Mechanics of feather pattern formation

Project for students in master or engineering school

IBDM, Turing Center for Living Systems, Marseille

Animals exhibit an exquisite diversity of adaptive patterns. What mechanisms produce such variation while ensuring pattern stability?

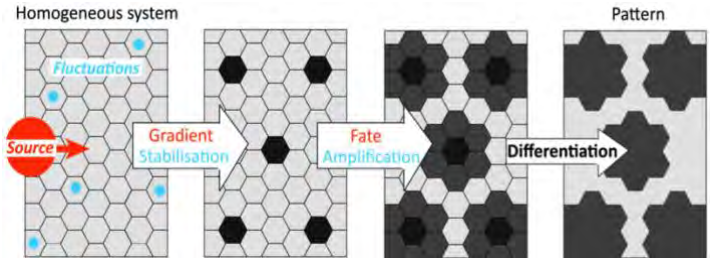
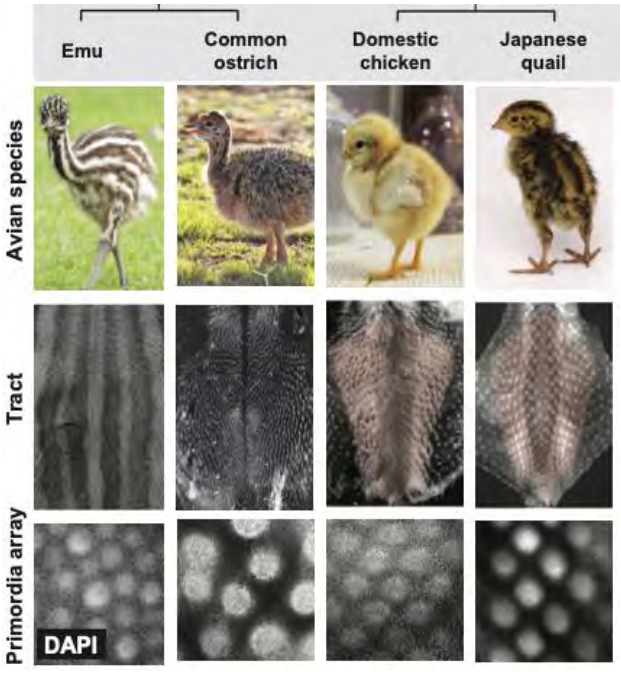


Fig 1: Stepwise patterning of an initially homogeneous system by two distinct models: in red, a chemical source produces a graded signal that instructs cells and defines their state; in blue, self-organization processes transform fluctuations into spatial references through stabilization/amplification.

Several mechanisms including reaction-diffusion or morphogen-mediated mechanisms have been proposed to explain this variation but have been poorly tested experimentally (Figure 1).

In this project, we propose to study candidate pattern-forming processes by exploiting inter-species variation in patterns formed by feather precursors (primordia) in birds (Figure 2). Their origins are both chemical and mechanical. The recruited student will characterize cellular and mechanical mechanisms controlling primordia aggregation. He/she will assess mechanical stresses in the developing epidermis and dermis using two approaches: (1) force inference, which consists in inferring local and global forces from the topology and geometry of cell contacts in fluorescence images; (2) deformable microbeads that are inserted in the tissue and whose deformations are mapped in space and time. He/she will contribute to the development of mechanical models in collaboration with partners in the project.



The 1rojectt requires a solid background in physics, computational skills, and a strong interest in living systems. The project will be carried out in a biophysics lab that combines experimental and theoretical approaches, in collaboration with the groups of Marie Manceau (Collège de France, Paris) and mathematicians, Thomas Lepoutre (INRIA Lyon) and Jonathan Touboul (Brandeis Univ, USA).

This project may lead to an ANR-funded PhD.

Keywords: complex systems, advanced microscopy, image analysis, cell mechanics, developmental biology, physical models.

Team*: Physical Approaches to Cell Dynamics and Tissue Morphogenesis*

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