AST1100 Lecture Notes

Introduction

This course gives an introduction to important topics in astrophysics, from orbital calculations to stellar evolution and the theory of relativity. After each lecture note, there are analytical and numerical exercises to test and improve the understanding of the topics. The course is divided into three parts:

1. **PART 1:** This part 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 part 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. **PART 2:** 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.
3. **PART 3:** In this section you will use what you learned about gases in part 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 starts 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.