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Minutest absolute magnetic field measurement

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Every measurement is potentially prone to systematic error. The more sensitive the measurement method, the more important it is to make sure it is also accurate. This is key for example in measuring magnetic fields in state-of-the-art fundamental physics experiments. Now, an international team of physicists has developed an extremely high-precision method for the determination of magnetic fields. The resulting device, they found, has an intrinsic sensitivity that makes it ideal for fundamental physics and cosmology experiments attempting to explain the missing antimatter of the universe. The findings by Hans-Christian Koch from the University of Fribourg, Switzerland, and colleagues have just been published in *EPJ D*.

The prototype magnetometer the team developed combines the accuracy of a helium (3He) magnetometer with the high sensitivity of a cesium magnetometer. It is also much more convenient than the previously used combination of helium magnetometers and SQUIDs, which requires cooling near absolute zero.

In this paper, the team establishes a theoretical formula describing the ultimately reachable sensitivity of the magnetometer. To do so, they analysed the dependence of the combined magnetometer's sensitivity on the properties of its constituents. They found that the sensitivity can be predicted from parameters characterizing the cesium magnetometers and the helium sample involved in the detection. The team's formula led to predictions that were in excellent agreement with experimental results.

They subsequently calculated the sensitivity of the magnetometer in the envisioned application in an experiment searching for the electric dipole moment of neutrons (nEDM), which are basic constituents of ordinary matter. Observing an nEDM would imply a broken symmetry of the laws of physics, called CP-violation. Such a finding could help to account for the primordial matter-antimatter imbalance at Big Bang stage, leading to the current abundance of matter.

More information: H.-C. Koch, G. Bison, Z. D. Gruji?, W. Heil, M. Kasprzak, P. Knowles, A. Kraft, A. Pazgalev, A. Schnabel, J. Voigt, and A. Weis (2015), Investigation of the intrinsic sensitivity of a 3He/Cs magnetometer , *Eur. Phys. J. D* 69, 262, DOI: 10.1140/epjd/e2015-60509-5

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