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Ultrasensitive detection of magnetic field using a single artificial atom MUSTAFA BAL, CHUNQING DENG, JEAN-LUC ORGIAZZI, FLORIAN ONG, ADRIAN LUPASCU, Institute for Quantum Computing, Department of Physics and Astronomy, and Waterloo Institute for Nanotechnology, University of Waterloo — We employ a single artificial atom to implement ultrasensitive magnetic field detection. The artificial atom is a persistent current qubit with a size in the micron range, which couples very strongly to magnetic field, with an equivalent magnetic moment of 3.8×10^5 Bohr magnetons. Sensitive detection is realized by employing the field-dependent coherent evolution of the artificial atom and high-fidelity quantum measurement, in a way similar to atomic magnetometry. Using an operation mode based on spin-echo manipulation and qubit reset by energy relaxation, we demonstrate a magnetic field detection sensitivity of $7.5\,pT/\sqrt{Hz}$ for an AC field at $10MHz$. The sensitivity is further improved if the reset step is eliminated and the correlation of consecutive projective measurements is used instead, reaching $3.3\,pT/\sqrt{Hz}$. The intrinsic sensitivity of this method to AC fields at frequencies in the $100\,kHz - 10\,MHz$ range compares favourably with DC-SQUIDs and atomic magnetometers of equivalent spatial resolution. More than an order of magnitude increase in sensitivity is possible using feasible improvements of qubit design and readout. This result illustrates the potential of artificial quantum systems for sensitive detection and related applications.

Mustafa Bal
Institute for Quantum Computing, Dept of Physics and Astronomy,
and Waterloo Institute for Nanotechnology, University of Waterloo

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