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Measuring Magnetic Fields with Magnetic-Field-Insensitive Transitions YOTAM SHAPIRA, YEHONATAN DALLAL, ROEE OZERI, Department of Physics of Complex Systems, Weizmann Institute of Science, ADY STERN, Department of Condensed Matter Physics, Weizmann Institute of Science — Atomic sensing is typically performed by tracking an accumulating dynamical phase, which appears due to the dependence of the energy on the quantity to be sensed. Contemporary high-sensitivity atomic magnetometers operate by tracking the phase difference between Zeeman-split atomic states. Here, we use clock states, atomic states that have a magnetic-field insensitive energy difference. These states are, in leading order, robust to magnetic field noises and therefore have long coherence time. They are typically used in atomic clocks. One would expect that clock states would be unable to sense magnetic fields. We show that, surprisingly, clock states can indeed acquire a phase, which is proportional to the magnetic field magnitude. We measure this effect on an ensemble of trapped Rb87 atoms. We propose a new magnetic field sensing method which uses magnetic-field-insensitive transitions. We show that our measurements sensitivity scales inversely with the coherence time of the clock subspace, which is typically much longer than in a Zeeman-split subspace. This implies that our proposed method may be used to improve upon the sensitivity of Zeeman-splitting based magnetometry methods. Our findings have been recently published on Phys. Rev. Lett. 123, 133204 (2019).

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