Lectures on Computational Physics of Cold Atoms

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The aim of the course is to present a basic numerical computational techniques used in the field of Cold Atoms. The course will have a form of a lecture intertwined with computer-laboratory tasks to be performed in the class. Every meeting a theoretical introduction will be followed by a solution of an exemplary simple problem and then by an analogues task to be completed on students own. The lectures will be given in person starting October 2024 at IF PAN, Warsaw, but anyone can replicate them by following the provided Jupyter Notebooks. The chosen programming language for the course will be Python.

Requirements

- Basic knowledge of Quantum Mechanics,
- Basic programming knowledge (on any language),
- Your own laptop with Python, to code and run your programs during class.

Syllabus

The course will consist of 10 meetings lasting for 1.5h, amounting to a total of **15 hours** (1 ECTS). The classes will take place on **Thursdays** from **13:30 to 15:00** in **room D** starting from **17-th of October**. The course will cover:

- Short overview of Python programming language and its necessary components;
- General Methods for Quantum Gases:
  - Schrödinger Equation: numerical evaluation – eigenstates and dynamics,
  - Non-linear Schrödinger equation: solitons, vortices and quantum droplets
  - Stochastic Methods at non-zero temperature
  - Bose gases
  - Monte Carlo Methods
- Atoms in Optical Lattices:
  - Hubbard models (bosons and fermions)
  - Eigenstates and construction of Fock basis
  - Unitary dynamics
  - Spin-full particles
  - Meanfield methods