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Gauribidanur radio spectropolarimeter

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A new set-up for ground based spectropolarimetric observations of the transient radio bursts from the solar corona at low frequencies (< 100 MHz) has been recently commissioned at the Gauribidanur radio observatory ($\approx 77^\circ$ E; 14° N) near Bangalore[1] Ramesh (2011). The front-end of the spectropolarimeter (Gauribidanur RAdio SpectroPolarimeter, GRASP) consists of two log-periodic dipoles (LPDs) designed and fabricated in the Gauribidanur observatory for observations in the above frequency range with VSWR $\lesssim 2$ and directional gain of ≈ 7 dBi Ramesh et al. (1998, 2008); Benz et al. (2009). The LPDs were mounted vertically with a spacing of 10 m between them in the north-south direction. While the orientation of the 'arms' in one of the LPDs is in the east-west direction, they are in the north-south direction for the other, i.e. the two LPDs are mutually perpendicular to each other. The LPDs respond to linearly polarized signal in the direction of the orientation of their 'arms'. The half-power width of the response pattern ('beam') of the above two LPDs is $\gtrsim 80^\circ$ in the right ascension/east-west direction and declination/north-south direction, independent of frequency. After amplification, the RF outputs from the individual LPDs are transmitted to the receiver room via two separate optic fiber cables buried ≈ 2 m below the ground. They are connected to the two inputs of a broadband four-port 90° (phase quadrature) hybrid. The latter has two outputs: one of them responds to the left circular polarization (LCP) and the other to the right circular polarization (RCP) components of the incident signal. This is because the direct signal from one of the LPDs and 90° phase shifted signal from the other are combined before each of the outputs in a hybrid. Depending on the direction of rotation of the electric field vector of the incoming radiation, i.e. clockwise (RCP) or counter-clockwise (LCP) as per the IAU definition Thompson et al. (2004), the net phase difference between the signals at the aforementioned signal combiners corresponding to the two outputs of the hybrid will be either 0° and 180° or vice versa. Note that in addition to the above circularly polarized component, the randomly polarized components of the incident signal (for cases where the incident signal is not 100% circularly polarized) whose electrical field vectors are parallel to the orientation of the 'arms' of the LPDs will also be present at the inputs of the signal combiners. So one of the outputs of the hybrid will be the sum

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of the polarized (LCP or RCP) and randomly polarized components of the incident signal, and the other will be the randomly polarized component alone. The outputs of the hybrid are connected to two independent spectrum analyzers to obtain the respective dynamic spectra. The sweep time and the instantaneous observing bandwidth are ≈ 100 ms and ≈ 250 kHz, respectively. The spectrum analyzers are interfaced to two personal computers (PCs) through GPIB interface as reported in Ebenezer et al. (2007). The computers are synchronized with a common GPS clock. This helps to achieve temporal coherence between the data acquired with the two systems.

The total intensity (Stokes I) of the emission at each frequency is estimated offline by adding the observed amplitudes at the corresponding frequency in the aforementioned two spectra. The difference between the two amplitudes gives the circularly polarized intensity (Stokes V). The possible contribution of the randomly polarized component to the latter gets subtracted out since they are expected to be of nearly equal strength in both the outputs of the hybrid. This is one of the advantages in the measurement of circular polarization with linearly polarized antennas Thompson et al. (2004). Note that linear polarization, if present at the coronal source region, tends to be obliterated at low radio frequencies because of the differential Faraday rotation of the plane of polarization (during transmission through solar corona and the Earth's ionosphere) over the usual observing bandwidths of a few kHz or more Grognard et al. (1973). The above method of observing circularly polarized emission with two linearly polarized LPDs arranged in orthogonal orientations with a spacing between them also helps to minimize the contribution from the galactic background radiation. Therefore the emission from discrete sources can be observed with better contrast. We calibrated the phase quadrature hybrid and the antenna/receiver systems by transmitting sine wave signal at different frequencies. The measurements indicate that the cross-talk between the two outputs of the hybrid is $\lesssim$ -40 dB, and the 90° phase shift in the hybrid is consistent to an accuracy of ±5° in the above frequency range. We equalized the total system gain and ensured that randomly polarized incident signal gives rise to deflection of equal amplitudes in the two spectrum analyzers. The LCP and RCP outputs of the hybrid were identified through observations of type I solar noise storm continuum emission which are 100% left circularly polarized, particularly when the associated sunspot region is near the central meridian on the Sun Ramesh et al. (20..). The *dcp* of the bursts are estimated from the ratio of the difference between the amplitude (A) of the deflection in the LCP and RCP channels to the sum of the amplitudes, i.e. $(A_{LCP} - A_{RCP})/(A_{LCP} + A_{RCP})$.

References

Benz A. O., et al., 2009, Earth, Moon & Planets, 104, 277
Ebenezer E., et al., 2007, BASI, 35, 111
Grognard R. J. -M., McLean D. J. 1973, Solar Phys., 29, 149
Ramesh R., Subramanian K. R., Sundara Rajan M. S., Sastry Ch. V., 1998, Solar Phys., 181, 439
Ramesh R., et al., 2008, Solar Phys., 253, 319

Ramesh R., 2011, in Choudhuri A. R. and Banerjee D. eds, Proc. 1st Asia-Pacific Solar Physics Meeting, ASICS, 2, 55
Ramesh R., et al., 2011, 39, Astrophys. J., 734, 10 June 2011
Ramesh R., et al., 2010, Astrophys. J. Lett., 719, L41
Thompson A. R., Moran J. M. and Swenson G. W., 2004, Interferometry and Synthesis in Radio Astronomy, Wiley-VCK, Weinheim, 100