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Next Generation Arecibo Telescope: A powerful instrument for redshifted molecular line surveys

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Extended Abstract

Following the collapse of the 305m telescope, the Arecibo Observatory's (AO) scientific and engineering staff and the AO user community overwhelmingly agreed on the need to build an enhanced, next-generation radar-radio telescope at Arecibo. Following several rounds of discussions, a conceptual design for a compact array of dishes on a titlable plate-like structure was proposed. This telescope design can vastly improve the scientific capabilities of the three research groups at AO - Radio Astronomy, Planetary Science and Space Atmospheric science - and can open many new frontiers for exploration and study.

The proposed telescope concept, referred to as the Next Generation Arecibo Telescope (NGAT), consists of an array of dishes 'tightly' packed on a plane to maximize the surface brightness sensitivity. The total collecting area of the telescope will be equivalent to that of a 300 m diameter dish. NGAT will have 4 receivers covering frequency range 0.2 to 30 GHz. The diameter of the individual dishes will be finalized based on the frequency coverage and science requirements but can be between 9 and 18 m. The telescope will operate either as an interferometer or as a phased array. The plane of the dish array will be tiltable to achieve zenith angle coverage between 0° and 48°. In addition to receivers, the NGAT will have transmitters with phased peak power of 10 MW operating at 0.2 to 0.5 GHz and at 2 - 6 GHz with phased continuous wave power of 5 MW. These transmitters will be used by the Space and Atmospheric Science and Planetary Radar groups. To summarize, the NGAT will have a field of view (FoV) at least two orders of magnitude larger, work over a frequency range 3 times larger, have 2.3 times more sky coverage, more than 4 times the transmitting power, and nearly double the sensitivity to receive radio signals when compared to the 305m telescope.

The enhanced sensitivity and increased frequency coverage from 10 to 30 GHz will be ideally suitable for redshifted molecular line surveys. The molecular lines from galaxies with redshift > 2.5 that fall in the above frequency range includes, but is not limited to, transitions of CO, HCN, HCO+ and H_2O. For making a large volume survey the critical quantity is the survey speed of the telescope, which is the product of the square of the effective area over system temperature and FoV. A number of factors can affect the survey speed of NGAT in the 10 to 30 GHz frequency range. The effective area of the telescope is determined by surface RMS of the individual dishes while the diameter of the individual dishes determines the FoV. The dominant contribution to the system temperature in this frequency range is atmospheric attenuation.

In this talk, we present the results of a study on the survey speed of NGAT in the frequency range 10 to 30 GHz. We use atmospheric models and GPS measurements at Arecibo site to obtain the atmospheric attenuation and its statistics. Finally, a survey strategy for detecting CO line from redshift > 3 is presented based on the results of the study.