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Decoherence due to elastic Rayleigh scattering[1] H. UYS[2], M.J. BIERCUK, A.P. VANDEVENDER, C. OSPELKAUS, J.J. BOLLINGER, NIST, Boulder, CO, D. MEISER, JILA, U. Colorado, Boulder, CO — Off-resonant light scattering (spontaneous emission) is an important source of decoherence in many coherent control experiments. Typically one focuses on the effects of Raman scattering, in which an atomic state is changed by a single scattering event. We present theoretical and experimental studies of the decoherence of hyperfine ground-state superpositions due to *elastic* Rayleigh scattering of off-resonant light. By a master equation technique we show that for a two-level superposition the elastic decoherence rate is the square of the difference between the two elastic scattering amplitudes. Thus, if the light detunings for the two states have opposite sign, the amplitudes interfere constructively and can result in a large decoherence rate. We calculate and measure the total decoherence rate for a superposition state of the valence electron spin in the ground state of $^9Be^+$ in a 4.5 T magnetic field. We find that for large ($\sim$20 GHz) detunings, decoherence due to elastic Rayleigh scattering can be 5 times larger than decoherence due to Raman scattering. This is in contrast with work[3] at low magnetic field where decoherence was dominated by Raman scattering.

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[3]R. Ozeri, et al., PRL **95**, 030403 (2005)

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