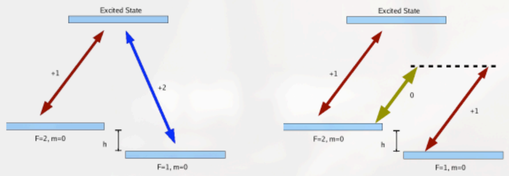
The N+CPT Resonance

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Rationale:

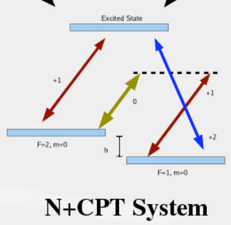
Laser-based ultracompact atomic frequency standards employ current modulated laser diodes to create the required optical side-bands. These sidebands unavoidably create simultaneous N- and CPT-type resonant systems on the same atomic levels.



CPT system

N-resonance

Due to Modulation Comb



N+CPT System

Quantum Optics Models of N+CPT

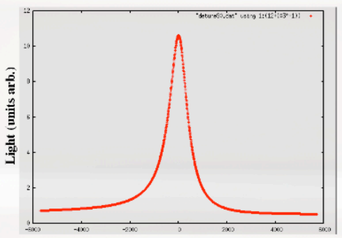
	Pro	Con
Semianalytic perturbation	Analytical detail	Only 4 level system
Truncated Floquet	Simple, general	Numerically Expensive

In the semianalytic perturbative model the presence of these combined pathways leads to an interference term (here written in the co-rotating frame) in the ground state coherence. A, B and C are the +1, carrier and +2 sideband Rabi frequencies, and the index '1' and '2' refer to the ground states whereas '0' refers to the excited state.

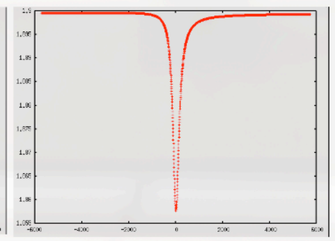
$$\partial_t \rho_{12} = \left(i\delta - \Gamma - i\frac{A^2 - B^2}{h - \Delta} \right) \rho_{12} - iA\rho_{02} + iC\rho_{10} + \frac{iAB}{h-\Delta}(\rho_{22} - \rho_{11})$$

CPT part — N-resonance part

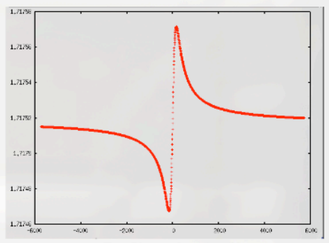
Typical CPT Lineshape



Typical N Lineshape



Typical N+CPT Lineshape



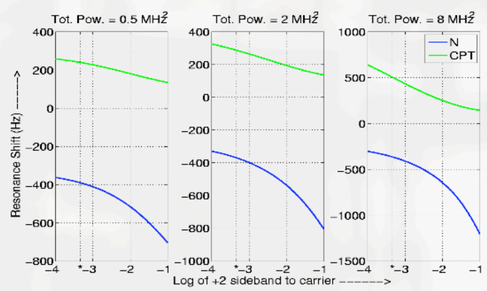
Peak Shift, Visibility and theT.Y. Point

The truncated Floquet analysis gives a detailed picture of the combined resonance's shape as a function of the intensity ratio of the sidebands. In the graphs below, the asterisk represents the T.Y. point, an operating condition for which the detuning and light shifts cancel to leading order.

See also:

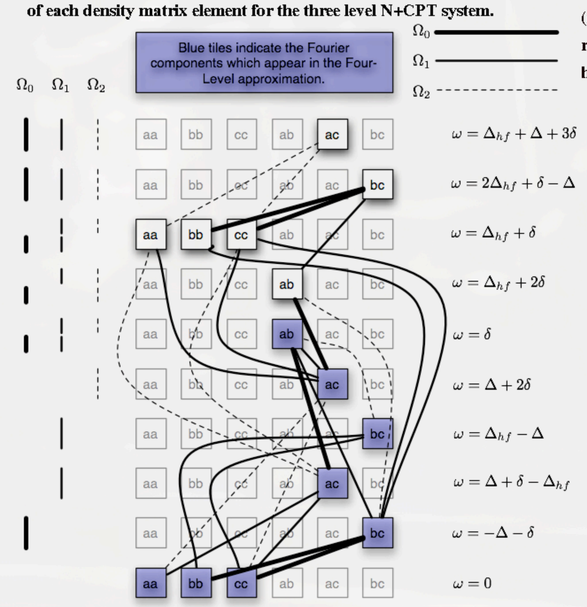
V. Taichenachev and V. I. Yudin, Private communication, Jan. 2005.

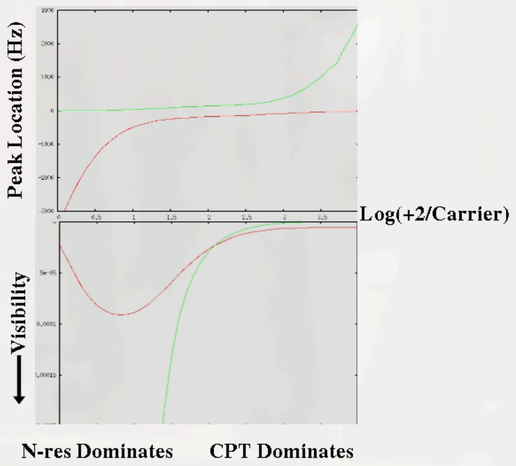
I. Novikova, D. F. Phillips, A. S. Zibrov, R. L. Walsworth, V. Taichenachev and V. I. Yudin, Optics Letters, 31, 2353-2355 (2006)



Crossover from CPT- to N- resonance

In both models one can capture the essential features of the crossover between a CPT- and an N- resonance. The graph below depicts the motion of the peaks (min=green and max=red) and the contrast of the peaks with change in the ratio of the carrier and +2 sideband rabi frequencies (the +1, and total light Rabi held fixed at 1 MHz)





Line Asymmetry: a consequence of the N+CPT system

The fact that the carrier and the +2 sideband 'compete' implicates the sidebands in the overall line asymmetry.

It is less obvious, but a consequence of this fact, that the line asymmetry increases as one decreases the power. In these two plots, one theory (on left) and the other experiment (on right) are lines for the line asymmetry as a function of total light at the TY point for the cases with an unfiltered +2 sideband (solid) and the case (dotted) where it is largely removed (reduced +2 intensity only 15% of other line)

