Sodium-calcium exchangers modulate excitability of spatially distributed astrocyte networks

Andrey Yu. Verisokin¹, Darya V. Verveyko¹, Dmitry E. Postnov³, Alexey R. Brazhe²

¹ Department of Theoretical Physics, Kursk State University, Kursk, 305000, Russian Federation
² Department of Biophysics, Lomonosov Moscow State University, Moscow, 119991, Russian Federation
³ Department of Physics, Saratov State National Research University, Saratov, 410012, Russian Federation

E-mail: ffalc0n@mail.ru

In this work we combine two models of astrocytic calcium dynamics: the first one is based on the IP3-dependent exchange with the intracellular calcium storage, the second local model considers the sodium-calcium exchanger (NCX) and Na+ response to the synaptic glutamate. The proposed model proceeds to a spatially distributed astrocyte network.

Conclusions

The results of the unified model numerical solution confirm the emergence of calcium waves, which occur due to the synaptic activity and spread over the astrocyte network (calcium excitation wave captures the entire astrocyte network, along with local waves, which exist only within one cell and terminate beyond its borders). The presence of NCX leads to a decrease in the average areas that are affected by a global calcium wave during excitation, while the number of events with equal duration time is the same on average for both models. However, the Na/Ca-exchanger stimulates calcium waves, making possible the formation of more long-lived waves.

Acknowledgements

This study was supported by Russian Science Foundation, grant 17-74-20089