Diamond sensing of magnetic fluctuations in nanoparticles

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The spin fluctuations in magnetic nanoparticles are of interest to both applications like nanoscale magnetic information storage and fundamental science like nanoscale condensed matter physics. The measurement of the spin fluctuations in single magnetic nanoparticles, however, is not trivial. We explore in theory various methods for detecting magnetic fluctuations of nanoparticles at different timescales based on diamond quantum sensing, including real-time measurement, correlation spectroscopy, spin coherence sensing, and relaxation time sensing. We will also present preliminary experimental results toward multi-timescale sensing of the magnetic fluctuations of single nanoparticles and discuss the challenges and opportunities in such studies, in materials science and in physics. This work was supported by the National Basic Research Program of China (973 Program) under Grant No. 2014CB921402, Hong Kong Research Grants Council.

Figure 1. The random jumps of the photon counts (shown in (a)) from a nanodiamond placed near a magnetic nanoparticle (TEM image and confocal image shown in (b)). The nitrogen-vacancy center spins in the nanodiamond are subjected to a microwave with frequency in resonance. The photon count jumps indicates the spectral jumps of the spin resonances and hence the magnetic fluctuations of the magnetic nanoparticle.