

Module 4 of the IFA Challenge Track investigates the use of numerical simulations to solve physical problems. It will take place in weeks 8-16 (exact dates to be announced).

## Module aims

The aim of the module is to build a numerical model of a real system, implement this as computer code and finally run a simulation to collect data about the behaviour of the system. Each participant will produce a written report on their project, split into 2 sections, and will present their results in a mini-symposium held at the end of the module.

## Project themes

Some suggested project themes are given below. You are also welcome to suggest your own project idea, provided that it fits within the overall theme of the module (i.e. it involves a numerical simulation of a physical system).

- A new proton therapy centre for cancer treatment is to be built at Aarhus University Hospital in Skejby. Design and simulate a cyclotron accelerator capable of producing the 250-MeV protons required
- A competing accelerator type for the project at Skejby is a synchrotron. Design and simulate a synchrotron accelerator capable of producing the 250-MeV protons required

For both the above projects, see the attached pdf for more details

- Build a model of an exoplanet: Use the relevant differential equations and a simple equation of state, which depends on temperature, to investigate the relation between radius and mass for different chemical compositions
- Measure star quakes on a star observed by the Kepler satellite: Calculate the power spectrum, find the oscillations and calculate physical properties of the star (radius, mass and age)

For further details on the astrophysics projects, contact Hans Kjeldsen.

## Café sessions

Throughout the module there will be café sessions where you can discuss your projects, both with each other and your instructor.

## Evaluation

The end products of module 5 are a short written report and an oral presentation (both in English). In the report you will introduce your problem and set out the mathematical basis for your simulation. The presentation will allow you to present the results and conclusions from your project to your peers. You will also submit your working code, together with any instructions required for testing and validating your code. The validation is an important step which provides evidence that your code produces physically sensible results.

### Report

The report is split into two sections to be submitted as the module progresses. The purpose of the sections is as follows. Part 1: Introduce the motivation for your project and set out your aims (maximum 2 pages). Part 2: Discuss the key physics concepts required for your project and set out a mathematical framework for your simulation (maximum 4 pages).

### Code

At the end of the module the code produced should be submitted together with any documentation / notes required to run the code and produce useful output.

### Presentation

We will hold a conference-style session where each speaker will have ~15 minutes to provide an overview of their project and discuss the outcomes of their simulations.

## Acquired skills

By the conclusion of this module you should be able to:

- Perform a literature review on a given topic and identify the key concepts.
- Apply your physics knowledge to create a mathematical description of a system.
- Use this description as the basis for a numerical simulation.
- Analyse simulated data and draw conclusions on the validity of the results.
- Communicate important ideas and concepts through written and oral reports.

## Important dates

**Deadline for signing up to the module: TBA**

Send an email to Heine Thomsen (heine@phys.au.dk), including your student number and FYS-team number.