Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Robust spatial memory maps in flickering neuronal networks: a topological model. YURI DABAGHIAN, ANDREY BABICHEV, Rice University, FACUNDO MEMOLI, SAMIR CHOWDHURY, Ohio State University, RICE UNIVERSITY COLLABORATION, OHIO STATE UNIVERSITY COLLABORATION — It is widely accepted that the hippocampal place cells provide a substrate of the neuronal representation of the environment—the "cognitive map". However, hippocampal network, as any other network in the brain is transient: thousands of hippocampal neurons die every day and the connections formed by these cells constantly change due to various forms of synaptic plasticity. What then explains the remarkable reliability of our spatial memories? We propose a computational approach to answering this question based on a couple of insights. First, we propose that the hippocampal cognitive map is fundamentally topological, and hence it is amenable to analysis by topological methods. We then apply several novel methods from homology theory, to understand how dynamic connections between cells influences the speed and reliability of spatial learning. We simulate the rat's exploratory movements through different environments and study how topological invariants of these environments arise in a network of simulated neurons with "flickering" connectivity. We find that despite transient connectivity the network of place cells produces a stable representation of the topology of the environment.

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Date submitted: 31 Oct 2015 Electronic form version 1.4