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Review of the PhD thesis "Organization and fluctuations in living systems " by Gabriel Morgado

The scientific project elaborated by Gabriel Morgado as a partial fulfillment of requirements for granting the PhD degree is rooted in statistical mechanics of nonequilibrium systems. Author's aim was to analyze optimal approaches to model spatio-temporal structures in chemical and biological systems.

The mesoscopic scale of these approaches renders biochemical reaction networks driven by fluctuations and therefore - stochastic in nature. Mr. Morgado presents results of his studies in the form of a series of five published articles accompanied with an introductory discussion of analytical and numerical methods adapted for the purpose of studies.

After short recollection of basic theory of chemical kinetics, linearisation technique and stability analysis, Chapter I of the thesis introduces the concepts of stochastic description in terms of Langevin and Master equations, followed by the introduction to essentials of chemical Monte Carlo methods and steady state approximation (Chapter II). Author focuses on the Gillespie's stochastic simulation algorithm (known also as kinetic Monte Carlo) which so far has been widely used to simulate biochemical and autocatalytic reactions, although mainly, in the homogeneous regime. In an elegant work on the subject (the article *Elimination of fast variables in stochastic nonlinear kinetics*, coauthored with B. Nowakowski and A. Lemarchand and published in PCCP), the algorithm is used to test reduced dynamics of three-variable kinetic models on the slow manifold defined by relaxation of one variable to its stationary concentration. Such reduction scheme may lead to non-trivial nonlinearities of two-variable systems, and in effect, bring about results which significantly differ from the conclusions drawn from a complete kinetic scheme. By designing two various three-species models of chemical kinetics which are contracted to the same form