

Multiscale Problems in the Life Sciences

Organizers: Vincenzo Capasso and Willi Jaeger

Abstract:

Experimental research is providing increasing information on biophysical and biochemical processes in cells and tissues. This information on cellular level has to be included in mathematical modelling of the dynamics of biological systems. Describing flow, transport and reactions of substances and their interactions leads to a coupled system of nonlinear partial differential equations in complex geometric structures. Using experimental information, the relevant parameters of this system have to be determined in order to pass to a macroscopic scale limit. It is important that the resulting system of equations including micro- and macro-variables are linking the different levels in a computable form. Thus, coupling information on the processes at the micro-scale with macroscopic properties we provide theoretical, but quantitative answers to important questions for diagnosis and prevention. A non trivial difficulty arises from the strong coupling of the kinetic parameters of the relevant processes with underlying fields; a major problem derives from stochasticity at the lower scales, that cannot be ignored as far as the geometric structures are concerned. Methods for reducing complexity include homogenization at mesoscales, thus leading to hybrid models (deterministic at the larger scale, and stochastic at lower scales); for example in tumour driven angiogenesis the two scales are bridged by introducing a mesoscale at which one may locally average the microscopic birth (branching)-and-growth model in presence of a large number of vessels (fibers).