**Continuity equations and super-resolution microscopy
for the reconstruction of a cell membrane potential.**

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Continuity equations are fundamental building blocks in the
modelling of natural systems at the mesoscopic and macroscopic level.
Therefore they are also essential in engineering control mechanisms
and in the formulation of inverse problems. In this framework, a central role is
played by the Liouville, the Fokker-Planck-Kolmogorov (FPK) and the
Boltzmann equations.

In this talk, the focus is on the stochastic motion of molecules on a cell membrane
and its modelling by a nonlinear mean-field FPK equation with the
purpose to illustrate a new method for the reconstruction of cell membrane
potentials based on super-resolution microscope images.

This inverse problem is formulated as an optimization problem governed by
the mean-field FPK equation, and the functional to be minimized includes
a least-squares error term of the computed and observed particles'
densities and a Tikhonov regularization term. This problem is solved on a
sequence of time windows to determine the potential together with an estimate
of uncertainty of its reconstruction.

Results of numerical experiments are presented that successfully validate the proposed
reconstruction procedure and demonstrate its applicability
in a super-resolution microscopy framework.
This is joint work with Mario Annunziato (U Salerno)