SPA 302: STELLAR EVOLUTION STUDY GUIDE

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Year 2015: First semester

Study Level: Third Year B.Sc. Astronomy and Astrophysics

Course overview
This course unit is one of the core units in the third year Bsc astronomy and astrophysics degree at the University of Nairobi. It addresses the important astrophysical subject of stellar evolution which describes how the observed physical properties of stars change during their lifetime- from birth to death. Stars constitute the basic building blocks of our Universe and the way in which they evolve over time- known as *"stellar evolution"*- forms a crucial link to our understanding of the structure and evolution of the cosmos.

Aims: This course aims to introduce the students to one of the most important topics in modern astrophysics concerned with unravelling hidden mysteries behind the birth and death of stars. It will equip the students with the basic concepts of the current state-of-the art stellar evolutionary theory and hence bring them up to date with the current status of stellar astrophysics studies.

Objectives: At the end of this course the students should be able to:

1. Discuss the basic concepts of stellar evolution: luminosity, stellar temperatures, mass, radius, energetics, the Hertzsprung-Russel diagram and stellar populations.
2. Display a good understanding of the birth of stars: interstellar medium, emission, reflection nebulae, dark clouds, globules, protostar formation, giant molecular clouds, newborn stars and their evolutionary tracks, importance of clusters in stellar evolution studies and pre-main sequence evolution.
3. Understand and discuss post main-sequence evolution of stars: Estimating main-sequence lifetimes, the star evolutionary phases, globular clusters, population I and population II stars.
4. Understand the evolution of the Sun, the solar cycle, solar prominences, solar flares, solar rotation.
5. Describe in detail the non stationary processes in stars: Pulsation, Cepheids, RR Lyraes-distance scale and interacting binary stars.
6. Understand in detail the end state of stars: White dwarfs, neutron stars, black holes as well as supernova explosions.

Programme of Lectures: This course shall consist of a series of **7 lectures** given over one semester with a hand-out of problem sets at the end of each lecture. The solutions to the problem sets shall be handed in **after one week**. Late submissions **will not** be accepted. The lecture times shall be as follows:

- Mondays: 2-3 Pm; Room 222, Second Floor Physics department.
- Fridays: 10-12 Pm; Room 229, Second Floor Physics department.

To ensure smooth running of the lectures and to avoid any disruptions, all lectures shall start on the dot and no late students will be allowed into the lecture.

Course Evaluation: This course will be made up of a coursework component composed of 7 problem sets, 2 Continuous Assessment Tests (CATs) and an end of semester examination. The coursework mark will be 30% while the final examination will contribute 70%. A student who would have not attended at least **three quarters** of the **total number of semester lecture hours**

will not be allowed to sit for the examination, unless under authorization from relevant university authorities.

<u>Course Unit Content:</u>

Lecture No	TITLE	CONTENTS
1	Basics of stellar evolution	• Luminosity • Stellar temperatures • Mass • Radius • Energetics • The Hertzsprung-Russel diagram • Stellar populations.
2	The birth of stars	• The interstellar medium • Emission • Reflection nebulae • Dark clouds • Globules • Protostar formation in dark clouds • Giant molecular clouds • Newborn stars and their evolutionary tracks • Importance of clusters in stellar evolution studies
3	The Sun	• The solar interior • The solar atmosphere • The solar cycle • Solar prominences
4	Pre-main sequence evolution of stars	• The Kelvin-Helmoltz timescale • The Hayashi tracks • Evolution of a low mass stars, a solar mass star and massive stars • Zero age main-sequence • Initial mass function • H II regions
5	Post-main sequence evolution of stars	• Evolution on the main sequence • Late stages of stellar evolution
6	Non-stationary processes in stars	• Pulsation • Cepheids • RR Lyraes • Interacting binary stars
7	The end-point of stars and stellar clusters	• White dwarfs • Neutron stars • Black holes • Population I and II stars • The physics of degenerate matter

Consultation times:

The consultation times with the course lecturer shall be **Tuesdays 3-4 Pm** and **Thursdays 4-5 Pm**.

Additional Reading

Although the course lecture notes shall be comprehensive enough for this course, students may find the following texts useful:

1. An Introduction to Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wesley.
2. Introduction to Stellar Astrophysics, E. B. Vitense, Volume 1, Cambridge University press.