6.6 Determination of Relative Oscillator Strengths by Coherent Raman Beats, Raman Heterodyne and Hole Burning Spectroscopy

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Coherent Raman beats are transient phenomena that can be observed when a resonant test laser field undergoes coherent Raman scattering from a sublevel coherence that has been excited between two non-degenerate sublevels of an atom. It allows spectroscopic experiments on transitions between atomic sublevels with a resolution that is neither limited by the broadening of the optical transitions nor by the laser frequency jitter. While in most cases the theoretical description uses a three-level model atom, actual experiments involve multilevel atoms. Our experiment was performed on an inhomogeneously broadened ensemble of multilevel atoms. Using a pump-and-probe technique with a frequency-tunable probe laser beam, we investigated the relative oscillator strengths of the $^3H_4 \leftrightarrow {}^1D_2$ transitions of the impurity ion solid Pr^{3+}:$YAlO_3$. They depend on the relative orientation of the quantization axes in the ground and excited state. These results were consistent with data obtained from optical - radio frequency double resonance methods and high-resolution spectral holeburning spectra.