Temporal and spatial aspects of correlation networks and dynamical network models: analytical approaches and physical applications

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In my dissertation presentation I will address the question of interrelation between the dynamics of the continuous system and the topology of the discrete object (such as a graph), which, to some extent, characterizes this continuous system dynamics. For this I used the framework of flow-networks, which is applicable to analyse Lagrangian and Eulerian static flow systems. I extended *the flow-networks* framework for analysis of broader class of dynamical non-equilibrium, non-autonomous systems.

What can be learned from *the general flow-networks method* and, importantly, what are the method limitations? Surprisingly, the general flow-networks method showed new insights about the system dynamics: the correlation network measures for non-autonomous systems strongly depend on scales of advective and dissipative components of the dynamical system, the dissipation creates "memory" effects even in markovian systems, and, moreover, time-dependent forcing does not affect the correlation network topology. These new insights were analytically shown for the given system of linear differential equations and should be taken into account when investigating the structure of correlation networks constructed from observed or analyzed data. Another question, addressed in the dissertation, is dedicated to study the "influence" of network topology on dynamics on this network. For this a novel model and analytical approaches, based on random walks and graph theories, were introduced.

All in all, methods and models, introduced in my thesis, allow to quantify evolution of various classes of equilibrium and out of equilibrium systems and to get new insights into dynamics of continuous and discrete complex systems.