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Circular polarization observations of Sun's magnetic field using commercial dish TV antennas

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The radio astronomy group in the Indian Institute of Astrophysics (IIA) has been carrying out routine observations of radio emission from the solar corona at low frequencies (≈40 – 440 MHz) at the Gauribidanur observatory, about 100 km north of Bangalore. Since IIA has been performing regular observations of the solar photosphere and chromosphere using different optical telescopes in its Kodaikanal Solar Observatory (KSO) also, the possibilities of carrying out Stokes-I and Stokes-V observations of the solar chromosphere using low-cost radio instrumentation to supplement the optical observations are being explored. Note that measurements of Stokes-V help to infer the magnetic field strength of the sunspots. As a part of the exercise, recently the group has developed prototype instrumentation for interferometric observations of radio emission from the solar chromosphere at high frequencies (≈11.2 GHz) using three commercial dish TV antennas. The antennas and the associated front end receiver systems have improved with advances in the TV systems. They operate typically over the frequency range 10.7 – 11.7 GHz (Ku-band) and provide very good Signal-to-Noise ratio (SNR). Among the three feeds, two are oriented in the same direction and the third one is oriented at an orthogonal position with respect to the other two. The correlation between two antennas with feeds oriented in the same direction provides information on total intensity (Stokes-I) and that between mutually orthogonal antennas provides information on the circularly polarized intensity (Stokes-V). A mechanical set-up was used with the dish antenna to change its 'pointing' with respect to the Right Ascension and Declination of the Sun. Considering the low cost of the set-up, it is proposed to fine tune the tracking system and setup an array of antennas to image the Sun (Stokes I & V) in the above frequency range to study the solar activity and its relation to space weather. The hardware set-up and initial observations are presented.

Figure 1. The correlation interferometer that was set up using three commercial dish TV antennas at the Gauribidanur observatory for observing the Sun in the Ku-band.

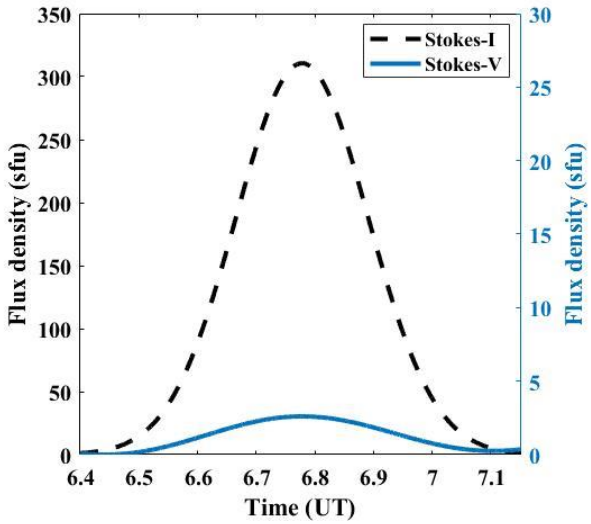

Figure 2. Estimated flux density of Stokes-I and Stokes-V obtained on 12 June 2022 (1 sfu = 10^{-22} W/m^2/Hz).