The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

Workshop on
NEW TRENDS IN QUANTUM DYNAMICS AND ENTANGLEMENT
21 - 25 February 2011

COMBINING DYNAMICAL DECOUPLING WITH FAULT-TOLERANT QUANTUM COMPUTATION

Daniel LIDAR
Depts. Of Chemistry & Electrical Engineering
Univ. of Southern California
90089-1062 Los Angeles, CA, U.S.A.

Abstract:

We study how dynamical decoupling (DD) pulse sequences can improve the reliability of quantum computers. We prove upper bounds on the accuracy of DD-protected quantum gates and derive sufficient conditions for DD-protected gates to outperform unprotected gates. Under suitable conditions, fault-tolerant quantum circuits constructed from DD-protected gates can tolerate stronger noise, and have a lower overhead cost, than fault-tolerant circuits constructed from unprotected gates. Our accuracy estimates depend on the dynamics of the bath that couples to the quantum computer, and can be expressed either in terms of the operator norm of the bath's Hamiltonian or in terms of the power spectrum of bath correlations; we explain in particular how the performance of recursively generated concatenated pulse sequences can be analyzed from either viewpoint. Our early results applied to Hamiltonian noise models with limited spatial correlations (arXiv:0911.3202, joint work with Hui Ng and John Preskill). We have recently been able to relax this restriction, so that our results apply to general noise models (joint work with Gerardo Paz, in preparation).