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Optical decoherence and spectral diffusion in an erbium-doped silica glass fiber featuring long-lived spin sublevels

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Rare-earth-ion (REI) doped materials offer unique spectroscopic properties, such as narrow optical linewidths, or long-lived shelving levels that allow for spectral tailoring of their inhomogeneously broadened absorption lines. Indeed, both these properties are required simultaneously in order to implement many of the potential applications of (REI) doped materials, such as optical quantum memories. REI-doped glasses come with some advantages compared to REI-doped crystal hosts such as a larger inhomogeneous broadening, benefitting large-bandwidth applications, but also disadvantages such as coherence times limited by two level systems. Here, we study the coherence properties of a weakly doped erbium silica glass fiber, motivated by our recent observation of efficient and long-lived Zeeman level storage in this material and due to its potential for applications at telecommunication wavelengths. We present a model describing the magnetic field and temperature dependence of the coherence lifetime and determine the processes limiting the latter in different regimes. Furthermore, we investigate spectral diffusion, and find that it is magnetic field independent over long time scales. We highlight the observation of effective linewidths of the order of 1 MHz at low magnetic fields, where efficient spectral tailoring is possible.

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