A B 346

received:

VLA OBSERVING APPLICATION

SEND TO: Director NRAO Edgemont Rd. Charlottesville, Va. 22901

DEADLINES: 15th of Mar., June, Sept., Dec. for Q 3, 4, 1, 2 respectively

(1) Date: 13 March 1985

(2) Title of Proposal: Low-brightness features of NGC6251

(3) Authors	Institution	Who will observe?	For Grad Students Only: Observations for PhD Thesis?	Anticipated PhD Year
A.H. Bridle	NRAO / CV			
R.A. Perley	NRAO / VLA			

(4) Related previous VLA proposal number: AP66 (request for rescheduling of failed part of AP6

(5) Contact author for scheduling: R.A. Perley

Address: VLA

(6) Telephone:

TWX:

(7) Scientific category: ☐ planetary, ☐ solar, ☐ stellar, ☐ galactic, ☑ extragalactic

(8) Configuration(s) (A, B, C, D, A/B, B/C, C/D, Any)	D				
(9) Wavelength (90 20 18 6 2 1.3 cm)	20/6				
(10) Time requested (hours or days)	24hrs				

(11) Type of observation: ☑ mapping, ☐ point source, ☐ monitoring, ☑ continuum, ☑ lin poln, ☐ circ poln, ☐ spectral line, ☐ solar, ☐ VLBI, ☐ phased array, ☐ other

(12) ABSTRACT (do not write outside this space):

We wish to be rescheduled for the part of AP66 which failed due to operationa problems with the VLA. The purpose is to examine the spectral gradients and Faraday rotation properties, as well as the magnetic field configurati over the low-brightness regions of the giant radio galaxy NGC6251. We also wish to test Laing's lobe magnetic field model for this source, and to understand why the S symmetry of the jet/counterjet does not extend eastwards in the source.

NRAO use only

(13) Observing style: ☑ Will be present ☐ Will prepare files & return to reduce ☐ Will use modem ☐ Absentee (NRAO prepares OBSERV file & sends calibrated data)

(14) Reduction: Number of maps 12 Maximum size of maps 512 Self-cal maps 12 Private disk pack ______

(15) Off-site reduction: ☑ none, ☐ post map, ☐ post calibration, ☐ everything.

(16) Help required: ☑ none, ☐ consultation, ☐ friend (extensive help), ☐ staff collaborator.

(17) Spectral line only:

	line 1	line 2	line 3		line 1	line 2	line 3
transitions to be observed				number of channels (N)			
channel bandwidth (KHz) (Δ)				number of antennas			
observing frequency (±NΔ/2)				rms noise after 1 hour (mJy)			

(18) Number of sources 1 (If more than 10 sources please attach list. If more than 30 give only selection criteria and LST range(s).)

Name	Epoch 1950☐ 2000☐ RA hh mm	Dec ±xx°x	Config.	Band (cm)	Band width (MHz)	Total Flux line (Jy)	Total Flux cont. (Jy)	Largest ang. size	Weakest signal (mJy/beam)	Required dynamic range	Possible LST range hh - hh	Time requested
NGC6251 (3 subfields)	16 36	+82°7	D	20,6	50/25			30'/10'	~0.1	4000:1	any	24hrs

(19) Special hardware, software, or operating requirements:

(20) Preferred range of dates for scheduling:

(21) Dates which are not acceptable:

(22) Please attach a self-contained Scientific Justification not in excess of 1000 words.

When your proposal is scheduled, the contents of this cover sheet become public information. (Any supporting documents are for refereeing only)

NATIONAL RADIO ASTRONOMY OBSERVATORY
Edgemont Road, Charlottesville

13 March 1985

TO: Paul Vanden Bout

FROM: Alan Bridle, Rick Perley

RE: Rescheduling of VLA D array observations of NGC6251

We wish to apply for rescheduling of the 'D' array segment of our proposal AP66 for mapping the low-brightness lobe features of NGC6251 at 6 and 20 cm with the VLA. This proposal was given time in the 'C' and 'D' array seasons in 1983 but the 'D' array observing was unsuccessful for operational reasons. To support the resubmission we attach the original proposal, and a map from the (successful) 'C' array observations.

AP66 called for 'C' array data mainly to define properties of the outer main jet, the counterjet and lobe fine structure, and 'D' array data mainly to define the spectral, polarization, and rotation measure characteristics over the extended lobe emission. We "piggybacked" an 18cm 'C' array run on a 28-hr VLB observation of NGC6251 which used the VLA in phased array mode; Figure 1 shows a tapered map from this run, at 25" resolution. It clearly demonstrates (a) that the two jets share a distorted S-symmetry, (b) that the counterjet is not a fainter replica of the main jet, but rather that the brightness ratio between the two jets changes with distance from the core, (c) that the "warm spot" in the west lobe shares the S-symmetry of the jet/counterjet system with a corresponding warm spot at a bend in the counterjet. The last result increases the importance of examining the magnetic and spectral properties of the extended emission to the east of the warm spot in the counterjet (Figure 2), as it is now much clearer that the most easterly emission in NGC6251 breaks an underlying S-symmetry in the source. The 'C' array 6cm data (required for better signal to noise on the main jet than achieved in our published work) were also of acceptable quality for our present purposes.

Unfortunately, the 'D' array data requested in AP66, taken in June 1983, are almost entirely useless. The observing run was scheduled just as the BD IFs were being brought into use. Due to various operational problems, the new BD channels were brought up with no delays set, and the AC channel delays were improperly determined. The result was that only the parallel-hand data were useful at 6cm, while at 20cm no valid data at all were obtained. We therefore request rescheduling of the 'D' array segment of this proposal for 12 hrs in the next 'D' array season.

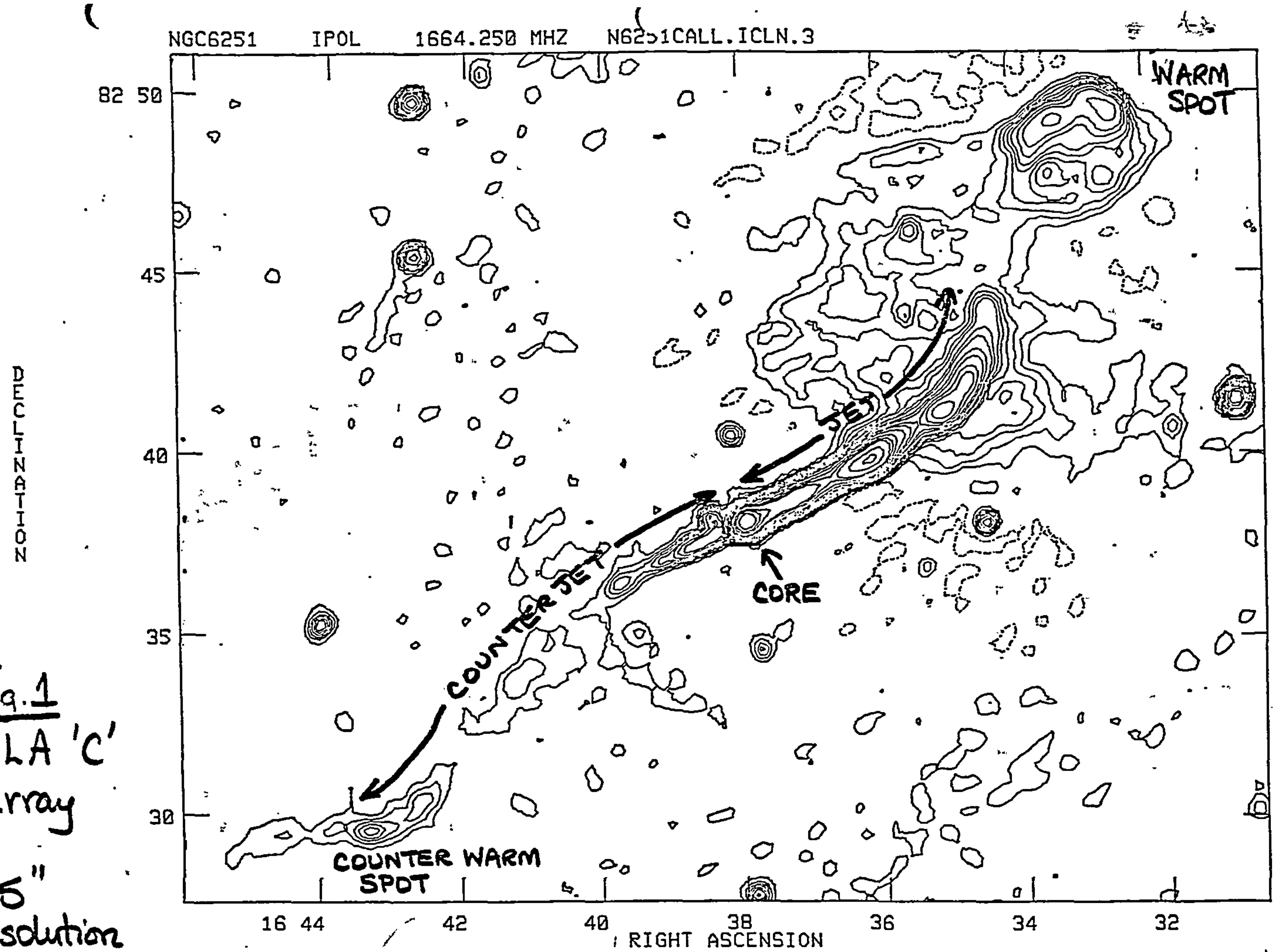


Fig. 1
VLA 'C' array
25" resolution
λ18cm

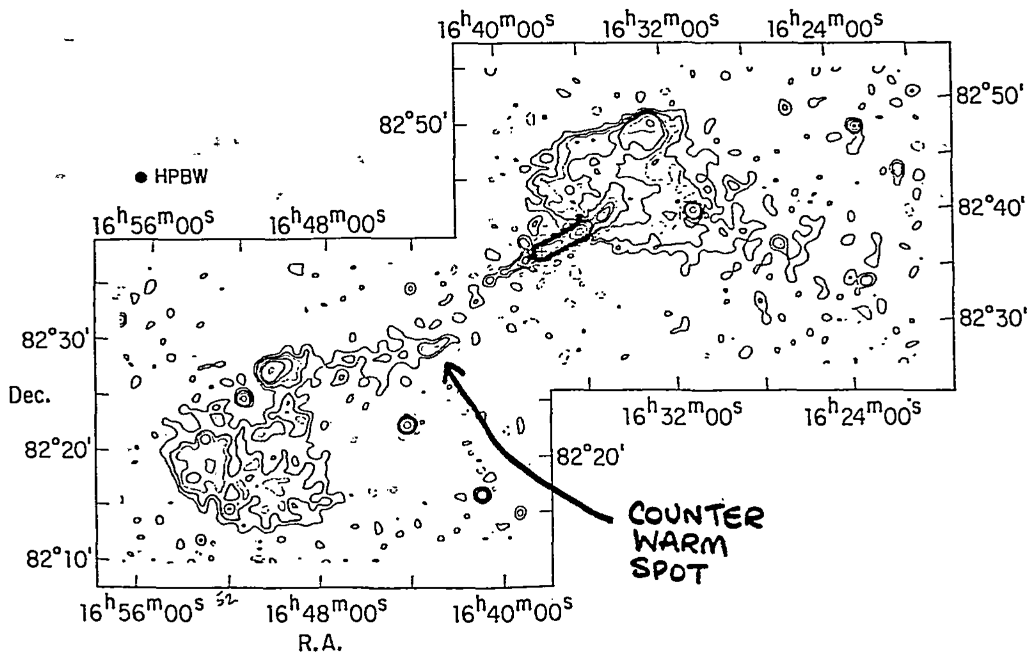


Fig. 2
WSRT
50" resolution
λ50cm

FIG. 1.—Map of the entire NGC 6251 source at 610 MHz with 50" resolution (from Willis *et al.* 1982). The cross marks the position of the nucleus of NGC 6251.

TABLE IA
VLA OBSERVING PARAMETERS

	Date			
Parameter	1979 Nov 05	1980 Mar 31	1980 Dec 05	1981 Oct 05

ORIGINAL PROPOSAL AP66

TO: M.S.Roberts

FROM: R.A.Perley and A.H.Bridle

DATE: 4 October 1982

SUBJECT: Proposal to observe the low-brightness features of NGC6251 at 6 and 20 cm with the VLA in the C and D configurations.

We request the use of the VLA for 24 hrs in each of the C and D configurations to map total and polarized intensities of the counterjet and lobes of the large radio galaxy NGC6251. The proposal is the first of a new program intended to explore aspects of the source revealed by, or related to, our previous study of the bright jet in this object.

BACKGROUND

NGC6251 is a 14th-magnitude elliptical galaxy with a redshift of 0.023 associated with a radio source 1.1 degrees in overall extent. For H=75 km/s/Mpc the linear diameter of the source is 1.7 Mpc, making it one of the largest known radio galaxies. A high-brightness jet some 120 kpc long was discovered in the source by Waggett, Warner and Baldwin (1977). We observed this jet using the A configuration at 21 and 18cm, a hybrid (construction) configuration at 20 and 6 cm, and a D configuration "snapshot" at 20cm. The main results of these observations were:

1. Evidence that the jet may be interacting with a surrounding medium: it expands in several discrete steps, and exhibits lateral oscillations which are readily interpreted as Kelvin-Helmholtz instability modes of a confined jet.

2. Evidence that the surrounding medium may be an ionized magnetosphere of NGC6251: there are large and complex Faraday rotation gradients over the central parts of the source. These gradients cannot be due to thermal electrons and fields in the jet because there is no significant depolarization between 21cm and 6cm. Rather, the gradients, which are largest closest to the center of NGC6251, must arise in material between us and the jet but associated with NGC6251.

3. Detection in the D array snapshot of a weak counterjet whose intensity within 90" of the core is about 1/40th that of the main jet, but decreases to <1/250th that of the main jet further from the core. The reality of this counterjet is confirmed by a WSRT 610 MHz map at 50" resolution.

4. Mapping of the magnetic structure of the jet in detail: the projected field contains both parallel and perpendicular components, with deep field-parallel layers at the edges of the field-perpendicular configuration in the more expanded outer regions of the jet. There are also regions of oblique projected field which can be explained only if there are departures from axial symmetry in the internal structure of the jet.

These results will soon be submitted to the Ap.J. They raise questions about NGC6251 which we wish to explore using various combinations of frequencies and configurations, now that reduction and interpretation of the earlier data are complete. Some of the new observations require modes of operation or equipment not yet installed at the VLA; these will be requested as the VLA becomes capable of supporting them. This request is for the parts of the ongoing study which can be done now.

STUDIES OF THE COUNTERJET

We wish to determine the internal structure, collimation and polarization properties of the counterjet, for comparison with those of the main jet. The counterjet is too faint and resolved to be detectable at A or B configuration resolution at 20cm, but is very clear in our D configuration snapshot at this frequency (Figure 1). We require a mixture of C and D configuration observations at 20cm and 6cm to examine its structure in both total and polarized intensities. The symmetries of its expansion, brightness-width evolution, field configuration and Faraday rotation properties relative to those of the main jet are all potent tests of models for these quantities which depend on the existence of a gaseous halo around the nucleus of NGC6251. The ratio of brightnesses between the counter jet and the main jet as a function of distance from the core source is also an important constraint on theories of the jet/counterjet mechanism. We will combine C and D configuration observations of about 3 hrs duration at 21cm, 18cm and 6cm to address these matters.

THE OUTER REGION OF THE MAIN JET

The parts of the main jet beyond about 5' from the core (see Figure 1) are resolved out in our earlier high-resolution observations but only poorly resolved in the D configuration snapshot at 20cm. Important questions about the transition between the main jet and the northwest lobe cannot be answered using the present data sets. What is the path and brightness evolution of the jet as it enters the northwest lobe ? What is the magnetic structure in the region where the jet "ends", presumably sharing its momentum with the surrounding material ? Can the jet be traced continuously to the "warm spot" at the northwestern edge of the source, and what is the structure of this warm spot ? The latter provides an indirect constraint on the jet velocity; if the jet does reach the warm spot, it presumably has sufficient thrust to overcome the internal pressure of the spot. We therefore require maps of the northwestern lobe with better resolution than at present, but with sufficient short spacings to sample and separate structural scales from 10" to 10' (see Figure 1). We need to combine C and D configuration observations at 20cm and 6cm of at least one more phase center along the probable path of the jet in the northwestern lobe.

ROTATION MEASURE AND SPECTRAL GRADIENTS IN THE LOBES

There is evidence from the Cambridge 151-1417 MHz observations of the lobe that the emission between the bright jet and the northwest warm spot has a spectrum similar to that of the jet, but that the more diffuse lobe emission away from the jet has a spectrum 0.5 steeper. Our data show that there is no significant spectral gradient along the jet and (from the brightness-width evolution) that particle acceleration continues for some tens of kpc along it. We wish to study both the rotation measure and spectral gradients over both lobes for comparison with the large RM gradients and negligible spectral gradients we have established for the jet. The RM data will test our interpretation of the RM gradients in the jet - we expect very little RM gradient over the lobes if the gradients over the jet indeed originate in the inner regions of a magnetosphere of NGC6251. WSRT 610 MHz data show that the lobes are significantly polarized and will be used for comparison with the VLA 20 cm observations. The C configuration observations will provide higher-resolution data for the more compact lobe features at 20cm for comparison with the VLA D configuration data at 6cm. They will also be used to measure the RMs of about five unresolved background sources which are viewed through the lobes.

The lobes of NGC6251 will also be a good arena in which to test the lobe magnetic field model of Laing (1980), wherein the field is sheared so as to be tangential to the surface of the lobe, with no radial component, but is otherwise random. To test this model quantitatively, we need to establish the projected magnetic field direction over the lobe, and to check for depolarization over it. Previous tests of the model in M84 (Laing and Bridle, in preparation) met with different degrees of success on the two different sides of the same source; again in the presence of large-scale RM gradients believed to be associated with the parent object. NGC6251 is suitable for further tests of the Laing model, as its lobes are bright, two-dimensional structures over which the VLA can map many pixels. To determine polarization structure (with typical degrees of polarization of 20%), 1-hr integrations at 50 MHz bandwidth are required for several phase centers at 20cm. Due to the 1.1 degree size of the source, three separate phase centers are required for the northwest lobe, counterjet, and southeast lobe observations, even at 20cm.

TIME REQUEST

We request 24 hrs in each of the D and C configurations of the VLA for these observations. In the D configuration, we will spend about 1 hr at each of three phase centres at 20cm, and the balance of the time at 6cm. We will be able to specify the time and frequency distribution of the C configuration observations in detail only after the D configuration data are available, but presently estimate our requirement as 24 hrs mainly at 20cm. Due to the 83 degree declination of NGC6251, a single 24-hr run in each configuration is feasible.

REFERENCES

Laing,R.A. 1980. M.N., 193, 439.
Waggett,P.C, Warner,P.J., Baldwin,J.E. 1977. M.N., 181, 465.

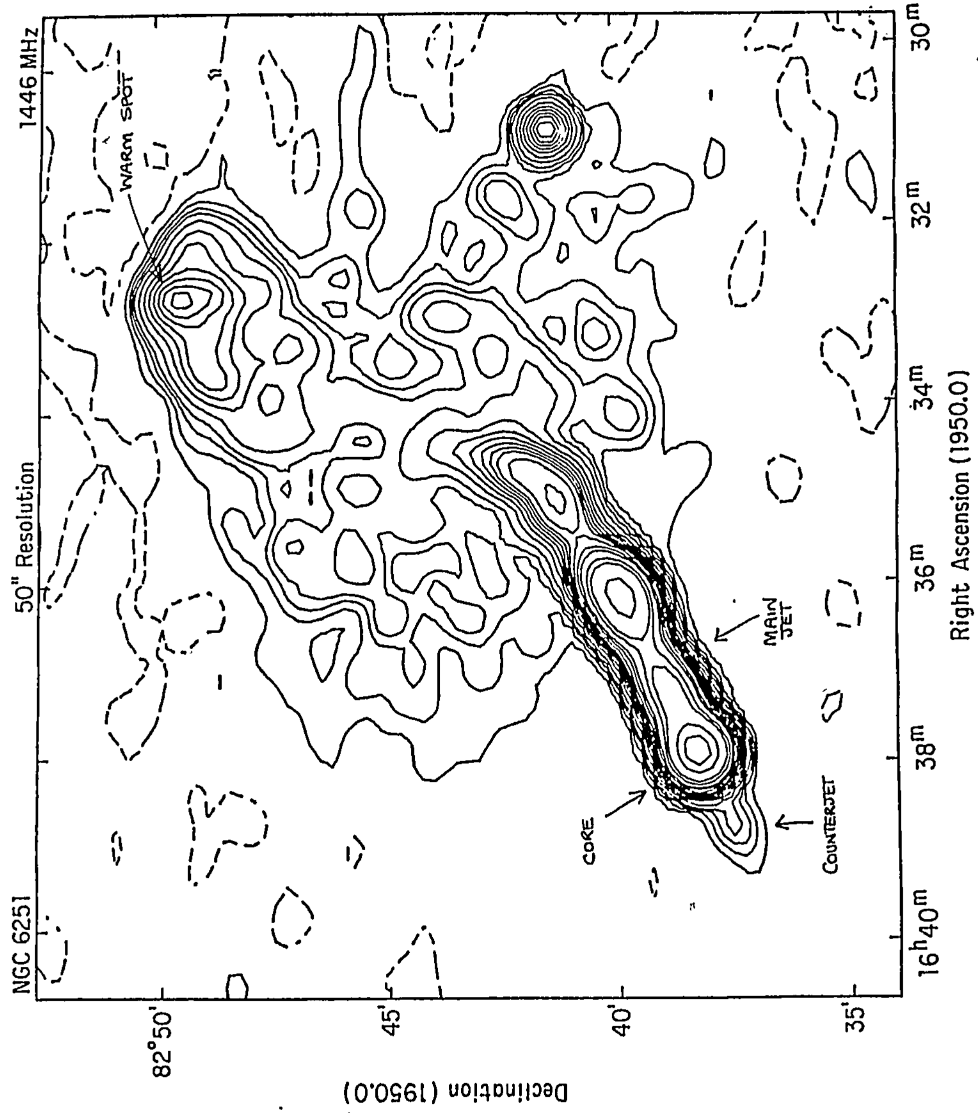


Figure 1

From: VAX3::RICK 12-JUN-1983 16:00
To: CVAX::BRIDLE
Subj: chagrin, embarassment, shame

I have just scanned our run from last night, and discovered the observe file had a crucial error. The A/C Fluke setting was 12.5 MHz too high, causing the 50MHz passband to contain only 37.5MHz width of data. Fortunately, this only occured on the calibrator 1803+784. All the observations of NGC6251 are all right, as are the observations of 3C48 and 3C138. It appears that only polarization calibration will suffer, and we'll probably be able to recover that from next week's run.

I cannot explain how this happened. I used SOS to substitute 100.0 and 200.0 (the correct settings) for 112.5 and 212.5 (the old setting used for the C array data). All the 212.5 did change to 200.0 (hence, the B/C

oops, I mean B/D data are o.k.), however, only the 112.5 Fluke settings on cards of the source, 3C48, and 3C138 changed. Somehow, I goofed. Of course, the real error was in the lack of adedquate final checking, and for th
I am truly sorry. I just hope we can recover the polarization calibration next week.

The operator said he saw no interference. I won't know for sure unti tomorrow. I'll make a quick map, and let you know.

From: VAX3::RICK 11-JUN-1983 15:21
To: CVAX::BRIDLE
Subj: New observations

I used my two hours of test time to integrate on the following frequencies: 4885, 4835, 1665, 1515, 1485, and 1435MHz. All were pretty clean except 1435 MHz, which had a lot of sporadic RFI, and one scan which was completely blown away. Thus, I believe we should do the following for tonight:

1) Observe the core at 4885/4835 MHz. No problem here.
2) Observe near the warm spot for 1 hour.
3) Observe the core at 1665/1515 MHz.
4) Observe the S lobe at 1465/1515 MHz.

In all cases, the more important/more reliable frequency is in the A-C channels. I thought that 2 hours on the core at 6cm, and 1.5 hours at each of the 20cm pairs (S lobe and core) plus the 1 hour at the warm spot should do.

I have been mulling over your comment about deferring the 6cm observations. Sounds good to me from an interference point of view. This (meaning tonight) is a night/weekend run, and much less likely to be zapped .

Cancel the above argument which I didn't finish. The long run next week is a midnight run. Nevertheless, given the reliability of the 6cm observations, it makes good sense to test the waters at 20cm now, on a weekend. I'll make up the file at 20cm only, using items 3 and 4 above. I'll split the time equally between the two observations. Any comments?

From: VAX3::RICK 11-JUN-1983 10:04
To: CVAX::BRIDLE
Subj: New observation

O.K. I'm at the site. It turns out that I have test time starting in one hour. I plan to tune to these new frequencies, and integrate for a while. Of course, I'll use NGC6251 as the object to integrate upon. The bug in filler which was ruining all the 4-IF data has now been repaired (turned out that the signs of the real and imaginary parts were being reversed), so I can properly calibrate the 2 hours of test data I took on blank sky a couple nights ago. This will tell us the best (i.e. least noisy) frequencies. I'll select the best (subject to careful reading of your comments from yesterday), and integrate on them for a while, to see if occasion RFI lurks about.

More late. Call the operator to get me.

From: VAX3::RICK 9-JUN-1983 10:13
To: CVAX::BRIDLE
Subj: New obs, and B/D IFs.

The B/D ifs are here, and they seem to operate. I ran a few hours of tests to find optimal frequencies. The best contiguous frequencies are 1465 and 1515 MHz. An alternative good pair are 1435 and 1485MHz. These have the advantage of averaging close to 1465MHz, the old default frequency. We're observing on Sunday, so we need to consider which pairs we would like. At 6cm, virtually any frequency can be chosen. 4885 and 4835MHz seem to work well.

If, on the other hand, we choose to spread our L-band frequencies, I got good results on any frequency except those which overlap 1600MHz (an enormous internal birdie). I am not in favor of this, however, as we have previously selected (for C array) 'median' frequencies. Furthermore, the noise noticeably increases below 1400MHz. So, I think either 1465/1515 or 1435/1485 are the best bets. Any preferences? Note that the B/Ds seem to work, but there are a few bugs left, such as bad samplers, which seem to cause high closure errors on a few correlators. The situation is similar to the A/C situation a few years ago.

There is a serious bug either in Filler or Antsol which is causing amazing errors in Antsol listings. I am convinced, however, that it is a software problem, and not due to the 4 IFs per se. The data looks good.

As part of the Baars et al experiment that Pat Crane and I are taking care of (checking the Baars flux scale), we have gotten a fair amount of data on 3C274. My summer student arrived yesterday, and I decided to use this data to cut his teeth on the VAX. We got an impressive map of the halo. The remarkable thing is the evidence for rotation of the jet as a function of scale size. I'll send a copy of the map over the wire to you.

How's the review coming? Haven't heard from you in a few days.

For the S lobe, we used 1452.4

jet 1664.25

From: VAX3::RICK 12-APR-1983 18:04
To: CVAX::BRIDLE
Subj: RE: Misc. matters

The VLBers do phase the A and C if-s independently, but so long as they use the same antenna for both, and the true A-C phase of that antenna doesn't change, there should be no problem. The potential problem is that the stupid VLB program may take a different reference antenna each time it phases up. It has some criterion by which it decides which antenna is best, and this criterion or criteria does not account for phase jumps. If there were no phase jumps in any antenna, then changing the reference antenna won't hurt the polarization. The danger is in the phase jumps, and as we all know, phase jumps are rather common here. I don't believe there is any record of which antenna was taken as reference, and of course you know that most phase jumps are invisible to the monitoring system. By the way, self-cal also adjust A and C IFs independently, with no deletorious result to polarization.

The only way I can think of to check the behaviour is to list the AC phases for 1803+784. Pat put in three observations of this source for every observation of NGC6251. Fortunately, 1803+784 has quite a respectable polarization. We should be able to learn a lot from this. Keep your fingers crossed.

To bad about the glossies. Will bribes help? Interesting info about Jennison.

From: VAX3::RICK 11-APR-1983 15:11
To: CVAX::BRIDLE
Subj: More N6251 Observations

Barry has tentatively scheduled our D-array N6251 observations for Sunday, June 19. Are you able to come for these observations, too? Given that we all leave for Italy shortly afterward, it seems reasonable to assume that you won't be able to come. I think it is also reasonable to presume tha at that time I'll be frantically working to complete my talk! I notice that you're not listed to give a talk at Bologna. Want some compact source data? Blowing hard today. New storm coming in.

Jet Velocity estimates in NGC6251 March 1983

(a) Steady-State Energy Balance

$$F = \left(u_{int} + \tfrac{1}{2}\rho_j v_j^2\right) v_j . \pi R_j^2 = L_{lobe}/\varepsilon$$

$L \sim 10^{24}$ @ 1480 →
$L_{lobe} = 1.1\times10^{32} \left(\nu_{max}(Hz)\right)^{0.3}$ watts
$\nu_{max} = 10$ GHz

$L_{lobe} \sim 10^{24}$ W/Hz/ster at 1480MHz → 1.1×10^{35} Watts. ←

(H) = 227″ $\Delta RM < 5$ → $n_e < 2\times10^{-4}\,cm^{-3} \equiv 200\,m^{-3}$

$\rho_j < 3.35\times10^{-31}\,kg/cm^3 \equiv 3.35\times10^{-25}\,kg/m^3$

$u_{min} \sim 6\times10^{-13}\,J/m^3$

$u_{min}/c^2 \sim 6.68\times10^{-30}\,kg/m^3$

$R_j \sim 6''.5 \sim 2.8\,kpc \sim 8.6\times10^{19}\,m$

$A = \pi R_j^2 = 2.35\times10^{40}\,m^2$

Hence: $$\left(6\times10^{-13} + \tfrac{1}{2}\times3.35\times10^{-25} v_j^2\right) v_j . 2.35\times10^{40} = \frac{1.1\times10^{35}}{\varepsilon}$$

$$1.28\times10^{-7} v_j + 3.59\times10^{-20} v_j^3 = 1/\varepsilon$$

If:	$\varepsilon = 1$	0.1	0.05	0.04	0.03	0.01	
$v_j =$	2640	6350	8080	8730	9630	14000	km/s

Light jet $\tfrac{1}{2}\rho_j v_j^2 \ll u_{min}$ $v_j \to 7801/\varepsilon$ km/s

Heavy jet $\tfrac{1}{2}\rho_j v_j^2 \gg u_{min}$ $v_j \to \frac{3031}{\sqrt[3]{\varepsilon}} . \left(\frac{3.4\times10^{-25}}{\rho_j(227'')}\right)^{1/3}$ km/s

Ⓗ = 32″ Depol → $n_e < 4\times10^{-3}\ cm^{-3}$

$\rho_j < 6.7\times10^{-30}\ kg/cm^3 \equiv 6.7\times10^{-24}\ kg/m^3$

$U_{min} \sim 5.4\times10^{-12}\ J/m^3$

$R_j \sim 1''75,\ 0.75\ kpc \sim 2.31\times10^{19}\ m$

$A = \pi R_j^2 = 1.69\times10^{39}\ m^2$

Hence $\left(5.4\times10^{-12} + \frac{1}{2}\times6.7\times10^{-24}\,V_j^2\right)V_j\,.\,1.69\times10^{39} = \frac{1.1\times10^{35}}{\varepsilon}$

$$8.28\times10^{-8}\,V_j + 5.14\times10^{-20}\,V_j^3 = 1/\varepsilon$$

If $\varepsilon =$	1.0	0.1	0.04	0.01	
$V_j =$	2490	5710	7,800	12,400	km/s

Light jet $V_j < \frac{12000}{\varepsilon}$ km/s

Heavy jet $V_j \simeq \frac{2690}{\sqrt[3]{\varepsilon}}\left(\frac{6.7\times10^{-24}}{\rho_j}\right)^{1/3}$ km/s

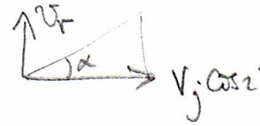
Suppose we accept expansion rate velocity $V_j \sim 8000$ km/s

$\varepsilon \sim 0.04$

$\rho_j \sim 6.7\times10^{-24}$ @ Ⓗ = 32″

$\frac{1}{2}\rho_j V_j^2 = 2.14\times10^{-10}\ J/m^3$ } 39.7 : 1

$U_{min} = 5.4\times10^{-12}\ J/m^3$ }



$\tan\alpha = v_r / V_j \cos i$
$= c_s / M c_s \cos i$

$M = \cot\alpha \sec i$

Method (b). Expansion rate.

If the jet is "free" at $\theta \lesssim 17''$, $M \sim 14 \sec i$ there.

At $\theta = 17''$, from BCH fit, $\frac{\rho_{17}}{\rho_{32}} = \frac{0.25}{0.32} = 0.78$ $\quad \rho_{17} = 5.2\times10^{-24}$ kg/m^3

From equipartition $\theta = 17''$ $\quad u_{min} = 4.4\times10^{-12}$ J/m^3.

p_{min} (using $\times 0.86$ factor) $\rightarrow 1.26\times10^{-12}$

Then $c_s = \sqrt{\frac{\gamma p}{\rho}} = \sqrt{\frac{1.333\times1.26\times10^{-12}}{5.2\times10^{-24}}} = 5.68\times10^5$ m/s

Hence $V_j = M c_s = 14\times5.68\times10^5 \sec i \rightarrow 7.95\times10^6$ m/s $\sec i$

$\rightarrow$ 8000 km/s. $\sec i$

NB BCH fit itself $\rightarrow M_{ed\,no} = 5.4$

V_j = 3000 km/s.

Method (c). Thrust balance

Warm spot in 50" 1446 MHz snapmap
- peak I = 33.3 mJy
$\theta_{obs} = 1'.8 \equiv 108''$
$\theta = \sqrt{108^2 - 50^2} = 96''$ intrinsic

$R_{HS} = 48'' \rightarrow 20.6$ kpc $= 6.35 \times 10^{20}$ m

Assume 0.7 index $\quad \nu \sim 1$ MHz $\rightarrow 1$ GHz (same $\underline{E}$ range as jet) 177 MeV lowest

$B_{eq} \sim 2.6 \times 10^{-6}$

$U_{min} \sim 6.18 \times 10^{-14}$

$$p_{HS} A_{HS} = 0.86 \times \frac{6.18 \times 10^{-14}}{3} \times \pi \times (6.35 \times 10^{20})^2$$

$$= 2.24 \times 10^{28} \text{ Nt}.$$

Momentum flux delivered to lobe is $\rho_j \, \phi^2 v_j^2 . A_j \qquad \phi = \frac{1}{1 + \sqrt{\rho_j / \rho_{IGM}}}$

Ⓗ = 227" parameters $\quad \left.\begin{array}{l}\rho_j = 3.35 \times 10^{-25} \\ A_j = 2.35 \times 10^{40}\end{array}\right\} \quad v_j = 1.69 \times 10^6 \left(\frac{3.35 \times 10^{-25}}{\rho_j}\right)^{1/2} . \frac{1}{\phi}$

Ⓗ = 32" $\quad \left.\begin{array}{l}\rho_j = 6.7 \times 10^{-24} \\ A_j = 1.69 \times 10^{39}\end{array}\right\} \quad v_j = 1.41 \times 10^6 \left(\frac{6.7 \times 10^{-24}}{\rho_j}\right)^{1/2} . \frac{1}{\phi}$

So for $v_j = 8000$ km/s, need $\phi \sim 0.194 \qquad \rho_j \sim 17 \, \rho_{IGM}$ at $\underline{\text{hotspot}}$.

Problem $\rho V R^2$

Method (d)

If it's heavy $\frac{1}{2} \rho_j v_j^3 A_j = \frac{L_{lobe}}{\epsilon}$ for energy balance

$$\rho_j \xi^2 v_j^2 A_j = p_{HS} A_{HS} \qquad \xi = \frac{1}{\sqrt{1+\sqrt{\rho_j/\rho_{IGM}}}}$$

$$v_j = \frac{2 L_{lobe} \xi^2}{p_{HS} A_{HS} \epsilon}$$

$$= \frac{2 \times 1.1 \times 10^{35} \xi^2}{2.24 \times 10^{28} \epsilon}$$

$$\lesssim \frac{9820 \xi^2}{\epsilon} \text{ km/s}.$$

NGC6251 outflow argument

$V_j^3 > \frac{2 L_{lobe} d_{hs}}{\epsilon M_{tot}}$ 1 yr = 3.156×10^7 sec

For M_{tot}, take Faber/Gallagher (ApJ, 204, 365 (1976))

Gas ejection rate from old stars in E galaxy = $0.015\, M_\odot / yr / (10^9 L_\odot)$

Absolute magnitude of NGC6251 $M_{B(0)} = -21.3$ $1.2 \times 10^{12} M_\odot$

Sun +5.48

Hence 26.8 = $2.5 \log(\mathcal{L}/\mathcal{L}_\odot)$ → $5 \times 10^{10} L_\odot$

→ $\sim 0.8\, M_\odot / yr$

$H = 75$ → $\tau_H \sim 1.3 \times 10^{10}$ yrs → $10^{10} M_\odot$ available ~10^{-2} galaxy?

$L_{lobe} = 1.1 \times 10^{35}$ watts $d_{hs} = 16' = 960'' = 412$ kpc $= 1.27 \times 10^{22}$ m

$V_j^3 > \frac{1.1 \times 10^{35} \times 1.27 \times 10^{22} \times 2}{\epsilon \times \frac{1}{2} \times 10^{10} \times 1.989 \times 10^{30}} = \frac{1.41 \times 10^{17}}{\epsilon}$ $V_j = 5.2 \times 10^5 / \sqrt[3]{\epsilon}$ m/s

$= 656 / \sqrt[3]{\epsilon}$ km/s.

For $\epsilon = 0.04$, this gives $V_j > 1640$ km/s $V_j \sim 800$ $\tau \sim 6 \times 10^7$ yrs

$\tau > 3.1 \times 10^8$ yrs

$dm/dt \lessapprox 32\, M_\odot / yr$ (both jets)

Note, could have taken other lobe, $d = 38'$, → $V_j > \sqrt[3]{\frac{38}{16}} \times 520 / \sqrt[3]{\epsilon}$

→ $694 / \sqrt[3]{\epsilon}$ km/s $\times \sqrt[3]{2}$

What's the optimum set of parameters for heavy N6251?

We have various estimates:

1) Energy balance $\Theta = 32''$

$$V_j = \frac{2690}{\sqrt[3]{\varepsilon}} \left(\frac{6.7\times10^{-24}}{\rho(32'')} \right)^{1/3} \text{ km/s}$$

2) Thrust

$$V_j = \frac{1400}{\xi} \left(\frac{6.7\times10^{-24}}{\rho(32'')} \right)^{1/2} \text{ km/s}$$

3) Expansion

$$V_j = 8000 \sec(i) \left(\frac{5.7\times10^{-24}}{\rho(32'')} \right)^{1/2} \text{ km/s}$$

4) Mass Flow

$$V_j \gtrsim \frac{520}{\sqrt[3]{\varepsilon \varepsilon_0}} \left(\frac{5\times10^{9} M_\odot}{M_{tot}} \right)^{1/3} \text{ km/s}$$

To balance energy and thrust we need $\frac{2690}{\sqrt[3]{\varepsilon}} \sim \frac{1400}{\xi}$ roughly

$$\xi^3 \sim 0.14\,\varepsilon.$$

So even for $\varepsilon = 1$, ξ must be $\lesssim 0.52$

This requires $\rho_{jet} \gtrsim 0.9\, \rho_{IGM}$.

To balance thrust and expansion we need

$$8000 \sec(i) = \frac{1400}{\xi}$$

$$\xi = 0.18 \cos(i)$$

This is much harder, and requires $\xi < 0.18$

i.e. $\rho_j > 20 \times \rho_{IGM}$!!

This is a big problem. It means we must have underestimated $p_{HS} A_{HS}$ somehow, if it's in pressure equilibrium. Either the hot spot is far from equipartition, or we have got very bad parameters for it.

As $v_j \sim \sqrt{p_{HS}}$, increasing v_j by a factor 5.7 corresponds to increasing p_{HS} by a factor ~33. This hot spot is ~ 1/33 the pressure we would have expected.

To balance energy budget and expansion

$$\frac{2690}{\sqrt[3]{\varepsilon}} \sim 8000 \sec i$$

$\cos^3 i$ @ 10° = 0.96
20° 0.83

$$\varepsilon \sim 0.04 \cos^3 i$$

This is the constraint we had in the draft paper, with $i = 0^\circ$.

Putting this in mass flow,

$$\frac{656}{0.34 \cos i \sqrt[3]{\varepsilon_0}} \left(\frac{5\times10^9 M_\odot}{M_{tot}} \right)^{1/3} = \frac{8000}{\cos i}$$

$$(0.24)^3 = 1.4\times10^{-2} = \frac{\varepsilon_0 M_{tot}}{5\times10^9 M_\odot}$$

So $\boxed{7.0 \times 10^7 \, M_\odot = \varepsilon_0 M_{tot}.}$ — minimum ejected mass.

$\varepsilon_0 \sim 0.1$?

$M_{tot} \sim$ 3 ~~4~~.5 $\times 10^8 \, M_\odot$. — fuel available.

Things would be much simpler if we had a value for $p_{HS} A_{HS}$ that was $\sim$ 25 × greater.

or if the jet had been decelerated? by a factor of five between the $\theta \sim 227''$ region and the hot spot.

So if the scale is ~ correct, need $f^{4/7} \sim (1/25)$

$f \sim 0.0036$!

i.e. there has to be something much smaller out there containing most of the flux?

Suppose we let $v_j = 8000$ km/s

$\varepsilon = 0.04$

At $\Theta = 32''$ $\quad dm/dt = \rho_j v_j A_j = 6.7\times10^{-24} \times 8\times10^{6} \times 1.69\times10^{39}$

$= 9.06\times10^{22}$ kg/s

$\left(1\, M_\odot/yr = \dfrac{1.989\times10^{30}\,kg}{3.156\times10^{7}\,sec} = 6.30\times10^{22}\,kg/s\right)$ $\quad = 1.44\, M_\odot/yr$

$\Theta = 227''$ $\quad = 3.35\times10^{-25} \times 8\times10^{6} \times 2.35\times10^{40}$

$= 1.00\, M_\odot/yr.$

Suppose we set ~~$\rho_I V_I^2$~~ $\rho_{IEM} V_{HS}^2 \sim p_{HS}$

$$\rho_{IEM} \sim 10^{-26}\ \mathrm{kg/m^3}$$

$$p_{HS} \sim \frac{0.86 \times 6.18 \times 10^{-14}}{3} = 1.77 \times 10^{-14}$$

then $V_{HS}^2 = 1.8 \times 10^{12}$

$V_{HS} = 1.3 \times 10^{6}$, or 1300 km/s.

So there is no difficulty providing ram pressure for confinement at <u>this</u> density.

Synchrotron scales.

Inner jet $B \sim 25\ \mu$gauss $5\,\text{GHz} \rightarrow 3.5\times10^{9}\,\text{eV}$ $\tau_{synch} \sim 3.79\times10^{6}$ yrs.

At 8000 km/s, τ_{synch} is 9.57×10^{20} metres

$\sim 3.1\times10^{4}$ pc $=$ 31 kpc $=$ $\underline{\underline{72''}}$

Outer jet $B \sim 7\ \mu$gauss 5GHz $\tau_{synch} \sim 2.56\times10^{7}$ yrs.

At 8000 km/s, $\rightarrow 6.46\times10^{21}$ metres

$\rightarrow 2.1\times10^{5}$ pc

$\rightarrow 488''$.

Therefore not surprising that we see no spectral gradients, as even if all 5GHz particles had been generated at (h) ~10″ ~~the origin~~, we could transport them out at 8000km/s slightly faster than we age them due to synchrotron losses.

Deflection of NGC6251 jet.

What angle does it deflect through?

Radius of curvature from the WSRT map is ~ 10′ ~ 600″

~ 257 kpc

$r_c = 257 \times 3.08 \times 10^{19}$ m.

$$v_j = \left(\sqrt{\frac{\rho_{IGM}}{\rho_j}\frac{r_c}{h}}\right) v_g$$

Inside the 30 kpc scale ISM r_c = large! (jet straight)

Outside. $h \sim d_{jet} \sim 16''$

$$v_j = v_g \sqrt{\frac{\rho_{IGM}}{\rho_j} \cdot \frac{600}{16}} \sim 6 v_g \sqrt{\frac{\rho_{IGM}}{\rho_j}}$$

Using our estimates, we have $\rho_{IGM}/\rho_j \sim 3$? $\therefore$ $v_j \sim 10 v_g$

Don't know v_g, but unlikely to be >> 1000 km.s^{-1}

$v_j \sim 10{,}000$?

If we used h ~ jet diameter at hot spot. $h = 96''$

$$v_j = v_g \sqrt{\frac{\rho_{IGM}}{\rho_j} \cdot \frac{600}{96}} = 2.5 \sqrt{\frac{\rho_{IGM}}{\rho_j}} v_g$$

4 Nov 83

Re your comments on the power spectra:

Indeed the angle data generally give better spectra (in terms of significant peaks) than the deflection data. This is an important point, as it means that the deflections ARE growing with distance from the core, in general.

When estimating significance, it is important to compare spectra at the same resolution. The only spectra whose significance should be judged from the Gaussian-noise spectrum at the front of the ones I sent you are the 256-resolution spectra. The reason why the 0.19 r.u. peak in the first spectrum looked puny is because that was a 128-resolution spectrum. It looks o.k. compared with the noise spectrum at its resolution (which, of course, I didn't send you !).

I don't know what to make of the broader peaks. They usually resolve at higher resolution into numbers of smaller peaks. I tend to think we should look at the peak excursions from the LOCAL MEAN LEVEL in the power spectrum, in which case these broad peaks are not as significant. Certainly they correspond to "things" in the spectra, whether real oscillations or not, which are not simple harmonic in the way that naive Kelvin-Helmholtz modes would be. I have therefore focused more on the "sharp" peaks so far.

The coming and going of peaks as we vary the distance range is not surprising - I could pick some small distance ranges out of the data and really blow up individual spectral peaks - e.g. the 31" oscillation at the beginning of the "outer" jet. In general I feel happier about spectra which exclude the angle data from the first 10" or so from the core, where we have those very rapid oscillations that decay away. These are obtained by dividing very small deviations by very small distances, and I am suspicious about their reality. Pity we can't carry the errors in individual points through the power spectrum analysis. I do feel the spectra with the close-in angle data excluded are more trustworthy, though.

The "averaged angle" plots are from data where I first plotted all of our results at different resolutions on the same scale (as in the Figures for the paper), then drew an "average" curve through by eye. That curve was then read off every 2" along the jet to get the data whose power spectra were shown. This is o.k. over a limited range of distances from the core - otherwise the effective resolution of the data varies somewhat even though its angular spacing doesn't.

I'll do some more quantitative things regarding statistical significance, then get back to you with revised text and some more power spectrum examples.

I'm starting to revise the Discussion section now. One of the first things I looked at is whether the Chan-Henriksen model we fitted should in fact have "detached" from the confining pressure according to Bob Sanders' criterion. According to his power-law expression it should have done, but according to the detailed criterion (local expansion velocity becoming locally supersonic) it shouldn't. I think the difference lies in the fact that his criterion as given in his paper is in fact only ASYMPTOTICALLY correct. In the 'real' jet, the external pressure changes before the jet has had TIME (distance from the core) enough to detach. I am therefore happier about our use of the CH model than I was when I talked to you from Queen's, but will look into this some more. What is clear is that if the nozzle was somewhat lower than we have modelled it, the jet might have detached sooner, and thereby set up the situation where it became free by the time we hit it with the "halo" pressure - generating the reconfinement shocks that Bob's paper was basically about. More to follow as I think it through and do a small number of further sums.

I got a letter from Jean-Luc Nieto with preprints of his NGC6251 paper, which has been rejected once. His pictures certainly don't show very much in the form he sent them to me, but he says he has some more observing time coming up soon, and we will keep in contact.

More ski holidays, eh ? Enjoy it while you can !

From: VAX3::RICK 3-FEB-1983 16:00
To: CVAX::BRIDLE
Subj: n6251

I have received your message, and am about to print the new version. I have looked over the deflection spectra and must confess that I'm a little worried about the changes in the significance of the peaks. For example, in the second plot (1.3" data, all distances), do we consider the broad peaks at 0.33 and 0.45 reciprocal units significant? They (especially the former) are almost as significant as the marked peak at 0.19 units (5.8"). Furthermo comparing to the Gaussian noise plot above, none of the peaks seems big enoug Use of 256 resolution does seem to help, though as the next plot (#3) does seem to enhance the "proper" peak at 0.19 r.u. (reciprocal units). Looking through the remaining plots, I notice that the last three (all at 2" separation) show interesting differences. The second of these shows a semi-significant peak at 0.32 r.u. This peak also shows up in the first of these three plots, although at a lower level. However, the last of these plots has no trace of said peak - in fact, there's an enormously deep trough! It seems that restriction of the range has made a great difference. This last plot is by far the most convincing in terms of the significance of the various peaks we have previously identified. By "averaged angle", do you mean that the points are averages of nearby measured values?

It seems to me that the angle data gives a better spectrum than the deflection data.

To Rick 5 Feb 83

Some further power spectrum thoughts -

I tried a set of different Gaussian random number streams, each 100 points long, with the power spectrum analysis program at 256 resolution. All of them gave basically similar "phoney peak" statistics. Features of width several channels and peak amplitude five or more times the average of surrounding channels cropped up about five times per spectrum. Similar features with peak amplitude seven or more times the average of surrounding channels cropped up once per spectrum. We could therefore be pretty sure of anything that was as much as eight or nine times the surroundings, very sure of anything ten times the surroundings. I'll go through my individual 6251 spectra now and see which ones survive the test.

They're forecasting snow here now. We shall see.

TEST

Name .... (SURNAME FIRST) Book No. .... of .... Books

Subject .... Section ....

NGC6251 X-ray luminosity [from Bill Ku's 22,000^s of Einstein IPC data]

$z = 0.023$, $H_0 = 75$ km/s/Mpc → $D = 92.4$ Mpc $= 92.4 \times 10^6 \times 3.0856 \times 10^{18}$ cm $= 2.853 \times 10^{26}$ cm

"Nuclear" X-ray source is 1.4×10^{-12} erg/cm²/sec [0.5 – 4.5 keV] – IPC.

$$L_X = 1.4 \times 10^{-12} \times 4\pi \times [2.853 \times 10^{26}]^2$$

$$= 1.4 \times 10^{42} \text{ erg/s.}$$

Halo is $\lesssim 15\%$ $= 2.1 \times 10^{41}$ erg/s. (~5′ radius), i.e. ~ 154 kpc radius.

Minimum jet pressure $= 0.86\, p_{eq}$, hence $n_{min} = 0.86\, n_{eq}$ for confinement, given T
$L_{min} = 0.74\, L_{eq}$ - - - - - - - -

Taking our old "halo" values $T = 4 \times 10^7$ K
L_X was 2.0×10^{42} → 1.5×10^{42} erg/s.
within 50 kpc (116")

Angular resolution of IPC is: ~~93" for 0.5~~ - 4.5 keV , i.e. 42 kpc.

Hence their "nuclear source" is our core + some halo.

Q. How much of our halo is well inside IPC "beam" ?

cf M87 ~ 1.5×10^{43} erg/sec

Table 4

0.5-4keV luminosity and mass of media required to confine NGC6251 jet

		Assumed isothermal temperature			
		4×10^7K	2×10^7K	10^7K	
"HALO"	Lx	2.0×10^{42}	6.7×10^{42}	1.6×10^{43}	erg/s
	M	1.8×10^{11}	3.6×10^{11}	7.1×10^{11}	$M_\odot$
"CORE"	Lx	7.0×10^{43}	2.3×10^{44}	5.6×10^{44}	erg/s
	M	1.9×10^9	3.8×10^9	7.6×10^9	$M_\odot$

90% of the predicted X-ray luminosity would originate within 50 kpc of the center of NGC6251 for the "halo" component, and within 1 kpc for the "core" component

Divide luminosities by 1.352

M87 ~ 1.5×10^{43}

Table 5

Parameters of field models fitted to transverse intensity and polarization profiles (see figure 30)

	$\Theta = 32''$	$\Theta = 227''$
Field Pitch angle ψ_R	48°	14°
Inclination of jet to sky	5°	40°
Random field magnitude	$0.75\,B_0$	$0.35\,B_0$
Relativistic particle distribution (density)	Uniform	Gaussian $\sigma = 0.94R$
Relativistic particle distribution (pitchangle)	Isotropic	Isotropic

Mass in the basic RM medium.

$\Delta RM \sim 70 \text{ rad/m}^2$ across $L \sim 70'' \sim 30 \text{ kpc}$.

So: $RM = 8.1\times10^5 \times \bar{n}_e \times 10^{-6} B_{-6} \times 30 \times 1000$

$\bar{n}_e = 0.00288 \text{ cm}^{-3}$

$\bar{\rho}_e = \bar{n}_e m_p \sim 4.818\times10^{-24} \text{ kg/m}^3$

$$M = \frac{4}{3}\pi\bar{\rho}_e R^3$$

$$= \frac{4}{3}\times\pi\times 4.818\times10^{-24} \times (3\times10^4 \times 3.0857\times10^{16})^3$$

$$= \frac{1.60\times10^{40}}{B_{-6}} \text{ kg}$$

$$= \frac{8.0\times10^9 M_\odot}{B_{-6}}$$

27 September 1982

Check Rick's ΔRM limit to n_e.

Take $\Theta \sim 240''$ $\quad \Delta RM < 5$ rad/m^2

$B_{eq} \sim 9\times10^{-6}$ gauss

$\Phi \sim .14' \sim 6000$ pc

$$RM = 8.1\times10^5\, n_e(\mathrm{cm}^{-3})\, B(\mathrm{gauss})\, L_{pc} \quad \mathrm{rad/m^2}$$

$$n_e < \frac{5}{8.1\times10^5 \times 9\times10^{-6} \times 6000} < 1.1\times10^{-4}\ \mathrm{cm}^{-3} \quad ✓.$$

If $B_{\parallel} \sim B_{\perp} \sim B_{eq}$!

Try actual CH config.^{n}? $\quad \Theta = 227''$

From the CH fit, FWHM of convolved jet $= 42.4 + 27.7 = 70.1$ units

normalisation of compute units is $\frac{1}{70.1} \times 13''.4 \times 0.429$ kpc

$= 0.082$ kpc/cell $= 82$ pc/cell

Now put $B_{eq} \sim \sqrt{\overline{B}_{CH}^2 + B_{rand}^2} \sim \sqrt{(\tfrac{1}{2}B_0)^2 + (0.35 B_0)^2}$

$= 0.61 B_0 = 9\times10^{-6}$ gauss

$B_0 = 14.7\times10^{-6}$ gauss.

Hence $ROT = 8.1\times10^5\, n_e(\mathrm{cm}^{-3}) \times 0.04 \times 14.7\times10^{-6} \times 82$

$= 39.05\, n_e$

$ROT = 0.0075 \equiv \underline{1.9\times10^{-4}}\ \mathrm{cm}^{-3}$

Out at $\theta \sim 227$

$n_e T \sim 2 \times 10^3$ [from the pressure curve fit to confinement]

$T \sim 3 \times 10^{-7}$ ~ $n_e \sim \frac{2}{3} \times 10^{-4}$

$\sim 6 \times 10^{-5}\ cm^{-3}$ [we used this for $\Theta = 240''$]

Rick's fared. est is $< 1.4 \times 10^{-4}\ cm^{-3}$. [ok] ✓

From the equipartition sum, $n_e T \sim 1 \times 10^4$ between in/the knots; ~2 higher within them ?

→ $n_e \sim 3 \times 10^{-4}\ cm^{-3}$

Correct to minimum from the "min. pres. cylinder" calculation [Owen/Burns]?

19 Aug 1982

Analysis of JETTX output on "NGC6251" $\Theta = 32^{\circ}$.

The parameter we specify is ROT

FARAD = ROT * NCO * BPARL * W / COS I (radians).

i.e. it is the Faraday depth of a cell 1 unit thick

$n_e = n_e(\max)$

$B = B_R$ (max at edge of jet)

All Faraday depths then scale to this.

$ROT = 8.1 \times 10^5 \; n_e(\mathrm{cm}^{-3}) \; \lambda^2_{\mathrm{metres}} \; B(\mathrm{gauss})$ [Lengths along l.o.s. in pc]

Cellwidth $W = 4R/(2NL - 1)$ Now NL = 1301

$R = 60$

$W = 0.0922$ 1301 of them → total depth of 120 ✓

Now from the CH fit, FWHM of convolved jet = 47 + 49 = 96 units

i.e. the normalisation here is that compute units are $\frac{1}{96} \times 3.75 \times 0.429$ kpc

$= 0.01676$ kpc

$= 16.76$ pc

Now put $B_{eq} \sim \sqrt{B_{CH}^2 + B_{rand}^2} = \sqrt{\left(\frac{1}{2}B_0\right)^2 + \left(0.75\,B_0\right)^2}$

$= 0.90\,B_0$

$B_{eq} = 2.4 \times 10^{-5}$ gauss

$B_0 = 2.67 \times 10^{-5}$ gauss.

Then here $ROT = 8.1\times10^{5}\ n_e(cm^{-3}) \times 0.04 \times 2.67\times10^{-5} \times 16.76$

$= 14.5\ n_e$.

Hence $ROT = 0.02$ $n_e = 1.38\times10^{-3}\ cm^{-3}$ 37% → 10% over profile

ΔPA 23° → −17° = 40°

= 0.04 $2.75\times10^{-3}\ cm^{-3}$ 37% → 1%

ΔPA 28° −34° 61°

[begining of the first bounce]

= 0.06 $4.13\times10^{-3}\ cm^{-3}$ 32% → 7%

ΔPA 57° −66° 123° !

[well-developed bounce]

= 0.10 $6.89\times10^{-3}\ cm^{-3}$ All < 20%

This is not seen ΔPA +70°, −90° noisy 160°!!

If we had used Cioffi & Jones (1980) we would have concluded that for $D > 0.8$ we would need $f_c \lesssim 2.6$

i.e., in their units $2fR < 2.6$

$$f = 1600\, n_e B \lambda^2 \ \text{rad/m}^2/\text{kpc}$$

i.e. $1600\, n_e B \lambda^2 . (1.61) < 2.6$

$$n_e < \frac{2.6}{1.61} \times \frac{}{24 \times 0.04} \times \frac{1}{1600}$$

$$< 1.1 \times 10^{-3}\ \text{cm}^{-3}$$

Suppose we had done it from the slab model as for NGC315 in Willis et al. (1981).

$$D \sim \frac{\lambda_2^2}{\lambda_1^2} \frac{\sin(RM\lambda_1^2)}{\sin(RM\lambda_2^2)}$$

$$RM = 8.1\times10^5 \; n_e(\mathrm{cm}^{-3})\; B(\mathrm{gauss})\; L\text{-pc} \quad \mathrm{rad/m^2}$$

We want $D > 0.8$ (say).

$\lambda_2 = 6\,\mathrm{cm}$
$\lambda_1 = 20\,\mathrm{cm}$

$$D = 9\times10^{-2} \frac{\sin(RM\lambda_1^2)}{\sin(RM\lambda_2^2)}$$

If RM $= 8.1\times10^5 \, n_e \times \frac{2.4\times10^{-5}}{\sqrt{3}} \times 1610 = 1.81\times10^4 \, n_e\,(\mathrm{cm}^{-3})$

Then $n_e = 10^{-4} \rightarrow RM = 1.81$ $\quad D = 1.00$

$n_e = 10^{-3} \rightarrow RM = 18.1$ $\quad D = 0.92$ ✓

So we would have concluded that $D \gtrsim 0.8$ needs $n_e > 1.6\times10^{-3}$?.
RM = 28.4

This would be ~ [illegible]x less than we got from the randomized CH sum.

If we used $n_e = 4\times10^{-3}\,\mathrm{cm}^{-3}$ here, we would get RM = 125.2

D = 0.2 !!

Conclude from these simulations that $n_e(32'') \lesssim 4 \times 10^{-3}$ cm^{-3}

We used $n(240'') = 6 \times 10^{-5}$

$\rightarrow n(32'') = 26.5 \times 6 \times 10^{-5}$ from BCH ratios

$= 1.6 \times 10^{-3}$ ✓

∴ we are OK for Hardee.

cf. Slab approach $n < 1.6 \times 10^{-3}$

Cioffi/Jones $n < 1.1 \times 10^{-3}$

NGC 6251 "1.″30 resolution" 1662 MHz

D = 92.4 Mpc
$\alpha = 0.7$
10 MHz → 10 GHz

VAX - fitted slice parms

(×0.86 → min p)

SLICE	θ (″)	I_{max} (mJy)	Φ (″)	Φ_0	Δ (″)		B_{eq} (μgauss)	U_{min} ($J m^{-3}$)	nT_{eq} ($m^{-3} K$)
1	0	419	1.413 ± .04		-0.0004				
2	1.1	61.7	1.429 ± .05		-0.0028				
3	2.2	3.089	1.510 ± .33		-0.036				
4	3.3	2.83	1.384 ± .32		-0.073				
5	4.4	3.21	1.43 ± .29		-0.173				
6	5.5	4.50	1.47 ± .17	(0.69)	-0.128				
7	6.6	3.49	1.58 ± .22	0.90	-0.111				
8	7.7	1.67	1.63 ± .52	0.98	-0.266				
9	8.8	1.02	1.68 ± .77	1.06	-0.408	27.3 ←	24.3	5.5×10^{-12}	1.4×10
10	9.9	1.55	2.04 ± .59	1.57	-0.414		24.5	5.6×10^{-12}	1.4×10
11	11.0	2.34	1.88 ± .41	1.36	-0.383		28.7	7.7×10^{-12}	1.9×10
12	12.1	2.93	1.99 ± .36	1.51	-0.415				
13	13.2	3.32	2.39 ± .35	2.01	-0.256		28.4	7.5×10^{-12}	1.9×10
14	14.3	3.13	2.31 ± .30	1.91	-0.359				
15	15.4	2.51	2.42 ± .37	2.04	-0.265				
16	16.5	1.84	3.14 ± .66	2.86	-0.217		21.7	4.4×10^{-12}	1.1×10
17	17.6	2.69	3.30	3.03	-0.087				
18	18.7	3.19	3.58	3.34	-0.335				
19	19.8	3.39	3.37	3.11	-0.292				
20	20.9	3.13	3.16	2.88	-0.489				
21	22.0	3.42	3.10	2.81	-0.402				
22	23.1	3.83	3.32	3.05	-0.295				
23	24.2	3.94	3.20	2.92	-0.168				
24	25.3	3.98	3.08	2.79	-0.189				
25	26.4	4.03	3.05	2.76	-0.290		27.4	7.0×10^{-12}	1.8×10
26	27.5	3.31	3.16	2.88	-0.328				
27	28.6	2.55	3.39	3.13	-0.484				
28	29.7	2.30	4.27	4.07	-0.234				
29	30.8	2.72	3.82	3.59	-0.259				
30	31.9	3.18	3.69	3.45	-0.250		24.0	5.4×10^{-12}	1.4×10
31	33.0	2.70	3.66	3.42	-0.304				
32	34.1	1.93	4.30	4.10	-0.263				
33	35.2	2.10	4.09	3.88	-0.190				
34	36.3	1.97	4.41	4.21	-0.504				
35	37.4	1.67	4.09	3.88	-0.533				
36	38.5	1.10	5.02	4.85	-0.998		16.1	2.4×10^{-12}	6.1×10^{10}
37	39.6	0.978	4.23	4.03	-0.977				
38	40.7	1.16	4.63	4.44	-0.539				
39	41.8	1.15	5.35	5.19	-0.701				
40	42.9	1.11	4.75	4.57	-0.625				
41	44.0	1.02	4.53	4.34	-0.922				
42	45.1	1.38	5.03	4.86	-0.478				
43	46.2	1.64	4.79	4.61	-0.408				
44	47.3	1.65	5.05	4.89	-0.361				
45	48.4	2.56	4.56	4.37	-0.276				
46	49.5	3.05	4.41	4.21	-0.229		22.4	4.7×10^{-12}	1.2×10
47	50.6	2.34	4.84	4.66	-0.148				
48	51.7	1.75	5.39	5.23	-0.229				
49	52.8	1.29	5.46	5.30	-0.372				
50	53.9	1.18	4.95	4.78	-0.697				

NATIONAL 42-384

1"3

	θ(")	I_{max}	Φ"	$Φ_0$	Δ(")	B_{eq}	u_{min}	nT
51	55.0	1.04	4.61	4.42	-0.821			
52	56.1	1.07	4.03	3.81	-0.823			
53	57.2	0.889	4.11	3.90	-0.724	16.1	2.4×10^{-12}	6.1×10
54	58.3	0.387	2.01		+0.841			
55	59.4	0.709	6.95	6.83	-0.541			
56	60.5	1.01	5.47	5.31	-0.614			
57	61.6	0.936	5.10	4.93	-0.815			
58	62.7	1.01	4.88	4.70	-0.978			
59	63.8	1.14	4.50	4.31	-1.043	16.8	2.6×10^{-12}	6.7×10
60	64.9	1.13	5.19	5.02	-0.914			
61	66.0	0.904	7.02	6.90	-1.067			
62	67.1	0.860	4.95	4.78	-1.700			
63	68.2	1.086	5.44	5.28	-1.247			
64	69.3	1.29	5.30	5.14	-1.459			
65	70.4	1.56	4.85	4.67	-1.436			
66	71.5	1.67	4.41	4.21	-1.247	18.9	3.3×10^{-12}	8.4×10
67	72.6	1.61	4.17	3.96	-1.385			
68	73.7	1.61	4.43	4.23	-1.429			
69	74.8	1.51	4.26	4.06	-0.875			
70	75.9	1.52	4.02	3.80	-1.148			
71	77.0	1.55	4.22	4.01	-1.380			
72	78.1	1.20	6.65	6.52	-1.173			
73	79.2	1.14	5.64	5.49	-1.316			
74	80.3	1.09	5.38	5.22	-0.753	15.7	2.3×10^{-12}	5.8×10
75	81.4	0.981	5.70	5.55	-0.876			
76	82.5	1.28	5.55	5.40	-0.869			
77	83.6	1.71	4.70	4.52	-0.990			
78	84.7	2.04	4.78	4.60	-0.784	19.5	3.5×10^{-12}	9.0×10
79	85.8	1.85	4.93	4.76	-0.398			
80	86.9	1.86	4.56	4.37	-0.370			
81	88.0	1.65	5.00	4.83	-0.352			
82	89.1	1.32	5.19	5.02	-0.474			
83	90.2	1.15	5.36	5.20	-1.110			
84	91.3	1.18	5.68	5.53	-1.644			
85	92.4	1.02	6.07	5.93	-1.513			
86	93.5	0.945	6.01	5.87	-1.574			
87	94.6	0.860	7.19	7.07	-0.662	13.5	1.7×10^{-12}	4.3×10
88	95.7	0.905	7.22	7.10	-1.041			
89	96.8	1.086	6.13	5.99	-0.605			
90	97.9	1.050	6.21	6.07	-0.056			
91	99.0	1.241	5.99	5.85	-0.097			
92	100.1	1.49	5.67	5.52	-0.122	16.9	2.7×10^{-12}	6.8×10
93	101.2	1.37	5.23	5.07	-0.321			
94	102.3	1.04	6.16	6.02	-0.777			
95	103.4	0.905	6.72	6.59	-0.656			
96	104.5	0.913	6.78	6.65	-0.299			
97	105.6	0.790	7.33	7.21	-0.411			
98	106.7	0.888	6.57	6.44	-0.396			
99	107.8	0.980	6.11	5.97	-0.201			

NGC6251 1662 MHz 2.″11 resolⁿ..

SLICE	θ″	I_{max}^{mJy}	Φ″	$Φ_0$	equiv $I_{1.3}$	Δ″
1	0	432				
2	1.5	111.5				−0.0022
3	3	6.74				−0.0428
4	4.5	5.87	2.24	0.75	2.23	−0.138
5	6	6.78	2.31	0.94	2.57	−0.132
6	7.5	3.75	2.38	1.10	1.42	−0.208
7	9	2.29	2.47	1.28	0.87	−0.358
8	10.5	3.66	2.61	1.36	1.39	−0.401
9	12	5.54	2.75	1.76	2.10	−0.370
10	13.5	6.33	3.07	2.23	2.40	−0.290
11	15	5.68	2.99	2.12	2.16	−0.296
12	16.5	4.72	3.46	2.74	1.79	−0.175
13	18	6.64	3.89	3.27	2.52	−0.239
14	19.5	7.72	3.83	3.20	2.93	−0.320
15	21	7.38	3.60	2.92	2.80	−0.398
16	22.5	8.17	3.64	2.97	3.10	−0.324
17	24	8.84	3.68	3.02	3.36	−0.227
18	25.5	9.03	3.62	2.94	3.43	−0.200
19	27	8.21	3.56	2.87	3.12	−0.311
20	28.5	6.12	3.89	3.27	2.32	−0.438
21	30	6.03	4.17	3.60	2.29	−0.342
22	31.5	7.09	3.94	3.33	2.69	−0.247
23	33	6.11	4.15	3.57	2.32	−0.250
24	34.5	4.92	4.49	3.96	1.87	−0.303
25	36	4.70	4.47	3.94	1.78	−0.428
26	37.5	3.69	4.68	4.18	1.40	−0.560
27	39	2.48	5.44	5.01	0.94	−0.874
28	40.5	2.60	5.21	4.76	0.99	−0.848
29	42	2.82	5.30	4.86	1.07	−0.631
30	43.5	2.66	5.08	4.62	1.01	−0.665
31	45	3.21	5.41	4.98	1.22	−0.648
32	46.5	4.10	5.19	4.74	1.56	−0.469
33	48	5.36	4.97	4.50	2.03	−0.306
34	49.5	6.52	4.86	4.38	2.48	−0.083
35	51.0	5.27	5.14	4.69	2.00	−0.194
36	52.5	3.55	5.68	5.27	1.35	−0.291
37	54	2.71	5.57	5.15	1.03	−0.624
38	55.5	2.56	4.52	(4.00)		−0.958
39	57	2.17	4.64	(4.13)		−0.841
40	58.5	1.78	6.24	5.87	0.68	−0.611
41	60	2.22	5.80	5.40	0.84	−0.485
42	61.5	2.30	5.45	5.02	0.87	−0.782
43	63	2.53	4.86	4.38	0.96	−0.985
44	64.5	2.76	5.12	4.67	1.05	−1.045
45	66	2.27	6.54	(6.19)	0.86	−1.124
46	67.5	2.27	5.76	5.36	0.86	−1.426
47	69.0	3.26	5.26	4.82	1.24	−1.503
48	70.5	3.81	5.13	(5.68)	1.45	−1.383
49	72	3.91	5.04	4.58	1.48	−1.339
50	73.5	3.78	4.98	4.51	1.44	−1.373

2".11 cont'd

#	θ"	I_{max}	Φ'	$Φ_0$	$I^{equiv}_{1.3}$	Δ"		B_{eq}	U_{min}	nT
51	75	3.73	4.48	3.95	1.42	-1.082				
52	76.5	3.68	4.60	4.09	1.40	-1.216				
53	78	3.17	6.32	5.95	1.20	-1.228				
54	79.5	2.88	6.07	5.69	1.09	-1.104				
55	81	2.59	5.67	5.26	0.98	-0.942				
56	82.5	3.24	5.62	5.21	1.23	-1.034				
57	84	4.31	5.20	4.75	1.64	-0.840				
58	85.5	4.66	5.15	4.70	1.77	-0.517				
59	87	4.26	5.20	4.75	1.62	-0.381				
60	88.5	3.59	5.56	5.14	1.36	-0.409				
61	90	2.84	6.01	5.63	1.08	-0.818				
62	91.5	2.75	6.39	6.03	1.04	-1.383		14.9	2.1×10^{-12}	5.2×10[illegible]
63	93	2.58	6.39	6.03	0.98	-1.334				
64	94.5	2.21	7.16	6.81	0.84	-0.941				
65	96	2.46	7.31	7.00	0.93	-0.882				
66	97.5	2.75	6.89	6.56	1.04	-0.482				
67	99	3.24	6.26	5.89	1.23	-0.173				
68	100.5	3.52	5.95	5.56	1.34	-0.277				
69	102	2.77	6.22	5.85	1.05	-0.614				
70	103.5	2.44	7.05	6.72	0.93	-0.511				
71	105	2.33	7.29	6.98	0.88	-0.379		13.6	1.7×10^{-12}	4.4×10[illegible]
72	106.5	2.33	7.08	6.76	0.88	-0.447				
73	108	2.68	6.40	6.04	1.02	-0.432				
74	109.5	3.16	6.23	5.86	1.20	-0.538				
75	111	2.81	7.06	6.74	1.07	-0.687				
76	112.5	2.38	7.72	7.43	0.90	-0.521		13.5	1.7×10^{-12}	4.3×10[illegible]
77	114	2.58	7.66	7.36	0.98	+0.211				
78	115.5	2.11	8.64	8.38	0.80	+0.301		12.6		
79	117	1.73	9.56	9.32	0.66	0.464		11.5	1.2×10^{-12}	3.1×10[illegible]
80	118.5	1.61	8.71	8.45	0.61	0.397				
81	120.0	1.53	8.86	8.61	0.58	0.508				
82	121.5	1.33	9.64	9.41	0.50	0.420		10.6	1.1×10^{-12}	2.7×10[illegible]
83	123	1.13	13.29	(13.12)	0.43	0.307				
84	124.5	1.17	15.07	(14.92)		0.474				
85	126	1.13	11.81	11.62	0.43	0.144		10.0	9.4×10^{-13}	2.4×10[illegible]
86	127.5	0.962	12.67	12.49	0.37	0.167		8.95	7.5×10^{-13}	1.9×10[illegible]
87	129	0.85	14.38	14.22	0.32	-0.346		8.33	6.5×10^{-13}	1.6×10[illegible]
88	130.5	0.987	14.24	14.08	0.37	0.177				
89	132	0.985	13.17	13.0	0.37	0.678		8.91	7.4×10^{-13}	
90	133.5	0.901	12.83	12.66	0.34	0.702				

NGC6251 "4".39 resolution" 1662 MHz

Cellsize = [illegible] 3".5

SLICE	Θ(")	I_{max} (mJy)	Φ(")	~~4.75 $Φ_0$~~	4.39 $Φ_0$	Δ(")	$I_{1.3}$ equiv	Beq μgauss	u_{min} J m^{-3}	nT m^{-3}K
1	0	4319	4.75	~~0.00~~	1.81	-0.00078				
2	3.5	85.1	4.78	~~0.53~~	1.89	-0.0199				
3	7.0	10.0	4.84	~~0.93~~	2.04	-0.189				
4	10.5	9.07	5.08	~~1.80~~	2.56	-0.363				
5	14	14.1	5.36	~~2.48~~	3.08	-0.320				
6	17.5	17.4	5.57	~~2.90~~	3.43	-0.241				
7	21	22.1	5.51	~~2.79~~	3.33	-0.320				
8	24.5	24.3	5.53	~~2.83~~	3.36	-0.270				
9	28	20.5	5.62	~~2.99~~	3.51	-0.316				
10	31.5	18.9	5.83	~~3.37~~	3.84	-0.243				
11	35	15.2	6.09	~~3.81~~	4.22	-0.346				
12	38.5	10.1	6.34	~~4.20~~	4.57	-0.604				
13	42	8.66	6.54	~~4.50~~	4.85	-0.697				
14	45.5	12.02	6.60	~~4.58~~	4.93	-0.532				
15	49	18.1	6.45	~~4.38~~	4.73	-0.252	1.59			
16	52.5	13.1	6.75	~~4.80~~	5.13	-0.314	1.15			
17	56	7.53	6.42	~~4.32~~	4.68	-0.705	0.660			
18	59.5	6.63	6.90	~~5.00~~	5.32	-0.568	0.581			
19	63	7.72	6.41	~~4.30~~	4.67	-0.921	0.677			
20	66.5	8.03	6.78	~~4.84~~	5.17	-1.205	0.704			
21	70	11.10	6.46	~~4.38~~	4.74	-1.369	0.973			
22	73.5	11.8	6.26	~~4.08~~	4.46	-1.211	1.04			
23	77	10.9	6.59	~~4.87~~	4.91	-1.133	0.956			
24	80.5	10.0	7.07	~~5.24~~	5.54	-0.953	0.877			
25	84	13.2	6.59	~~4.57~~	4.91	-0.732	1.16			
26	87.5	13.1	6.80	~~4.87~~	5.19	-0.481	1.15			
27	91	9.58	7.45	~~5.74~~	6.02	-0.977	0.840			
28	94.5	8.51	7.71	~~6.07~~	6.34	-0.988	0.746			
29	98	10.2	7.48	~~5.78~~	6.06	-0.434	0.894			
30	101.5	10.3	7.31	~~5.86~~	5.84	-0.390	0.903			
31	105	8.50	7.90	~~6.31~~	6.57	-0.477	0.745			
32	108.5	9.61	7.47	~~5.77~~	6.04	-0.464	0.843			
33	112	9.42	8.04	~~6.49~~	6.74	-0.405	0.826			
34	115.5	7.75	8.65	~~7.23~~	7.45	+0.224	0.680			
35	119	5.79	9.27	~~7.96~~	8.16	0.344	0.508			
36	122.5	4.82	10.03	~~8.83~~	9.02	0.118	0.423			
37	126	4.05	10.36	~~9.21~~	9.38	0.110	0.355			
38	129.5	3.39	10.54	~~9.41~~	9.58	0.343	0.297			
39	133	3.38	10.65	~~9.53~~	9.7	0.946	0.296			
40	136.5	3.71	11.77	~~10.77~~	10.92	0.927	0.325			
41	140	5.05	9.83	~~8.61~~	8.8	-0.0006	0.443			
42	143.5	5.07	9.12	~~7.79~~	7.99	-0.159	0.445	9.07	7.68×10^{-13}	$1.94\times10^{4?}$
43	147	3.96	10.29	~~9.13~~	9.31	-0.103	0.347			
44	150.5	3.14	10.85	~~9.75~~	9.92	+0.191	0.275			
45	154	2.62	10.64	~~9.52~~	9.69	+0.393	0.230			
46	157.5	2.68	11.38	~~10.34~~	10.50	+0.338	0.235			
47	161	2.67	12.25	~~11.29~~	11.44	+0.339	0.234			
48	164.5	2.18	14.32	~~13.81~~	13.63	+0.150	0.191	6.52	2.58×10^{-13}	6.52×10^{9}
49	168	2.261	13.76	~~12.91~~	12.14	-0.459	0.198			
50	171.5	2.[illegible]	11.92	~~10.94~~	11.09	+0.231	0.229			

NGC 6251 4.39 resol. 1662 MHz
Cell 3!5

SLICE	θ	I_{max} (mJy)	Φ (")	$Φ_0$		Δ (")	$I_{1.3}$ equiv	B_{eq}	u_{min}	nT
51	175	3.68	12.54	11.75		+0.679	0.323			
52	178.5	5.18	11.27	10.38		+0.693	0.454			
53	182	6.52	10.64	9.69		−0.296	0.572			
54	185.5	6.91	9.89	8.86		−0.585	0.606			
55	189	7.82	9.66	8.60		−1.162	0.686			
56	192.5	9.90	9.26	8.15		−1.114	0.868	10.9	1.10×10^{-12}	$2.78 \cdot 10^{10}$
57	196	8.10	10.48	9.51		−0.983	0.710			
58	199.5	6.25	11.30	10.4		−0.414	0.548	8.28	6.41×10^{-13}	$1.62\ 10^{10}$
59	203	7.70	12.37	11.56		+0.941	0.675			
60	206.5	16.0	10.29	9.31		+1.114	1.403			
61	210	17.5	10.12	9.12		0.959	1.54	12.0	1.34×10^{-12}	$3.39\ 10^{10}$
62	213.5	11.4	11.29	10.40		−0.304	1.00			
63	217	6.82	13.0	12.23		−1.583	0.598	7.74	5.60×10^{-13}	1.42×10^{10}
64	220.5	7.64	13.6	12.87		−1.529	0.670			
65	224	11.20	13.3	12.6		−1.801	0.982			
66	227.5	13.9	13.4	12.7		−1.632	1.219			
67	231	14.1	12.7	11.9		−1.791	1.24	9.67	8.74×10^{-13}	2.21×10
68	234.5	10.4	13.3	12.6		−1.561	0.912			
69	238	8.17	16.4	15.8		+0.247	0.716	7.04	4.63×10^{-13}	1.17×10^{10}
70	241.5	10.85	15.1	14.4		+0.999	0.951			
71	245	10.65	14.7	14.0		1.404	0.934			
72	248.5	9.68	15.0	14.3		2.397	0.849			
73	252	8.83	14.7	14.0		3.787	0.774	10.7	1.08×10^{-12}	2.7×10^{13}
74	255.5	7.23	14.3	13.6		4.580	0.634			
75	259	5.15	16.0	15.4		5.800	0.450			
76	262.5	3.24	18.1	17.6		7.555	0.284	5.08	2.41×10^{-13}	6.1×10^{9}
77	266	2.56	17.9	17.4		9.350	0.224			
78	269.5	1.82	19.2	18.7		10.22	0.160			
79	273	1.31	21.9	21.5		11.05	0.115			
80	276.5	1.27	19.3	18.8		11.58	0.111	3.74	1.31×10^{-13}	3.31×10^{9}

HBC turbulence - NGC6251

Θ	Φ	|dΦ/dθ|	⟨dΦ/dθ⟩	$\langle\ \rangle^3$	v_j	v_j/Φ	$(v_j/\Phi)^2$	$\langle\ \rangle^3(\ )^2$	$\log_{10}$
1.6	(0.12)								
2.0	(0.1278)	0.020	0.020	8×10^{-6}	1.33	$1.04\ 10^{1}$	$1.08\ 10^{2}$	$8.66\ 10^{-4}$	-3.06
3	(0.1826	0.055	0.055	$1.66\ 10^{-4}$	1.80	9.59	97.2	$1.61\ 10^{-2}$	-1.79
4	(0.257)	0.074	0.074	$4.05\ 10^{-4}$	2.05	7.98	63.6	$2.58\ 10^{-2}$	-1.59
5	(0.35)	0.093	0.093	$8.04\ 10^{-4}$	2.17	6.20	38.4	$3.09\ 10^{-2}$	-1.51
6	(0.50)	0.15	0.15	$3.38\ 10^{-3}$	2.26	4.52	20.4	$6.91\ 10^{-2}$	-1.16
7	(0.85)	0.35	0.35	$4.29\ 10^{-2}$	2.32	2.73	7.45	$3.20\ 10^{-1}$	-0.49
9	1.35	0.25	0.20	$8\ 10^{-3}$	2.38	1.76	3.11	$2.49\ 10^{-2}$	-1.60
11	1.55	0.10	0.175	$5.36\ 10^{-3}$	2.43	1.57	2.46	$1.32\ 10^{-2}$	-1.88
15	2.15	0.15	0.15	$3.38\ 10^{-3}$	2.475	1.15	1.33	$4.48\ 10^{-3}$	-2.35
17	2.60	0.225	0.15	$3.38\ 10^{-3}$	2.487	0.957	0.915	$3.09\ 10^{-3}$	-2.51
19	2.85	0.125	0.13	$2.20\ 10^{-3}$	2.49	0.874	0.763	$1.68\ 10^{-3}$	-2.78
21	2.95	0.050	0.08	$5.12\ 10^{-4}$	2.493	0.845	0.714	$3.66\ 10^{-4}$	-3.44
23	3.00	0.025	0.03	$2.70\ 10^{-5}$	2.4935	0.831	0.691	$1.87\ 10^{-5}$	-4.73
25	3.00	0.000	0.0	0.00					
27	3.05	0.025	0.025	$1.56\ 10^{-5}$	2.485	0.815	0.664	$1.04\ 10^{-5}$	-4.99
29	3.25	0.100	0.07	$3.43\ 10^{-4}$	2.48	0.763	0.582	$2.00\ 10^{-4}$	-3.70
31	3.40	0.075	0.09	$7.29\ 10^{-4}$	2.475	0.728	0.530	$3.86\ 10^{-4}$	-3.41
33	3.65	0.125	0.125	$1.95\ 10^{-3}$	2.472	0.677	0.459	$8.94\ 10^{-4}$	-3.05
35	3.90	0.125	0.125	$1.95\ 10^{-3}$	2.473	0.634	0.402	$7.84\ 10^{-4}$	-3.11
37	4.10	0.100	0.110	$1.33\ 10^{-3}$	2.478	0.604	0.365	$4.86\ 10^{-4}$	-3.31
39	4.35	0.125	0.110	$1.33\ 10^{-3}$	2.486	0.572	0.327	$4.34\ 10^{-4}$	-3.36
41	4.50	0.075	0.08	$5.12\ 10^{-4}$	2.49	0.553	0.306	$1.57\ 10^{-4}$	-3.81
43	4.60	0.050	0.06	$2.16\ 10^{-4}$	2.50	0.544	0.295	$6.38\ 10^{-5}$	-4.20
45	4.70	0.050	0.05	$1.25\ 10^{-4}$	2.51	0.534	0.285	$3.56\ 10^{-5}$	-4.45
47	4.80	0.050	0.05	$1.25\ 10^{-4}$	2.515	0.524	0.275	$3.43\ 10^{-5}$	-4.46
49	4.85	0.025	0.025	$1.56\ 10^{-5}$	2.52	0.520	0.270	$4.21\ 10^{-6}$	-5.38
51	4.90	0.025	0.025	$1.56\ 10^{-5}$	2.523	0.515	0.265	$4.14\ 10^{-6}$	-5.38
53	4.95	0.025	0.025	$1.56\ 10^{-5}$	2.527	0.511	0.261	$4.07\ 10^{-6}$	-5.39
55	4.97	0.010	0.010	$1.00\ 10^{-6}$	2.531	0.509	0.259	$2.59\ 10^{-7}$	-6.59
57	4.99	0.010	0.010	$1.00\ 10^{-6}$	2.531	0.507	0.257	$2.57\ 10^{-7}$	-6.59
59	5.00	0.005	0.005	$1.25\ 10^{-7}$	2.532	0.506	0.256	$3.21\ 10^{-8}$	-7.49
80	5.05	0.0024	0.0024	$1.38\ 10^{-8}$	2.53	0.501	0.251	$3.46\ 10^{-9}$	-8.46
82	5.1	0.025	0.025	$1.56\ 10^{-5}$	2.53	0.496	0.246	$3.84\ 10^{-6}$	-5.42
84	5.2	0.050	0.050	$1.25\ 10^{-4}$	2.532	0.487	0.237	$2.96\ 10^{-5}$	-4.53
86	5.32	0.060	0.060	$2.16\ 10^{-4}$	2.534	0.476	0.227	$4.90\ 10^{-5}$	-4.31
88	5.53	0.105	0.105	$1.16\ 10^{-3}$	2.535	0.458	0.210	$2.44\ 10^{-4}$	-3.61
90	5.74	0.105	0.105	$1.16\ 10^{-3}$	2.537	0.442	0.195	$2.27\ 10^{-4}$	-3.64
92	6.0	0.13	0.13	$2.20\ 10^{-3}$	2.54	0.423	0.179	$3.94\ 10^{-4}$	-3.40
94	6.4	0.20	0.20	$8.00\ 10^{-3}$	2.542	0.397	0.158	$1.26\ 10^{-3}$	-2.90
96	6.6	0.10	0.10	$1.00\ 10^{-3}$	2.545	0.386	0.149	$1.49\ 10^{-4}$	-3.83
98	6.4	0.10	0.10	$1.00\ 10^{-3}$	2.548	0.398	0.159	$1.59\ 10^{-4}$	-3.80
100	6.1	0.15	0.125	$1.95\ 10^{-3}$	2.551	0.418	0.175	$3.41\ 10^{-4}$	-3.47
102	5.8	0.15	0.15	$3.38\ 10^{-3}$	2.553	0.440	0.194	$6.54\ 10^{-4}$	-3.18
104	6.25	0.225	0.225	$1.14\ 10^{-2}$	2.555	0.409	0.167	$1.91\ 10^{-3}$	-2.72
106	6.8	0.275	0.275	$2.08\ 10^{-2}$	2.557	0.376	0.141	$2.94\ 10^{-3}$	-2.53
108	6.3	0.25	0.27	$1.56\ 10^{-2}$	2.559	0.406	0.165	$2.57\ 10^{-3}$	-2.59
110	5.8/6.3	0.25	0.26	$1.56\ 10^{-2}$	2.561	0.416	0.173	$2.70\ 10^{-3}$	-2.57
112	6.8	0.25	0.25	$1.56\ 10^{-2}$	2.563	0.376	0.142	$2.21\ 10^{-3}$	-2.65
114	7.25	0.225	0.25	$1.16\ 10^{-2}$	2.565	0.354	0.125	$1.43\ 10^{-3}$	-2.85
116	7.9	0.325	0.30	$3.43\ 10^{-2}$	2.567	0.325	0.106	$3.62\ 10^{-3}$	-2.44

HBC turbulence - NGC 6251 cont'd.

Θ	Φ	$\lvert d\Phi/d\theta \rvert$	< >	$< >^3$	V_j	(V_j/Φ)	$( )^2$	$< >^3 ( )^2$	$\log_{10}$
118	8.4	0.25	0.25	$1.56\ 10^{-2}$	2.568	0.306	0.093	$1.46\ 10^{-3}$	-2.84
120	8.7	0.15	0.16	$4.10\ 10^{-3}$	2.568	0.295	0.087	$3.57\ 10^{-4}$	-3.45
122	8.95	0.125	0.14	$2.74\ 10^{-3}$	2.569		0.082	$2.25\ 10^{-4}$	-3.65
124	9.2	0.125	0.125	$1.95\ 10^{-3}$	2.57	0.279	0.078	$1.52\ 10^{-4}$	-3.82
126	9.4	0.10	0.10	$1\ 10^{-3}$	2.571	0.274	0.075	$7.48\ 10^{-5}$	-4.13
128	9.50	0.05	0.08	$5.12\ 10^{-4}$	2.571		0.073	$3.75\ 10^{-5}$	-4.43
130	9.65	0.075	0.06	$2.16\ 10^{-4}$	2.572	0.267	0.071	$1.53\ 10^{-5}$	-4.81
132	9.70	0.025	0.03	$2.70\ 10^{-5}$	2.573		0.070	$1.90\ 10^{-6}$	-5.72
134	9.70	0.000	0.00	—	2.574				
136	9.60	0.05	0.05	$1.25\ 10^{-4}$	2.575	0.268	0.072	$8.99\ 10^{-6}$	-5.05
138	9.4	0.1	0.1	10^{-3}	2.576	0.274	0.075	$7.51\ 10^{-5}$	-4.12
140	8.9	0.25	0.25	$1.56\ 10^{-2}$	6	0.289	0.084	1.31×10^{-3}	-2.88
142	8.4	0.25	0.25	$1.56\ 10^{-2}$	7			$1.47\ 10^{-3}$	-2.83
144	8.3	0.05	0.1	10^{-3}	7			$3.1\ 10^{-4}$	-3.51
146	8.45	0.075	0.06	$2.16\ 10^{-4}$	8		0.093	$2.01\ 10^{-5}$	-4.70
148	8.75	0.15	0.15	$3.38\ 10^{-3}$	2.578			$2.93\ 10^{-4}$	-3.53
150	9.15	0.2	0.18	$5.83\ 10^{-3}$	8			$4.63\ 10^{-4}$	-3.33
152	9.5	0.175	0.18	$5.83\ 10^{-3}$	9			$4.30\ 10^{-4}$	-3.37
154	9.9	0.2	0.2	$8\ 10^{-3}$	2.579			$5.43\ 10^{-4}$	-3.27
156	10.2	0.15	0.15	$3.38\ 10^{-3}$	9			$2.16\ 10^{-4}$	-3.67
158	10.8	0.3	0.15	$3.38\ 10^{-3}$	80			$1.93\ 10^{-4}$	-3.71
160	10.95	0.075	0.15	$3.38\ 10^{-3}$	0			$1.88\ 10^{-4}$	-3.73
162	11.3	0.175	0.18	$5.83\ 10^{-3}$	0			$3.04\ 10^{-4}$	-3.52
164	11.55	0.125	0.18	$5.83\ 10^{-3}$	2.580			$2.91\ 10^{-4}$	-3.54
166	11.85	0.15	0.15	$3.38\ 10^{-3}$	0			$1.60\ 10^{-4}$	-3.80
168	12.1	0.125	0.13	$2.20\ 10^{-3}$	1			$1.00\ 10^{-4}$	-4.00
170	12.25	0.075	0.1	10^{-3}	1			$4.44\ 10^{-5}$	-4.35
172	12.1	0.075	0.08	$5.12\ 10^{-4}$	1			$2.33\ 10^{-5}$	-4.63
174	11.8	0.15	0.15	$3.38\ 10^{-3}$	1			$1.62\ 10^{-4}$	-3.79
176	11.2	0.3	0.3	$2.70\ 10^{-2}$	1			$1.43\ 10^{-3}$	-2.84
178	10.6	0.3	0.3	$2.7\ 10^{-2}$	2			$6.58\ 10^{-3}$	-2.18
180	10.2	0.2	0.25	$1.56\ 10^{-2}$	2			$1.0\ 10^{-3}$	-3.00
182	9.8	0.2	0.2	$8\ 10^{-3}$	2			$5.55\ 10^{-4}$	-3.26
184	9.45	0.175	0.18	$5.83\ 10^{-3}$	2.582			$4.35\ 10^{-4}$	-3.36
186	9.1	0.175	0.16	$4.10\ 10^{-3}$	2			$3.30\ 10^{-4}$	-3.48
188	8.8	0.15	0.15	$3.38\ 10^{-3}$	2			$2.92\ 10^{-4}$	-3.54
190	8.45	0.175	0.13	$2.20\ 10^{-3}$	3			$2.06\ 10^{-4}$	-3.69
192	8.3	0.075	0.08	$5.12\ 10^{-4}$	3			$4.96\ 10^{-5}$	-4.30
194	8.4	0.05	0.05	$1.25\ 10^{-4}$	3			$1.18\ 10^{-5}$	-4.93
196	8.8	0.2	0.1	10^{-3}	2.583			$8.62\ 10^{-5}$	-4.06
198	9.6	0.4	0.3	$2.7\ 10^{-2}$	3			$1.95\ 10^{-3}$	-2.71
200	10.4	0.4	0.4	$6.4\ 10^{-2}$	3			$3.95\ 10^{-3}$	-2.40
202	11.8	0.7	0.5	$1.25\ 10^{-1}$	4			$5.99\ 10^{-3}$	-2.22
204	11.8	0.0	0.4	$6.4\ 10^{-2}$	4			$3.07\ 10^{-3}$	-2.51
206	11.5	0.15	0.3	$2.7\ 10^{-2}$	4			$1.36\ 10^{-3}$	-2.87
208	9.6	0.45	0.2	$8\ 10^{-3}$	2.584			$5.80\ 10^{-4}$	-3.24
210	9.2	0.2	0.2	$8\ 10^{-3}$	4			$6.31\ 10^{-4}$	-3.20
212	9.4	0.1	0.15	$3.38\ 10^{-3}$	5			$2.56\ 10^{-4}$	-3.59
214	10.15	0.375	0.18	$5.83\ 10^{-3}$	5			$3.78\ 10^{-4}$	-3.42
216	10.5	0.175	0.18	$5.83\ 10^{-3}$	6			$3.59\ 10^{-4}$	-3.45
218	11.3	0.1	0.1	10^{-3}	2.586			$3.24\ 10^{-5}$	-4.28

Fits to NGC6251 1480MHz 15"

Θ	Δ	Θ	Δ
12"	−0."016	324	+13.95
24	−0.333	336	+15.53
36	−0.381	348	+20.10
48	−0.544	360	+18.00
60	−0.672	372	+17.62
72	−1.299	384	+16.39
84	−1.193	396	+17.32
96	−0.911	408	+24.10
108	−0.611	420	+29.22
120	−0.304	432	+37.19
132	+1.304	444	+44.61
144	+1.966	456	+52.36
156	+2.103	468	+ ???
168	+4.021	480	+67.79 ?
180	−0.055	492	+61.73
192	−0.810	504	+124.6
204	−0.397		
216	−0.031		
228	−1.487		
240	−0.869		
252	+1.719		
264	+4.951		
276	+9.080		
288	+11.32		
300	+11.93		
312	+14.60		

— Burbidge GR, ODell SL
ApJ, 178, 583 (1972)

— Lake RG and Roeder RC
JRASC, 66, 1111 (1972)

Power Spectra of NGC6251 oscillations.

Theoretical detection probability for random noise:

$$\Pi(P>P_0) \Rightarrow 1 - \{1 - \exp(-P_0)\}^n$$

where $n(k_1<k<k_2) = \left(\frac{k_2-k_1}{2\pi}\right)(\theta_2-\theta_1)$ — $\theta_1 \to \theta_2$ data range, $k_1 - k_2$ spectral range.

$\sim 0.5 \times 98 \sim 50$ in our case.

So $\Pi \sim 1 - \exp(-50\exp(-P_0))$

~ 0.29 for $P_0 = 5$, i.e. ~ 15 occurrences / spec.

~ 0.045 for $P_0 = 7$ — ~ 2 occurrences / spec

~ 0.002 for $P_0 = 10$ — $\sim .1$ occurrence / spec.

i.e. $P(>5)$ is $\sim 7\times P(>7)$ (we saw $\sim 5\times$) — 99.

$P>10$ is $\sim \frac{1}{20} P(>7)$ **SAFE**

For the shorter data sets, $n \sim 0.5\times 40 \sim 20$

$\Pi \sim 1-\exp(-20\exp(-P_0))$

~ 0.13 for $P_0 = 5$

~ 0.02 — $P_0 = 7$

~ 0.001 — $P_0 = 10$ — 1 occurrence in 50 spectra

$P = 10\times$ mean is *fairly* safe, and easy to read.

Compute significances peak by peak though, they vary.

Turn send 143'' 9''
31''
17.5''
12''

Hence:-

Average angle data $20'' < \theta < 100''$

						λ
Peak at	0.0234	.4199E-6	is ~ 7.9 × bgrd	$\Pi = .008$	1 in 6 spectra	× 85.
	0.112	.8139 E-7	is ~ 8.1 × —	.006	8	× 17.
	0.172	.477 E-7	12.2 ×		490 spectra	✓ 11.
	0.287	.223 E-7	16 ×	2.3×10^{-6}	21151 spectra	✓ 7.0
	0.359	.122E-7	28 × —		unconfirmable	✓ 5.6

⇒ SIGN peaks 11''.6, 7''.0, 5''.6

Average angle data $0'' < \theta < 100''$

				λ
0.292	10 × bgrd	$\Pi = 9.3\times10^{-4}$	1 in 52 spectra	✓ 6''.85
0.3575	11 ×	3.4×10^{-4}	1 in 143 sp—	✓ 5''.6

1''.3 angle data $0'' < \theta < 100''$

0.190	10.4 × bgrd	$\Pi = 1.5\times10^{-3}$	1 in 14 spectra	✓ 5''.8

1''.3 deflection data $0'' < \theta < 100''$

0.190	9.3 × bgrd	$\Pi = 4.5\times10^{-3}$	1 in 4.6 spectra	5''.8

2''.1 angle data $0'' < \theta < 134''$

0.0885	7.7 × bgrd	$\Pi = 2.0\times10^{-2}$	1 in 1.2	× 16''.9
0.166	11.5 × bgrd	$\Pi = 4.5\times10^{-4}$	1 in 51 spectra	✓ 9''.0
0.260	11.1 ×	$\Pi = 6.6\times10^{-4}$	1 in 34	✓ 5''.8

2''.1 angle data **$15'' < \theta < 134''$**

0.166	16.2 × bgrd	$\Pi = 3.5\times10^{-6}$	1 in 7170	✓ 9''.0
0.266	23 ×	——	——	✓ 5''.6
0.31	10 ×		1 in 14	✓ 4''.8

4"4 angle data 125 < θ < 276"

0.148	10.3×bgrd	$\Pi = 7.4\times10^{-4}$	1 in 62 spectra	23".6
0.102	10.2×	8.2×10^{-e}	1 in 56	34".3
0.274				12".7
0.372				9"4

4".4 angle data '80" < θ < 276"

No significant peaks

Sidelobes at 230" bad aliasing

15" angle data 210" < θ < 440"

0.029	413"
0.086	140"
0.141	85"

2".1 angle data 30" < θ < 100"

0.115	10.2×bgrd	0.001	1 in 26 spectra	13".0
0.163	9.1×bgrd	0.004	1 in 9 spectra	9"2

1"3 angle data 30" < θ < 100"

0.190	26.3×bgrd	small	∞	5".8
0.083	5.8×bgrd			13".3
0.140	5.2×			

15" angle data 0" < θ < 456"

0.0781	7.5×bgrd	$\Pi = 0.010$	1 in 5.1 spectra	153".6

22 July 1982

CH fit to NGC6251
Core integration
1.6 $\times 10^5$ cells

$z_s = 0.6864$ (kpc)
$a = 1.0$
$m = 4.15$

$p_s = 4 \times 10^8$ cm^{-3} K
$n_e T \sim 4 \times 10^8$

R_{max} =		$n_e = 10$, $T = 4\times10^7$	$n = 20$, $T = 2\times10^7$	$n = 40$, $T = 10^7$	
1	M	8.83×10^8	1.77×10^9	3.53×10^9	M
	L_x	6.39×10^{43}	2.13×10^{44}	5.10×10^{44}	erg/sec
2		1.44×10^9	2.88×10^9	5.77×10^9	
		6.98×10^{43}	2.33×10^{44}	5.57×10^{44}	
10		1.85×10^9	3.70×10^9	7.48×10^9	
		6.99×10^{43}	2.33×10^{44}	5.58×10^{44}	
20		1.89×10^9	3.78×10^9	7.58×10^9	
		6.99×10^{43}	2.33×10^{44}	5.58×10^{44}	

Conclude: At $T = 2\times10^7$ K
Core has $L_x \sim 2.3\times10^{44}$ erg/sec
90% within 1 kpc of center

22 July 1982

CH fit to NGC6251
Halo integration
1.6×10^5 cells.

$z_s = 16.73$ kpc
$a = 1.0$
$m = 2.60$

$p_s = 4 \times 10^5$ cm^{-3} K (halo)

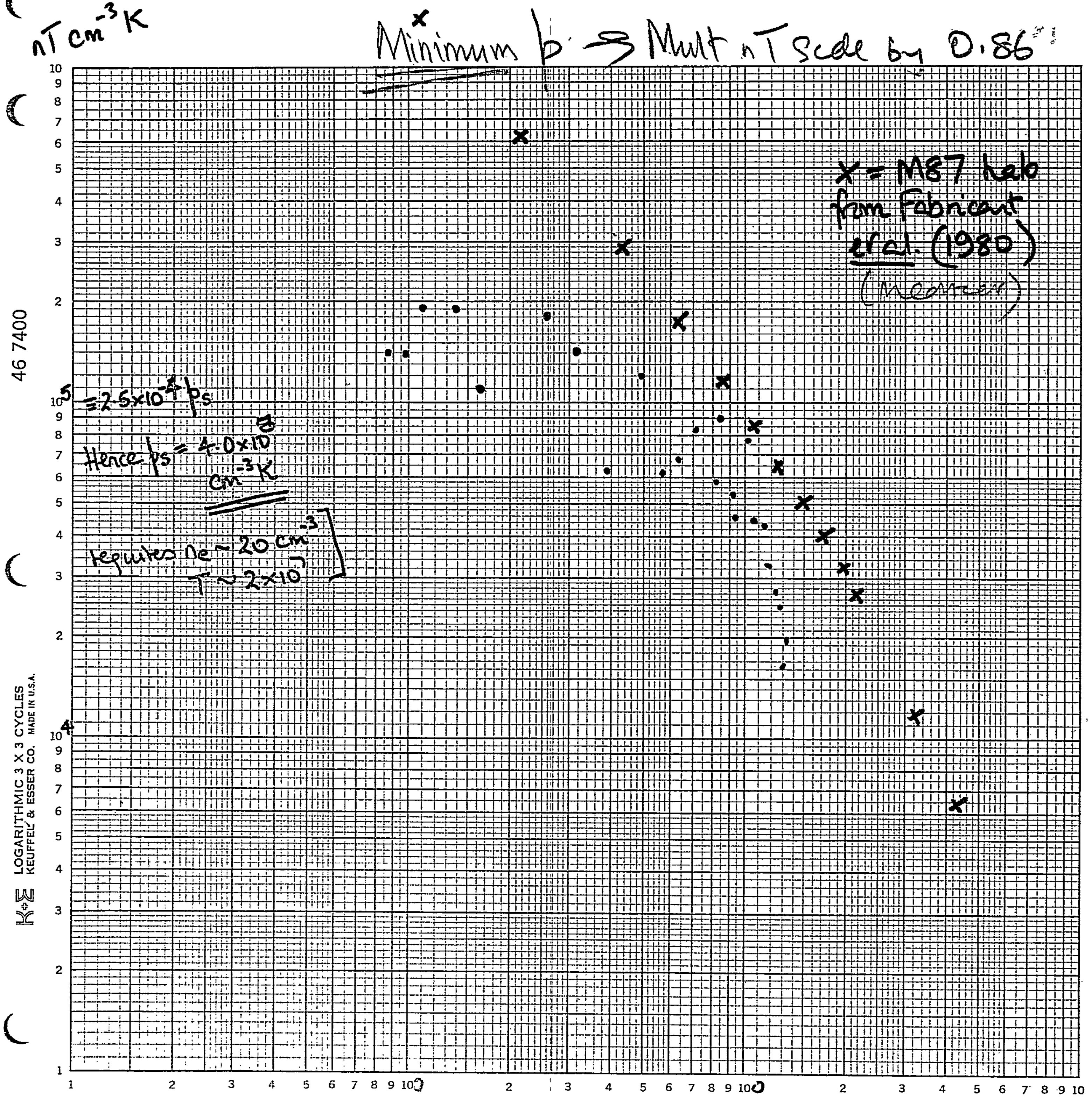
		$n_e = 10^{-2}$ $T = 4 \times 10^7$	$n_e = 2 \times 10^{-2}$ $T = 2 \times 10^7$	$n_e = 4 \times 10^{-2}$ $T = 10$
$R_{max} = 100$	M	8.41×10^{10}	1.68×10^{11}	3.36×10^{11}
	L_x	1.97×10^{42}	6.56×10^{42}	1.57×10^{43}
200	M	1.38×10^{11}	2.76×10^{11}	5.52×10^{11}
	L_x	2.01×10^{42}	6.68×10^{42}	1.60×10^{43}
300	M	1.77×10^{11}	3.55×10^{11}	7.09×10^{11}
	L_x	2.01×10^{42}	6.70×10^{42}	1.60×10^{43}
50	M	4.39×10^{10}	8.78×10^{10}	1.76×10^{11}
	L_x	1.81×10^{42}	6.02×10^{42}	1.44×10^{43}

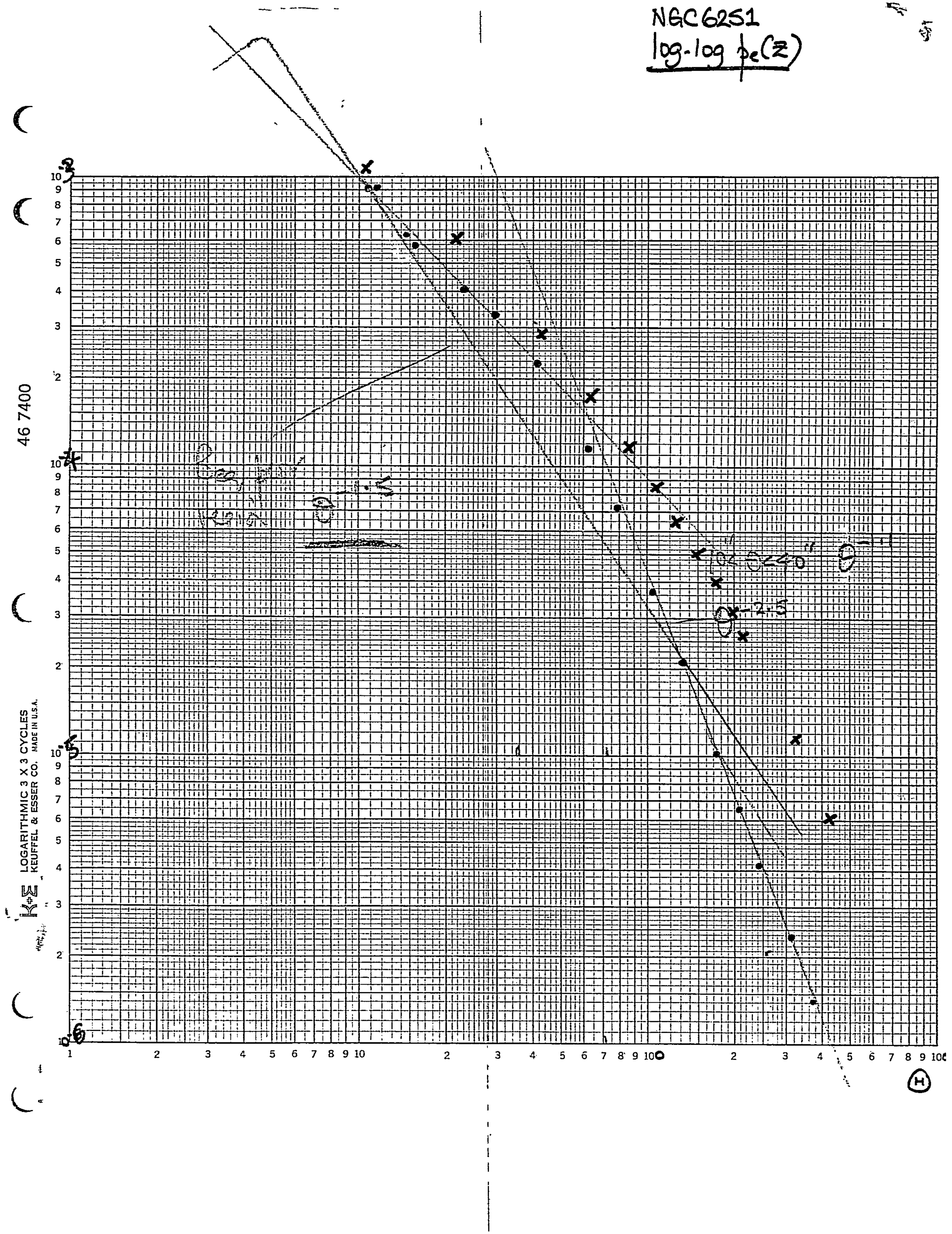
Conclude: At $T = 2 \times 10^7$ K
Halo has $L_x \sim 6.7 \times 10^{42}$ erg/sec
90% within 50 kpc of center

N.B. Divide L's by 1.352
M's by 1.163

NGC6251

log-log $u_{min}(\Theta)$ $(\equiv nT)$





NGC 6251
log-log ρe(z)
46 7400
LOGARITHMIC 3 X 3 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
θ^-1.5
10² θ<40" θ^-1
θ^-2.5
Θ

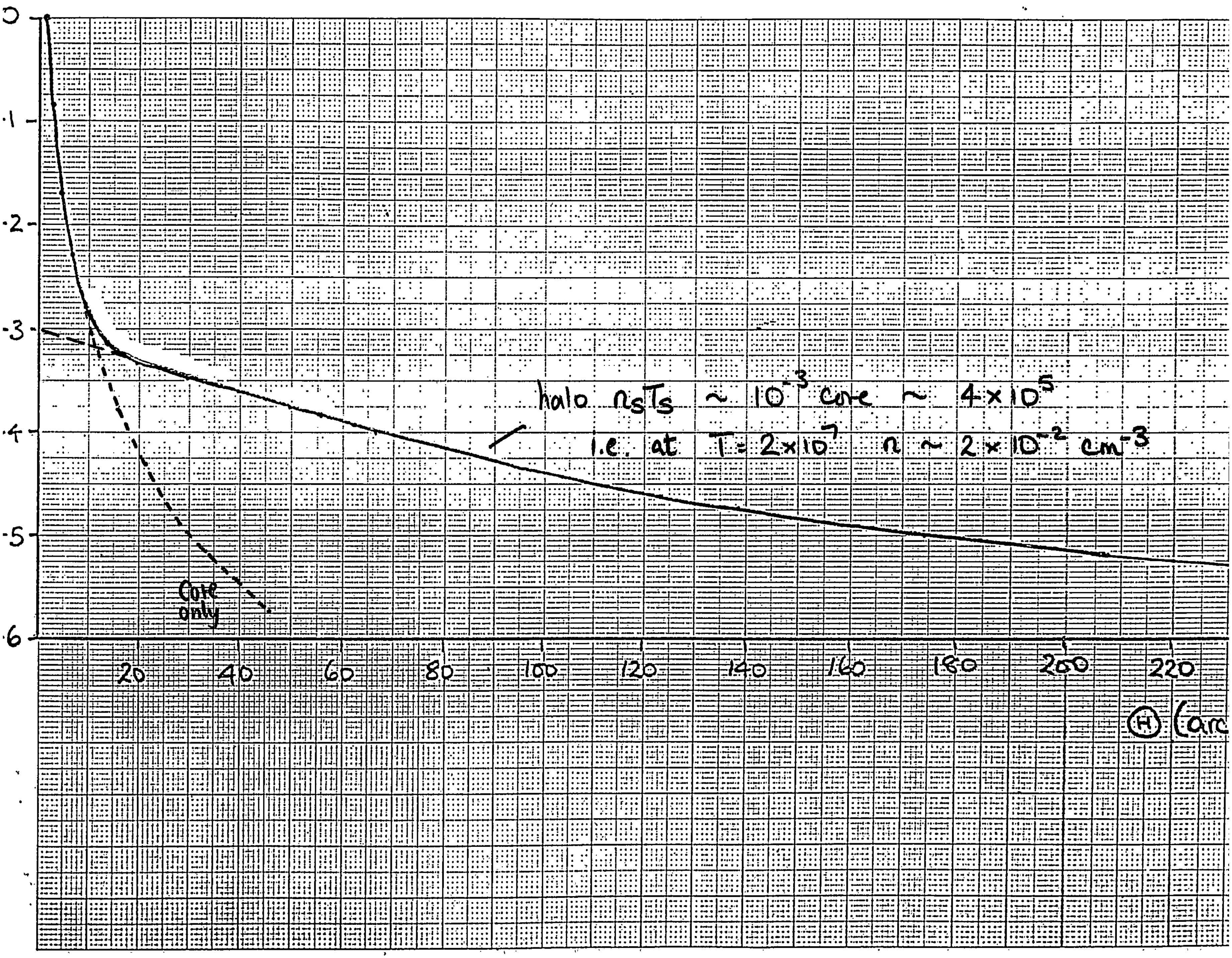

0
-1
-2
-3
-4
-5
-6
halo nsTs ~ 10-3 core ~ 4×105
i.e. at T=2×107 n ~ 2×10-2 cm-3
Core only
20
40
60
80
100
120
140
160
180
200
220
Ⓗ (arc

Table 4

Minimum Mass and 0.5-4keV luminosity of media required to confine NGC6251 jet

Assumed Isothermal Temp.	4×10^7 K	2×10^7 K	10^7 K
L_x(2.0 to 50 kpc), erg.s^{-1}	1.3×10^{42}	4.5×10^{42}	1.1×10^{43}
M (2.0 to 50 kpc), $M_\odot$	3.8×10^{10}	7.5×10^{10}	1.5×10^{11}
L_x(2.0 to 200 kpc), erg.s^{-1}	1.5×10^{42}	4.9×10^{42}	1.2×10^{43}
M (2.0 to 200 kpc), $M_\odot$	1.2×10^{11}	2.4×10^{11}	4.7×10^{11}
L_x (< 1.0 kpc), erg.s^{-1}	4.7×10^{43}	1.6×10^{44}	3.8×10^{44}
M (< 1.0 kpc), $M_\odot$	7.6×10^{8}	1.5×10^{9}	3.0×10^{9}
L_x (< 2.0 kpc)	5.2×10^{43}	1.7×10^{44}	4.1×10^{44}
M (< 2.0 kpc)	1.2×10^{9}	2.5×10^{9}	5.0×10^{9}

Converted to form from Unit

15 April 1983

Outflow limit from Lobe Depol:

Willis, Wilson, Strom (1978) → n_e in lobe $< 2 \times 10^{-5}$ cm^{-3}

$< 2 \times 10^{1}$ m^{-3}

$B_{eq} = 1.5 \times 10^{-6}$ gauss.

Lobe radius $\sim 7'.5 = 450'' = 193$ kpc $= 5.96 \times 10^{21}$ m

Mass in sphere of this radius $= \frac{4}{3} \times \pi \times 20 \times 1.67 \times 10^{-27} \times (5.96 \times 10^{21})^3$

$= 2.96 \times 10^{40}$ kg

$= 1.5 \times 10^{10}$ $M_\odot$

Entrainment Upper Limit

$$\frac{dm}{dt\,dl} = 2\pi R_j \rho_{IGM} c_{s\,IGM}$$

10" from core

$nT \sim 1.6\times10^{5}\ cm^{-3}\,K.$ $\quad p = 2.2\times10^{-12}\ J/m^3$

$T \sim 3\times10^{7}$

$n \sim 5.33\times10^{-3}\ cm^{-3}$ $\quad \rho = 8.9\times10^{-24}\ kg/m^3$

$c_s = \sqrt{\frac{\Gamma p}{\rho}} = 6.4\times10^{5}\ m/s. = 640\ km/s.$

$R_j = 0.''75, = 322\,pc = 9.93\times10^{18}\ m$

Hence $\frac{dm}{dt\,dl} = 2\times\pi\times9.93\times10^{18}\times8.9\times10^{-24}\times6.4\times10^{5}\ m/s$

$= 3.55\times10^{2}\ kg/m/sec.$

$= 1.09\times10^{22}\ kg/kpc/sec$

$= 3.46\times10^{29}\ kg/kpc/yr$

$= 0.17\ M_\odot/kpc/yr.$

i.e. the length scale for entraining its own flow rate must be $\gtrsim \frac{1.2\ M_\odot/yr}{0.17\ M_\odot/kpc/yr}$

$\gtrsim 7\ kpc$

i.e. velocity could be halved by ~ 7 kpc further down the jet
~ 16"

i.e. by $\theta \sim 26''$ $\quad R_j = 1.84\times R_{j\,in}$

K+E 10 X 10 TO THE CENTIMETER 18 X 25 CM. KEUFFEL & ESSER CO. MADE IN U.S.A.

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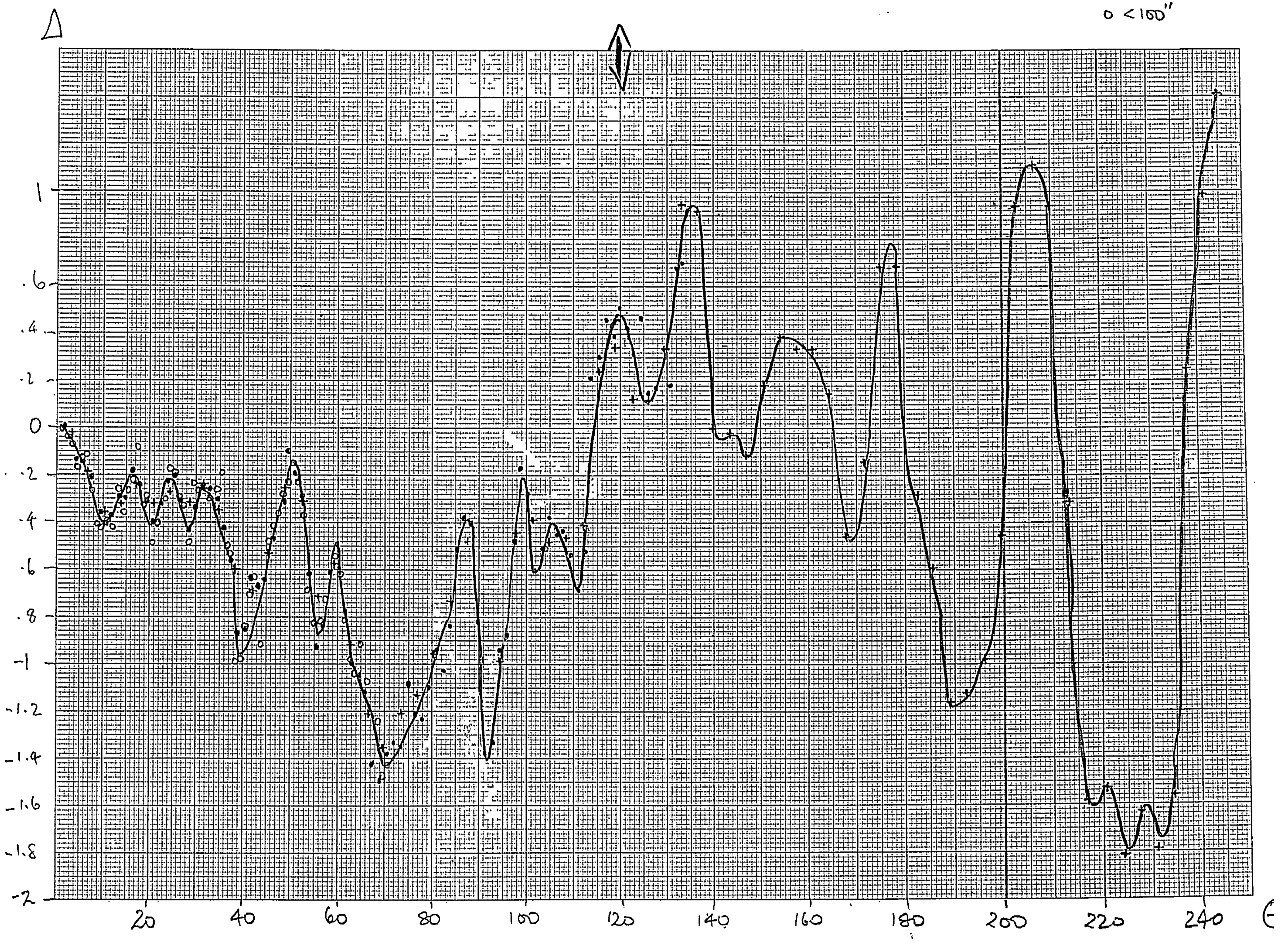

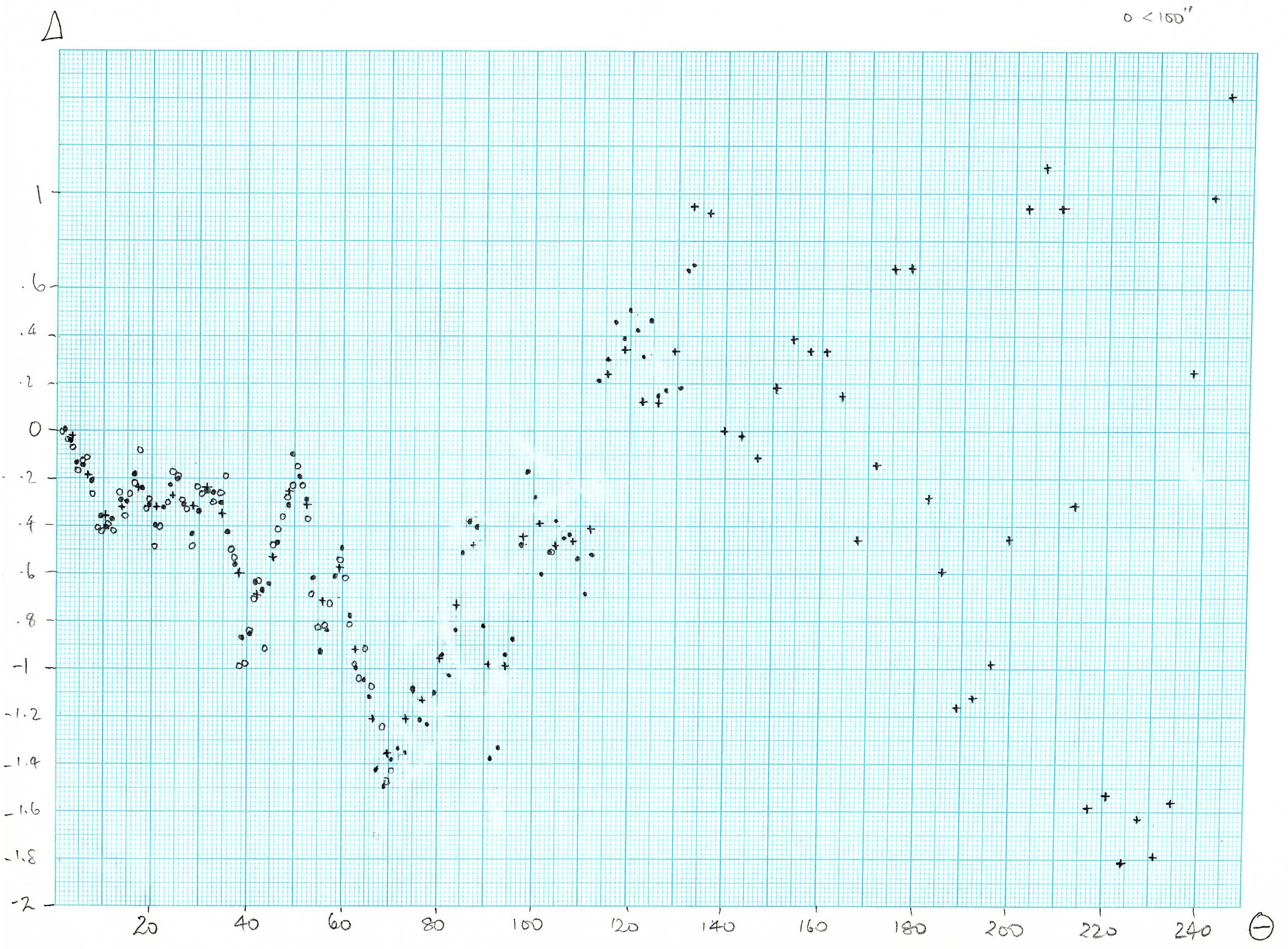
o < 100"
Δ
1
.6
.4
.2
0
-.2
-.4
-.6
-.8
-1
-1.2
-1.4
-1.6
-1.8
-2
20
40
60
80
100
120
140
160
180
200
220
240
Θ

Hanning Prewhitened

Power Sp. (512) (Inner Jer)

1''.3 data Δ(θ) 28'' 17'' 12''.7 10''.4 5''.8 θ > 15''.4

↕ ↕

Δ/θ(θ) 25'' 17''.5 12''.3 10''.5 7''.1 5''.7 θ > 15''.4

(1024) → (27''.8) (16''.9) (9''.0) (5''.8) (all) (107'' of data)

2''.11 data Δ(θ) 37''.5 17''.3 9''.1 12''.1? 15'' < θ < 134''

↑ ↑ ↕ ↓

26''.5 18''? 9''.1 12''.5 15'' < θ < 100''

Δ/θ 39''.6 17''.6 9''.1 12''.2 5''.6 15'' < θ < 134''

↑

54''.9 24''.9 18''.3 12''.4 9''.1 15'' < θ < 100 (all)

Conclude 9''.1
12''.4 growing
17''.6?

Averaged Δ/θ 2'' cell

20'' < θ < 60'': 17''.5, 11''.8, 9''.0

20'' < θ < 80'': 17''.8, 11''.4, 9''.5

20'' < θ < 100'': 17''.3, 11''.6, 8''.7

20'' < θ < 120'': 17''.1, 11''.5, 8''.7, 64''.9

Conclude finally] 9''.0, 12''.1, 17''.5

Power Sp (S12) Outer Jet

			too short					
15" data	Δ(θ)	140"	35".5	28".0				θ > 0
		143"		27".3				θ > 180"
	Δ/θ (θ)	146"	35".5	26".3	58".6			θ > 0
		144"	34".7	27".4	56"			θ > 180"
4".4 data	Δ(θ)	(137")	31".2	23".3	17".1	12".6	9".4	θ > 0
	Δ (θ)	(133")	31".3		17".2	12".6		20 < θ < 260
	Δ/θ (θ)	(151")	30".6	17".1	11".8	[illegible]		θ > 0
	Δ/θ (θ)	(140")	31".3	17.2	12".7	58".0		20 < θ < 260

Conclude: 143" 57"?
31".1
17".2
12".4

Over-all 143" 57"
31".1
17".5
12".1
9".0