Polarization Characteristics of the Green Bank Telescope

T. H. Troland*, University of Kentucky, Physics & Astronomy Department, USA
T. Robishaw & C. Heiles, Berkeley Astronomy Department, USA

Commission J4 – Antennas and antenna arrays

The 100m Green Bank Telescope (GBT), operated by the National Radio Astronomy Observatory in Green Bank, WV, is in its commissioning phase. This fully steerable radio telescope is currently equipped with receivers operating at 300 MHz to 50 GHz, operation above 100 GHz eventually expected. Receivers above 1 GHz are at the Gregorian focus of the telescope.

An innovative design feature of the GBT is its offset feed system. This system eliminates blockage of the aperture, resulting in very low sidelobes if aperture illumination is properly tapered. For example, the first sidelobe at L-band is approximately 30db below than the main beam.

We have recently conducted tests of the polarization performance of the GBT at L, C and X-bands. We perform scans across radio continuum sources in four directions and use a cross-correlation spectrometer to derive the beam characteristics out to the first sidelobe in all four Stokes parameters. At each band, we observe four separate sky frequencies to assess polarization properties as a function of frequency.

From our data, we derive *beam squint*, *beam squash* and telescope efficiencies. Beam squint is the difference in directions of the main beam in orthogonal polarizations. It is measured in arcsec. In the Stokes parameter Q, U, or V beam patterns, beam squint appears as a two-lobed pattern with lobes of opposite sign on opposite sides of beam center. Beam squint is expected in the Stokes V pattern owing to misalignment of the electrical axis of the feed with that of the reflecting surface. Beam squash is a deviation from circular symmetry of the primary beam cross-section in orthogonal polarizations. Beam squash is also measured in arcsec, it is the difference in beamwidth in orthogonal directions. In the Stokes parameter Q, U, and V beam patterns, beam squash appears as a four-lobed pattern with lobes of opposite signs on opposite sides of beam center. Beam squash is expected in Stokes Q and U patterns.

Preliminary analysis of our data at L-band reveals beam squint and beam squash in Stokes parameters Q, U and V. In the Stokes parameter V beam, we find squint of order 0.5 arcsec or less and squash of order 1 arcsec or less. These dimensions are very small fractions of the primary beamwidth of 540 arcsec. Therefore the circular cross polarization performance of the GBT is excellent. In the Stokes parameter Q and U beams, we find beam squint of order 2-4 arcsec and beam squash of up to 30 arcsec. Linear cross polarization of the telescope is significantly higher than circular polarization, as is usually the case in radio telescopes.

The circular polarization performance of the GBT indicates that it will be an excellent instrument for measurement of the Zeeman effect in radio frequency spectral lines. Such measurements involve detection of very small fractional polarizations in the lines.