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EDITORIAL

Focus on Pattern Formation

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Abstract

Pattern formation is a subfield of nonlinear dynamics in spatially extended systems. Although the latter term is often used narrowly to describe nonlinear systems with not too many degrees of freedom, in general it may be applied to describe more or less everything that happens in the Universe. Thus this statement can hardly be used as a definition. More precisely, the field of pattern formation focuses on systems where the nonlinearities conspire to form spatial patterns that sometimes are stationary, travelling or disordered in space and time. The latter is often referred to as spatio-temporal chaos.

The past two decades have provided major progress in the field of pattern formation. We now have a well-developed theoretical framework for understanding weakly nonlinear patterns that can be described by Ginzburg-Landau-type theories. Close to the onset of instability, our understanding of time-independent or simple time-dependent patterns is quite advanced. Phase field models for the investigation of interfacial instabilities are leading to a breakthrough. Nonlinear phase diffusion equations that are derived from first principles allow the investigation of the `elastic' properties of pattern dynamics even in the fully nonlinear region.

Rapid progress continues to be made possible by a close collaboration of experiment and theory. Advances in computational power are enabling the study of complex spatio-temporal patterns in systems of large spatial extent. In experiment, the increase in computational power combined

with novel imaging technology allows the analysis of millions of high-resolution digital images. For instance, novel visualization and data analysis techniques have yielded progress in identifying and studying the nonequilibrium dynamics of extended systems in terms of the spatial and temporal evolution of defect structures that are found in many spatio-temporal chaotic systems. Numerical simulations based on first principles or on general higher-order equations can now be conducted in large systems under realistic boundary conditions.

Pattern formation is a truly interdisciplinary science. The similarity in fundamental mechanisms and the accompanying mathematics brings together scientists from many disciplines, such as biology, chemistry, fluid dynamics, material science, mathematics, medicine, geophysics, ecology, physics and surface science. We believe that the articles collected here provide an overview of the widespread activities within this field.

We feel that *New Journal of Physics*, as a purely electronic journal, is particularly useful for our field of research: if a picture says a thousand words, a movie can say many more about the spatio-temporal dynamics of a pattern. We would like to thank all of the authors for their contributions and, in many cases, for bearing the additional burden of including moving pictures for the undoubted benefit of readers.

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