Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Strong Field Control of Multilevel Quantum Systems

By

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In this thesis, we present work on coherent control of multilevel quantum systems in the strong field limit using shaped ultrafast laser pulses. The optimal pulse shapes used for control of atomic/molecular systems are discovered using closed-loop learning control and interpreted via pulse shape parameter scans and numerical integration of the Schrodinger equation. Our interpretation of the pulse shape dependence on control illustrates the difference between sequential population transfer and adiabatic rapid passage in multilevel systems with multiphoton coupling between levels. Additionally, we demonstrate control of an atomic interferometer in the strong field limit and highlight the difference between interference of two quantum pathways when driven by weak vs. strong fields.

We also show how stimulated emission near threshold can turn modest coherent control yields into essentially perfect discrimination between systems where a control factor of about 10^4 is achieved between atomic and molecular species. This is achieved by selective two-photon driven superfluorescence where the shape of an ultrafast drive laser controls which atoms or molecules superfluoresce. Additionally, we use shaped femtosecond pulses to demonstrate a phenomenon in which an atom becomes a modulator of an ultrafast pulse. The results are based on a scheme that is very similar to Electromagnetically Induced Transparency (EIT). Important dynamics associated with a time dependent coupling field are examined.

Date: June 15th, 2010
Time: 1:30 PM
Place: Physics Building, D-128

Program: Physics
Dissertation Advisor: Thomas Weinacht