Abstract Submitted
for the MAR05 Meeting of
The American Physical Society

Probing Vesicle Dynamics in Single Synapses MATTHEW SHTRAHMAN, Department of Physics and Astronomy, University of Pittsburgh, CHUCK YEUNG, School of Science, The Pennsylvania State University at Erie, GUO-QIANG BI, Department of Neurobiology, University of Pittsburgh School of Medicine, XIAO-LUN WU, Department of Physics and Astronomy, University of Pittsburgh — The classic mode of communication between neurons occurs via chemical synapses. In this process, vesicles dock at release sites (active zone), and fuse with the cell membrane, emptying neurotransmitter into the synaptic cleft. This process is stochastic, and the fidelity of this synaptic communication depends on the availability of docked vesicles. We use fluorescence correlation spectroscopy (FCS) and fluorescence recovery after photobleaching (FRAP) to study vesicle dynamics inside the synapses of cultured neurons labeled with a fluorescent vesicle marker. These studies show that when the cell is electrically at rest, only a small population of vesicles is mobile, taking seconds to explore the synapse. Applying pharmacological agents causes vesicles to diffuse freely, moving 30 times faster than vesicles in control synapses. These results suggest that vesicles move sluggishly due to binding to structural elements within the synapse. Motivated by these results, a model is constructed consisting of diffusing vesicles that bind reversibly to the cytomatrix. This stick-and-diffuse model agrees with the experimental data, and also predicts the well-known exponential refilling of docked vesicles.

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Date submitted: 01 Dec 2004 Electronic form version 1.4