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Nanometer Scale Distance Measurements for Biological Systems using Gd^{3+}-based Spin Probes at High Magnetic Fields DEVIN EDWARDS, Department of Physics, University of California, Santa Barbara, DANIELLA GOLDFARB, Department of Chemical Physics, Weizmann Institute of Science, Israel, SONGI HAN, Department of Chemistry, University of California, Santa Barbara, MARK SHERWIN, Department of Physics, University of California, Santa Barbara — Determination of nanometer-scale distances is critical for understanding structure and dynamics of proteins. Electron Paramagnetic Resonance (EPR), primarily below 1 T, is used to complement other structural techniques by quantifying sparse distances up to 8 nm in biomolecules labeled with nitroxide-based radicals. EPR becomes more powerful with increasing magnetic fields and frequencies. At 95 GHz (3.5 T), Gd^{3+} ions have shown clear advantages over nitroxide probes (Potapov, JACS 2010). We show that these advantages are even more dramatic at 240 GHz (8.5 T). The width of Gd^{3+}'s central EPR transition narrows with increasing average distance between Gd^{3+} ions out to distances as long as 5 nm. This doubles the distances accessible with nitroxides in continuous wave measurements, which can be carried out above the 200K protein-glass transition and with broad distance distributions. Temperature-dependent measurements of the phase memory times at 8.5 T and low temperatures show distance dependence out to 10 nm. Measurements of Gd^{3+} labeled Proteorhodopsin confirm that phase memory times remain long enough to observe distance dependence in a spin-labeled protein. This work is supported by the National Science Foundation and the Binational Science Foundation.

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