

# Quantum Computing

## Control

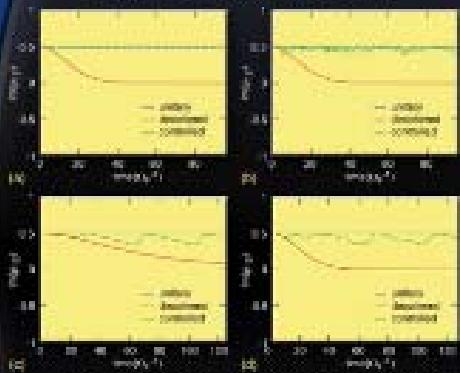
### Control of Decoherence in Quantum Logic Gates

#### Aim

Design efficient, robust, and scalable control strategies to maintain quantum entanglement/decoherence in quantum logic gates.

#### Research:

- Optimal control for quantum systems
- Robust control of decoherence in realistic one-qubit gates:
  - the simulation of “quantum” decoherence control for adiabatic and/or thermal decoherence regimes



Control of density matrix element for the initial state:  
 $|0\rangle|0\rangle$ ,  $|1\rangle|1\rangle$ ,  
 $|0\rangle|1\rangle + |1\rangle|0\rangle$ ,  
 $|+\rangle|+\rangle$

- High control frequency, no noise
- High control frequency, with noise
- Low control frequency, no noise
- Low control frequency, with noise

- Targeting qubit states using open-loop control:
  - can achieve any arbitrary state, with ensemble performance similar to quantum feedbacks
- Global control of multiple qubits and quantum logic gates:
  - producing and maintaining entanglement

Controlling Qubit Evolution

Center for Engineering SCIENCE Advanced Research  
Computing and Computational Sciences Directorate

## Algorithms

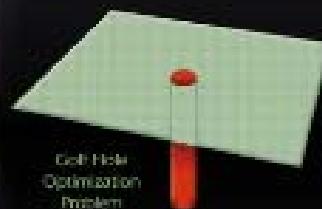
### Development and Applications of Quantum Algorithms

#### Aim

Design and simulate efficient quantum algorithms for solving continuous-function problems such as global optimization and multidimensional integration.

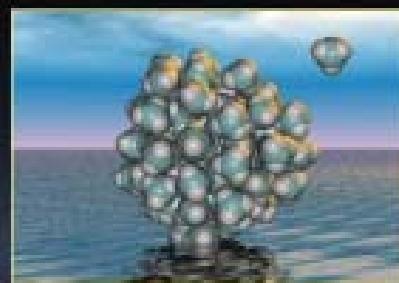
#### Research:

- Quantum Algorithm for Continuous Global Optimization:
  - apply Grover's algorithm for discrete unsorted search by taking advantage of information that cannot be used within the classical framework [V. Protopopescu and I. Bartha, Phys. Lett. A, 256(1), 2000, pp. 9-14]



Local Min Optimization Problem

- New summing algorithm using ensemble computing:
  - query randomly depends only on the scaling of the measurement sensitivity
  - can result in an exponential speedup, compared with known quantum and classical summing algorithms
- Ensemble algorithm for global optimization and NP-complete problems



Molecular Ensemble

