Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

A variational model for propagation time, volumetric and synchronicity optimization in the spinal cord axon network, and a method for testing it[1] BRUNO MOTA, IF - UFRJ — Most information in the central nervous system in general and the (simpler) spinal cord in particular, is transmitted along bundles of parallel axons. Each axon's transmission time increases linearly with length and decreases as a power law of caliber. Therefore, evolution must find a distribution of axonal numbers, lengths and calibers that balances the various tradeoffs between gains in propagation time, signal throughput and synchronicity, against volumetric and metabolic costs. Here I apply a variational method to calculate the distribution of axonal caliber in the spinal cord as a function of axonal length, that minimizes the average axonal signal propagation time, subject to the constraints of white matter total volume and the variance of propagation times, and allowing for arbitrary fiber priorities and end-points. The Lagrange multipliers obtained thereof can be naturally interpreted as 'exchange rates', e.g., how much evolution is willing to pay, in white matter added volume, per unit time decrease of propagation time. This is, to my knowledge, the first model that quantifies explicitly these evolutionary tradeoffs, and can obtain them empirically by measuring the distribution of axonal calibers. We are in the process of doing so using the isotropic fractionator method.

[1]I thank FAPERJ for financial support

Bruno Mota
IF - UFRJ

Date submitted: 15 Nov 2013 Electronic form version 1.4