1077-81-1273 **Sheng Xiong*** (`sheng@temple.edu`), Deaprtment of Math & Science, 1658 Kings Road, Jacksonville, FL 32209, and **Shimao Fan**, **Zhiyong Feng** and **Wei-Shih Yang**. *Convergence of quantum random walks with decoherence.*

In this paper, we study the discrete-time quantum random walks on a line subject to decoherence. The convergence of the rescaled position probability distribution $p(x,t)$ depends mainly on the spectrum of the superoperator $\mathcal{L}_{kk}$. We show that if 1 is an eigenvalue of the superoperator with multiplicity one and there is no other eigenvalue whose modulus equals 1, then $\hat{P}(\frac{\nu}{\sqrt{t}},t)$ converges to a convex combination of normal distributions. We give an necessary and sufficient condition for a $U(2)$ decoherent quantum walk that satisfies the eigenvalue conditions. We also give a complete description of the behavior of quantum walks whose eigenvalues do not satisfy these assumptions. Specific examples such as the Hadamard walk, walks under real and complex rotations are illustrated. For the $O(2)$ quantum random walks, an explicit formula is provided for the scaling limit of $p(x,t)$ and their moments. We also obtain exact critical exponents for their moments at the critical point and show universality classes with respect to these critical exponents. (Received September 18, 2011)