Course Title: **Accreting Compact Binaries**
Course Convener: Prof David Buckley
Course Lecturers: Prof David Buckley, Prof Paul Groot, Dr Itumeleng Monageng, Dr Elias Aydi
Course credits: 1
Lecturer contact hours: 24
Tutorial/practical hours: 6

1) Course overview:

This course focuses on a broad range of astrophysical processes in accreting compact binary system consisting of accreting white dwarfs, neutron stars or black holes. The focus will be primarily on cataclysmic variables and X-ray binaries, both low and high mass systems. Some of the common features of accretion, including mass transfer and the formation and nature of accretion discs will be discussed, both from theory and observational perspective. We will look at the origin and evolution of these binaries, as well as the various physical processes that give rise to transient events associated with outbursts. The course will also cover some of the observational methods used in the study of these system, including X-ray, optical and radio observations and the detection of periodic phenomena. The role magnetic fields in the accretion process will also be discussed and how polarimetric observations can assist in modelling magnetically influenced accretion.

The course includes will include a practical component where students will reduce and analyse high speed optical photometric observations of selected object in order to characterise the various periodic time signals (binary orbit, rotation of the accreting white dwarf, etc) in these systems. The course also includes a literature research component.

2) Course breakdown/syllabus:

- gravitational equipotentials; mass transfer; mass and angular momentum loss; accretion disk formation; accretion disk physics; accretion simulations
- The origin and evolution of Cataclysmic Variables, Low and High Mass X-ray binaries; population studies
- Thermal instabilities in accretion discs; outbursts
- Low & High Mass X-ray Binaries and their detection and study; observational X-ray astronomy; outburst cycles; multi-wavelength observations
- Gamma ray binaries
- Propeller mechanisms; transitional millisecond pulsars
- Flickering; quasi-periodic oscillations (QPOs); dwarf nova oscillations; techniques for detecting periodicities; X-ray bursts; X-ray QPOs
- Magnetically influenced accretion in white dwarfs and neutron stars; accretion columns; polarized emission
- Accretion induced thermonuclear runaways in novae, recurrent novae and super soft X-ray sources
- Surveys and new discoveries; multi-messenger observations; the Rubin Observatory LSST
- Observing compact binaries with SALT and MeerKAT

3) Resources

All lecture material will be provided, primarily in the form of PowerPoint presentations. In addition supporting selected lecture notes will be made available.

4) Breakdown of practicals/tutorials:

Practical (6 hours):

- Introduction to high speed photometry and data reduction (requires some Linux experience and ideally some Python familiarity);
- differential photometry reductions using the *TEA-Phot* Python program;
- reducing spectroscopic data (e.g. using *IRAF*)
- period analysis using the *Gatspy* Lomb-Scargle Python program;
- interpreting and writing up your results.

5) Additional skills to be developed during the course:

Using Python for data reduction and period analysis; experience with spectroscopic reduction techniques; scientific writing and reporting.

6) Assessment

Practical (high-speed photometry and/or spectroscopy) report: 25%
Essay on selected topics: 25%
Final exam: 50%