

# Midterm Exam (part 1) - Computational Physics I

NAME: \_\_\_\_\_ SCORE: \_\_\_\_\_

**Date:** Monday 13 October 2025    **Duration:** 45 minutes

**Credits:** 10 points (5 questions)    **Type of evaluation:** MT

**Please provide concise answers to the following items:**

**1. (2 points) Input/Output and data formats**

- a. Describe 2 distinct methods suitable for handling tabulated data input and output in Python.
- b. List and briefly describe 2 types of scientific data formats used in physics.

**2. (2 points) Systems of linear equations**

- a. Explain how the Gauss elimination method for solving systems of linear equations works.
- b. List the main steps for solving such systems via symbolic algebra with SymPy in Python.

**3. (2 points) Systems of nonlinear equations**

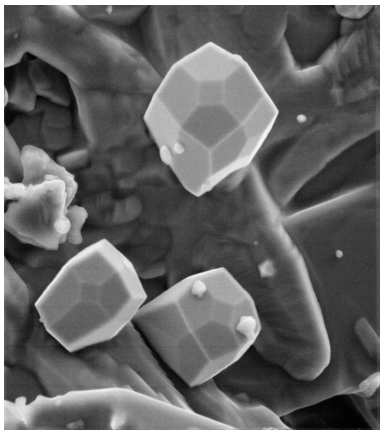
- a. Indicate 2 methods that we can use to solve systems of nonlinear equations in Python.
- b. Briefly explain how each method works.

#### 4. (4 points) Data processing

You have a simulation dataset consisting of 50 HDF5 files, each containing time, gas density ( $\rho$ ), and velocity components ( $v_x, v_y, v_z$ ). Each file corresponds to a different time in the simulation.

- Write a Python function prototype for reading a single HDF5 file, computing the mean kinetic energy, and returning the time and the mean kinetic energy as NumPy arrays.
- Sketch the loop needed to process all 50 files using the above function, so that you obtain and plot the mean kinetic energy versus time.

#### 5. (2 points) Image processing



Imagine you obtain this photograph of iron crystals from a scanning electron microscope (credits: NASA/JSC), and you are asked to isolate the more prominent crystals from the background and from the rest of the image. Design and sketch a suitable algorithm workflow to achieve this goal in Python.