Patterns and dynamics: homage to Pierre Coullet / *Formes et dynamique : hommage à Pierre Coullet*

Foreword

This thematic issue of the *Comptes rendus Mecanique* is dedicated to Pierre Coullet, a definitely original character in the scientific landscape. Pierre studied at the University of Nice, where he obtained a Master thesis (so-called *thèse de troisième cycle* at the time) supervised by Enrique Tirapegui on the topic of the renormalization group in field theory. He then got his PhD (*thèse d'État*) under the supervision of Jean Coste. This research led him, in an unexpected way, to exploit the ideas of fixed point and functional equation in a domain fully original at the time: whereas the bifurcation of a limit cycle by period doubling was well known, the discovery by Pierre and Charles Tresser of an infinite set of period doubling bifurcations in a finite range of parameters, together with its properties of universality, was a complete surprise. This research has opened a new field in the theory of bifurcations and of dynamical systems with a few degrees of freedom. These wonderful theoretical works have given rise to many applications and new experiments. Notably, fluid mechanics experiments directed him naturally to the study of chaotic phenomena in spatially extended systems, with many degrees of freedom.

Pierre has an original view as well as a very deep understanding of the underlying physical mechanisms. However, his most salient characteristic is, perhaps, the desire to experience novelty in science, in technology and in life, as he made innovations since his early scientific age. In the mid 1980's, he switched from the study of finite-dimensional dynamical systems to the understanding of partial differential equations (PDE's). Very soon he understood that the qualitative behavior of partial differential equations requires intensive numerical simulations. He brought a first pair of Apple McIntosh to the "Laboratoire de physique théorique" at Parc Valrose in Nice. His first study concerned the complex Ginzburg–Landau equation, a topic on which he received the help of his now former students Lionel Gil and Jocelyne Lega.

He was one of the first to understand that nonlinear optics belonged also to this field. This led him to predict the existence of a regime of turbulence mediated by optical vortices, a regime indeed observed afterwards (Fig. 1). In his
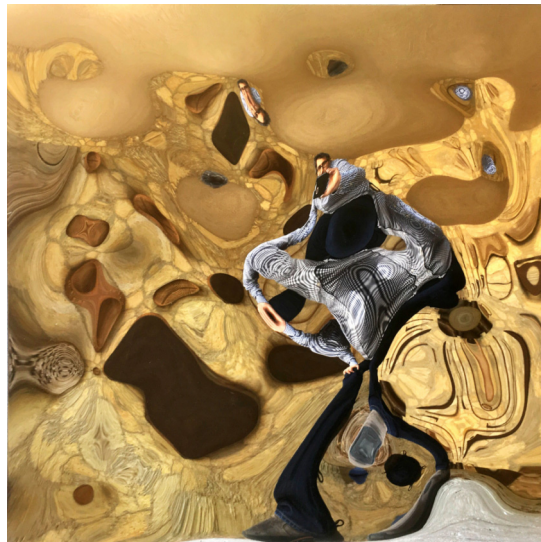
Fig. 1. Curved mirror with concave and convex domains: illustration of the problem of geometric aberration and multiple images (problem posed by Ptolemy and solved in the simple case of a spherical concave mirror by Ibn al-Haitham). The photographer's face appears three times in the image. Once isolated, in the middle right and then doubled, in the vicinity of a saddle node bifurcation in the upper part of the picture, slightly to the right of its center. Artwork conception by Pierre Coullet, picture by Sergio Rica.

quest for the best, Pierre got a few advanced *Sun sparc* workstations and he and his team (particularly Kjartan Emilsson) developed original interactive numerical simulations, largely recognized as a revolutionary innovation. The main purpose of an interactive numerical simulation (instead of simulation running in batch) is that the user can interact with the simulation, changing the values of the control parameters during the computation itself for instance, with the routine that simulates a physical system governed by elementary rules like in PDE's. This tool made possible a big step forward in the qualitative understanding of the behavior of PDE's. It is impossible to enumerate the many direct or indirect new ideas generated in this way. Today he programs and teaches Swifth (the language for MacOS) always with the same passion as in his early days. As a common principle, Pierre always experiences the last technological release or everything he could use to solve a problem or express an idea in a better way, a distinct feature of Pierre's character.

These remarkable achievements earned him a well-deserved scientific recognition nationally and abroad testified by a number of awards: Langevin Prize of the French Physical Society (1990), C.S. Freycinet Prize of the French Academy of Sciences (1991), Silver medal of the CNRS (1993), Foreign member of the Chilean Academy of Sciences (1999), Humboldt Prize (Germany, 2000), Holweck Prize from the SFP and IOP (2001).

Remaining the same very inventive and prolific researcher, Pierre is spending much time and efforts in the training of young researchers and in improving the pedagogy of physics at all levels, including to primary and high school teachers, to the general public, and within advanced sessions in prestigious institutes and foundations. His passion for the history of science has lead him to a reconsider, from a modern point of view, some classical problems in optics and mechanics.

He puts a lot of energy to successfully federate actions for research in his University. Remaining at the forefront of worldwide research, with multiple collaborations and a busy activity, he has kept intact the gaiety of his character and his friendly and optimistic personality.

We wish you, dear Pierre, to continue with your good mood and to stay on this trajectory of a man and a researcher with just as much inventiveness and beautiful discoveries.

Pierre Collet

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