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Spin ensembles as sensitive probes of environmental magnetic field noise ABRAHAM ASFAW, Department of Electrical Engineering, Princeton University, Princeton NJ 08544, USA, GARY WOLFOWICZ, JOHN J. L. MORTON, London Centre for Nanotechnology, University College London, London WC1H 0AH, UK, ALEXEI TYRYSHKIN, STEPHEN LYON, Department of Electrical Engineering, Princeton University, Princeton NJ 08544, USA — Environmental magnetic field noise makes quantum control of electron and nuclear spins difficult. Conversely, the sensitivity of spins to small magnetic fields implies that they can be used as sensitive probes of magnetic field fluctuations. We report spin resonance measurements of donors in silicon showing that the phase information in single-shot measurements of spin ensembles combined with quadrature detection can yield useful information about environmental noise. By measuring the accumulated phase statistics with time, we extract the power spectrum of the environmental magnetic field noise. The range of noise frequencies probed in this way is set by the magnetic moment of the spins. We measure the noise power spectrum at high frequencies (100 Hz - 10 kHz) using electron spins and at low frequencies (1 - 100 Hz) using nuclear spins. We also show that a broadband measurement of the noise power spectrum can be obtained by tuning the magnetic moment of electron spins in bismuth donors over a wide range from 0.01 to 1 electron magnetic moment. Our method, which uses the full statistics of the accumulated phase, can be viewed as complementary to existing dynamical decoupling schemes which use filter functions to probe the noise power spectrum.

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