

A Mathematical Model for the Node of Ranvier

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Abstract

In this note, the author proposes a model for the node of Ranvier of a neuronal axon.

Claude Shannon, the father of information theory [1], emphasized that simplifying a model was key to solving the associated problem; later more details could be added. The nerve is a tough problem to understand and solve. With so many parts to it, it is useful if simplifying models are used.

The node of Ranvier is a key feature of a nerve axon. A typical node consists of thousands of ion channels. Thus modeling it mathematically poses a challenge. In this note we propose the model shown in Figure 1. The cylindrical surface is shown segmented into three segment-slices. Each segment subtends some angle ϕ at the central axis. The model is not the most accurate possible, but it captures the one essential detail, that the surface of the node is replete with ion channels. In our model, these channels are constrained to lie along surface strands of the segment-slices which is a limitation since in reality there is no such constraint apparent. The thickness of the nodal membrane has been ignored in this figure.

If the problem of consciousness [2] is to be tackled scientifically and solved, simplifications will be necessary for starting off. There has been much work on ephaptic coupling recently, for example: [3], and much of it could be expanded in the light of better models for the node.

References

- [1] Claude E Shannon. A mathematical theory of communication. *The Bell System Technical Journal*, 27:379–423, 1948.
- [2] Christof Koch. The quest for consciousness (englewood, co: Roberts & company). 2004.
- [3] Aman Chawla and Salvatore Domenic Morgera. Differential ephaptic networks. *Journal of Applied Mathematics and Physics*, 10(10):2876–2882, 2022.

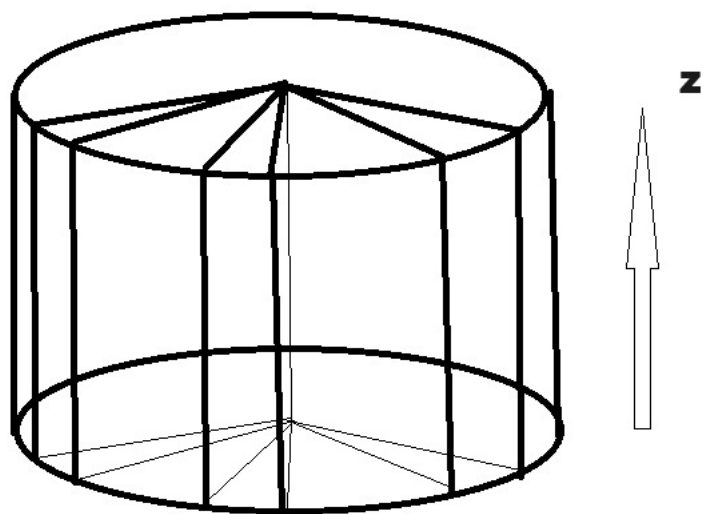


Figure 1: The node of Ranvier.