

Mentor-Postdoc Spotlights Series 2020



Peter Jonas, M.D.

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Dr. Jonas is Professor of Physiology and Neuroscience at the Institute of Science and Technology Austria (IST Austria). Dr. Jonas received his M.D. degree with distinction from the University of Giessen. He completed his postdoctoral training with Prof. Dr. Bert

Sakmann at Max Planck Institute for Medical Research, Heidelberg. Subsequently, he became Associate Professor at the Technical University of Munich, and full professor and head of department at the University of Freiburg. Since 2010, he is professor, head, and founder of a Neuroscience Research Cluster at the Institute of Science and Technology (IST) Austria.

Dr. Jonas's research centers on understanding how information is processed at individual synapses. Specifically, what are the biophysical signaling and plasticity mechanisms at glutamatergic and GABAergic synapses in the cortex? And how do specific synaptic properties generate higher network functions? To address these questions, he combines electrophysiological recording from cortical presynaptic terminals, confocally targeted dendritic and axonal recording, paired and multi-cell recording from synaptically connected neurons, *in vivo* intracellular recording, and *in vivo* two-photon Ca^{2+} imaging techniques. The ultimate goal of research in Dr. Jonas's laboratory is to understand how synapses shape higher-order computations in the brain and to lay the basis for the future understanding of brain diseases in which synaptic function is perturbed. His additional contributions to the scientific community have included serving on numerous grant review committees, including the ERC Starting Grant evaluation panel, the Advisory Board of Max Planck Institute of Biophysical Chemistry in Göttingen, and the ERC Synergy Grant evaluation panel. He is or was member of the Editorial Boards of several prestigious journals such as Science, Neuron, The Journal of Neuroscience, and The Journal of Physiology.

Dr. Jonas identified several biophysical mechanisms underlying rapid signaling at synapses, including tight coupling between presynaptic Ca^{2+} channels and release sensors, fast gating of postsynaptic receptors, and co-release of multiple fast transmitters. He also discovered several novel mechanisms of synaptic plasticity, such as analogue modulation of presynaptic action potential shape, loose coupling between presynaptic Ca^{2+} channels and release sensors, and formation of structural and functional vesicle pool engrams. Finally, he elucidated how the properties of synapses shape higher-order computations, particularly how inhibitory synapses shape rhythmic activity in the brain, and how specific connectivity rules for excitatory and inhibitory neurons facilitate pattern separation and pattern completion. He is considered the pioneer of the new field of nanophysiology and one of the major protagonists of the combined experimental–computational approach to fundamental questions in neuroscience at the level of synapses, cells, and neuronal networks. His research program has long-standing support by the European Union. Dr. Jonas received several research awards, such as the Erwin Schrödinger Prize of the AAS (2018), the Wittgenstein Prize of the FWF (2016), and the Gottfried

Wilhelm Leibniz Prize of the DFG (2006). He is also member of several organizations and academies, such as EMBO (2019), Academia Europaea (2015), and the German National Academy of Sciences Leopoldina (2002).

Notable publications from Dr. Jonas's lab are:

1. Hefft S, Jonas P (2005) Asynchronous GABA release generates long-lasting inhibition at a hippocampal interneuron–principal neuron synapse. *Nature Neuroscience* 8:1319–1328.
2. Geiger JRP, Melcher T, Koh DS, Sakmann B, Seeburg PH, Jonas P*, Monyer H (1995) Relative abundance of subunit mRNAs determines gating and Ca^{2+} permeability of AMPA receptors in principal neurons and interneurons in rat CNS. *Neuron* 15:193–204. * = corresponding author.
3. Jonas P, Bischofberger J, Sandkühler J (1998) Corelease of two fast neurotransmitters at a central synapse. *Science* 281:419–424.
4. Geiger JRP, Jonas P (2000) Dynamic control of presynaptic Ca^{2+} inflow by fast-inactivating K^+ channels in hippocampal mossy fiber boutons. *Neuron* 28:927–939.
5. Vyleta NP, Jonas P (2014) Loose coupling between Ca^{2+} channels and release sensors at a plastic hippocampal synapse. *Science* 343:665–670.
6. Vandal D, Borges-Merjane C, Zhang X, Jonas P (2020) Short-term plasticity at hippocampal mossy fiber synapses is induced by natural activity patterns and associated with vesicle pool engram formation. *Neuron* 107:509–521.e7.
7. Bartos M, Vida I, Jonas P (2007) Synaptic mechanisms of synchronized gamma oscillations in inhibitory interneuron networks. *Nature Reviews Neuroscience* 8:45–56.
8. Guzman SJ, Schlögl A, Frotscher M, Jonas P (2016) Synaptic mechanisms of pattern completion in the hippocampal CA3 network. *Science* 353:1117–1123.
9. Espinoza C, Guzman SJ, Zhang X, Jonas P (2018) Parvalbumin⁺ interneurons obey unique connectivity rules and establish a powerful lateral-inhibition microcircuit in dentate gyrus. *Nature Communications* 9:4605.
10. Zhang X, Schlögl A, Jonas P (2020) Selective routing of spatial information flow from input to output in hippocampal granule cells. *Neuron* 107:1212–1225.

Learn more about Dr. Jonas's research: <https://ist.ac.at/en/research/jonas-group/>



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Dr. Xiaomin Zhang received her Ph.D. degree from the Institute for Physiology und Pathophysiology of the University of Heidelberg under the mentorship of Prof. Andreas Draguhn. Her doctoral thesis work focused on studying the functional role of the amyloid precursor protein family in neuronal network function. After completing her Ph.D., Dr. Zhang joined Professor Peter Jonas's lab at IST, Austria, where she studied how the dentate gyrus granule cells encode spatial and non-spatial information. She received an IST fellowship jointly funded by IST and the European Union's Horizon 2020 research and innovation

programme under the Marie Skłodowska-Curie grant agreement.

With almost a decade worth of research experience, Dr. Zhang is the author of 10 publications and has presented her work in several national and international conferences. Her poster at FENS Forum 2020 was among the top 10% of the most viewed posters according to the FENS viewing statistics. In addition, her recent work was recommended in Faculty Opinions as being of special significance in its field.

Please read Zhang and Jonas article titled *Integration of spatial and non-spatial information by heterogeneous dentate gyrus granule cells* [published](#) in the December 2020 issue of *JoLS, Journal of Life Sciences*.