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Spiraling patterns in evolutionary models inspired by bacterial games with cyclic dominance[1]

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Understanding the mechanisms allowing the maintenance of biodiversity is a central issue in biology. Evolutionary game theory, where the success of one species depends on what the others are doing, provides a promising framework to investigate this complex problem. Experiments on microbial populations have shown that cyclic local interactions promote species coexistence. In this context, rock-paper-scissors games - in which rock crushes scissors, scissors cut paper, and paper wraps rock - are often used to model the dynamics of populations in cyclic competition. After a brief survey of some inspiring experiments, I will discuss the subtle interplay between individuals' mobility and their local interactions in two-dimensional rock-paper-scissors systems. This leads to the loss of biodiversity above a certain mobility threshold [1], and to the formation of spiraling patterns below the critical mobility rate [1-4]. I will then study a generic rock-paper-scissors metapopulation model formulated on a two-dimensional grid of patches. When these have a large carrying capacity, the model's dynamics is faithfully described in terms of the system's complex Ginzburg-Landau equation properly derived from a multiscale expansion. The properties of the ensuing complex Ginzburg-Landau equation are exploited to derive the system's phase diagram and to characterize the spatio-temporal properties of the spiraling patterns in each phase. This enables us to analyze the spiral waves stability, how these are influenced by linear and nonlinear diffusion, and to discuss phenomena such as far-field breakup [5-7].

[1] Nature **448**, 1046 (2007);
[2] Phys. Rev. Lett. **99**, 238105 (2007);
[3] J. Theor. Biol. **254**, 368 (2008);
[4] Eur. Phys. J. B **82** 97 (2011);
[5] EPL **102**, 28012 (2013);
[6] Phys. Rev. E **90**, 032702 (2014);
[7] J. R. Soc. Interface **11**, 20140735 (2014).

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