# THEORY FOR DIRECT FREQUENCY COMB SPECTROSCOPY

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We introduce a theory for the interaction of a multi-level atom with a train of well-stabilized ultrashort pulses, which is general enough to take into account an arbitrarily-shaped frequency comb. We illustrate its application by studing the interaction of rubidium-87 atoms with trains of pulses of various shapes, resonant with the 5S-5D two-photon transition of rubidium. More specifically, we treat the interaction with hyperbolic secant pulses, chirped pulses, and 0-$\pi$ pulses, respectively. The theory is designed to work at an arbitrary perturbation order. For the results presented here, we mostly used a twelfth-order perturbation series at the pulse's electric field. Due to the large number of levels involved, such modeling may be quite complex computationally, and an important point of the present work is then to introduce the required numerical approach to treat this problem efficiently.