Energetic Suppression of Decoherence in Exchange-Only Quantum Computation  

C. STEPHEN HELLBERG, YAAKOV S. WEINSTEIN, Naval Research Lab — We present a scheme for universal quantum computation requiring only the Heisenberg exchange interaction. The combination of an always-on exchange interaction between the three physical qubits comprising the encoded qubit and a global magnetic field generates an energy gap between the subspace of interest and all other states. This energy gap suppresses decoherence. Always-on exchange couplings greatly simplify the implementation of the logical gates. A controlled phase gate can be implemented using only three Heisenberg exchange operations all of which can be performed simultaneously.