Laser Control of Three Level Quantum Systems

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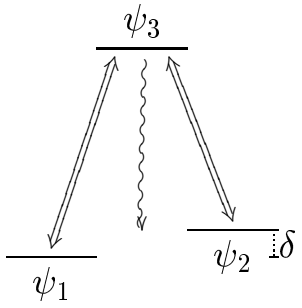
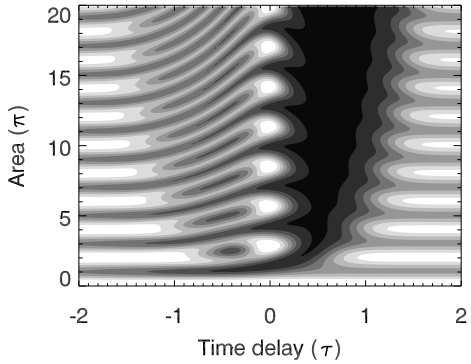
Background: There is an increasing interest in influencing systems at the quantum and molecular scale. Using laser impulses it is possible to drive atomic state transitients and molecular reactions. For this purpose the design of laser impulses is of paramount importance, but difficult to achieve based on intuitive modeling.

Applications: Control of chemical reactions, development of quantum computers

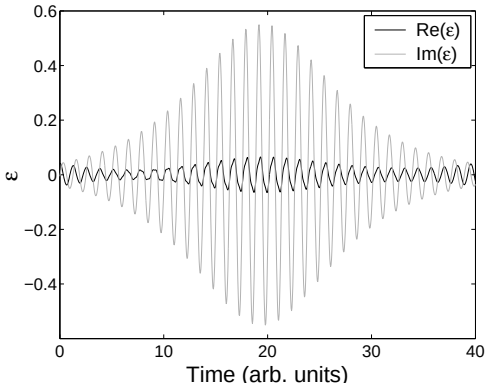
Objective: Designing laser pulses that efficiently bring a quantum dot from state Ψ_1 to Ψ_2 using an auxiliary unstable state Ψ_3.



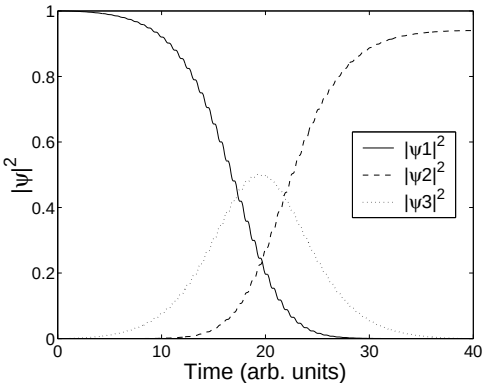
Λ-type system.



Effectiveness for two laser pulses.



Optimal laser impulse.



Occupation of quantum states.

Optimization Problem:

$$\min J(\psi,\varepsilon) \;:=\; \frac{1}{2}|\psi(T)-\psi_d|^2_{\mathbb{C}^n} + \frac{\gamma}{2}||\varepsilon||^2_{L^2(\mathbb{C},[0,T])} + \frac{1}{2}\sum_{j=1}^{n}\alpha_j||\psi_j||^2_{L^2(\mathbb{C},[0,T])}$$

Schrödinger equation:

$$i\dot{\psi} = H(\varepsilon)\psi, \quad \psi(0)=\psi_0.$$