The Far Side of the Galactic Rotation Curve, with Ultra-Precise Astrometric measurements of OH maser Parallaxes.

M. Rioja (ICRAR; maria.rioja@icrar.org) & R. Dodson (ICRAR; richard.dodson@icrar.org)

The VLBA BeSSeL survey has formed a keystone in our measurements of the rotation of the Galaxy, but the observations are limited to the nearer arms. Combining the sensitivity of VLBI anchored by the Greenbank telescope, with multibeam technologies and next-generation calibration methods (Rioja & Dodson 2020) we can extend the observations to the far side of the Galaxy by increasing the precision of the observations.

For the canonical distance error of 10% at the Galactic Centre we have required astrometric errors of 10uas. To increase the distance to ~20kpc and reduce the errors to 5% (giving a similar error in the location with respect to the arms) we will require systematic astrometric errors of a few uas, which is well beyond those achievable with conventional (even in-beam) astrometry. (Furthermore, the thermal limit for 5uas precision will require dynamic ranges of 200:1.)

The recent development of MultiView offers the only route to such exquisite removal of systematic errors, where a number of calibrators around the target are simultaneously observed to cancel out both spatial (with multiple directions) and temporal (with contemporaneous observation) errors. These include errors due to low elevation observations.

VLBA plus Green Bank would have 3mJy/beam image RMS over 0.2km/s channels with just 3 hours of observations. Thus OH masers with flux densities greater than 1Jy/beam would be suitable targets and there are over a hundred known sources (Qiao 2016) with velocities suggesting that they lie beyond the Galactic centre. Four epochs of 100 sources with 3 hours of observations would require about 1000 hours of observations.

ALPACA, with the ability to observe multiple targets simultaneously, on Green Bank for its collecting area, will be the only way to undertake these observations before the arrival of SKA/ngVLA, and even then we imagine that the observations would continue with a weaker population of targets.