

Groupe : Biophysics of gliotransmitter release

Laboratoire de Neurophysiologie et Nouvelles Microscopies

CNRS UMR8154, INSERM S603

Université Paris Descartes

45, rue des Saints Pères

<http://www.biomedicale.univ-paris5.fr/neurophysiologie/Groups/oheimropergroup.php>

`martin.oheim@parisdescartes`

Formed in 2004 through the association of a (bio-) physicist, Martin Oheim, and a neurobiologist, Nicole Ropert, our group aims at understanding the role of cortical astrocytes, we are interested in the signalling pathways by which the astrocytes modulate neuronal activity in adult mice. We use advanced sub-cellular imaging techniques to study single-organelle dynamics and to measure spatially and temporally limited ion concentration domains in conjunction with electrophysiological recording techniques on isolated cells and brain slice preparations.

We develop new tools for highly resolved sub-cellular imaging using evanescent fields and structured illumination, using novel FRET-based hybrid semiconductor/organic indicators for Ca^{2+} and pH (see below).

To study a possible non-conventional mode of transmitter release in the central nervous system during the development of rodents, we examine the possibility of a glutamate/serotonin co-transmission during the development of the specific sensory cortical maps of the newborn mice.

Our team currently works on four different biological and physical topics:

- Serotonin-glutamate co-transmission in thalamo-cortical neurons

See: A. Evrard, N. Ropert, 2009. Early development of the thalamic inhibitory feedback loop in the primary somatosensory system of the newborn mice. J Neurosci. vol.29. 31. 9930-40

- Superresolution techniques in total-internal reflection microscopy

See: M. van 't Hoff, V. de Sars, M. Oheim, 2008. A programmable light engine for quantitative single molecule TIRF and HILO imaging. Optics Express. vol.16. 22. 18495-18504

- Mechanisms of lysosomal exocytosis from cortical astrocytes

See: D. Li, N. Ropert, A. Koulakoff, C. Giaume, M. Oheim, 2008. *Lysosomes are the major vesicular compartment undergoing Ca^{2+} -regulated exocytosis from cortical astrocytes. J Neurosci. vol.28. 30. 7648-58*

- nanoFRET biosensors (see below)
-

nanoFRET biosensors

Our group is part of the [nanoFRET consortium](#) (Anne Feltz, Jean-Maurice Mallet, Wolfgang Parak) that is interested in [FRET-based nanobioprobes for super-resolution fluorescence imaging and ion sensing](#). The goal of this ANR PNANO project is the development of intracellularly targetable nanobiosensors that are lightsource, sensor and ratiometric (and eventually polyvalent) reporter in one. Compared to conventional imaging, this "pointillistic" microscopy offers superior spatial precision and temporal resolution. We have successfully generated proton and calcium sensors, combining a semiconductor nanocrystals ("quantum dot") donor, provides non-radiative energy transfer between to a small number of acceptor fluorophores attached to the nanocrystal surface. Different ion indicators can be used to detect different analytes such as: calcium, zinc and proton. NanoFRET biosensors are applied for calcium microdomain detection, local pH measurements and study the modulation of postsynaptic neurotransmitter receptors by zinc.

References

- Tamura, Hiroyuki Feltz, Anne Mallet, JM, **Oheim, M** Burghardt I; Ab initio study of excitation energy transfer between quantum dots and dye molecules; J. Phys. Chem. C, 2009, 113 (18), 7548-52
- A. Yakovlev, F. Zhang, A. Zulqurnain, A. Azhar-Zahoor, C. Luccardini, S. Gaillard, J. Mallet, P. Tauc, J. Brochon, W. Parak, A. Feltz, **M. Oheim**, 2009. [Wrapping Nanocrystals with an Amphiphilic Polymer Preloaded with Fixed Amounts of Fluorophore Generates FRET-Based Nanoprobes with a Controlled Donor/Acceptor Ratio](#). Langmuir 25(5):3232-9.
- C. Luccardini, A.V. Yakovlev, M. Pasche, S. Gaillard, D. Li, F. Rousseau, R. Ly, U. Becherer, J.M. Mallet, A. Feltz, **M. Oheim**, 2008 [Measuring mitochondrial and cytoplasmic \$Ca^{2+}\$ in EGFP expressing cells with a low-affinity Calcium Ruby and its dextran conjugate](#). Cell Calcium, 45(3):275-83.
- MT. Fernandez-Argüelles, A. Yakovlev, R. Sperling, C. Luccardini, S. Gaillard, A. Medel, J. Mallet, J. Brochon, A. Feltz, **M. Oheim**, W. Parak, 2007 [Synthesis and characterization of polymer-coated quantum dots with integrated acceptor dyes as FRET-based nanoprobes](#). Nano Lett. 2007 Sep;7(9):2613-7.
- C. Luccardini, A. Yakovlev, S. Gaillard, M. van 't Hoff, A. Piera Alberola, J. Malet, W. Parak, A. Feltz, **M. Oheim**, 2007. [Getting across the plasma membrane and beyond: intracellular uses of colloidal semiconductor nanocrystals](#). Journal of Biomedicine and Biotechnology. 2007(7): 68963

- S. Gaillard, A. Yakovlev, C. Luccardini, **M. Oheim**, A. Feltz, J. Mallet, 2007. [*Synthesis and Characterization of a New Red-Emitting Ca²⁺ Indicator, Calcium Ruby.*](#) Organic Letters. 9 (14): 2629-32.

Patents

W. H. Chang, C.-A. J. Lin, J. K. Li, **M. Oheim**, A. Yakovlev, A. Feltz, C. Luccardini, M. T. Fernández-Argüelles, R. A. Sperling, W. J. Parak. [*Amphiphilic polymer, method for forming the same and application thereof.*](#) Taiwanese and US patent