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Magnetic resonance with squeezed microwaves PATRICE BERTET, AUDREY BIENFAIT, PHILIPPE CAMPAGNE-IBARCQ, CEA-Saclay, ALEXANDER HOLM-KIILERICH, Aarhus University, XIN ZHOU, IEMN, SEBASTIAN PROBST, CEA-Saclay, JARRYD PLA, University of New South Wales, THOMAS SCHENKEL, Lawrence Berkeley National Laboratory, DENIS VION, DANIEL ESTEVE, CEA-Saclay, JOHN MORTON, University College London, KLAUS MOELMER, Aarhus University — Although vacuum fluctuations appear to represent a fundamental limit to the sensitivity of electromagnetic field measurements, it is possible to overcome them by using so-called squeezed states. In such states, the noise in one field quadrature is reduced below the vacuum level while the other quadrature becomes correspondingly more noisy, as required by Heisenberg's uncertainty principle. At microwave frequencies, cryogenic temperatures are required for the electromagnetic field to be in its vacuum state and reach the quantum limit of sensitivity. Here we report the use of squeezed microwave fields to enhance the sensitivity of magnetic resonance spectroscopy of an ensemble of electronic spins beyond the standard quantum limit. Our scheme consists in sending a squeezed vacuum state to the input of a cavity containing the spins while they are emitting an echo, with the phase of the squeezed quadrature aligned with the phase of the echo. We demonstrate a total noise reduction of 1.2dB at the spectrometer output due to the squeezing. These results provide a motivation to examine the application of the full arsenal of quantum metrology to magnetic resonance detection.

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