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Site Characterization and radio telescope validation in Antarctica for Epoch of Reionization Studies and Development of Radio Astronomy Capacities in Colombia

The Epoch of Reionization (EoR) is one of the most mysterious phases in the evolution of the universe, a further signature, observable over the entire sky, should mark the overlap stage of reionization. During overlap, the IGM is transformed from being a neutral, preheated and thus emitting gas, to being almost completely ionized. marking the transition from a neutral hydrogen-filled cosmos to the ionized state we observe today [1]. Observing the 21-cm signal from this epoch is key to unlocking our understanding of early galaxy formation, cosmic structure, and the universe's thermal history, providing a powerful new tool for the next generation of precision cosmology measurements [2].

The 50-200 MHz frequency band, crucial for observing EoR signals, was identified as a priority range [3], however, due to its faint nature, detecting this signal requires radio-quiet environments, free from human-made radio frequency interference (RFI), and long, stable observing periods [2], [4]. Our project focuses on the Antarctic Peninsula, particularly around General Bernardo O'Higgins Station, to characterize the site's suitability for establishing a low-frequency radio observatory.

Polar regions like Antarctica offer unique advantages such as extended winter nights, and low RFI, making it an ideal location for radio astronomy at these frequencies [5]. Site characterization efforts include RFI Measurements. In the Antarctic summer of 2023 and 2024, we deployed wideband RFI monitoring systems to assess potential interference sources, both human-made and natural. Initial results indicate that this site of the peninsula remains pristine from terrestrial RFI, with only occasional disturbances from research stations and satellite communications.

Detailed studies on environmental conditions such as temperature, wind, and solar irradiance have been conducted to evaluate the site's suitability for hosting permanent radio astronomy infrastructure. The results point to challenging but manageable conditions, with the potential for year-round operations supported by specialized infrastructure.

Telescope Development involves the design and testing of a prototype low-frequency radio telescope capable of EoR observations [6]. This telescope, developed in partnership with Colombian and Chilean institutions specializing in radio astronomy instrumentation, will also serve as the basis for future installations in Antarctica and Colombia.

Concurrently, our team is advancing the development of a radio observatory at Universidad Industrial de Santander in Bucaramanga, Colombia, to complement Antarctic observations. We present advances on this observatory that will focus on 21cm signals by developing our own low frequencies radio telescope and a 1420 MHz 5m dish radio interferometer.

This radio observatory also serves as a training ground for a new generation of Colombian astronomers, engineers, and data scientists. By involving students and early-career researchers in instrument design, deployment, and data analysis, we aim to build local capacity in radio astronomy and strengthen Colombia's role in international scientific collaborations.

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