Course Title: **COSMOLOGY**
Course Lecturer: **DR ALVARO DOMBRIZ (UCT)**
Course credits: 1
Lecturer contact hours: 24
Tutorial/practical hours: 6

1) Course overview:

This course brings students up to date with the basic concepts and key results in current cosmology. The focus is on building physical understanding and making links to modern observations where possible.

The course begins with an overview of the accelerating universe model (LCDM), from the Big Bang and Inflation to the current era of Dark Energy. Then we discuss cosmic times, distances, masses and densities and their standard units in order to develop familiarity with the scales of cosmology.

Since General Relativity is not assumed, we use a Newtonian framework to motivate the Friedmann equation. Together with the energy conservation equation, this allows us to solve for the evolution of the universe through the radiation, matter and accelerating eras.

We use basic ideas of Special Relativity to describe the past lightcone of the observer, and thus derive the comoving, angular diameter and luminosity distances. This leads to qualitative descriptions of supernova cosmology and of the baryon acoustic oscillation scale. It also lays the basis to analyse number counts in galaxy surveys.

Finally, we end with a brief analysis (in a Newtonian approximation) of matter density perturbations and their growth rate.

Students are assisted to write their own basic Python codes to compute cosmological distances and solve basic equations.

2) Course breakdown/syllabus:

1. Overview of the LCDM model, from Inflation to Dark Energy.
2. Cosmic scales: times, lengths, masses and densities in astronomical units.
3. Cosmological dynamics: derivation of the energy conservation equation and heuristic Newtonian-like ‘derivation’ of the Friedmann equation. Solutions of the equations in the radiation, matter, matter-radiation and accelerating eras, to build an overall picture of the evolution of the universe.
4. Cosmological distances: the past lightcone of the observer (using Special Relativity locally); derivation of the formulas for comoving, angular diameter and luminosity distances; angular sizes and the BAO as ‘standard ruler’; supernovae as ‘standard candles’.
5. Galaxy surveys: number counts and volumes on the past lightcone.
6. The growth of large-scale structure: Newtonian-like ‘derivation’ of the evolution equation for matter density perturbations; analytical and numerical solutions; the growth rate.

3) Resources:

Lecture slides will be provided.

Recommended text:
Introduction to Cosmology, B Ryden (Cambridge UP 2006)

4) Breakdown of practicals/tutorials:

Tutorials will cover:
(a) analytical calculations to solve problems set in lectures and in tutorial sheets;
(b) Python codes to compute distances and solve differential equations.

5) Additional skills to be developed during the course:

Python programming skills

6) Assessment

2 Class tests: 80%
Hand-in Python problems: 20%