Scientific Goals of The Large Adaptive Reflector (LAR)

P. E. Dewdney* and S. M. Dougherty
National Research Council of Canada

Radio astronomy continues to be an important contributor to the overall growth of astronomical knowledge. Moreover, radio telescopes can be designed with extraordinary capabilities – large imaging fields-of-view, polarization measurement, and high spatial and spectral resolutions. Using recent technologies, all of these attributes can be achieved simultaneously. This is balanced by the general weakness of the flux to be detected, and the need to build very sensitive telescopes to detect emission from sources at distances comparable to the largest scales in the Universe.

The next-generation radio telescope, the Square Kilometer Array (SKA), will have a hundred times more collecting area than our most powerful existing radio telescopes. This telescope will be required to meet the scientific challenges presented by the desire to observe the early stages of the evolution of the Universe. Cost effective, new antenna technology is needed to build such a large collecting area. The Large Adaptive Reflector (LAR) is a new concept in antenna design being developed to address this challenge. The LAR is a long focal-length parabolic reflector that requires an air-borne platform to support the focal receiver. A very large, nearly flat active reflecting surface brings incoming radiation to a focus on the airborne platform. The long focal length permits the reflector to present a very flat profile and therefore the reflector, made up of adjustable panel segments, does not need to be mechanically tilted as in traditional designs. This concept offers the possibility of an order-of-magnitude reduction in the cost per m^2 of collecting area for very large antennas.

A prototype telescope is needed to prove the concept under operational conditions. This presentation will outline the specifications envisaged for such a prototype and explore its scientific potential. The prototype will be a 300-m diameter reflector, with an upper frequency of about 2 GHz, an instantaneous bandwidth of 750 MHz, and a wide-field feed (a cluster of ~300 beams on the sky). The reflector will be an offset design, steerable to an Elevation Angle of 30º, and yielding a beam with very low side-lobes, minimal scattering, and high antenna efficiency. Its flux sensitivity will be ~50 $\mu Jy/s^{0.5}$ using room temperature receivers (T_{rcvr} = 18 K; T_{sys} = 30 K); in a 100 kHz line-channel, this corresponds to ~4 $mJy/s^{0.5}$.

Such high sensitivity, combined with the surveying speed enabled by the multi-beam feed, will enable rapid surveys of red-shifted gas, most particularly hydrogen, over a large volume of the Universe. For example, it is expected that this telescope will map, in emission, the small neutral fraction of neutral gas that can now only be detected by Lyα optical absorption. Additionally, this telescope will have an enormous impact on pulsar research.