

# The Cause of Complexity in Nature

## An Analytical, Computational, and Philosophical Approach

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**Abstract.** According to several prominent authors, a main part of 21<sup>st</sup> century science will be on complexity research. The intuitive idea is that global patterns and structures emerge from locally interacting elements like atoms in laser beams, molecules in chemical reactions, proteins in cells, cells in organs, neurons in brains, transistors in electrical circuits, etc. by self-organization. But what is the cause of self-organization? Complexity phenomena have been reported from many disciplines (e.g. astronomy, physics, biology, chemistry, ecology, etc.) and analyzed from various perspectives. Are there unifying principles in modern science to explain the emergence of complexity in nature? This lecture is going to present the cause of complexity in nature from an analytical and computational point of view. The cause of complex pattern formation is explained by the local activity of cells in complex systems which are analytically modeled by nonlinear reaction-diffusion equations in physics, chemistry, biology, and brain research. There are not only rigorous analytical criteria of local activity and the edge of chaos, but also constructive procedures to visualize them by computer simulations. In technology, the question arises whether these criteria and procedures can be used to construct artificial life and artificial minds. In Japanese and Western philosophy, thinking on the wholeness of nature has a great tradition. In the end, we aim at an integration of science and philosophy in complexity.

**References:** K. Mainzer, *Thinking in Complexity: The Computational Dynamics of Matter, Mind, and Mankind*, 5<sup>th</sup> ed., Springer: New York 2007; K. Mainzer (Ed.), *Complexity*, European Review (Academia Europaea) vol. 17 no.2 Cambridge University Press: Cambridge 2009; K. Mainzer, L.O. Chua, *The Universe as Automaton: From Simplicity and Symmetry to Complexity*, Springer: Berlin, 2011; K. Mainzer, L.O. Chua, *Local Activity Principle: The Cause of Complexity and Symmetry Breaking*, Imperial College Press: London (forthcoming in 2012).