1. Level of the project: Honours

2. Name of primary supervisor: Prof. Oleg Smirnov

3. Institution supervisor: Rhodes University

4. Name of co-supervisor: Prof. Gianni Bernardi; Dr. Ntsikelelo Charles

5. Institution of co-supervisor: INAF-IRA & Rhodes University; SARAO

6. Contact details of supervisor and co-supervisor: o.smirnov@ru.ac.za; giannibernardi75@gmail.com, ntsikelelo.charles@gmail.com

7. Project title: The evolution of the 21 cm emission from the intergalactic medium in the 6 < z < 200 range

8. Description of project, including the aims and anticipated outcomes, what will be expected of the student, and any special qualifications required (maximum 500 words). Please also stipulate if any specific skills are required (eg, computational skills):

One of the outstanding questions in modern cosmology is to understand how the first luminous structures (stars, galaxies) formed (likely at $z \sim 30$) and how they subsequently evolved and completely ionized the intergalactic medium ($z \sim 6$). These two epochs are generally known as Cosmic Dawn and Epoch of Reionization. One of their best observational probes is the redshifted 21 cm line emitted from neutral Hydrogen, observable in the 50-200 MHz radio window. In this project the candidate will review the literature that studies the evolution of the 21 cm emission from the intergalactic medium at high redshift ($6 < z < 100$) and, following the basic theory formalism, will compute the evolution of the gas temperature and the related emission from the 21 cm

transition. The candidate will, eventually, plot the evolution of these components and compare them with the literature results.

The goal of the project is make the candidate familiarize with a frontier research field in modern astrophysics and cosmology that has driven the construction of the last generation of radio telescopes (for example, the Hydrogen Epoch of Reionization Array and the Square Kilometre Array) and offer them the basis to continue work in this research area for their MSc thesis (if desirable).

Familiarity with python programming is preferable but can also be learned throughout the project.

Supervisor

Oleg Smirnov   14 March 2025