Novel Mechanisms for Pattern Formation

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Alan Turing is said to have discovered his scientific vocation as a child reading the school book *Natural Wonders Every Child Should Know*. One particular chapter of the book describes the striking reproduction properties of Hydra: once a part is separated from its body, the part regenerates itself and forms a complete new organism. It is not unreasonable to suppose that years later Turing's early readings triggered his seminal work on *morphogenesis*[1]. In addition to its intrinsic relevance, the study elucidated the relation between a spatio-temporal structure and the morphological instabilities associated with partial differential equations. The past year we commemorated the fiftieth anniversary of the publication of Turing's seminal work on pattern formation. Since then, enormous effort has been invested in the understanding and identification of pattern formation mechanisms.

Herein we review recently proposed mechanisms for pattern formation. Then, we show how deterministic or random alternation of dynamics, neither of which exhibits patterns, induces stationary or oscillatory ordered structures[2]. In the latter the alternation process induces a probability density splitting that gives raise to pattern formation. The switching mechanism can also be applied to reaction-diffusion systems. There, alternation induces a short time instability that leads to a Turing instability[3] (see figure).

We have also extended recently the mechanism for noise-induced phase transitions proposed by Ibañes *et al.*[4] to pattern formation phenomena. In contrast with known mechanisms for pure-noise induced pattern formation, this mechanism is not driven by a short time instability amplified by collective effects[5].

Finally, we lately explored the conditions under which the presence of quenched dichotomous disorder induces spatial patterns in systems with coupling *a la* Swift-Hohenberg[6]. We illustrate this phenomenology with a family of force functions that includes the paradigmatic models for noise-induced phase transitions and noise-induced patterns[7]. As one of the main results, it worth mentioning how pattern formation can be achieved through continuous and discontinuous transitions, and that pattern formation is reentrant with the coupling.

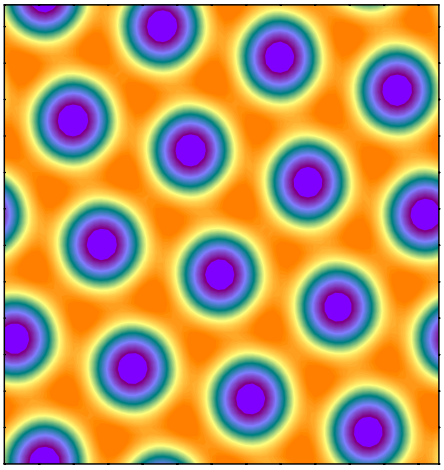

Figura 1. Stationary structure induced by alternation of pattern-free dynamics in a particular reaction-diffusion model.

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