EUROPEAN AI FOR
FUNDAMENTAL PHYSICS
CONFERENCE
EuCAIFCon 2025

Contribution ID: **83** Type: **Poster + Flashtalk**

Machine learning methods for studying cosmology with upcoming SKA data

The formation of the first galaxies was a pivotal period in cosmic history that ended the cosmic dark ages and paved the way for present-day galaxies such as our Milky Way. This period, characterised by distinct conditions—such as the absence of crucial metals necessary for efficient gas cooling—poses a frontier in cosmology and astrophysics, offering opportunities to discover novel physics. Emitting energetic radiation into the intergalactic medium (IGM), these early galaxies initiated "cosmic reionisation", a process gradually heating and ionising the gas. The 21-cm signal, produced by the neutral hydrogen, is a unique signal that can probe the evolution of gas in the IGM. Although current radio experiments, such as Low-frequency Array (LOFAR), Hydrogen Epoch of Reionization Array (HERA) and Murchison Widefield Array (MWA), are attempting to detect this signal, the upcoming low-frequency component of the Square Kilometre Array (SKA) will revolutionise the field by producing images of the distribution of this signal on the sky at various epochs of reionisation. This data is a treasure trove of information about the evolution of our universe.
In this talk, I will present a U-Net-based framework designed to detect physical patterns in 21-cm images, extending beyond the Gaussian information captured by the power spectrum. I will address the challenges of image reconstruction posed by telescope systematics, including noise, resolution limitations, and foreground residuals, and introduce a machine learning-based approach optimised for mitigating these effects in 21-cm images. Additionally, I will discuss a simulation-based inference framework aimed at constraining the physics of the early universe.

AI keywords

pattern recognition, image reconstruction, simulation-based inference

Primary author: GIRI, Sambit (University of Groningen)

Presenter: GIRI, Sambit (University of Groningen)

Track Classification: Patterns & Anomalies