

## Experimental Mathematics

**Course description:** In this course, we learn how to use *Mathematica* in various mathematical problems. *Mathematica* is great for visualizing mathematical objects (such as functions, sets, polytopes etc.), for collecting empirical data and for testing conjectures. In particular, we focus on 3D graphics tools provided by *Mathematica*. These tools are ideal for drawing high precision pictures for mathematical papers.

**What is *Mathematica*?** *Mathematica* combines a computer algebra system and a high-level programming language. It is a commercial product developed by Wolfram Research. There are free alternatives to *Mathematica* such as Sage and other commercial alternatives such as Maple. There are two reasons for choosing *Mathematica* for our course: first, *Mathematica* is already installed on many department computers, second, *Mathematica* has special features (such as manipulator) that can be used to display results nicely. If you master *Mathematica* you will have no difficulty working with other computer algebra systems since they are all build on the same principles.

### Topics of the course

1. How to use *Mathematica*: syntax and grammar; lists, matrices and tables; manipulator.
2. Graphics in *Mathematica*: function plots; parameteric plots; polygons and polytopes.
3. Numbers: decimal and continued fractions; arithmetic operations.
4. Functions: elementary and special functions; differentiation and integration; Taylor series.
5. Algebra: polynomials and algebraic equations; discriminants and resultants; rational functions and simple fractions; generating functions; linear operators and normal forms.
6. Differential equations: linear ordinary differential equations, Riccati equations, first order partial differential equations.