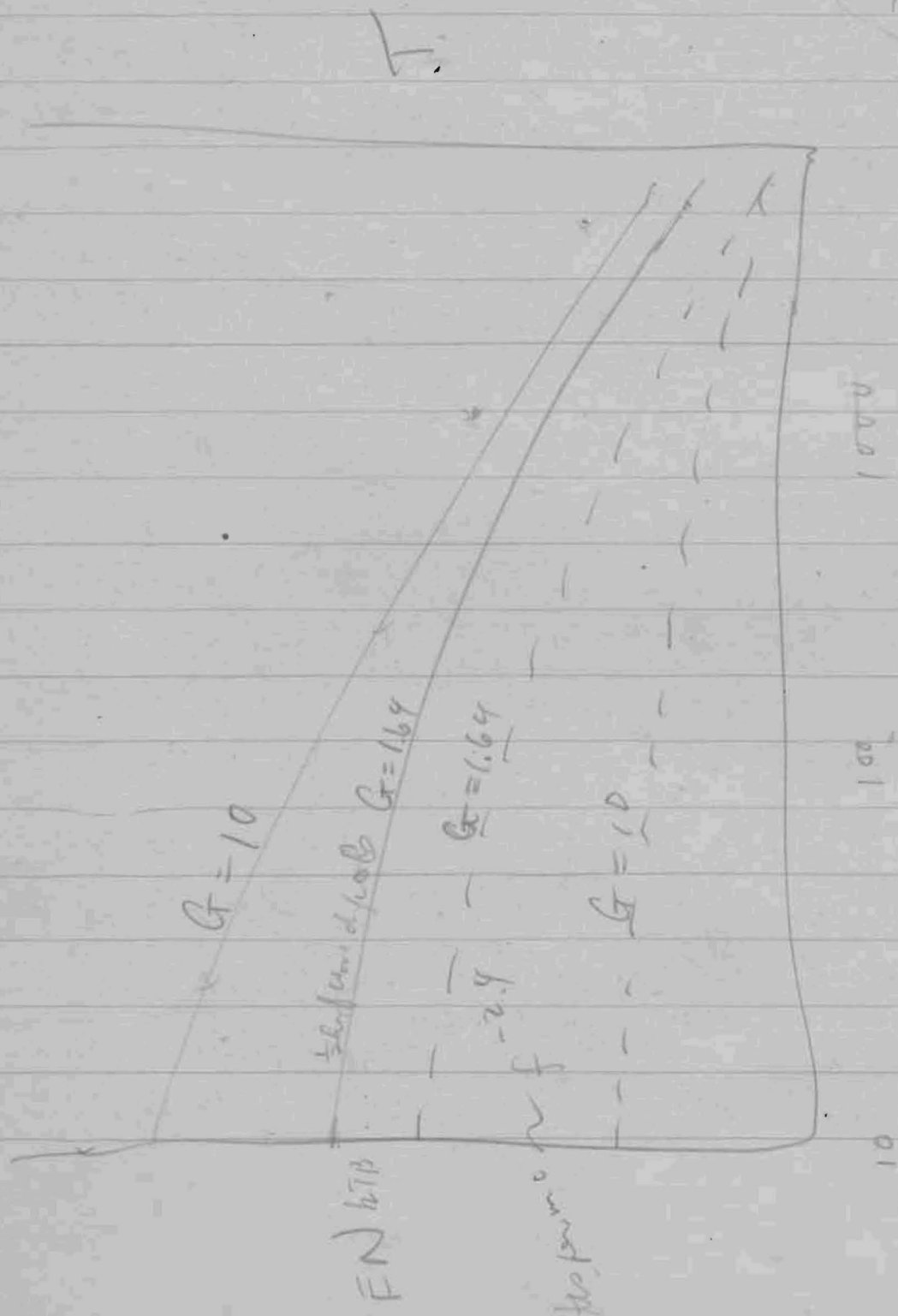


"An Investigation of Galactic Radiation
in the Radio Spectrum", Hay,
Phillips & Parsons, 18th July 1947.

Operational Research Group report # 355.
Ministry of Supply (restricted)



T

$$\bar{A} = \frac{\lambda^2}{4\pi} = 1$$

$$\bar{G} = \frac{4\pi \bar{A}}{\lambda^2}$$

1000

100

10

$$G = \frac{4\pi A}{\lambda^2}$$

Wasserform

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3-11-47 (X)

Temperature in Thousands of Degrees	Sidereal Time in Hours	Local Time due to azimuth	True Position in <u>R.A.</u>	Direction of Measurement	Declination in Degrees
5.5	2.5 <i>max</i>	0156	135.5 - 63.1	South	<u>-8°</u>
5.0	2.3 <i>min</i>	0415	169.3 - 35.4		
5.5	2.5	0551	181.5 - 14.3		
6.1	2.8 <i>max</i>	0730	193.0 + 7.0		
5.5	2.5	0845	203.1 + 22.6		
4.8	2.2	0934	211.8 + 32.4		
4.4	2.0 <i>min</i>	1150	249.6 + 52.0		
4.1	2.2	1234	267.0 + 53.9		
5.5	2.5	1336	292.6? + 51.5		
6.6	3.0	1440	303.3 + 43.8		
7.7	3.5	1530	325.0? + 35.3		
9.9	4.5	1635	336.9 + 22.6		
12.9	5.9	1708	341.5 + 16.0		
16.5	7.5	1731	344.7 + 10.9		
22.0	10.0	1801	348.2 + 4.9		
23.3	10.6 <i>max</i>	1818	350.3 + 1.2		
22.0	10.0	1854	354.5 - 6.8		
16.5	7.5	1932	358.9 - 15.2		
12.9	5.9	2000	2.2 - 21.4		
9.9	4.5	2033	6.2 - 28.4		
7.7	3.5	2136	15.7 - 42.3		
6.6	3.0	2231	27.3 - 53.8		

same as R.A.
 Figures 5 and 7

(X)

North

Temperature in Thousands of Degrees	Sidereal Time in Hours	Correction due to azimuth	True Position in <u>R.A.</u>	Direction of Measurement <small>North</small>	Declination in Degrees		
			Figure 3 ↓	a	b		
5.5	2.5 x 2.2	0520	+1200	1720	65.1	33.2	+68
6.6	3.0	0721	"	1921	66.5	22.2	"
7.7	3.5	0845	"	2045	70.5	15.4	"
9.9	4.5	1120	"	2320	82.6	7.1	"
10.3	4.7 max	1245	"	0045	90.4	6.	"
9.9	4.5	1418	"	0218	99.0	7.7	"
7.7	3.5	1754	"	0554	113.2	21.6	"
6.6	3.0	1950	"	0750	115.0	32.3	"
5.5	2.5	2231	"	1031	106.5	45.7	"
5.0	2.3 min	0200	"	1400	78.9	48.2	"

Temperature in Thousands of Degrees	Sidereal Time in Hours	Correction due to azimuth	True Position in RA	Direction of Measurement	Declination in Degrees
---	------------------------------	---------------------------------	---------------------------	--------------------------------	------------------------------

Figure 4

3.0	2350	+0440	0430	East,	+23 $\frac{1}{4}$
3.3	0145	"	0625	"	"
3.0	0309	"	0749	"	"
2.5	0415	"	0855	"	"
2.2	0612	"	1052	"	"
2.5	0826	"	1306	"	"
3.0	1016	"	1456	"	"
3.5	1137	"	1617	"	"
4.5	1305	"	1745	"	"
5.9	1412	"	1852	"	"
6.4	1445	"	1925	"	"
5.9	1524	"	2004	"	"
4.5	1652	"	2132	"	"
3.5	1819	"	2259	"	"
3.0	1950	"	0030	"	"
2.9	2135	"	0215	"	"

Temperature in Thousands of Degrees	Sidereal Time in Hours	Correction due to azimuth	True Position in R.A.	Direction of Measurement	Declination in Degrees
---	------------------------------	---------------------------------	-----------------------------	--------------------------------	------------------------------

Figure 6

5.9	0010	-0440	1930	West	+23 $\frac{1}{4}$ ^o
4.5	0202		2122		
3.5	0320		2240		
3.0	0424		2344		
2.7	0545		0105		
3.0	0734		0254		
3.4	1042		0602		
3.0	1218		0738		
2.5	1319		0839		
2.2	1407		0927		
1.9	1530		1050		
2.2	1718		1238		
2.5	1828		1348		
3.0	1952		1512		
3.5	2105		1635		
4.5	2238		1758		

GEOTECHNICAL
HERB

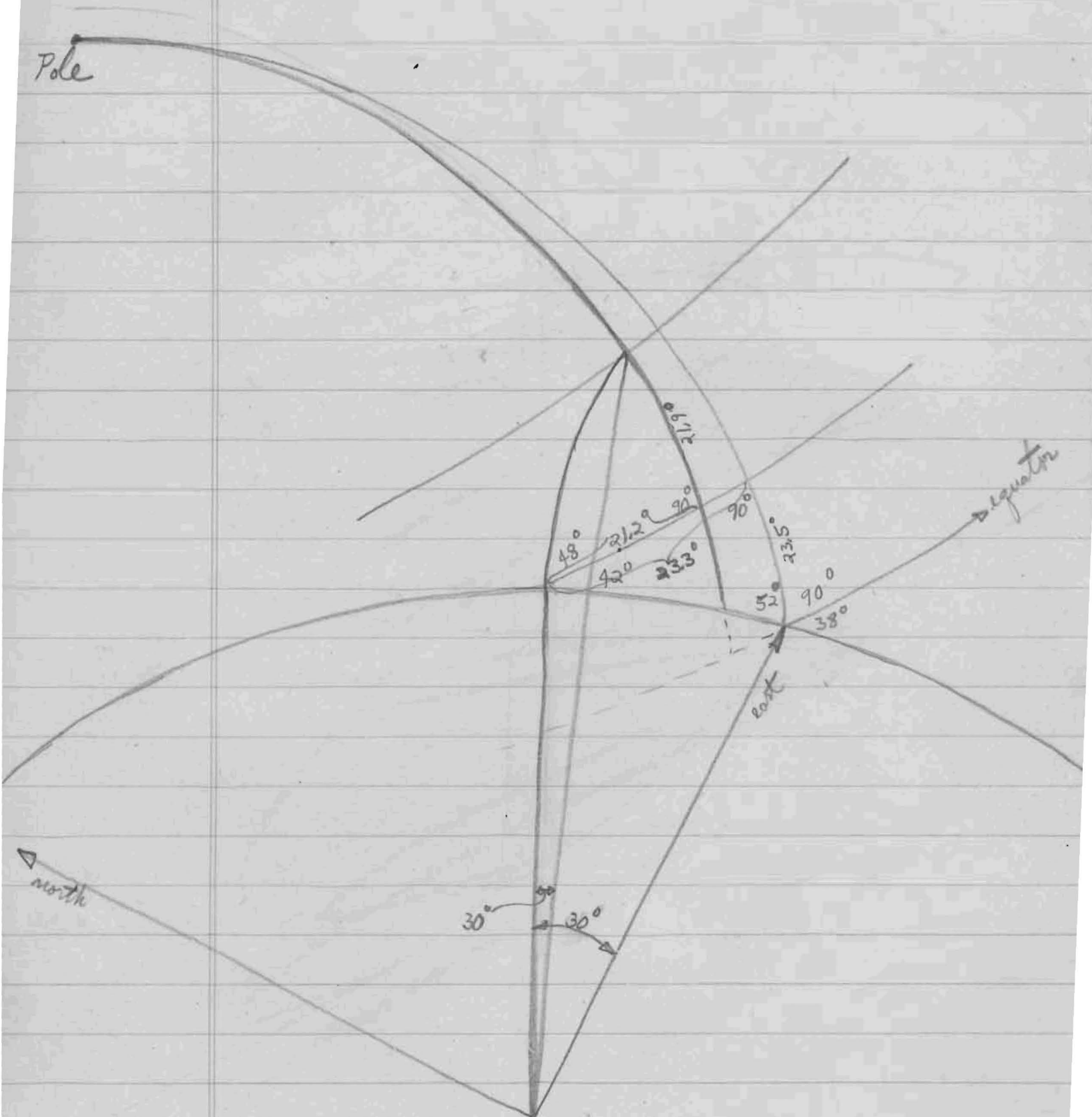
Temperature
in Thousands
of Degrees.

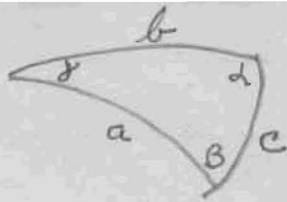
Right Ascension in Hours
East West Average

Temperature in Thousands of Degrees.	Declination $+23\frac{1}{4}^{\circ}$ RA			l	b
	East	West	Average		
24.0 6.4 x 2.2	1925	-	1925	26.2	+2.1
12.9 5.9	2004	1930	1947	28.2	-3.1
9.9 4.5	2132	2122	2127	42.8	-21.1
7.7 3.5	2259	2240	2250	60.3	-31.6
6.6 3.0	0030	2344	0007	80.8	-37.4
6.1 min (2.9)	0215	(2.7) 0105	(2.8) 0140	107.3	-37.0
6.6 3.0	0430	0254	0342	135.3	-23.7
7.4 max (3.3)	0625	(3.4) 0602	(3.4) 0614	156.7	+5.2
6.6 3.0	0749	0738	0744	165.7	+24.0
5.5 2.5	0855	0839	0847	171.5	+37.9
4.4 min (2.2)	1052	(1.9) 1050	(2.0) 1051	185.5	+65.2
5.5 2.5	1306	1348	1327	337.9	+78.1
6.6 3.0	1456	1512	1504	355.5	+57.2
7.7 3.5	1617	1635	1626	9.1	+39.4
9.9 4.5	1745	1758	1752	15.8	+20.6
12.9 5.9	1852	1930	1911	23.9	+4.0
24.0 6.4	1925	-	1925	25.3	+1.6

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3-12-47





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$$\sin b = \frac{\sin a \sin B}{\sin \alpha} = \frac{\sin 30^\circ \sin 52^\circ}{\sin 90^\circ} = \frac{.50 \cdot .789}{1.00} = .395$$

$$b = 23.3^\circ$$

$$\tan \frac{1}{2} c = \tan \frac{1}{2} (a+b) \frac{\cos \frac{1}{2} (\alpha + \beta)}{\cos \frac{1}{2} (\alpha - \beta)}$$

$$= \tan \frac{1}{2} (30 + 23.3) \frac{\cos \frac{1}{2} (90 + 52)}{\cos \frac{1}{2} (90 - 52)}$$

$$= \tan 26.7^\circ \frac{\cos 71^\circ}{\cos 38^\circ} = .503 \frac{.326}{.789} = .208$$

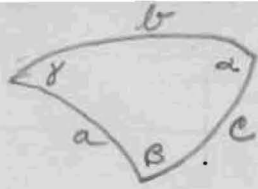
$$c = 23.5^\circ$$

$$\cot \frac{1}{2} \gamma = \tan \frac{1}{2} (\alpha + \beta) \frac{\cos \frac{1}{2} (a+b)}{\cos \frac{1}{2} (a-b)}$$

$$= \tan \frac{1}{2} (90 + 52) \frac{\cos \frac{1}{2} (30 + 23.3)}{\cos \frac{1}{2} (30 - 23.3)}$$

$$= \tan 71^\circ \frac{\cos 26.7^\circ}{\cos 3.4^\circ} = 2.9 \frac{.894}{.998} = 2.595$$

$$\gamma = 42^\circ$$



New Triangle (primes)

$$\sin b' = \frac{\sin a' \sin B'}{\sin d'} = \frac{\sin 30^\circ \sin 48^\circ}{\sin 90^\circ} = \frac{.50 \cdot .743}{1.00} = .372$$

$$b' = 21.9^\circ$$

$$\tan \frac{1}{2} c' = \tan \frac{1}{2} (a' + b') \frac{\cos \frac{1}{2} (d' + B')}{\cos \frac{1}{2} (d' - B')}$$

$$= \tan \frac{1}{2} (30^\circ + 21.9^\circ) \frac{\cos \frac{1}{2} (90^\circ + 48^\circ)}{\cos \frac{1}{2} (90^\circ - 48^\circ)}$$

$$= \tan 26^\circ \frac{\cos 69^\circ}{\cos 21^\circ} = .488 \frac{.359}{.938} = .187$$

$$c' = 21.2^\circ$$

$$\text{declination} = c + b' = 23.5 + 21.9 = +45.4^\circ$$

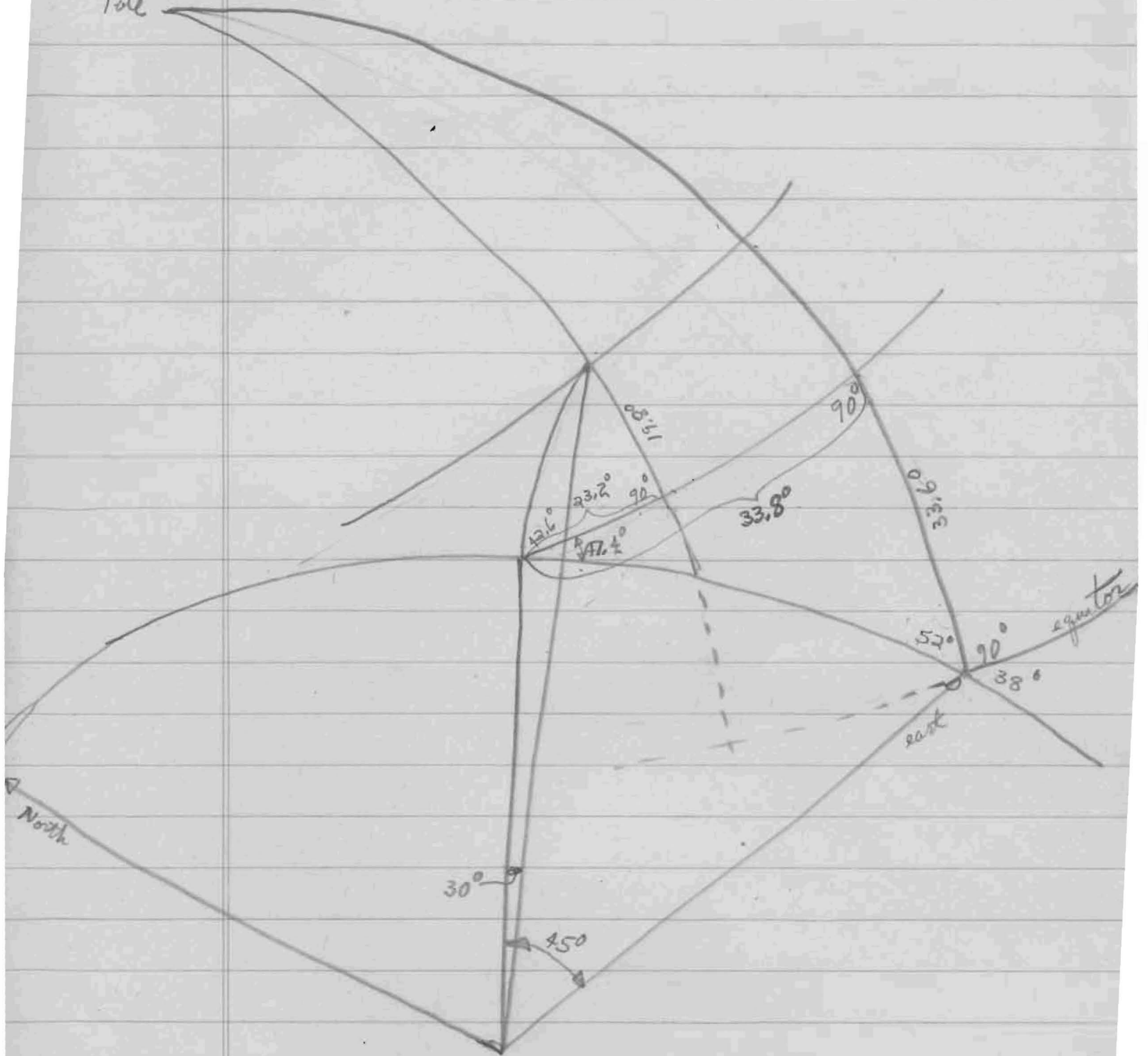
$$\text{Distance below horizon} = b - c' = 23.3 - 21.2 = 2.1^\circ$$

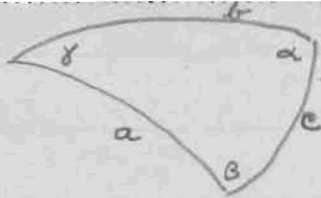
$$2.1^\circ = 8' \text{ of time}$$

Distance from Pole, with north meridian 6 hrs 30 min.
 Thus add 0608 to sidereal time when antenna points 30° north of east, and subtract 0608 from sidereal time when antenna points 30° north of west, (bearing 300°)

The other data is at $S+68$ and $+23.3^\circ$. Thus this

Pole





Page 207 Case VI

$$\sin b = \frac{\sin a \sin B}{\sin \alpha} = \frac{\sin 45^\circ \sin 52^\circ}{\sin 90^\circ} = \frac{.707 \cdot .789}{1.00} = .558$$

$$b = 33.8^\circ$$

$$\tan \frac{1}{2} c = \tan \frac{1}{2} (a-b) \frac{\sin \frac{1}{2} (\alpha + \beta)}{\sin \frac{1}{2} (\alpha - \beta)}$$

$$= \tan \frac{1}{2} (45 - 33.8) \frac{\sin \frac{1}{2} (90 + 52)}{\sin \frac{1}{2} (90 - 52)} = \tan 5.6^\circ \frac{\sin 71^\circ}{\sin 19^\circ}$$

$$= .099 \frac{.948}{.325} = .289$$

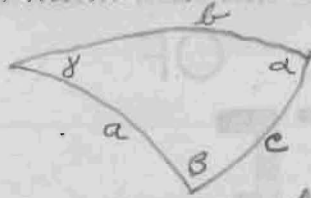
$$c = 33.6^\circ$$

$$\cot \frac{1}{2} \gamma = \tan \frac{1}{2} (\alpha + \beta) \frac{\cos \frac{1}{2} (a+b)}{\cos \frac{1}{2} (a-b)}$$

$$= \tan \frac{1}{2} (90 + 52) \frac{\cos \frac{1}{2} (45 + 33.8)}{\cos \frac{1}{2} (45 - 33.8)} = \tan 71^\circ \frac{\cos 39.4^\circ}{\cos 5.6^\circ}$$

$$= 2.9 \frac{.772}{.991} = 2.26$$

$$\gamma = 47.4^\circ$$



New triangle (prime)

$$\sin b' = \frac{\sin a' \sin \beta'}{\sin \alpha'} = \frac{\sin 30^\circ \sin 42.6^\circ}{\sin 90^\circ} = \frac{.50 \cdot .678}{1.00} = .339$$

$$b' = 19.8^\circ$$

$$\tan \frac{1}{2} c' = \tan \frac{1}{2} (a' - b') \frac{\sin \frac{1}{2} (\alpha' + \beta')}{\sin \frac{1}{2} (\alpha' - \beta')}$$

$$= \tan \frac{1}{2} (30 - 19.8) \frac{\sin \frac{1}{2} (90 + 42.6)}{\sin \frac{1}{2} (90 - 42.6)} = \tan 5.1 \frac{\sin 66.3^\circ}{\sin 23.7^\circ}$$

$$= .090 \frac{.918}{.403} = .205$$

$$c' = 23.2^\circ$$

$$\text{Declination} = c + b' = 33.6 + 19.8 = +53.4^\circ$$

$$\text{Distance below horizon} = b - c' = 33.8 - 23.2 = 10.6^\circ$$

$$10.6^\circ = 42 \text{ mins of time}$$

Distance from pole, zenith, south meridian 6 hrs 42 mins
 Thus add 0642 to sidereal time to get RA
 when antenna pointed 45° north of east and
 subtract 0642 from sidereal time to get RA
 when antenna pointed 45° north of west.

The other data is at $\delta + 68^\circ + 23.3$. Thus this
 will give a band 30.5 deg above and 14.2° below other data.

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3-14-97

Data of 3-24-45 at Malvern, Wore., England.

Time	Bearing	Temp.	From Fig 8
1207A	60	3900	
1227A	60	4800	
<u>1247A</u>	<u>60</u>	<u>6000</u>	
1227A	60	4900	average values.

Time	Bearing	Temp	From Fig 8
1213A	300	4100	
1233A	300	4000	
<u>1253A</u>	<u>300</u>	<u>3700</u>	
1233A	300	3900	Average Values

1230A
mean time

Time	Bearing	Temp.	From Fig 9
902A	60	4100	
922A	60	4200	
<u>942A</u>	<u>60</u>	<u>4300</u>	
922A	60	4200	Average Values

Time	Bearing	Temp	From Fig 9
908A	300	3100	
928A	300	3100	
<u>948A</u>	<u>300</u>	<u>3400</u>	
928A	300	3200	Average Values

925A
mean time

Close to micron post

Data of 3-24-45 at Malvern, Wore., England,

Time	Bearing	Temp.	From Fig 10.
506P	60	4000	
526P	60	4000	
<u>546P</u>	<u>60</u>	<u>4200</u>	
526P	60	4100	Average Values.
512P	300	1800	
532P	300	1800	
<u>552P</u>	<u>300</u>	<u>1900</u>	
532P	300	1800	Average Values

Time	Bearing	Temp	From Fig 11
916P	60	3000	
936P	60	3000	
<u>956P</u>	<u>60</u>	<u>3000</u>	
936P	60	3000	Average Values
Time	Bearing	Temp	From Fig 11
902P	300	3800	
922P	300	3800	
<u>942P</u>	<u>300</u>	<u>3800</u>	
922P	300	3800	Average Values

Example 1
page 303

Calculations of Meridian Time at Greenwich.

GST of 0 ^h GCT	12 04 25
Long. Corr.	00
LST of 0 ^h LCT	12 04 25
add local time	00 30 00
Reduction Table VI	+ 00 05
Req'd S.T. of meridian	12 34 30

Fig 8

LST of 0 ^h LCT	12 04 25
add Local Time	09 25 00
Reduction Table VI	+ 1 33
Req'd S.T. of meridian	21 30 58

Fig 9

LST of 0 ^h LCT	12 04 25
add Local Time	17 29 00
Reduction Table VI	+ 2 52
Req'd S.T. of meridian	05 36 17

Fig 10

LST of 0 ^h LCT	12 04 25
add Local Time	21 29 00
Reduction Table VI	+ 3 32
Req'd S.T. of meridian	09 36 57

Fig 11

Tabulation of Position in R.A. at Dec +45.4°

Figure	R.A. of Meridian	Bearing in Degrees	Correction to R.A.	R.A. of Antenna	Temperature in Degrees
8	1235	60	+0608	1843	4900
	1235	300	-0608	0629	3900
9	2131	60	+0608	0339	4200
	2131	300	-0608	1523	3200 (minor peak)
10	0536	60	+0608	1144	4100 (minor peak)
	0536	300	-0608	2324	1800 (low min wrong)
11	0937	60	+0608	1545	3000
	0937	300	-0608	0329	3800
	<i>l</i>	<i>b</i>	<i>T</i>		
8	42.2	+18.9	4900		
	137.2	+17.5	3900		
9	119.8	-5.8	4200		
	39.6	+53.3	3200		
10	118.7	+69.2	4100		
	73.3	-14.5	1800		
11	X 38.4	+49.9	3000		
	X 118.2	-7.2	3800		

Operational Research Group (W. and E.) Report No. 355.

Distribution:

S.A./A.C. (20) for distribution

D. Radar (1)

A.A.Command

M.O.R.U.

F.D.S.R. (D)

T.R.D. 1b.

P.D.T.D. (D)

D.C.R.D.

D.W.R. (D)

D.G. of A. (4)

T.R.E.

Radio Research Board

C.S./R.R.D.E. (2)

C.A.E.E.

Secretary Ordnance Board

N.P.L.

Major General W.R.C.Penney

Imperial and Foreign Liaison (37) thro' T.P.A.3.D.

B.C.S.O. (3)

B.S.O. (3)

Aust. Army Staff (2)

Aust. Mun. Rep. (1)

C.M.H.Q. (6)

O.C.O. India (7)

N.Z. M.L.O. (2)

N.Z. S.L.O. (1)

Mil. Ad./S. Africa (1)

S.L.O./S. Africa (1)

O.S.R.D. (3)

U.S.Military Attache (2)

U.S. Naval Attache (2)

U.S. Naval Air Attache (1)

Central Tech. Records (2)

D S.R. Admiralty

D.G.D. Admiralty

D.N.C.R. Admiralty

H.M.S. Vernon

H.M.S. Excellent

A.G.E.

D.D.Sc. Air Ministry (3)

D.S.R. (A) H. of S.

D.G.D. (A) H. of S.

R.A.E. Farnborough

Controlled Weapons Dpt. R.A.E.

F.V.D.D.

North Dec + 74°

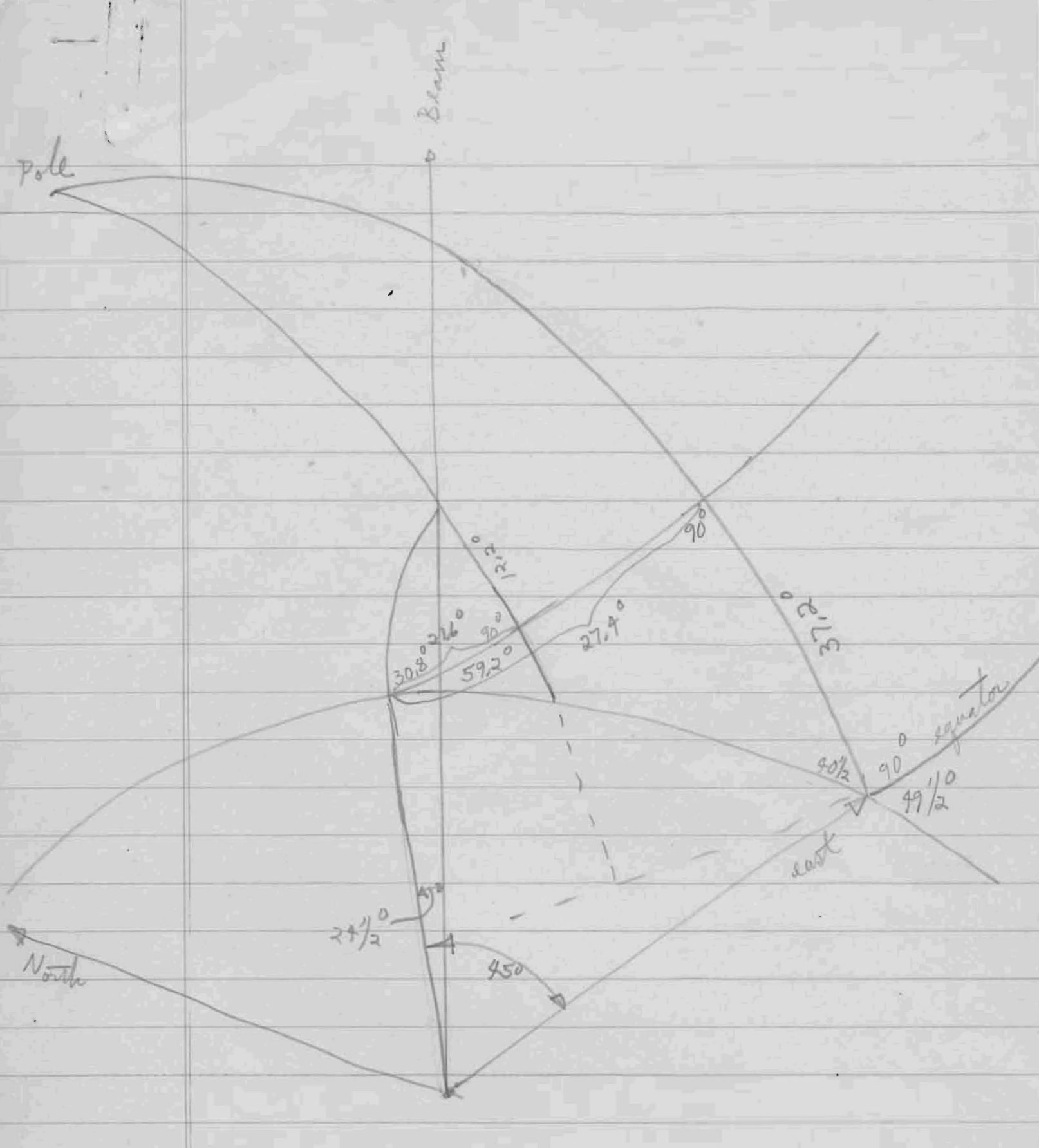
ST	R.A.	R.A.	DB
ions	Meridian	Antenna	Chart
00P		0545	11.6
620		0605	11.5
740		0625	11.6
700		0645	11.5
720		0705	11.5
740		0725	11.5
800		0745	11.5
820		0805	11.5
840		0825	11.5
900		0845	11.4
920		0905	11.5
940		0925	11.5
1000		0945	11.5
1020		1005	11.4
1040		1025	11.1
1100		1045	10.9
1120		1105	10.7
1140P		1125	10.7
1200MN		1145	10.8

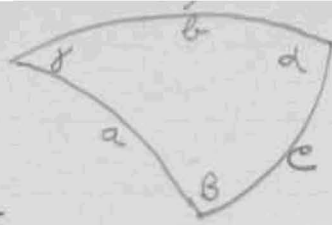
North S+79°

I	DB	RA.		
13	11.0	2340	85.8	12.5
17	12.0	0320	100.6	15.4
17	12.4 max	0355	102.5	16.9
17	12.0	0430	104.2	18.7
13	11.0	1200	93.8	43.7
11	10.3 min	14.00	82.6	42.8
13	11.0	2340	85.8	12.5

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20.5 m/s by Janstky





Page 207 Case VI

$$\sin b = \frac{\sin a \sin \beta}{\sin \alpha} = \frac{\sin 45^\circ \sin 40\frac{1}{2}^\circ}{\sin 90^\circ} = \frac{.707 \cdot .650}{1.00} = .460$$

$$b = 27.4^\circ$$

$$\tan \frac{1}{2}c = \tan \frac{1}{2}(a-b) \frac{\sin \frac{1}{2}(\alpha+\beta)}{\sin \frac{1}{2}(\alpha-\beta)}$$

$$= \tan \frac{1}{2}(45-27.4) \frac{\sin \frac{1}{2}(90+40.5)}{\sin \frac{1}{2}(90-40.5)} =$$

$$= \tan 8.8^\circ \frac{\sin 65.4^\circ}{\sin 24.8^\circ} = .155 \frac{.909}{.419} = .336$$

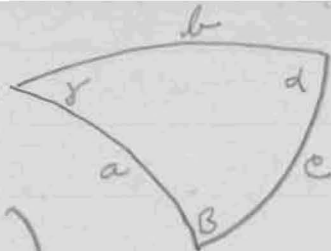
$$c = 37.2^\circ$$

$$\cot \frac{1}{2}\gamma = \tan \frac{1}{2}(\alpha+\beta) \frac{\cos \frac{1}{2}(a+b)}{\cos \frac{1}{2}(a-b)}$$

$$= \tan \frac{1}{2}(90+40\frac{1}{2}) \frac{\cos \frac{1}{2}(45+27.4)}{\cos \frac{1}{2}(45-27.4)} = \tan 65.2^\circ \frac{\cos 36.2^\circ}{\cos 8.8^\circ}$$

$$= 2.16 \frac{.807}{.990} = 1.76$$

$$\gamma = 59.2^\circ$$



New Triangle (prime)

$$\sin b' = \frac{\sin a' \sin \beta'}{\sin d'} = \frac{\sin 24.5^\circ \sin 30.8^\circ}{\sin 90^\circ} = \frac{.414 \cdot .511}{1.00} = .212$$

$$b' = 12.2^\circ$$

$$\tan \frac{1}{2} c' = \tan \frac{1}{2} (a' - b') \frac{\sin \frac{1}{2} (d' + \beta')}{\sin \frac{1}{2} (d' - \beta')}$$

$$= \tan \frac{1}{2} (24.5 - 12.2) \frac{\sin \frac{1}{2} (90 + 30.8)}{\sin \frac{1}{2} (90 - 30.8)} = \tan 6.15^\circ \frac{\sin 60.4^\circ}{\sin 29.6^\circ}$$

$$.109 \frac{.869}{.494} = .191$$

$$c' = 21.6^\circ$$

$$\text{Declination} = c + b' = 37.2 + 12.2 = +49.4^\circ$$

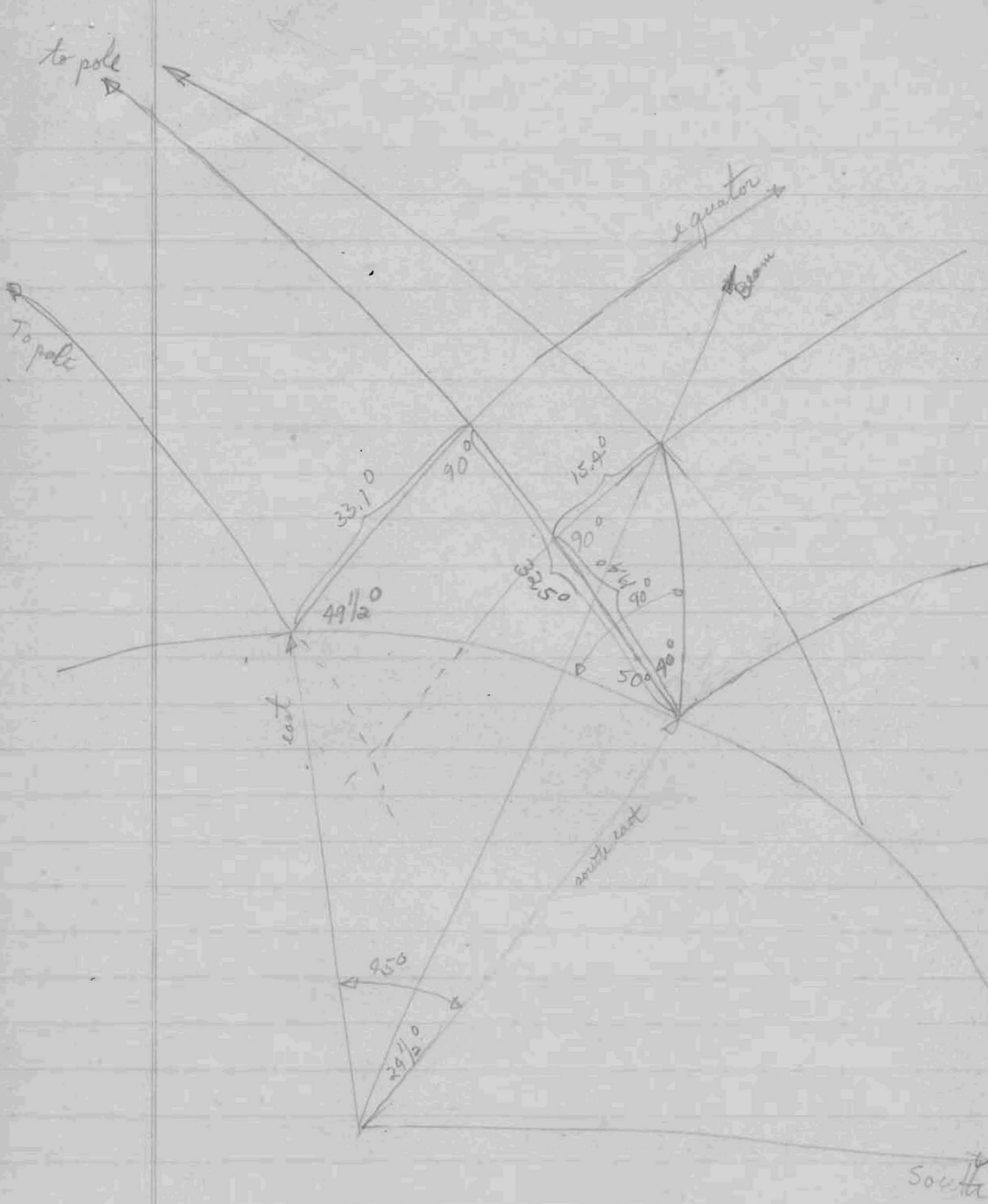
$$\text{Distance below horizon} = b - c' = 27.4 - 21.6^\circ = 5.8^\circ$$

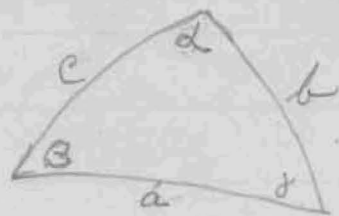
$$5.8^\circ = 23 \text{ min of time}$$

Distance from pole, zenith, south meridian = 6 hrs 23 min

Thus add 0623 to sidereal time of meridian to get RA of antenna pointed North east; conversely subtract 0623 from sidereal time of meridian to get RA of antenna pointed north west.

The other data is at $+74^\circ + 16^\circ$. Thus this will give a band 24.6° below and 33.4° above other data.





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$$\sin b = \frac{\sin a \sin B}{\sin d} = \frac{\sin 45^\circ \sin 49\frac{1}{2}^\circ}{\sin 90^\circ} = \frac{.707 \cdot .761}{1.00} = .538$$

$$b = 32.5^\circ$$

$$\tan \frac{1}{2} c = \tan \frac{1}{2} (a-b) \frac{\sin \frac{1}{2} (d+B)}{\sin \frac{1}{2} (d-B)}$$

$$= \tan \frac{1}{2} (45 - 32.5) \frac{\sin \frac{1}{2} (90 + 49.5)}{\sin \frac{1}{2} (90 - 49.5)} =$$

$$= \tan 6\frac{1}{4}^\circ \frac{\sin 69\frac{3}{4}^\circ}{\sin 20\frac{1}{4}^\circ} = .1095 \frac{.939}{.346} = .297$$

$$c = 33.1^\circ$$

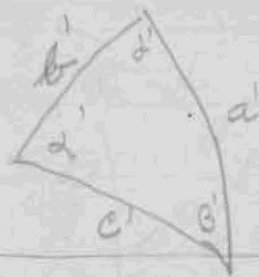
$$\cot \frac{1}{2} \gamma = \tan \frac{1}{2} (d+B) \frac{\cos \frac{1}{2} (a+b)}{\cos \frac{1}{2} (a-b)}$$

$$= \tan \frac{1}{2} (90 + 49\frac{1}{2}) \frac{\cos \frac{1}{2} (45 + 32.5)}{\cos \frac{1}{2} (45 - 32.5)}$$

$$= \tan 69\frac{3}{4}^\circ \frac{\cos 38\frac{3}{4}^\circ}{\cos 6\frac{1}{4}^\circ} = 2.71 \frac{.781}{.992} = 2.13$$

$$\gamma = 50^\circ$$

New Triangle (prime)



$$\sin b' = \frac{\sin a' \sin \beta'}{\sin \alpha'} = \frac{\sin 24.5^\circ \sin 40^\circ}{\sin 90^\circ} = \frac{.414 \cdot .643}{1.00} = .266$$

$$b' = 15.4^\circ$$

$$\tan \frac{1}{2} c' = \tan \frac{1}{2} (a' - b') \frac{\sin \frac{1}{2} (a' + b')}{\sin \frac{1}{2} (a' - b')}$$

$$= \tan \frac{1}{2} (24.5 - 15.4) \frac{\sin \frac{1}{2} (90 + 40)}{\sin \frac{1}{2} (90 - 40)}$$

$$= \tan 4.6^\circ \frac{\sin 65^\circ}{\sin 25^\circ} = .080 \frac{.908}{.424} = .171$$

$$c' = 19.4^\circ$$

$$\text{Declination} = -b' + c' = -13.1^\circ$$

Distance above horizon = $c + b' = 48.5^\circ = 3 \text{ hrs. } 14 \text{ min.}$

Distance from pole, zenith, south meridian = $2 \text{ hrs } 46 \text{ min.}$

Thus add 0246 to sidereal time of meridian to get RA of antenna pointed South east and subtract 0246 to sidereal time of meridian to get RA of antenna pointed South west.

Other data is at $+16^\circ$ to -25° . Thus, this will give a band 29° below and 12° above other data.