Mathematical Phyllotaxis (L4)

Graduate Course (Non-Examinable)

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Fibonacci numbers in plants, such as in sunflower spiral counts, have long fascinated mathematicians. Most analyses are variants of a Standard Model in which organs are treated as point nodes successively placed on a cylinder according to a given function of the previous node positions, not too close or too far away from the existing nodes. These models usually lead to lattice solutions. As a parameter of the model, like the diameter of the cylinder, is changed, the lattice can transition to another, more complex lattice, with a different spiral count. It can typically be proved that these transitions move lattice counts to higher Fibonacci numbers. While mathematically compelling, empirical validation of the Standard Model is as yet weak.

The course will begin with a gallery of examples of Fibonacci patterning and a survey of the quantitative datasets available. We will give a brief history of mathematical approaches, including a partially successful attempt by Alan Turing. We study the mathematics of lattices on cylinders and classify lattice space using a fractal decomposition with close links to number theory. We will see the general properties a model will need to have to lead generically to Fibonacci structure. We will then introduce a range of biological models and survey the links between models and data, from the statistical to the molecular.

This non-examinable course will consists of four lectures and an examples class. It is strongly recommended for anyone who intends to offer the Mathematical Phyllotaxis essay.

Pre-requisites There are no pre-requisites for this course.

Preliminary reading There is no preliminary reading for this course.

Literature

- Roger V. Jean. *Phyllotaxis: A Systemic Study in Plant Morphogenesis.* Cambridge University Press, 1994
- Roger V. Jean and Denis Barabé. *Symmetry in Plants.* World Scientific, 1998.
- Jonathan Swinton. *A Textbook of Mathematical Phyllotaxis.* Deodands Ltd, 2020. This text is available online to students on request to jonathan@swintons.net.