Paper ID: 51726

IAF SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Technology Needs for Future Missions, Systems, and Instruments (3)

Author: Dr. Raj Thilak Rajan
Delft Institute Of Technology (TU Delft), The Netherlands

Dr. Prem Sundaramoorthy
Eindhoven University of Technology, The Netherlands
Mr. C.J.C. Vertegaal
Eindhoven University of Technology, The Netherlands
Mr. Anton Montage
Delft University of Technology (TU Delft), The Netherlands
Mr. Visweswaran Karunanithi
Technical University of Delft/Innovative Solutions In Space.BV, Delft, The Netherlands
Mr. Maneesh Kumar Verma
Delft University of Technology (TU Delft), The Netherlands, The Netherlands
Prof. Mark Bentum
Eindhoven University of Technology, The Netherlands
Dr. Chris Verhoeven
Delft University of Technology (TU Delft), The Netherlands

LOW-FREQUENCY OBSERVATIONS USING HIGH-ALTITUDE BALLOON EXPERIMENTS (LOBE)

Abstract

The past two decades have witnessed a renewed interest in low-frequency (LF) radio astronomy, driven by fundamental scientific questions, such as studying the dark ages, epoch of re-ionization and search for extra-terrestrial intelligence. However, terrestrial observations at low frequencies below 30 MHz are severely hampered by ionospheric distortion and by man-made radio frequency interference (RFI), and hence the spectrum of 0.3-30 MHz remains one of the last unexplored spectrum. To circumvent these limitations, space-based radio astronomy arrays, such as OLFAR (Orbiting Low Frequency Antennas for Radio Astronomy) have been investigated. Such futuristic radio telescopes, will consist of over 10 single-antenna satellites, employing interferometry to construct radio maps of the cosmos. One of the key challenges in this context is the validation of the various critical OLFAR technologies, and subsequently to increase the TRLs (technology readiness levels) of the respective systems.

To this end, we propose the use of high-altitude ballooning experiments to validate OLFAR subsystems in harsh representative conditions (e.g., temperature). Secondly, these ballooning experiments will measure the man-made RFI at various altitudes from Earth, which is an impediment to ground-based radio astronomy. These measurements will enable, for the first time, the construction of spatial-interference model for LF interference at high-altitudes, which is an impediment to terrestrial radio astronomy. More concretely, this project is termed as LOBE (Low-frequency observations using high-altitude Balloon Experiments), which will be executed in 2 Phases.

In Phase 1, aimed for deployment in last quarter of 2019, a single plastic zero-pressure balloon will be deployed, carrying a science payload weighing less than 5 kg, to reach altitudes of up to 30 km, with a mission lifetime of up to 4 hours. The science payload will comprise of a LF antenna and custom designed LF front-end for observing the frequency band of 1-80 MHz, which is followed by a polyphase filter bank

and a data storage system. In Phase 2, multiple balloons will be launched and crucial OLFAR technologies, such as distributed relative navigation, inter-satellite and downlink communication, distributed interferometry will be validated in harsh environments.

In summary, LOBE offers quick and affordable access to measure and characterize LF science payloads, both electrically and structurally, and in addition enables RFI monitoring at high-altitudes. In this paper, we present an overview of the science objectives, payload, collaboration, roadmap, and the technological and programmatic challenges of the LOBE project.