Ultraslow and ultrafast optical dephasing

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In the optical region, the dipole dephasing time T_2 spans and enormous range, extending typically from milliseconds to picoseconds. For example, nonlinear optical free induction decay (FID) of the impurity ion Pr^{3+}, the $^1D_2 \rightarrow {}^3H_4$ transition (5925 Å) of Pr^{3+}:LaF_3 at 2K, yields $T_2 \sim 16$ μsec corresponding to an exceedingly narrow optical linewidth of 10 kHz.[1] The Pr^{3+} ions are coherently prepared by a cw ring dye laser which is frequency-locked, and the FID signal appears in the forward beam when the laser beam is suddenly frequency switched. The Pr^{3+} optical linewidth, which is due to the fluctuating local nuclear magnetic fields, can be reduced even further, to$\sim$2 kHz, by the application of an rf magnetic field which quenches the fluctuating ^{19}F-^{19}F dipolar interaction.[2] A theory of this effect, the magic angle line narrowing technique, will be described. Other measurements, on a 100 psec time scale, are facilitated by a novel traveling wave electro-optic phase modulator that frequency switches a cw dye laser.[3] New coherence effects arise at these short times such as the first order FID and test theoretical predictions.

References

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超慢和超快光学退相

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在光频区内，偶极退相时间 T_2 跨越极大的范围，一般是从毫秒到微微秒。例如，杂质离子 Pr^{3+} 的非线性光学自由感应衰变 [FID]，即在 2K 时 Pr^{3+}:LaF_3 的 $^1D_2 \longrightarrow {}^3H_4$ 跃迁 (5925 埃)，获得 $T_2 \sim 16$ 微秒，相当于 10 千赫的极窄的光学线宽。Pr^{3+} 离子是用锁频的连续环形染料激光相干地制备的，而当激光束频率突然变化时，FID 讯号就出现在前面光束中，可以进一步减少这种由于涨落的局部核磁场所引起的 Pr^{3+} 光学线宽，即应用一个射频磁场以猝灭涨落的 ^{19}F-^{19}F 偶极相互作用而达到$\sim$ 2 千赫。这一效应的理论，即奇特的角线变窄技术将予以叙述。另一些在 100 微微秒量级上的测量，由于采用新的行波光-电相位调制器使连续染料激光器频率调谐而变得方便了。在这些短暂的时间中产生了一些新的相干效应，例如第一级 FID，以及检验了理论的预言。