Chemical organizations in living systems

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Complex dynamical reaction networks consisting of many components that interact and produce each other are difficult to understand, especially, when new components may appear over time. In this talk, I outline a theory, which has been inspired by artificial chemistry research, to deal with such systems. It has been sucessully applied to regulated metabolic networks, virus-immunsystem dynamics, chemical information processing, chemical evolution, and planetary athmosphere photochemistries. I will show how the approach can be used to predict growth phenotypes and to evaluate the quality of large bio-models. The theory consists of two parts. The first part introduces the concept of a chemical organization as a closed and self-maintaining set of components. This concept allows to map a complex (reaction) network to its set of organizations. The theory provides a new view on the system's "organizational structure", which is fundamentally different from a pathway-oriented view. The second part of the approach connects dynamics with the set of organizations, providing a link to classical dynamical systems theory, e.g., by mapping a movement of the system in state space to a movement in the set of organizations. It is shown that every dynamically stable state must be an instance of an organization.