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Photon echo Measurement of Optical Decoherence in Er^{3+}-doped Silicate Fiber[1] ROGER M. MACFARLANE, YONGCHEN SUN, PETER B. SELLIN, RUFUS L. CONE, Physics Dept., Montana State University, Bozeman, MT 59717 — The dephasing time T_2 ($\Gamma_h = 1/\pi T_2$ is the homogeneous linewidth) of the $^4I_{15/2}$ – $^4I_{13/2}$ transition of Er^{3+} in a silicate optical fiber was measured by two-pulse photon echoes vs. external magnetic field and temperature. A field of 2 T reduces the homogeneous linewidth by 1.8 MHz from its value of 3.2 MHz at zero field, an anomalously large reduction compared to that in oxide crystals with similar Er^{3+} concentration. We propose that the dephasing is caused by two classes of low frequency tunneling modes: elastic "two-level-systems" (TLS) responsible for 1.4 MHz and coupled spin-elastic TLS modes for 1.8 MHz. The coupled modes acquire a magnetic character from an elastic Er^{3+} spin-TLS interaction. The temperature dependence of the homogeneous linewidth is linear in the measured range of 1.4 to 4 K. Three- pulse photon echo decays measured from 0.5 μs to 500 μs and at a field of 5 T characterized spectral diffusion caused by the distribution of TLS tunneling rates. Our results suggest a potential for application of doped communication fibers in frequency selective optical processing, buffer memories and spatial-spectral holographic devices.

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