Mathematica for Physicists: computational methods and tools.

2 CFU

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The aim of this course is to present methods and toolkits for solving numerical and analytical problems in quantum physics. By exploiting suitable softwares, the students of this course will learn how to visualize, display and generate numerical and graphical solutions of many physics problems. Such a softwares are a good supplement both for students and researchers.

In the first part of this course, I will introduce the use of the software with a clear explanation of the basilar elements for the creation of a list of objects (numerical and symbolic), manipulation of expressions, the use of built-in functions (trigonometric, logarithmic, etc.), visualization of a graphic (2D and 3D), differentiation, symbolic and numeric integration, solving algebraic expressions, solutions for linear systems, and numerical solutions of differential equations.

In the second part, I will show how to implement notebooks, applying the skills acquired in the first part, in order to obtain solutions (numerical and analytical) for a class of fundamental problems in quantum physics: quantum harmonic oscillator, barrier potential, transfer matrix method, perturbation theory, second quantization, quantum two level systems, light-matter interaction.

The final part of the course will focus on the implementation of a specific calculation tool, that aims to develop particularly useful and powerful numerical methods such as Monte Carlo Wave Function or Density Matrix Renormalization Group theory.

During the course, various interactive tests will be assigned in order to certify the learning, students abilities and the acquired skills.
The final exam consists of a discussion, with a presentation, on the results obtained with a notebook for a particular problem tackled in the course.