

Tracking the Neuronal Paths of Ephaptic Information

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Abstract

In this note, the authors propose a Maxwell-like system of equations but for the “transverse information field” propagating bi-directionally in a system of synchronizing axons with longitudinal current flows.

Consider an ephaptic tract with $N = 3$ synchronizing axons. It is clear that the axoplasmic and extracellular currents which enable synchronization are along the axons, i.e. longitudinal. However, it was shown in (see the discussion in Section 4 of [1]) that when two axons synchronize they are able to perform a bidirectional information exchange in the orthogonal or transverse direction, which is contact-less.

The situation is akin to a radiating antenna. The charges and hence fields oscillate along the antenna but information (on the waves) travels in the orthogonal or transverse direction, omnidirectionally. This suggests that we might be able to setup a system of four basic equations and then derive a type of wave equation for information flow, but for the axon tract setting described above.

With such an equation in hand, one can look at various scenarios of axon tracts in the nervous system such as the corpus-callosum, and, for the different geometries, solve the new equations and obtain the major and minor ephaptic information pathways of the brain.

References

- [1] Aman Chawla and Salvatore Domenic Morgera. Towards a network coding view of ephaptic synchronization. February 2023.