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The notion of system in chemistry

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One of the first things that comes to mind when thinking about chemistry is probably the idea of a chemical reaction. In simple terms, one can imagine a process in which two species (atoms or molecules) react giving rise to a third one completely different. Despite the specificity of the chemical nature of these processes, generally speaking, reductionist laws or traditional Cartesian approaches used in physics remain valid in certain chemical processes.

In most cases, however, chemical processes present a so called complex behavior under certain conditions. To this end, the systems must be open to the exchange of information, matter and energy with the environment, so that this exchange will allow them to be kept outside the state of thermodynamic equilibrium (basically the state in which "things happen"). Out of equilibrium, open systems dynamic is usually described by non-linear terms. Therefore, the possibility of multiple states or paths by which the system can evolve becomes a key feature. In other words, there is a change of focus from being to becoming, using prigoginian words.

The so-called oscillatory processes are paradigmatic examples of chemical complexity, resulting from the coupling of various chemical reactions that characterize the stability of living systems. When distributed in space, usually oscillatory reactions organize themselves, generating phenomena as reactional chemical waves that carry information between different regions.

Chemical waves are not described by molecules or specific reactions, but by the coupling between the different reactions and transport processes of chemical species that occur simultaneously. Networks formed by different chemical reactions are taking on increasingly important role in the chemistry of the 21st century, primarily by the possibility of mimicking some features present in

biological networks, more complex but also more fragile and less tractable. Understanding the dynamics of these networks has implications in different processes, including the origin of life.

The ubiquitous presence of emergent properties in chemical processes highlights the need of a new way of dealing with complexity. After all, new issues require new approaches. The notion of system in chemistry recently culminated in the creation of "Systems Chemistry" which comes with the proposal of an integrative treatment. Its main objective is to advance the understanding of emergent properties of chemical systems in which many variables are handled simultaneously. More than overcoming the prevailing Cartesian paradigm, the adoption of systems approaches, where applicable, will expand considerably the understanding of complex chemical processes.

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