

IBM Scientists Observe Elusive Gravitational Effect in Solid-State Physics

Previously thought to only occur in the early stages of the universe and within neutron stars and black holes

ZURICH - 19 Jul 2017: An international team of physicists, materials scientists and string theoreticians have observed a phenomenon on Earth that was previously thought to only occur hundreds of light years away or at the time when the universe was born. This result could lead to a more evidence-based model for the understanding the universe and for improving the energy-conversion process in electronic devices.

Using a recently discovered material called a Weyl semimetal, similar to 3D graphene, scientists at IBM Research have mimicked a gravitational field in their test sample by imposing a temperature gradient. The study was supervised by [Prof. Kornelius Nielsch](#), Director at the [Leibniz Institute for Materials and Solid State Research Dresden \(IFW\)](#) and [Prof. Claudia Felser](#), Director at the [Max-Planck-Institute](#) for Chemical Physics of Solids in Dresden.

After conducting the experiment in a cryolab at the [University of Hamburg](#) with high magnetic fields, a team of theoreticians from [TU Dresden](#), [UC Berkeley](#) and the [Instituto de Fisica Teorica UAM/CSIC](#) confirmed with detailed calculations that they observed a quantum effect known as an axial-gravitational anomaly, which breaks one of the classical conservation laws, such as charge, energy and momentum.

This law-breaking anomaly had previously been derived in purely theoretical reasoning with methods based on string theory. It was believed to exist only at extremely high temperatures of trillions of degrees, as an exotic form of matter, called a quark-gluon plasma, at the early stages of the universe deep within the cosmos or created using particle colliders. But to their surprise, the researchers discovered that it also exists on Earth in the properties of solid-state physics, on which much of the computing industry is based on, spanning from tiny transistors to cloud data centers. This discovery is appearing today in the peer-reviewed journal *Nature*.

“For the first time, we have experimentally observed this fundamental quantum anomaly on Earth which is extremely important towards our understanding of the universe,” said [Dr. Johannes Gooth](#), an IBM Research scientist and lead author of the paper. “We can now build novel solid-state devices based on this anomaly that have never been considered before to potentially circumvent some of the problems inherent in classical electronic devices, such as transistors.”

“This is an incredibly exciting discovery. We can clearly conclude that the same breaking of symmetry can be observed in any physical system, whether it occurred at the beginning of the universe or is happening today, right here on Earth,” said Prof. [Dr. Karl Landsteiner](#), a string theorist at the [Instituto de Fisica Teorica UAM/CSIC](#) and co-author of the paper.

IBM scientists predict this discovery will open up a rush of new developments around sensors, switches and thermoelectric coolers or energy-harvesting devices, for improved power consumption.

Read more at: <https://www.ibm.com/blogs/research/2017/07/scientists-observe-gravitational-anomaly-on->

[earth/](#)

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Images are available at: https://www.flickr.com/gp/ibm_research_zurich/6690Y4

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Experimental signatures of the mixed axial-gravitational anomaly in the Weyl semimetal NbP, [Johannes Gooth](#), [Anna C. Niemann](#), [Tobias Meng](#), [Adolfo G. Grushin](#), [Karl Landsteiner](#), [Bernd Gotsmann](#), [Fabian Menges](#), [Marcus Schmidt](#), [Chandra Shekhar](#), [Vicky Süß](#), [Ruben Hühne](#), [Bernd Rellinghaus](#), [Claudia Felser](#), [Binghai Yan](#), [Kornelius Nielsch](#), DOI: 10.1038/nature23005

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