SPACE EXPLORATION SYMPOSIUM (A3)
Space Based Astronomy (4)

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A NOVEL ASTRONOMICAL APPLICATION FOR FORMATION FLYING SMALL SATELLITES

Abstract

Purpose One of the last unexplored frequency ranges in radio astronomy is the frequency band below 30 MHz. This band is scientifically interesting for exploring the early cosmos at high hydrogen redshifts, the so-called dark-ages. This frequency range is also well-suited for discovery of planetary and solar bursts in other solar systems, for obtaining a tomographic view of space weather, and for many other astronomical areas of interest.

Methodology Because of the ionospheric scintillation below 30 MHz and the opaqueness of the ionosphere below 15 MHz, earth-bound radio astronomy observations in those bands would be severely limited in sensitivity and spatial resolution, or would be entirely impossible. A radio telescope in space would not be hampered by the earth's ionosphere, but up to now such a telescope was technologically and financially not feasible. However, extrapolation of current technological advancements in signal processing and small satellite systems imply that distributed low frequency radio telescopes in space could be feasible.

Results In order to achieve sufficient spatial resolution, a low frequency telescope in space needs to have an aperture diameter of approximately 100 km. Clearly, only a distributed aperture synthesis telescope-array would be a practical solution to explore the new frequency band for radio astronomy. Such an array would have identical elements (small or miniaturized satellites, e.g. nano satellites). Initially, such a system could be tested in earth orbits. In later stages, swarms of satellite arrays could be sent to outer space. Individual satellites consist of deployable antennas. The sky signals will be amplified using an integrated ultra-low power direct sampling receiver and digitizer. Using digital filtering, any subband within the LNA passband can be selected. The data will be distributed over the available nodes in space. On-board signal processing will filter the data, invoke (if necessary) RFI mitigation algorithms and finally, correlate the data in a phased array mode. If more satellites are available, they will automatically join the array. The final correlated or beam formed data will be sent to Earth using a radio link. As the satellites will ultimately be sent to larger distances from Earth, communication to and from Earth requires diversity communication schemes using all the individual satellites.

Conclusions A new, unique distributed system of formation flying small satellites for low frequency radio astronomy is presented. In the paper a more detailed description of the concept is presented.