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Extreme precision magnetometry

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Searches for electric dipole moments (EDM), axion-like particle searches, ultra-cold atom experiments in space, atomic fountains or a new neutron-antineutron oscillation search at the European Spallation Source require precisely characterized and also very small magnetic fields. Some of these experiments actually are the most accurate and precise magnetic field sensors ever built.

Developments triggered by gradient-induced so-called "geometric phase" effects in the PanEDM experiment to search for the neutron EDM, the magnitude of magnetic fields over cubic meter dimensions has been reduced to few 10-12 T, with noise below 10-15 T and a stability of 10-14 T over several 100 s.

At this level of precision, it is difficult to disentangle properties of the magnetic field from the behavior of a probe to actually measure the field. In this talk I will discuss the state-of-the-art in small magnetic field research: (i) the best magnetic fields outside of superconductors and the level of understanding of how to generate and control these fields; (ii) recent advances of sensors to measure magnetic field stability and a 129-Xe EDM experiment with a sensitivity of 10-44 eV sensitivity, as well as a novel electrostatic storage ring to search for axion-like particles at TUM; (iii) transfer of these technologies being transferred to applications, in particular an example where a new diagnostic method for fetal heart diseases using atomic magnetometry has recently been developed.

Scientific topic

Application of new technologies

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