Astrophysical Radiation Processes: AS7005 Lab: 26.09.2022
Evan O'Connor & Yutong He Due: 31.10.2022; on Athena

Introduction to AS7005 Laboratory Exercise

The purpose of this laboratory exercise is to solidify your understanding of of the fundamental radiation theory concept of polarization, introduce you to some basic tools for radiation transport, and get practice performing research, analysing results, and writing scientifically. These cover some of the learning outcomes of the course, but also some of the learning outcomes of the Master's program in general and is good preperation for the research project later on in the degree program.

There is a prelab exercise (one of the standard weekly exercises) to prep you for the content we will be looking at in the lab. The lab itself will be two parts. The first will guide you through the concepts of Thomson scattering, angular distributions, polarization, and net polarization. Then proceed to have you perform Monto Carlo simulations of radiation from aspherical supernovae in order to determine the net polarization of the signal. This will be the major work in the lab session. The second part will be writing a paper-like lab report to summarize the findings. Even though this research has been done before (we'll see this below), when writing the report, please work under the assumption you are doing this for the first time, typical for a scientific paper. Please read `https://www.nature.com/articles/d41586-019-02918-5` for tips on writing scientifically.

For the paper please follow the outline below and pay attention to the questions posed in the lab. We suggest using overleaf (`www.overleaf.com`), choose a new project with a template, choose either "Astronomy and Astrophysics" or "American Astronomical Society". Include an **Abstract** summarizing the paper and the findings. An **Introduction** where you give an general overview of the astrophysical system we are modelling, and any other background information needed for the paper. Include a summary of the layout of the paper. Have a **Methods** section where you discuss briefly the theoretical model and methods (including a brief description of the Monto Carlo transport). Include key equations (e.g., among others, the differential Thomson Scattering cross section, $d\sigma/d\Omega$) and ket derivations. Have a **Results** section where you go through and present the verification of the Monte Carlo simulations and the results of the net polarization study. Please pay attention to the specific questions asked in the lab and ensure you provide an answer to them. End with a **Conclusions** section where you discuss and summarize the results. Wrap things up with assessing what you think are the main limitations of the methods (including sources of error) and possible improvements.

The lab write up is intended to be done independently. But you are encouraged to have dicussions with each other and the lab instructors during the lab itself, but please come to your own conclusions, present your own data in your own plots, answer the questions on your own, and submit your own paper. An A will be given for a well written paper that follows the above outline and shows a excellent understanding of the methods and results, perhaps with some extension, analysis, or insight beyond what what is presented in the lab notebook. An acceptable lab report is required to complete the course. The lab componant (the paper and the prelab exercise) is 15% of the total grade in the course. Please also save the notebook and include in your submission a pdf copy of the jupyter notebook you generated in the lab. This will be especially useful when you write up the lab, but also helps us with seeing your methods.