The Simulated Effect of Navigation Satellites on Future HI Intensity Mapping Surveys

Stuart Harper, University of Manchester

At present, much of the constraints on the standard ΛCDM model of cosmology have come from the cosmic microwave background (CMB). However, the CMB has many limitations and if we are to further understand dark energy for example different *cosmological probes* will be required. One of these probes is the study of large-scale structures (LSS) within the Universe. BAOs In Neutral Gas Observations (BINGO) is an upcoming single-dish HI intensity mapping survey that plans to measure LSS using the 21cm line between $0.13 < z < 0.48$ (corresponding to a bandpass of 960 to 1260MHz).

The HI intensity mapping technique works by integrating all the 21cm emission within large volumes of the Universe using beams with large angular-resolution and coarse frequency channels. This gives it an advantage over traditional 21cm galaxy surveys in that the HI signal is much brighter, therefore allowing for large areas of sky to be surveyed very rapidly. The trade-off is the signal is much less clean, and cannot be easily decoupled from *foregrounds* such as Galactic emission or man-made radio frequency interference (RFI). To an extent, choosing an isolated, quiet observing site can mitigate many sources of RFI. However L-band transmission from satellites within the Global Navigation Satellite System (GNSS) will be inescapable and each satellite has brightness comparable to that of the Sun (when observed in the transmission bands).

I will present simulations of the effect of L-band transmissions of GNSS constellations such as GPS, GLONASS, BeiDou and Galileo on the frequency response of BINGO. The simulation models the true orbits of each GNSS constellation and the output frequency response of each transmitter. The GNSS emissions are then convolved with the BINGO beam and one full year of simulated observations are generated. It will be shown that after filtering out any satellites that pass close (5, 10 or 15 degrees) to the BINGO main beam the residual, low-level RMS of fluctuations from satellites across the top third (>1160MHz) of the BINGO bandpass exceeds, by several orders-of-magnitude, the expected HI signal. This is extremely worrying for all future intensity mapping experiments as surveys with other telescopes such as the Green Bank Telescope (GBT) or the SKA1-MID array have far worse beam responses than BINGO, which will amplify the satellite contamination for these instruments.