”

Hajdukovic said. “If antimatter really has negative gravitational charge (which could be revealed by the AEGIS experiment at CERN), the above papers have started a new scientific revolution. But the papers are important even if antimatter has no negative gravitational charge, because they encourage reconsidering the quantum vacuum as a key for the understanding of the Universe.”

In addition to the AEGIS experiment in [CERN](#), which is designed to reveal the gravitational properties of antihydrogen, Hajdukovic said that other experiments are also investigating the gravitational properties of antimatter. For instance, physicists at the University of California, Riverside, have recently begun studying the gravitational properties of positronium (an electron-positron pair).

## **Part 1. [Repulsive gravity as an alternative to dark energy \(In voids\)](#)**

**More information:** Dragan Hajdukovic. “Quantum vacuum and virtual gravitational dipoles: the solution to the dark energy problem?” *Astrophysics and Space Science*. DOI: [10.1007/s10509-012-0992-y](https://doi.org/10.1007/s10509-012-0992-y)

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