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Low Frequency Radio Emission from the 'Quiet' Sun

R. Ramesh, *Indian Institute of Astrophysics, Bangalore 560034, India, e-mail:ramesh@iiap.ernet.in*

Abstract. We present observations of the 'quiet' Sun close to the recent solar minimum (Cycle 22), with the Gauribidanur radioheliograph. Our main conclusion is that coronal streamers also influence the observed radio brightness temperature.

Key words. Sun—corona—radio observations—streamers—scattering.

1. Introduction

It is well known that the appearance of the corona changes with frequency due to opacity and refraction effects. As we move towards low frequencies, the optical depth (τ) increases due to a rise in the absorption coefficient, which is inversely proportional to the square of the frequency. Therefore, the observed brightness temperature (T_b) should approach the electron temperature (T_e) of the medium (~ 10^6 K), since $T_b \approx T_e$ for large values of τ . But the observed T_b at frequencies ≤100 MHz has always been low so far (Sheridan 1970; Aubier *et al.* 1971; Erickson *et al.* 1977; Sastry *et al.* 1981, 1983; Thejappa & Kundu 1992). Also, the observed peak brightness temperature varies by a factor of more than three, even during periods when the Sun is 'quiet' and free of any sunspots (Thejappa & Kundu 1992; Sastry 1994). In this paper, we discuss the effect of the streamers on the behaviour of the observed radio brightness temperature of the 'quiet' Sun at low frequencies.

2. Observations

The radio data reported were obtained with the Gauribidanur radioheliograph (GRH, Ramesh *et al.* 1998) during April-August 1997, close to the minimum of the last solar cycle (Cycle 22). The observing frequency was 75 MHz and the integration time used was 4.64 sec. The Sun was 'quiet' and no transient burst activity was noticed in our data. Table 1 shows the minimum and maximum values of the different parameters measured by us during the above period.

3. Discussions and conclusions

As scattering by small-scale (~ 100 km) density inhomogeneities is one of the major reasons attributed for low values of the observed T_b and the variations in it, one should

Table 1.

Parameter	Minimum	Maximum
Integrated flux density	7576 Jy	19283 Jy
Brightness temperature	0.25×10^6 K	0.83×10^6 K
E-W diameter	32′	51′
N-S diameter	33′	36′

expect an inverse correlation between the observed flux densities and the half-power widths (Aubier *et al.* 1971; Ramesh 1999). Fig. 1 shows the variation of the E-W diameter with the integrated flux density during our observational period, at 75 MHz. One can notice that the above two parameters are anti-correlated, indicating that scattering plays a major role in the solar corona. However, the correlation coefficient is small, ~ –0.52. The other possibility is the refraction effect due to the large scale structures in the solar atmosphere, since it is known that they contribute in a variable proportion to the observed flux of the 'quiet' Sun (Borkowski 1982). Fig. 2 shows the radioheliogram taken with the GRH for one of the observing days during the period mentioned earlier. The corresponding white light coronagraph picture

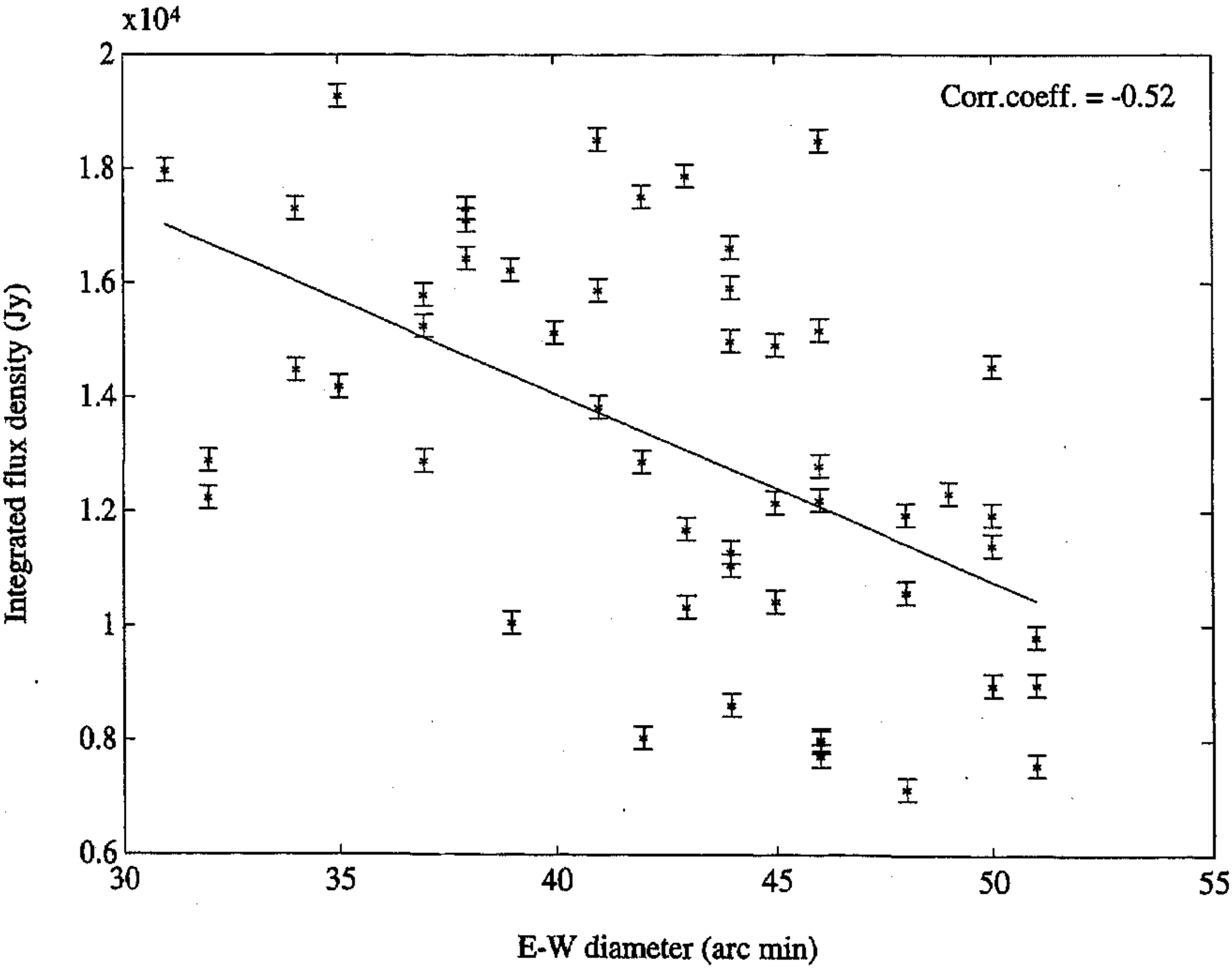

Figure 1. Variation of E-W diameter of the Sun with integrated flux density during 1997 April-August, at 75 MHz.

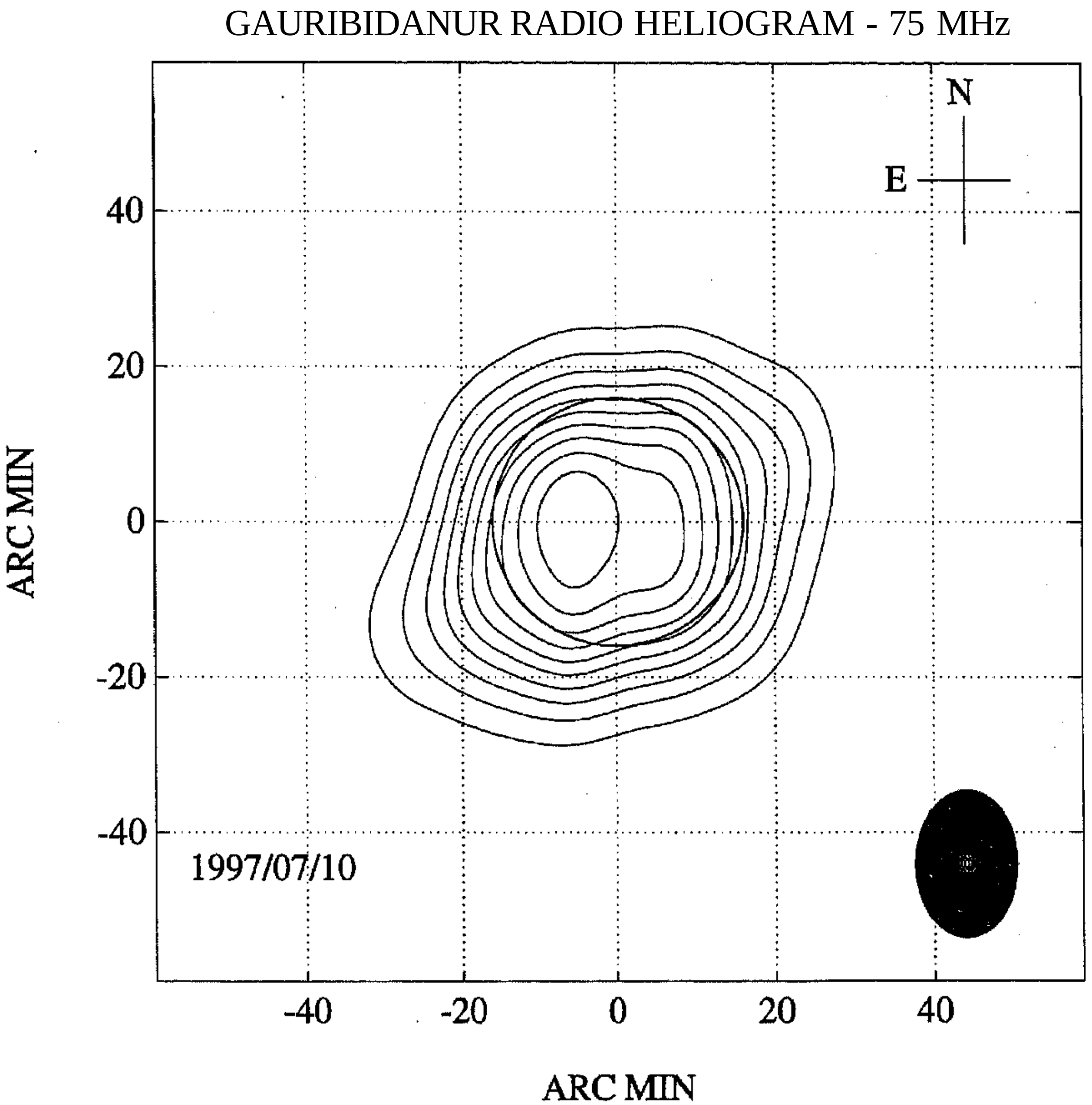

Figure 2. Radioheliogram obtained with GRH on 1997 July 10 at 06:30 UT. The open circle at the center is the solar limb and the filled circle at the bottom right corner is the beam of the instrument.

obtained on the same day is shown in Fig. 3. One can see that there is a good agreement between the elongated features off the limb in both the figures. In this connection we would like to point out that according to Thejappa & Kundu (1994), the shape of the radio corona depends on the position angle of the coronal streamers. The associated discrete source appears either as an enhancement or a depression depending on its shape and position on the disk (Riddle 1974; Thejappa & Kundu 1994). Therefore, it is possible that the variations in the integrated flux density, E-W diameter, and hence the T_b in the present case is a consequence of both scattering and the presence of coronal streamers.

Figure 3. White light picture of the corona obtained with the Mauna Loa MKIII K-Coronameter. The occulting disk is at a height of $1.122R_{\odot}$ from the center.

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