The Virginia Tech Physics Department proudly presents the following colloquium:

Dr. Sinisa Pajevic

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"The Functional Topology and Architecture of Neuronal Avalanches"

Fri., October 5
2:30 P.M.
2030 Pamplin Hall

Abstract:

In the neocortex, synaptic inputs have to converge in order to elicit postsynaptic action potentials, requiring neuronal activity to propagate in the form of transiently synchronous neuronal groups. The rapid and selective synchronization between neurons across many spatial and temporal scales is considered a key mechanism in the formation of neuronal cell assemblies. Recent studies have shown that this type of synchronization arises in the form of `neuronal avalanches' in which the size distribution of synchronized groups follows a power law with an exponent of -1.5 indicative of a critical network state. Propagation of such avalanches can be interpreted as a branching process on a network. We derive and test a robust algorithm for reconstructing such network from the observed avalanche dynamics and apply it to spontaneous activity in cortical organotypic cultures or acute slices. As controls, we use different network randomizations schemes: (i) Erdos-Renyi; (ii) degree sequence preserving; (iii) weight randomization. The reconstructed functional networks reveal small-world topology characterized by a large clustering coefficient and a small network diameter. The motif analysis reveals a feed-forward structure of these networks, in which the dominant network motifs have reciprocally (bi-directionally) coupled neuronal groups that provide and receive common inputs from other groups. We also report novel functional network architecture of neuronal avalanches. The architecture is organized in such way that the small-world property is preserved upon removing the weakest links in the network. We explain how such architecture can arise and discuss its functional role.