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Magnetic-field diagnostics in a cold-atom trap using Rydberg electromagnetically induced transparency[1] XIAOXUAN HAN, Department of Physics, University of Michigan, YONGMEI XUE, State Key Laboratory of Quantum Optics and Quantum Optics Devices, Institute of Laser Spectroscopy, Shanxi University, JIANMING ZHAO, Collaborative Innovation Center of Extreme Optics, Shanxi University, GEORG RAITHEL, Department of Physics, University of Michigan — We perform an in-situ, atom-based measurement of a time-dependent magnetic field in a gas of ultra-cold cesium atoms using Rydberg electromagnetically induced transparency (EIT). The three-level ladder EIT system consists of ground ($6S_{1/2}$), excited ($6P_{3/2}$), and Rydberg levels ($48D_{5/2}$), with a total of 96 magnetic sublevels. The magnetic field we measure in the present demonstration is a superposition of an adjustable field from a set of Helmholtz coils and a rapidly decaying eddy-current field. The EIT spectrum exhibits two dominant lines with a Zeeman splitting of 5.6 MHz per Gauss, which are employed to measure the time-dependent magnetic field. A quantum Monte Carlo wave-function (QMCWF) approach is used to solve the quantum Master equation of the 96-level problem. The QMCWF results allow us to interpret the EIT spectra in considerable detail, showing good agreement with the experiment, and to gain insight into optical-pumping and radiation-pressure effects. To demonstrate the utility of the in-situ, time-resolved magnetic-field measurement method, we determine the decay time of the eddy-current magnetic field at the location of the cold atom cloud. The field and time resolutions of the measurement are about 5 mG and 100 μs, respectively.

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