# Introduction to AST2000

This introduction gives you **(1) a short overview of the course, (2) important information on how to obatin necessary codes for the exercises/projects you will be doing and (3) how to use course software.**

## Lecture notes and exercises

This course gives an introduction to important topics in astrophysics, from orbital calculations to stellar evolution and the theory of relativity. There are normal 'lecture notes' (in English only) and interactive lecture notes (in Norwegian only). The former is similar to chapters in a book, the latter very similar to the physical lectures. Both will fully cover the necessary curriculum, but note that the weekly exercises are only found in the normal lecture notes: at the end of these lecture notes, there are analytical and numerical exercises to test and improve the understanding of the topics. These exercises are not necessary for project students, but for everybody else, some of these exercises will appear on the exam. The course is divided into three sections:

1. **Section 1 consisting of part 1A, 1B, 1C, 1D, 1E, 1F, 1G:** This section is constructed as a space mission to another planet. Each student is given a random seed value which gives you access to a randomly generated solar system with randomly generated planets. You are given a home planet and can choose a planet you want to visit. Through a python class you can read out the details of your solar system and through a computer game engine (Unity) you can visualize it and check your calculations. The documentation for the python class and computer game engine application will be given in a separate document. In this section you will learn some statistics and gas dynamics (and building the rocket engine for you space mission), orbital calculations, methods for indirect detection of extrasolar planets, radiation physics and data analysis techniques to analyze spectra from your planet and finally some quantum mechanics for gases with very high density which you will need in the section on stellar death.
2. **Section 2 consisting of part 2A, 2B, 2C, 2D, 2E:** In this section you will learn the special theory of relativity in a new way. You will look into the details of what happens to time and space when changing frame of reference. You will learn how to transform time and space coordinates as well as velocity, momentum and energy between different frames of reference. A new mathematical framework for doing physics in four (space and time) dimensions will be introduced. After learning the details of the special theory of relativity you will learn the basic principles of the general theory of relativity describing how space and time bend around objects in order to create gravity. In particular you will calculate the strange effects which happen when falling into a black hole and how light from distant light sources are bent around galaxies. In this section you will use the computer game application even more: many of the exercises consist of videos of events taken from different frames of reference. You will need to measure and calculate positions and time of events in the videos.
3. **Section 3 consisting of part 3A, 3B, 3C, 3D, 3E:** In this section you will use what you learned about gases in section 1 to study how stars form from a huge gas cloud, how they produce energy through nuclear reactions and how they evolve from being main sequence stars to giants. You will learn the physics that governs the evolution of stars which will allow you to interpret observations and calculate stellar properties from these. Finally you will look into the physics of supernova explosions and the strange quantum effects occurring in the very dense white dwarf and neutron stars resulting from stellar death.

## The AST2000 python package

For programming exercises, both for the project and for the weekly exercises you will often need the AST2000 python package. Here (also link from semester page) you will find instructions on how to install the package.

Under 'Get started' you obtain information on how to get **your personal seed value** from your UiO username. Each student will have his/her personal solar system to work with (this applies to both variants of the course) and many programming exercises will be based on data from this solar system. There are also some examples on how to obtain parameters like masses and distances in your solar system.

In the 'Get started' meny, click on the 'Solarsystem' class link: this will give you an overview of all the parameters of the solarsystem class. When you need numbers for your project/programming exercise you will normally find these here. (note that some of the parameters and methods are only needed by the project students)

## AST2000 software

The AST2000 visualization software is necessary for project students, but can be helpful also for all other students. Using this link (also link from semester page) you can download SSView of MCast which are two different visualization applications. SSView can be used to move around in your solar system and get a glimpse of your planets (but you need to simulate orbits and upload these to SSView first). The use of MCast is twofold, first of all it is what project students use when they communicate with their space craft after launch. This is where you can get pictures and videos back taken by the space probe. Secondly, it is used to generate the video-exercises in the chapters on relativity. Project students need MCast to generate the videos on their destination plantes. Other students may choose to use MCast to view these videos (for better quality and control) or just look at the already generated videos here (also link from semester page). More detailed instruction on how to use SSView and MCast can be found here (also link from semester page).