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THE FLUX DENSITY VALUES OF STANDARD SOURCES USED FOR ANTENNA CALIBRATIONS

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Replace equation (1) by:

$$S(\varphi_E) = \overline{S}\,\{1 + p - 2\,p\sin^2(\varphi_P - \varphi_E)\}$$

(9/9/64)

THE FLUX DENSITY VALUES OF STANDARD SOURCES USED FOR ANTENNA CALIBRATIONS

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Our recent analysis of the spectra of the strongest nonthermal radio sources [1] led to a very accurate determination of their spectral parameters. It is convenient to use the flux density values of these sources for antenna calibrations. In order to reduce the necessary computations to a minimum, we have computed the flux density values for the radio sources Cassiopeia A, Taurus A, Cygnus A, and Virgo A at various frequencies between 300 MHz and 85 GHz, and especially at those frequencies allocated for radio astronomy.

We estimate the following mean errors of these computed flux density values:

300 MHz $\leq \nu \leq$ 10 GHz	m.e. $\pm$ 1.5%
10 GHz $\leq \nu \leq$ 15 GHz	m.e. $\pm$ 5.0%
15 GHz $\leq \nu \leq$ 36 GHz	m.e. $\pm$ 8.0% (for Taurus A only)

The flux density values of Cassiopeia A, Cygnus A, and Virgo A for $\nu > 15$ GHz and of Taurus A for $\nu > 36$ GHz are based entirely on an extrapolation of the spectra computed for lower frequencies. These extrapolated flux density values might be completely wrong and should be used, therefore, only with the utmost caution.

At high frequencies both the polarization and temperature distribution of the radio sources have to be considered in a computation of the effective antenna area from the known flux density of this source and the measured antenna temperature. Both the distribution parameters for the four sources considered here and the corresponding correction formulas are given in [1], section 2.

If the source is linearly polarized, its polarization is completely described by the degree of polarization p and the polarization angle φ_p. We call φ_E the position angle of the electric plane of the antenna. Both angles are counted counterclockwise, starting at north. The flux density values given in Table 1 are total flux density values $\overline{S}_\upsilon$. In order to calculate the flux density value $S(\varphi_E)$ of the source, we use the relation

$$(1) \qquad S(\varphi_E) = \overline{S}\,[1 + 2p\sin^2(\varphi_p - \varphi_E)]$$

Values of p and φ_p for Taurus A and Cygnus A are given in figures 1a and 1b. Polarization of Virgo A and Cassiopeia A has not yet been detected, the upper limit of a possible polarization being about 0.5%.

In order to obtain the flux density of Cassiopeia A at any given time t, one has to take the difference $\Delta t = 1964.4 - t$ (t has to be expressed in years and decimals of a year) and calculate

$$(2) \qquad S_\upsilon(t) = S_\upsilon(1964.4)\begin{cases} 1 + 0.011\,|\Delta t| & \text{for } t < 1964.4 \\ 1 - 0.011\,|\Delta t| & \text{for } t > 1964.4 \end{cases}$$

In order to interpolate flux density values at frequencies between the computed flux density values, one uses the following relation:

$$(3) \qquad S(\upsilon + \Delta\upsilon) = S(\upsilon)\left[1 - \alpha\frac{\Delta\upsilon}{\upsilon} + \frac{\alpha(\alpha - 1)}{2}\left(\frac{\Delta\upsilon}{\upsilon}\right)^2 \cdots\right]$$

$S(\upsilon)$ is the flux density value at the frequency υ, which is given in Table 1. $\Delta\upsilon$ is the difference between the frequency at which the flux density shall be computed and the frequency at which the flux density is given in

Table 1. α is the spectral index of the source which is given in Table 9 of [1].

The flux densities given in Table 1 are referred to outside the atmosphere. In order to reduce the extraterrestrial flux density to the flux density observed with an earth-bound telescope at a zenith distance z use the relation

(4) $$S_\nu(z) = S_{extraterr.}\ p^{F(z)}$$

F(z) is the air mass function, which can be approximated for zenith distances $z \leq 80°$ by $F(z) \approx \sec z$. p is the zenith transmission coefficient of the atmosphere which is a function of frequency. Values of log p, computed for the altitude of Green Bank, can be found in [2].

References

[1] Baars, J.W.M., P.G. Mezger and H. Wendker. The Spectra of the Strongest Nonthermal Radio Sources in the Frequency Range 320 MHz $\leq \nu \leq$ 14.5 GHz. Submitted for publication.

[2] Menon, R. Atmospheric Absorption in the Range of Wavelength Between 10 cm and 1 Micron. NRAO Internal Report, January 1964.

[3] Mayer, C. H., T. P. McCullough and R. M. Sloanaker, Ap.J. 139, 248, 1964.

[4] Boland, J. W., J. P. Hollinger, C. H. Mayer, and T. P. McCullough. Paper presented at AAS meeting, Flagstaff, 1964.

Table 1

Computed Flux Density Values

Frequency MHz	Flux density $10^{-26} Wm^{-2} Hz^{-1}$			
	Cassiopeia A (1964.4)	Cygnus A	Taurus A	Virgo A
300	7609	6375	1311	736
400	6145	4948	1221	583
408	6055	4862	1215	573
500	5206	4065	1156	486
600	4546	3462	1105	419
700	4054	3022	1064	369
750	3852	2844	1046	349
800	3671	2687	1029	331
900	3364	2422	1000	301
1000	3110	2207	974	276
1100	2898	2029	951	256
1200	2716	1880	931	238
1300	2560	1752	913	223
1400	2422	1641	896	210
1410	2410	1631	895	209
1420	2397	1621	893	208
1500	2301	1544	881	199
1600	2194	1459	867	188
1700	2097	1355	854	179
1800	2010	1266	842	171

Table 1 continued

Frequency MHz	Flux density $10^{-26}Wm^{-2}Hz^{-1}$			
	Cassiopeia A (1964.4)	Cygnus A	Taurus A	Virgo A
1900	1931	1187	831	164
2000	1858	1116	821	157
2500	1575	856	777	131
2695	1489	783	762	123
3000	1375	689	742	113
3500	1226	574	715	100
4000	1110	489	692	89
4500	1017	425	672	81
4995	941	376	655	75
5000	941	375	654	75
5500	876	335	639	69
6000	822	302	626	64
6500	774	275	613	60
7000	754	251	602	57
7500	695	232	592	54
8000	644	214	583	51
8500	600	200	574	48
9000	560	186	566	46
9500	526	175	558	44
10000	495	164	551	42

Table 1 continued

Frequency MHz	Flux density $10^{-26}Wm^{-2}Hz^{-1}$			
	Cassiopeia A (1964.4)	Cygnus A	Taurus A	Virgo A
10500	467	155	545	41
10690	457	152	542	40
11000	442	147	539	39
11500	420	139	533	38
12000	399	132	527	37
12500	380	126	522	35
13000	363	120	517	34
13500	347	115	512	33
14000	333	110	507	32
14500	319	106	503	31
15000	307	102	499	30
15375	298	99	496	30
15500	295	98	495	30
16000	284	94	491	29
16500	274	91	487	28
17000	265	87	484	28
17500	256	84	480	27
18000	247	82	477	26
18500	239	79	474	26
19000	232	77	471	25

Table 1 continued

Frequency MHz	Flux density $10^{-26}Wm^{-2}Hz^{-1}$			
	Cassiopeia A (1964.4)	Cygnus A	Taurus A	Virgo A
19350	227	75	468	25
19500	225	74	468	25
20000	218	72	465	24
21000	206	68	459	23
22000	195	64	454	22
23000	185	61	449	22
24000	176	58	444	21
25000	168	55	440	20
26000	160	53	436	19
27000	153	50	431	19
28000	147	48	428	18
29000	141	46	424	18
30000	135	44	420	17
31000	130	43	417	17
31400	128	42	416	17
32000	125	41	414	16
33000	121	40	411	16
34000	117	38	408	16
35000	113	37	405	15
36000	109	36	402	15
37000	106	35	399	15

Table 1 continued

Frequency MHz	Flux density $10^{-26}Wm^{-2}Hz^{-1}$			
	Cassiopeia A (1964.4)	Cygnus A	Taurus A	Virgo A
38000	102	34	397	14
39000	99	33	394	14
40000	96	32	392	14
85000	40	13	325	7

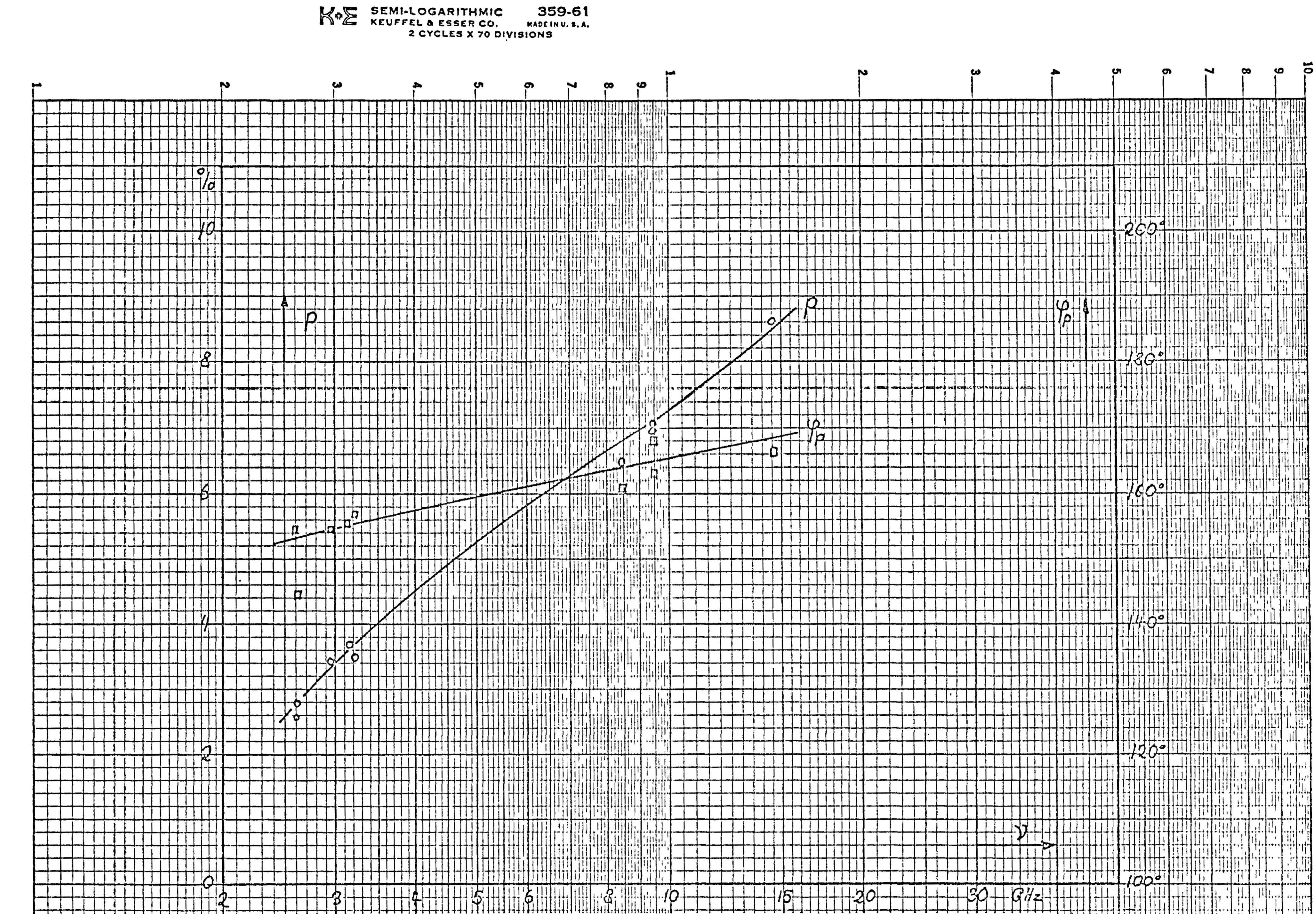

Figure 1: Degree of polarisation and polarisation angle of Taurus A as a function of frequency.[3],[4]

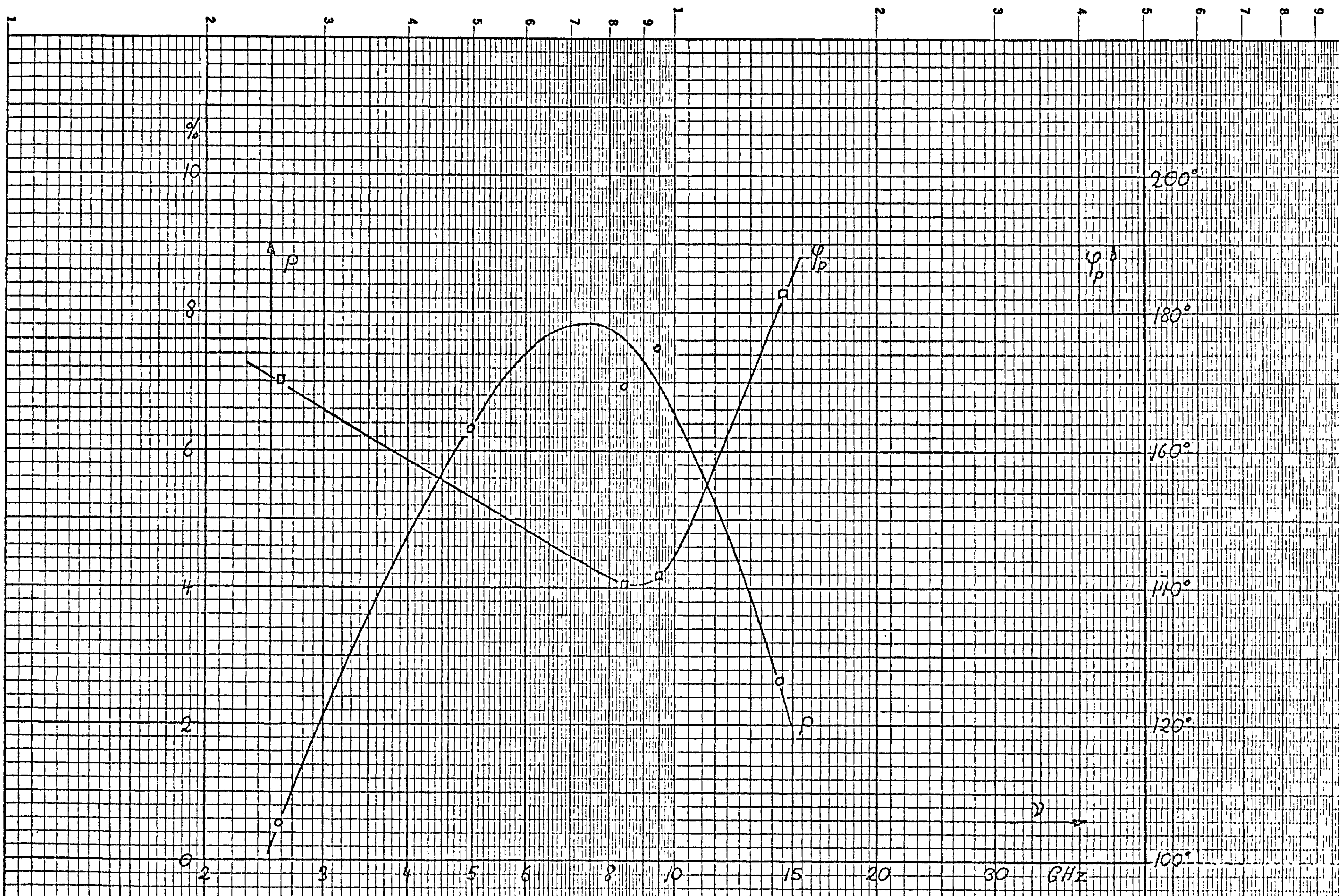

Figure 2: Degree of polarisation and polarisation angle of Cygnus A as a function of frequency.[3],[4]

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