HII Absorption
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It would make all of the drift curve simulations and data much more convincing if they accurately agreed at the lower frequencies where we can be assured that the system sky noise dominance is high and that the dipole response pattern is simple. If we cannot get agreement at low frequencies, I would then have serious doubts about the results at higher frequencies.

However, in my Bruny Island data (LWA #58) the simulated ratios between the maximum and minimum of the drift curves are 0.5 to 1.0 dB larger than the measured ratio at 30 MHz. In his draft paper on the ETA antenna, Steve Ellingson appears to find a similar situation thing at 39 MHz, his simulation is about 0.8 dB above the data. One reason for this might be HII absorption which is not modeled in simulations that only project high frequency data to lower frequencies with a constant spectral index.

There are a number of ways that one might try to estimate the absorption. One might use optical maps of HII distributions. One might compare the constant index extrapolations with Rogers' 22 MHz Pentiction map or Dwarka's 30 MHz Gauribidanur map. Since I have easy access to Hilary Cane's PhD thesis [1] where HII absorption is extensively discussed, I decided to have a look at the appropriate parts of her thesis. I have scanned eight of the relevant pages and they are reproduced below.

These data are very old but they were obtained by skilled, careful observers (I know or knew most of them.) and the necessary equipment, noise sources, attenuators, and the like, has not developed much over the intervening years. I doubt that the data could be very greatly improved today.

Figure 6.24 provides data from which the absorption at Galactic Latitude 0º and a few Longitudes can be estimated. Figures 6.21, 6.22, and 6.23 provide data from which the width of the absorption trough can be estimated. I took a stab at estimating the absorption using the "Scaling" shown in the last figure. I used the slope of the l=40º spectrum to extrapolate the higher frequency data down to 20 MHz at l=340º, l=360º, l=20º, i.e. to estimate the shapes of the spectra in the absence of HII absorption. Measuring the differences between the extrapolated spectra and the measured points I get the b=0º absorption values shown below.

HII absorption in dB at b=0º

F (MHz)	l=340º	l=360º	l=20º
20	2.5	3.4	3.0
30	1.4	1.0	1.6
40	0.8	0.5	1.1
60	0.2	0.0	0.4
75	0.0	0.0	0.2
85	0.0	0.0	0.0

From Figures 6.21, 6.22, &6.23 it appears that the absorption trough is ≤10º wide in latitude at 30 MHz and it probably covers only 40ºto 60º in longitude. In other words it has a solid angle of ≤0.2 sterradian. Since it appears to be only ≤2 dB deep at 30 MHz, it seems to me that it probably cannot account for an ~1dB effect when averaged over the solid angle of the dipole beam. However, perhaps it could, if most of the background radiation comes from this restricted area. I'd suggest that Emil enter corrections of this magnitude into his galactic model and run the drift curve simulations again. This needs to be done in order to evaluate the effects quantitatively.

If these crude estimates prove to be valid and/or are confirmed by other ways of estimating absorption effects, we will have to seek some other reason for the lack of agreement between the simulations and observations at low frequencies.

References

[1] H.V. Cane 1978, PhD Thesis, University of Tasmania, Sandy Bay, Tasmania 7005, Australia.

TABLE 6.3

DETAILS OF SPECTRAL MEASUREMENTS

FREQUENCY (MHz)	RESOLUTION	ACCURACIES	OBSERVER	
153	2^{o}	R $\pm$ 5%	Hamilton & Haynes	(1969)
85	$3.5^{o} \times 3.8^{o}$	A $\pm$ 7%	Yates et al.	(1967)
30	0.8^{o}	A $\pm$ 2%	Jones & Finlay	(1974)
19.7	1.4^{o}	A 20%	Shain et al.	(1961)
16.5	1.6^{o}	*	Cane	(1975)
13.0	2.1^{o}	*	Cane	
10.0	$4^{o} \times 5^{o}$	*	Hamilton & Haynes	(1968)
8.3	3.2^{o}	*	Cane	
5.6	4.8^{o}	*	Cane	
4.7	$3^{o} \times 11^{o}$	*	Ellis & Hamilton	(1966)
3.7	7.3^{o}	*	Cane	
2.1	8^{o}	*	Reber	(1968)

R = relative accuracy A = absolute accuracy

* Relative accuracy - about 20%
The absolute accuracy of the surveys at frequencies <20MHz is determined by the accuracy of the reference spectrum. The latter could be too high by up to 30% in the range 2.5 - 20 MHz.

after Cane (1976)

maps. However, when drawing a smooth spectrum care has been taken to ensure the observed relationship between intensities at one frequency but different latitudes has been retained.

Figures 6.21 - 6.23 show three sets of spectra for longitudes 330°, 10° and 20°. The most striking feature is the plateau in the $|b| = 5°$ spectra for frequencies between approximately 6 and 15 MHz. This is seen in all sets of spectra for longitudes within 40° of the galactic centre. In figure 6.24 we show several spectra in the galactic plane. Unfortunately, there is little data in the region $30° \lesssim \ell \lesssim 100°$ as this is at the edge of the region accessible to both northern and southern observers. However Figure 6.24 shows that the effect observed (i.e. the plateau) is the result of additional emission and excess absorption taking place in directions towards the galactic centre in comparison to other directions.

Many other spectra have been compiled but are not illustrated. They all present the same basic features with minor variations. The most notable variation is that for longitudes in the approximate range 340° - 355° the galactic plane spectra are depressed further at low frequencies than for other longitudes.

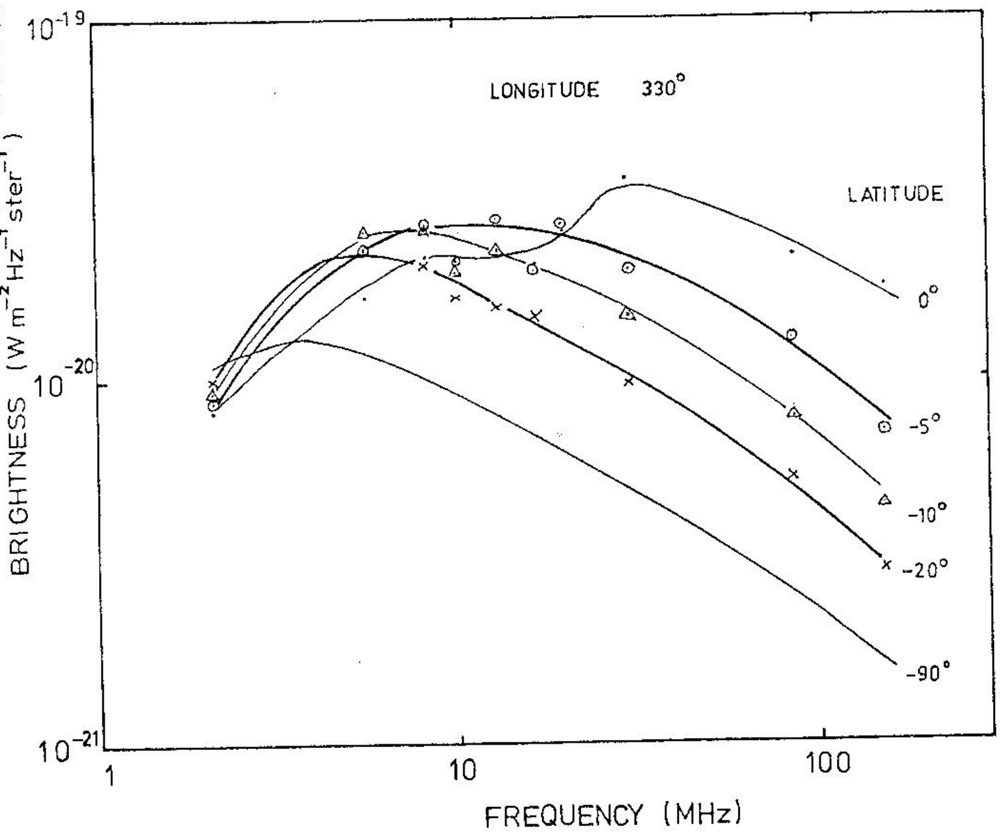
The basic features of the spectra are outlined below:

(i) At frequencies greater than about 40 MHz the emission decreases with increasing latitude.

(ii) The $b = 0°$ and $b = 5°$ spectra turn over at approximately 30 MHz whereas the $b = 10°$ and $b = 20°$ spectra turn over at about 9 MHz and 6 MHz respectively.

(iii) There is a plateau in the spectra for latitudes less than 10° between 15 and 6 MHz.

(iv) As a consequence of (i) and (ii) the maximum intensity results at higher latitudes with decreasing frequency for frequencies less than 30 MHz.



LONGITUDE 330°
LATITUDE
0°
-5°
-10°
-20°
-90°
10^{-19}
10^{-20}
10^{-21}
BRIGHTNESS $(W\,m^{-2}\,Hz^{-1}\,ster^{-1})$
1
10
100
FREQUENCY (MHz)

FIGURE 6.21

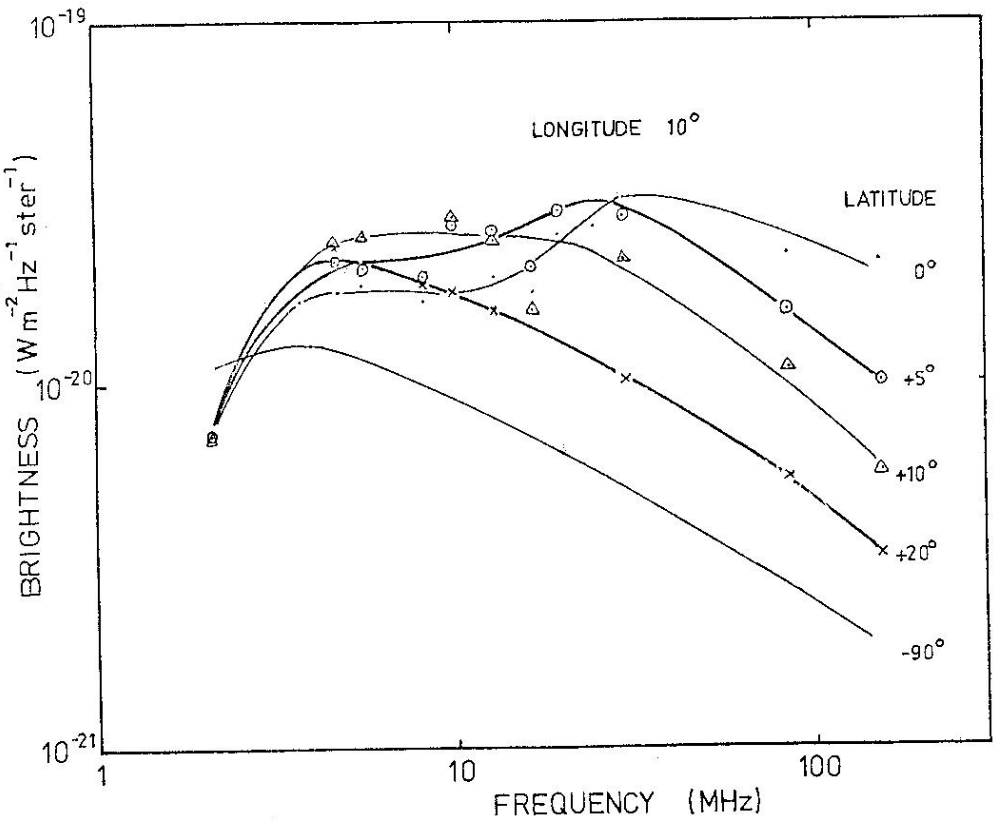

LONGITUDE 10°
LATITUDE
0°
+5°
+10°
+20°
-90°
BRIGHTNESS ($W m^{-2} Hz^{-1} ster^{-1}$)
10^{-19}
10^{-20}
10^{-21}
1
10
100
FREQUENCY (MHz)

FIGURE 6.22

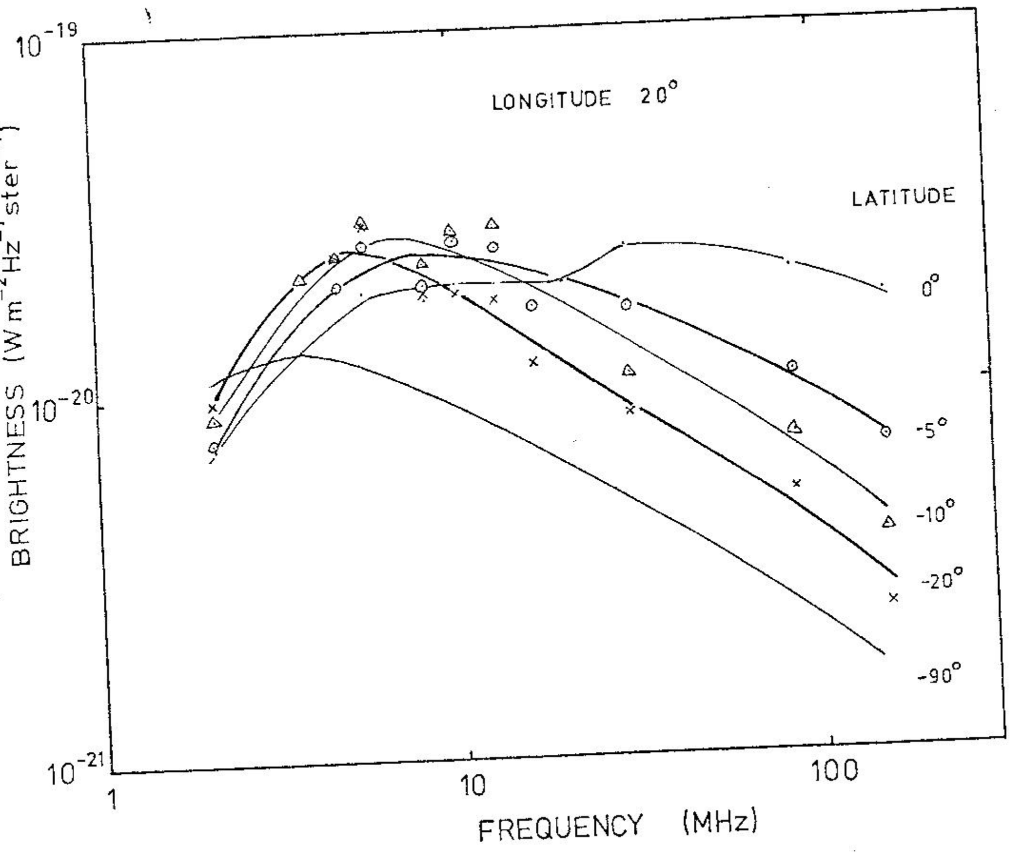

LONGITUDE 20°
LATITUDE
0°
-5°
-10°
-20°
-90°
BRIGHTNESS (W m⁻² Hz⁻¹ ster⁻¹)
10^{-19}
10^{-20}
10^{-21}
1
10
100
FREQUENCY (MHz)

FIGURE 6.23

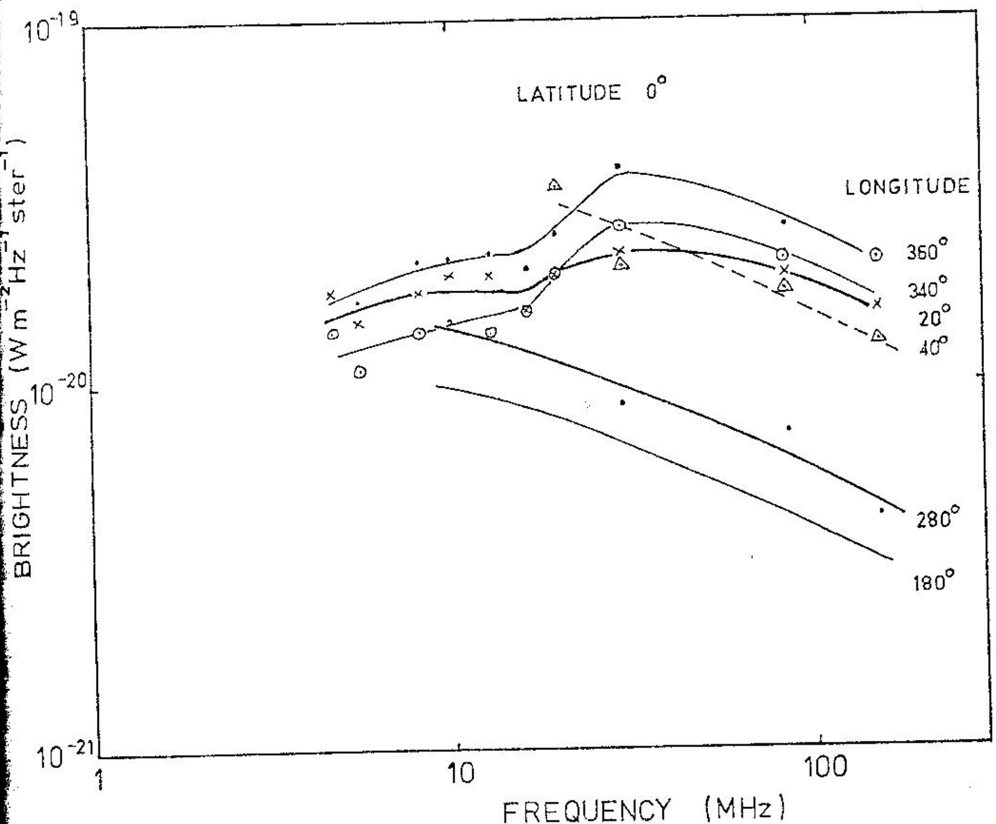

LATITUDE 0°
LONGITUDE
360°
340°
20°
40°
280°
180°
10^{-19}
10^{-20}
10^{-21}
1
10
100
BRIGHTNESS ($W m^{-2} Hz^{-1} ster^{-1}$)
FREQUENCY (MHz)

FIGURE 6.24

Discussion

The new data shows that the appearance of the sky does not change as rapidly with frequency as had been previously thought. With only the 19.7, 10, 4.7 and 2.1 MHz maps in existence in 1969 it is not surprising that Hamilton (1969) made the statement that "the changes are so great as to make comparisons of the maps difficult". To add to the confusion the contours of the 4.7 MHz map did not represent the data. The new map compiled by the author shows that the minimum along the galactic plane for the region of interest is centred at about 345° in accordance with the 5.6 and 8.3 MHz maps, whereas the map compiled by Ellis and Hamilton had the minimum centred at approximately 0°. It is interesting to note that an earlier version of the map presented by Ellis, Green and Hamilton (1963) did in fact present similar features to those seen in figure 6.14.

In the light of the discussion in Chapter 5 it is felt that the 10 MHz map of Hamilton and Haynes (1968) is in error in the region $270° \lesssim \ell \lesssim 355°$ and $0° \lesssim b \lesssim 60°$. Northern and southern sky surveys at 10 MHz could only be combined if the contours in this region were altered. This was achieved by incorporating 13 MHz data.

When the alterations to the 4.7 and 10 MHz maps have been taken into account it can be seen that there is a gradual trend from the 30 MHz map down to the 4.7 MHz map. Comparisons between the 30 MHz map and the two higher frequency maps are difficult, mainly because the 85 and 153 MHz maps are presented on a very small scale and because the resolution of the former map is not high enough. A comparison of the finer details in the galactic plane is better made with the 85 MHz pencil beam survey of Hill, Slee and Mills (1958).

The 3.7 and 2.1. MHz maps do not present the same features as the higher frequency maps. This is not really surprising as the optical depth changes by a factor of 5 between 4.7 MHz and 2.1 MHz. In the work that follows we shall consider the spectra as defined only to 5 MHz. We do this because the lower frequency data is less reliable due to ionospheric effects and it is apparent from figures 6.21 - 6.23 that the shapes of the spectra below approximately 5 MHz are determined by the 2.1 MHz data points.

"SCALING"

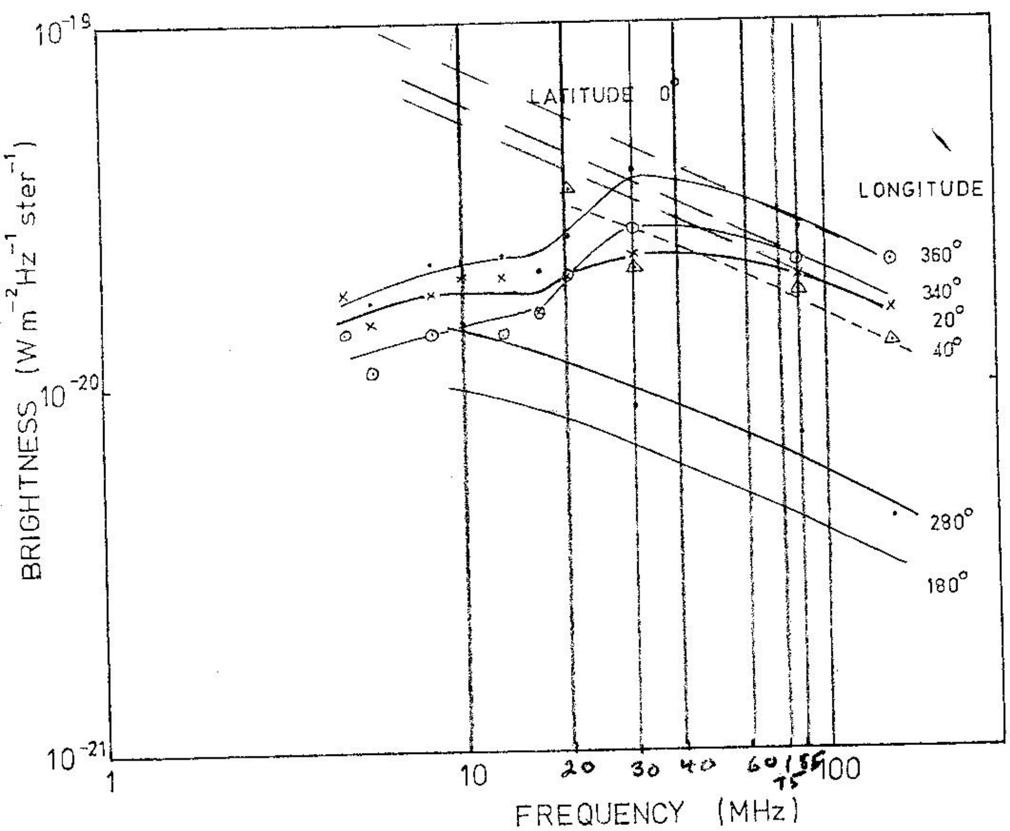


FIGURE 6.24