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Parametric Amplification Protocol for Frequency-Modulated Magnetic Resonance Force Microscopy Signals LEE HARRELL, Department of Physics and Nuclear Engineering, U.S. Military Academy, West Point, NY, ERIC MOORE, SANGGAP LEE, STEVEN HICKMAN, JOHN MAROHN, Department of Chemistry and Chemical Biology, Cornell University, Ithaca, NY — We present data and theoretical signal and noise calculations for a protocol using parametric amplification to evade the inherent tradeoff between signal and detector frequency noise in force-gradient magnetic resonance force microscopy signals, which are manifested as a modulated frequency shift of a high- Q microcantilever. Substrate-induced frequency noise has a $1/f$ frequency dependence, while detector noise exhibits an f^2 dependence on modulation frequency f. Modulation of sample spins at a frequency that minimizes these two contributions typically results in a surface frequency noise power an order of magnitude or more above the thermal limit and may prove incompatible with sample spin relaxation times as well. We show that the frequency modulated force-gradient signal can be used to excite the fundamental resonant mode of the cantilever, resulting in an audio frequency amplitude signal that is readily detected with a low-noise fiber optic interferometer. This technique allows us to modulate the force-gradient signal at a sufficiently high frequency so that substrate-induced frequency noise is evaded without subjecting the signal to the normal f^2 detector noise of conventional demodulation.

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