Modelling the Ca^{2+}-dynamics in Cardiac Myocytes

Thomas Schendel, Martin Falcke

Max Delbrück Centre for Molecular Medicine, Berlin, Germany

The second messenger Ca^{2+} is the key element in excitation-contraction coupling (ECC) in cardiac myocytes. It is known that one crucial step of the ECC, namely the interaction between the Ca^{2+}-influx through the L-type Ca^{2+}-channels (LCCs) and the nearby localized ryanodine receptors (sarcoplasmic reticulum (SR) Ca^{2+} release channels), takes place in cellular micro domains, called diads.

For a mathematical description of these local units not only the Ca^{2+}-dynamics in the dyadic cleft and the nearby junctional part of the SR have to be considered, but also the stochastic gating of the Ca^{2+}-channels (LCCs and RyRs). Therefore we used a hybrid version of the Gillespie algorithm and combined in this way the deterministic description of diffusion with the stochastic channel gating.

Moreover, a mathematical model of ECC has finally to couple the local units into a global system of the cardiac myocyte that describes the membrane currents, the SR-Ca^{2+}-uptake and the Ca^{2+}-buffers. To reproduce experimentally measured phenomena like calcium waves or calcium transient alternans, the model has to be space-resolved. We intend to use here the method of Green functions. I shall present some ideas for developing such a multiscale model.