NELSON MANDELA
UNIVERSITY

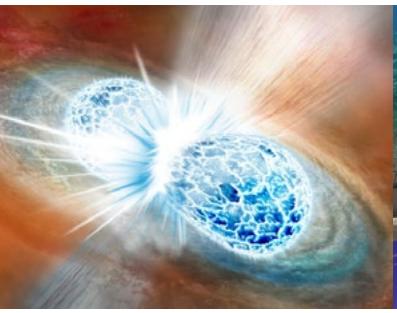
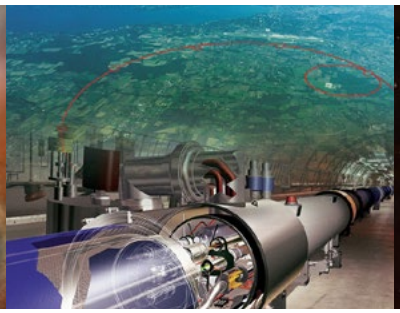
Faculty of Science

Nelson Mandela University invites applications for two MSc and two PhD positions

Positions: MSc and PhD positions in Theoretical High-Energy Particle-Nuclear Physics, and Astrophysics

Theme: Connecting Quarks with the Cosmos

Focus Areas: Matter under extreme conditions in heavy ion collision and astrophysical processes

OVERVIEW

Theoretical study of matter under extreme temperature and densities covers a large area of contemporary research. Such matter is produced during heavy ion collisions at particle accelerators and astrophysical processes. This study entails a detailed use of relativistic fluid dynamic description, statistical and thermal model description of the matter. Relativistic kinetic and microscopic theories as complementary topics to fluid dynamics, play a major role in this study. Computational and data science tools, mathematical and analytical methods are to be employed in carrying out the investigation. The study of quarks and gluons as well as hadronic matter produced under extreme conditions of temperature and densities will be undertaken. The matter under study is produced in particle accelerators such as RHIC-BNL, LHC-CERN, CBM-FAIR and NICA-JINR. At the other end such exotic matter are believed to be formed in astrophysical processes such as neutron star collisions, supernovae explosions, black hole mergers etc. and the subsequent detection of astrophysical signals (messengers) from these events by the ground-based and space-based telescopes and detectors such as SKA, SALT, MeerKAT, LIGO, Hubble telescope etc.

OUTLINE

Theoretical understanding of the Equation of State (EoS) and transport properties of matter under extreme conditions. The effects of strong magnetic and gravitational fields on dynamics and properties of the matter will be investigated. The research topics are applicable for both heavy ion collisions at accelerators and astrophysical processes.

1. Fluid dynamics

- Derivation of relativistic fluid dynamic equations including effects of dissipations and external fields.
- Solving the fluid dynamic equations analytically
- Solving the fluid dynamic equations numerically up to full (3+1) dimension simulation.
- Comparison with the experimental observables.
- Investigate the effects of initial and final states on fluid evolution.
- Constraining EoS

2. Statistical and thermal models

- Study particle production
- Extracting information on temperature, chemical potential, and net charge density of matter.
- Investigating QCD phase transition and phase diagram
- Investigate EoS of the matter which will serve as input into fluid dynamic models.

3. Kinetic and microscopic theories

- To develop microscopic transport models for describing the produced matter
- Using the transport models to generate phase-space distribution of particles
- Studying collective properties of matter such as EoS, transport properties etc. from generated phase space information.
- To use microscopic models to compare with fluid dynamic models.
- Using microscopic models as input to fluid dynamic evolution both for initialization and final states interaction.

REQUIREMENTS:

1. For MSc program:

Applicants need to have honours degree in Physics with following subjects: quantum physics, statistical physics, electrodynamics, and classical mechanics. Added advantage will be given to knowledge on special theory of relativity, astrophysics, particle physics, mathematical physics, nuclear physics, and computational physics.

2. For PhD program

Applicants need to have MSc degrees in Physics with following subjects: quantum physics, statistical physics, electrodynamics, and classical mechanics. Added advantage will be given to knowledge on special theory of relativity, astrophysics, cosmology, particle physics, nuclear physics, quantum field theory, mathematical physics, and computational physics.

Starting Date: 01/01/2021

Duration MSc: 2 years

PhD: 3 years

Interested and qualified students should send their CVs, academic records and cover letter to Ms Dolly Ntintili: dolly.ntintili@mandela.ac.za