How to unbalance nothingness

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German scientists succeeded in calculating the time evolution of the vacuum decay in detail.

Nothingness – this is the research subject-matter of a team of theoretical physicists from the Universities Jena (Germany) and Graz (Austria). "The ground state of our world can't be described by the absence of all matter," Professor Dr. Holger Gies from the Institute of Theoretical Physics of the Friedrich-Schiller-University Jena and the Helmholtz-Institute Jena explains. "This so-called quantum vacuum rather turns out to be a complex state of constantly fluctuating quantum fields with physical properties."

The world-wide community of physicists is hoping to be able to witness a particularly spectacular characteristic in a few years' time: the spontaneous decay of the vacuum into pairs of particles of matter and antimatter in super strong electric fields. Due to the new research results of the Austro-German team of physicists, this goal came a few steps closer.

Although first theoretical consideration concerning the spontaneous decay of the vacuum dates back to the year 1931, its comprehensive understanding is still in its infancy. "A great challenge in modern theoretical physics is the description of quantum fields out of equilibrium," Professor Gies explains. "We are facing this problem in phase transitions in the early Universe as well as in many experiments in solid state physics." Therefore experimental proof of the vacuum decay – as it might be delivered by high intensity lasers in the near future – will

provide knowledge exceeding this particular field.

The scientists from Graz and Jena now succeeded calculating the time evolution of the vacuum decay in detail. "Even we were surprised by the results," Professor Gies confesses. According to the results particles of matter and antimatter behave in a novel self-focusing way and therefore the possibility of discovering them is higher than expected. "The quantum vacuum has already had some surprises in store," says the Heisenberg-Professor for Theoretical Physics. "To unbalance this nothingness could develop into a new prolific field of research."

The results of this work have just been published in the scientific journal *Physical Review Letters*.

More information: F. Hebenstreit, R. Alkofer, H. Gies: Particle Self-Bunching in the Schwinger Effect in Spacetime-Dependent Electric Fields, *Phys. Rev. Lett.* 107, 180403 (2011), DOI: 10.1103/PhysRevLett.107.180403

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