EXPLORER 12 OBSERVATIONS OF
CHARGED PARTICLES IN THE
INNER RADIATION ZONE*

by

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Abstract

Measurements of energetic charged particles in the inner radiation zone with two shielded, omnidirectional Geiger-Mueller tubes flown on Explorer 12 have been used to construct B-L contours of the omnidirectional intensities of protons $E_p > 21$ Mev and $E_p > 70$ Mev for the period 16 August to 19 September, 1961, prior to the Starfish high-altitude nuclear burst on 9 July 1962. The values of proton $(E_p > 21$ Mev) omnidirectional intensities are in substantial agreement with the post-Starfish values from Telstar 2 and with other observations. Upper limits for the omnidirectional intensities of electrons $E_e > 1.6$ Mev at the geomagnetic equator before the Starfish test are $J_o \leq 10^4$ $(cm^2\text{-sec})^{-1}$ at L = 1.2, $\leq 4 \times 10^4$ $(cm^2\text{-sec})^{-1}$ at L = 1.25, $\leq 2.5 \times 10^5$ $(cm^2\text{-sec})^{-1}$ at L = 1.5, $\leq 8 \times 10^4$ $(cm^2\text{-sec})^{-1}$ at L = 1.8 and $\leq 1.5 \times 10^4$ $(cm^2\text{-sec})^{-1}$ at L = 2.4.

I. Introduction

        Explorer 12 observations of charged particle intensities

in the inner radiation zone during August-September 1961 provide

significant contributions to the existing body of knowledge

concerning the inner radiation zone in two major areas of

interest. First, the B-L contours of the omnidirectional

intensities of protons E_p > 21 Mev and > 70 Mev over the

ranges $1.2 \lesssim L \lesssim 2.2$ and $B_o \lesssim B \lesssim 0.20$ as derived from the

counting rates of two shielded, omnidirectional Geiger-

Mueller tubes and presented herein furnish further information

concerning the stability of inner zone proton intensities

during the epoch approximately three years after the solar

activity maximum. These observations supplement and are

compared in part with previously reported observations

extending over the period late-1958 to 1964 [cf. McIlwain, 1961;

Freden and White, 1959; Naugle and Kniffen, 1963; McIlwain, 1963;

Gabbe and Brown, 1965]. The second purpose of the present

report is to provide upper limits for the electron (E_e > 1.6 Mev)

omnidirectional intensities at the geomagnetic equator from

$L \sim 1.2$ to ~ 2.4 during the period approximately ten months

previous to the injection of energetic electrons by the Starfish

high-altitude nuclear burst on 9 July 1962.

II. Description of the Apparatus

Explorer 12 was launched at 1321 U.T., 16 August 1961, into a highly eccentric orbit with initial apogee 83,600 km and perigee 6700 km geocentric radial distances, inclination 33° and period 26.5 hours. The satellite was spin-oriented with its spin axis directed initially toward right ascension 47.0° and declination - 27.5°. The spin rate slowly increased during the period of observations reported here, 27.8 r.p.m. at launch to 28.9 r.p.m. in mid-September.

The satellite transited the inner radiation zone approximately twice each day (one inbound and one outbound pass). The duration of these transits, perigee to L $\sim$ 2.5, was $\sim$ 30 minutes. Approximately 30% of the telemetered data from these passes over the above L range were received by tracking stations and were provided by the Goddard Space Flight Center for further processing at the University of Iowa.

Of present interest are the responses of two shielded Geiger-Mueller tubes designated as the 302, an Anton type 302 G.M. tube shielded with $\sim$ 1 gm(cm)$^{-2}$ (Al and stainless steel), and the SPB, an Anton type 213 G.M. tube shielded with $\sim$ 5 gm(cm)$^{-2}$

(Pb and other materials) [Laughlin, 1960]. A description of
the entire complement of University of Iowa detectors on
Explorer 12 has been given previously by Freeman [1964].
Table I provides a summary of the omnidirectional geometric
factors and shielding materials for the two G.M. tubes. The
energy threshold for penetrating protons is 70 ($\pm$ 4 Mev)
over a solid angle of 10 steradians for SPB; the remaining
solid angle is shielded by an additional shielding $\sim$ 3 gm(cm)$^{-2}$.
The electron bremsstrahlung efficiency of SPB is $\sim$ 2 x 10^{-4}
counts-cm^2(electron)$^{-1}$ for E_e = 8 Mev and $\sim$ 8 x 10^{-6}
counts-cm^2(electron)$^{-1}$ for E_e = 2 Mev and decreases rapidly
with decreasing electron energies $E_e \lesssim$ 1 Mev [Van Allen,
Frank and O'Brien, 1963]; the energy threshold for penetrating
electrons is $\sim$ 20 Mev. Energy thresholds for penetrating
protons and electrons for the shielded 302 G.M. tube are
E_p = 21 Mev and $E_e \simeq$ 1.6 Mev, respectively (for a detailed
analysis of a nominally identical detector see Frank,
Van Allen and Hills [1964]). The omnidirectional geometric
factor of SPB was determined by comparing its response to
galactic cosmic rays at apogee, 0.36 counts(sec)$^{-1}$, with the
simultaneous response of the 302, 1.5 counts(sec)$^{-1}$. Since
the omnidirectional geometric factor ϵG_o of the 302 is known
by laboratory measurements within an uncertainty of 20%,

TABLE I

Omnidirectional Geometric Factors and
Shieldings for the 302 and SPB G.M. Tubes on Explorer 12

Detector	302	SPB
eG_o for Penetrating Particles	$0.55(\pm\ 0.1)$ cm^2	$0.13(\pm\ 0.02)$ cm^2
Shielding	265 mg/cm^2 Al 400 mg/cm^2 stainless steel	3.5 gm/cm^2 Pb 0.9 gm/cm^2 stainless steel 0.2 gm/cm^2 potting materials 1.0 gm/cm^2 Mg
Penetrating Particles	protons $E_p > 21$ Mev electrons $E_e \gtrsim 1.6$ Mev	protons $E_p > 70(\pm\ 4)$ Mev electrons $E_e \gtrsim 20$ Mev

0.55 ($\pm$ 0.1) cm^2, the SPB omnidirectional geometric factor,

ϵG_o, is (0.36/1.5) (0.55) = 0.13 ($\pm$ 0.03) cm^2.

The response of each detector was accumulated for

10.24 seconds, or ~ 5 spin periods of the spacecraft, and the

contents of the accumulators were redundantly telemetered

once each 79 seconds. All of the University of Iowa detectors

operated satisfactorily from launch until transmission of

data by the spacecraft terminated on 6 December 1961 with the

exception of the SPB which failed on 20 September. No

failure of the SPB prior to 20 September has been detected

after a careful inspection of plots of the entire body of

data [Frank, Bohlin and DeCoster, 1966], and subsequently

the SPB responses for the period extending from launch on

16 August through 19 September 1961 have been used in the

present analysis.

III. Observations

The responses of the SPB and the 302 G.M. tubes for the period 16 August through 19 September 1961 for L < 2.4 have been organized in plots of counting rate versus B for selected values of L and are shown in Figures 1 and 2 (302 responses) and 3 and 4 (SPB responses). A prelaunch laboratory calibration curve has been used to convert the telemetered apparent counting rates of the G.M. tubes to the true counting rates shown in the above graphs; this correction is negligible for apparent counting rates $\lesssim$ 1000 counts $(sec)^{-1}$. Observations on L-shells within $\Delta L = \pm 0.05$ of the specified L-shell have been used in constructing these counting rate versus B plots. The largest uncertainty in the assignment of B to a given observation occurs at the lowest L-values and has been designated in Figures 1 and 3 by appropriate horizontal error bars. Vertical error bars indicate the calculated standard deviations for selected counting rates of the detectors.

Omnidirectional geometric factors for penetrating protons E_p > 21 Mev and E_p > 70 Mev for the 302 and the SPB, respectively, have been included in the legends of the graphs. It is important to note that the complement of University of

Iowa detectors on Explorer 12 is inadequate to eliminate

penetrating electrons $E_e > 1.6$ Mev and $E_e \gtrsim 20$ Mev as

substantial contributors to the responses of the 302 and

SPB, respectively. The identification of the responses of

these shielded G.M. tubes in the inner radiation zone

$L < 2.4$ resides primarily in the observed temporal

stability of inner zone proton intensities and the close

agreement of the present measurements with other observations

of energetic proton intensities (see Discussion). Early

measurements of inner zone proton intensities and spectra

which identified the principal contributors to the inner

zone responses of shielded (~ 1 gm(cm)$^{-2}$) G.M. tubes as

penetrating protons were reported by Freden and White [1959],

Armstrong, Harrison, Heckman and Rosen [1961], and Naugle

and Kniffen [1961]. Bremsstrahlung from nonpenetrating

electrons can be eliminated as a significant contributor

to the responses of the 302 and the SPB by simultaneous

measurements of the total energy fluxes of electrons

$E_e \gtrsim 100$ eV with unshielded CdS crystals (for a discussion

of the Explorer 12 CdS detectors, see Freeman [1964]). This

upper limit for the electron ($E_e > 100$ eV) energy fluxes is

~ 50 ergs(cm^2-sec)$^{-1}$ throughout the region of observations

reported here. The maximum efficiency for counting

nonpenetrating electrons for the 302 is $\sim 10^{-5}$ count-cm^2(electron)$^{-1}$
$E_e \sim 0.5$ Mev [Frank, 1962]. Hence a 302 response $\sim 10^4$ counts(sec)$^{-1}$
due to bremsstrahlung from nonpenetrating electrons requires a
minimum electron energy flux ~ 1000 ergs(cm^2-sec)$^{-1}$. A comparison
of this upper limit with the CdS observed upper limit on the
electron $E_e > 100$ eV energy fluxes, ~ 50 ergs(cm^2-sec)$^{-1}$ shows
that bremsstrahlung from nonpenetrating electrons is negligible
for 302 responses $\gtrsim 10^3$ counts(sec)$^{-1}$. The maximum efficiency
of the SPB for counting nonpenetrating electrons 1.6 Mev
$\lesssim E_e \lesssim 20$ Mev is $\sim 10^{-4}$ counts-cm^2(electron)$^{-1}$ [Van Allen,
Frank and O'Brien, 1963; Petschek, 1963]. A solid upper limit
for the electron intensities in the above energy range can be
obtained by attributing the entire 302 response to penetrating
electrons $E_e > 1.6$ Mev. For example, at B = 0.14 gauss
L = 1.7 the 302 response is $\sim 3 \times 10^3$ counts(sec)$^{-1}$ and the
corresponding upper limit for electron 1.6 Mev $\lesssim E_e \lesssim 20$ Mev
intensities is $\sim 3 \times 10^4$ (cm^2-sec)$^{-1}$, an intensity corresponding
to a SPB bremsstrahlung response of $\sim (10^{-4}) (3 \times 10^4) =$
3 counts(sec)$^{-1}$. Comparison of this upper limit with the
observed SPB response $\sim 3 \times 10^2$ counts(sec)$^{-1}$ eliminates
nonpenetrating electrons 1.6 Mev $\lesssim E_e \lesssim 20$ Mev as a substantial
contributor to the SPB response. For electrons $E_e = 1.6$ Mev,

the efficiency of SPB is $\sim 4 \times 10^{-6}$ count-cm^2(electron)$^{-1}$ and

rapidly decreases with decreasing electron energy. Utilizing

an argument similar to that applied above to the 302 response,

an electron ($E_e \sim 1.6$ Mev) energy flux ~ 50 ergs(cm^2-sec)$^{-1}$

corresponds to a SPB response ~ 80 counts(sec)$^{-1}$, a severe

upper limit for the SPB response due to nonpenetrating

electrons $E_e \lesssim 20$ Mev for the inner radiation zone observations

reported here. Hence it is unlikely that substantial con-

tributions to the 302 and SPB responses in the inner radiation

zone can be attributed to bremsstrahlung from nonpenetrating

electrons.

The observations shown in Figures 1 through 4 have

been summarized in B-L coordinates as contours of constant

counting rate in Figures 5 (the 302 responses) and 6 (the

SPB responses). Each point in these graphs represents a

single observation. The densities of observations are reason-

ably adequate for the determination of the iso-count contours

shown. The contours in the two regions, $0.14 \lesssim B \lesssim 0.18$,

$1.3 \lesssim L \lesssim 1.6$ and $1.0 \lesssim B/B_o \lesssim 1.3$, $1.6 \lesssim L \lesssim 2.0$, with

sparse or no observations have been determined by inter-

polation of the counting rate versus B plots of Figures 1-4.

Responses of the 302 and the SPB at the geomagnetic equator

for $1.2 \lesssim L \lesssim 2.4$ are shown in Figures 7 and 8, respectively.

For L $\gtrsim$ 1.6 the observations as summarized in Figures 1-4 have been extrapolated to the magnetic equator, $B/B_o = 1.0$ ($\lambda_m = 0°$) from typically $B/B_o \lesssim 1.3$ ($\lambda_m \lesssim 15°$). These extrapolated values are judged to be accurate to within 50% of the responses of the detectors at the magnetic equator.

IV. Discussion And Comparison With

Previously Reported Observations

Comparisons of these Explorer 12 observations with several previously reported measurements of inner zone proton intensities have been undertaken and are summarized as follows.

Telstar 2. The omnidirectional proton 21 Mev < E_p < 145 Mev intensities versus B for selected L = 1.3, 1.5, 1.9 and 2.3 observed with Telstar 2 during summer 1963 [Gabbe and Brown, 1965] are shown in Figure 9 with the corresponding Explorer 12 measurements with the shielded 302 G.M. tube. Omnidirectional intensities of protons E_p > 21 Mev corresponding to the 302 responses have been calculated by assuming its entire response is due to penetrating protons. The vertical error bars in Figure 9 and the following Figure 10 are the estimated errors in our calculations of intensities from published data obtained with other satellites and the calculated standard deviations for the counting rates of the Explorer 12 G.M. tubes. Within the ranges of B and L shown in Figure 9 these two sets of observations are in substantial agreement and strongly indicate that (1) the 302 responses are predominantly due to penetrating

protons and (2) no large temporal variation (i.e., by a factor $\gtrsim 2$ in proton intensities at a given position) in the structure of inner zone proton $E_p > 21$ Mev intensities occurred over the two-year period extending from September 1961 to September 1963. It is possible, of course, that transitory intensity variations did occur during unmonitored intervals between the periods of these observations.

1964-45A. Figure 10 displays the results of a comparison of measurements of proton $(E_p > 70$ Mev$)$ omnidirectional intensities with satellite 1964-45A in August 1964 reported by Freden, Blake and Paulikas [1965] with Explorer 12 observations at $L = 1.8$ and 2.0 in August-September 1961. The proton $E_p > 70$ Mev omnidirectional intensities observed with Explorer 12 have been calculated by assuming that the SPB response is wholly due to penetrating protons. These observations are in agreement within experimental errors as indicated in Figure 10. Although the intensity versus B curves observed with Explorer 12 are apparently characterized by a steeper slope when compared with the measurements of Freden et al, the experimental uncertainties in comparing observations with dissimilar apparatus and at different periods prohibit the conclusive identification of this

feature as a temporal variation of proton E_p > 70 Mev
intensities.

Explorer 4. McIlwain (1961) has summarized the
responses of an 'unshielded' 302 G.M. tube flown on Explorer 4
for the period August-September 1958; several of these curves
of constant counting rate have been reproduced in Figure 11.
The Explorer 4 302 G.M. tube has nominally the same
omnidirectional geometric factor but has excess shielding
materials by $\sim$ 0.5 $gm(cm)^{-2}$ [Van Allen, McIlwain and Ludwig,
1958] when compared to those of the Explorer 12 G.M. tube. The
Explorer 12 observations during August-September 1961, three
years after the period of Explorer 4 measurements, are also
included in Figure 11. The two sets of contours of constant
counting rate are in general agreement. The depression of
the Explorer 12 1,000 $counts(sec)^{-1}$ contour toward lower B
values at L $\sim$ 1.2 to 1.4 may be a manifestation of a combination
of atmospheric heating and a temporal variation in neutron
albedo source strength [Blanchard and Hess, 1964] or an artifact
of the differing penetrating proton energy thresholds of the
Explorer 4 and 12 G.M. tubes, 31 and 21 Mev, respectively. These
two groups of observations are in agreement to within the
accuracy possible in comparing intensity observations at a

given B-L position; the single possibility of disagreement
originates from the differing characters of the contours,
1,000 counts(sec)$^{-1}$, over the ranges $1.2 \lesssim L \lesssim 1.6$ and
$0.18 \lesssim B \lesssim 0.20$ (Figure 11).

Injun I. An omnidirectionally shielded 213 G.M. tube
utilized as a background detector (also designated as SPB)
for an electron magnetic spectrometer flown on Injun I
(launch, 29 June 1961) was nominally identical to the
Explorer 12 SPB G.M. tube with respect to omnidirectional
geometric factor and shielding materials. Van Allen [1965]
has summarized the inner radiation zone responses of the
Injun I SPB for the period July 1961 through June 1962.
Injun I measurements overlap some of the Explorer 12
observations displayed in Figure 6 and comparisons at
selected B and L coordinates show that the SPB responses
are in agreement to within an experimental uncertainty of
~ 50% (see Table II for an abbreviated table of selected
observations). Hence the Explorer 12 SPB responses
reported here provide a useful extension in B-L coordinates
of pre-Starfish SPB responses for the study of the decay of
the artificially injected radiation [cf Van Allen, 1965;
Walt, 1964].

Table II

Comparison of Injun 1 and Explorer 12 SPB Responses

at Selected B and L Coordinates.

L	B	Injun 1 SPB Response $(\text{counts}(\text{sec})^{-1})$	Explorer 12 SPB Response $(\text{counts}(\text{sec})^{-1})$
1.25	0.165	800	700
1.30	0.172	800	500
1.40	0.180	500	600
1.50	0.194	200	200
1.50	0.218	50	30
1.60	0.215	50	40

The temporal stability of inner zone proton intensities
for $L \lesssim 2$ indicated here by the above comparisons of Explorer 12
measurements with observations by other satellites during
various epochs in the solar cycle has been previously reported
[cf. Freden and White, 1962; Rowland, Bakke, Imhof and Smith,
1963; Gabbe and Brown, 1965; Freden, Blake and Paulikas, 1965;
Filz and Holeman, 1965; Fillius, 1966]. Explorer 7 observations
[Pizzella, McIlwain and Van Allen, 1962] during the period
October 1959 through December 1960 revealed temporal variations
in inner zone proton intensities by factors ~ 3 at $L \gtrsim 1.3$.
Since the Explorer 7 measurements were obtained with a 302 G.M.
tube similar in shielding and geometric factor with respect to
the 302 G.M. tubes flown on Explorers 4 and 12 and are enclosed
in time by the Explorers 4 and 12 observations during August-
September 1958 and August-September 1961, respectively,
(Figure 11) it appears that, although increases in proton
intensities occurred during the period of Explorer 7
observations, the proton intensities returned to intensity
values observed in 1958 by late 1961. The epochs (time spans
from the beginning of solar activity cycle 19 [Central Radio
Propagation Laboratory Bulletin-F, Part B, issued January 1965]

to dates of observations) for Explorers 4, 7 and 12 observations
are ~ 4.4, 5.5 - 6.7 and 7.4 years, respectively, and are
during the descending portion of the solar activity cycle as
indicated by smoothed sunspot numbers. Temporal variations
in proton E_p > 34 Mev intensities by a factor of ~ 10 at
higher L-values L $\gtrsim$ 2.5 during a geomagnetic storm in
September 1963 have been reported by McIlwain [1965]
[see also Gabbe and Brown, 1965]. Observations during the
next few years of increasing geomagnetic activity will be of
fundamental importance toward identifying and understanding
the predominant loss and acceleration mechanisms for inner
zone protons.

A secondary maximum of proton (40 < E_p < 110 Mev)
unidirectional intensities, $j_\perp$, at L ~ 2.2 on the magnetic
equator was observed with Explorer 15 in late 1962
[McIlwain, 1963]. Explorer 12 measurements of the omni-
directional intensities of protons E_p > 21 Mev and > 70 Mev
at the geomagnetic equator as summarized in Figures 7 and
8, respectively, show only a change of slope in the
equatorial intensity versus L profiles in the region
2.1 $\lesssim$ L $\lesssim$ 2.4. Observations of this secondary peak with

Explorer 12 were perhaps precluded by the omnidirectional

nature of these observations and the extrapolations of

observed intensities from $\lambda_m \sim 15°$ to the magnetic

equator over these L-values.

The Explorer 12 observations reported here provide an

unique opportunity to obtain upper limits for the intensities

of natural electrons $E_e > 1.6$ Mev from L ~ 1.2 to L ~ 2.4

at the magnetic equator prior to the Starfish nuclear burst

on 9 July 1962. Solid upper limits for these natural electron

E > 1.6 Mev intensities in the inner radiation zone can be

obtained by assuming the detector response is wholly due to

penetrating electrons and multiplying the equatorial 302

G.M. tube counting rates displayed in Figure 7 by a factor of

10 [Frank, Van Allen and Hills, 1964]. Representative

upper limits for the omnidirectional intensities of electrons

$E_e > 1.6$ Mev are given in Table III.

Table III

Upper Limits for the Omnidirectional
Intensities of Electrons $E_e > 1.6$ Mev
at the Geomagnetic Equator Prior to
The Starfish Nuclear Burst

L	$J_o(E_e > 1.6$ Mev$)$ $(cm^2$-sec$)^{-1}$
1.2	$\leq 10^4$
1.25	$\leq 4 \times 10^4$
1.3	$\leq 10^5$
1.4	$\leq 2 \times 10^5$
1.5	$\leq 2.5 \times 10^5$
1.6	$\leq 2 \times 10^5$
1.8	$\leq 8 \times 10^4$
2.0	$\leq 4 \times 10^4$
2.2	$\leq 2.5 \times 10^4$
2.4	$\leq 1.5 \times 10^4$

Acknowledgements

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Figure Captions

Figure 1.   Counting rates of the Explorer 12 302 G.M. tube

plotted as a function of B (gauss) for selected values

of L.   The ordinate scales for each successive L-shell

have been separated by one decade.

Figure 2.   Continuation of Figure 1 for L = 1.8 to 2.4.

Figure 3.   Counting rates of the Explorer 12 SPB G.M. tube

plotted as a function of B (gauss) for selected values

of L.   The ordinate scales for each successive L-shell

have been separated by one decade.

Figure 4.   Continuation of Figure 3 for L = 1.8 to 2.3.

Figure 5.   Contours of constant counting rate for the Explorer 12

302 G.M. tube in B-L coordinates.

Figure 6.   Contours of constant counting rate for the Explorer 12

SPB G.M. tube in B-L coordinates.

Figure 7.   Responses of the 302 G.M. tube plotted as a function

of L at the magnetic equator.

Figure 8.   Responses of the SPB G.M. tube plotted as a function

of L at the magnetic equator.

Figure 9.   Comparisons of observations of the omnidirectional

intensities of protons E_p > 21 Mev with Explorer 12 in

August-September 1961 and Telstar 2 in summer 1963.

Figure 10.   Comparisons of observations of the omnidirectional

intensities of protons E_p > 70 Mev with Explorer 12

in August-September 1961 and 1964-45A in August 1964.

Figure 11.   Contours of constant counting rates in B-L

coordinates for the 302 G.M. tubes on Explorer 4

(August-September, 1958) and Explorer 12 (August-
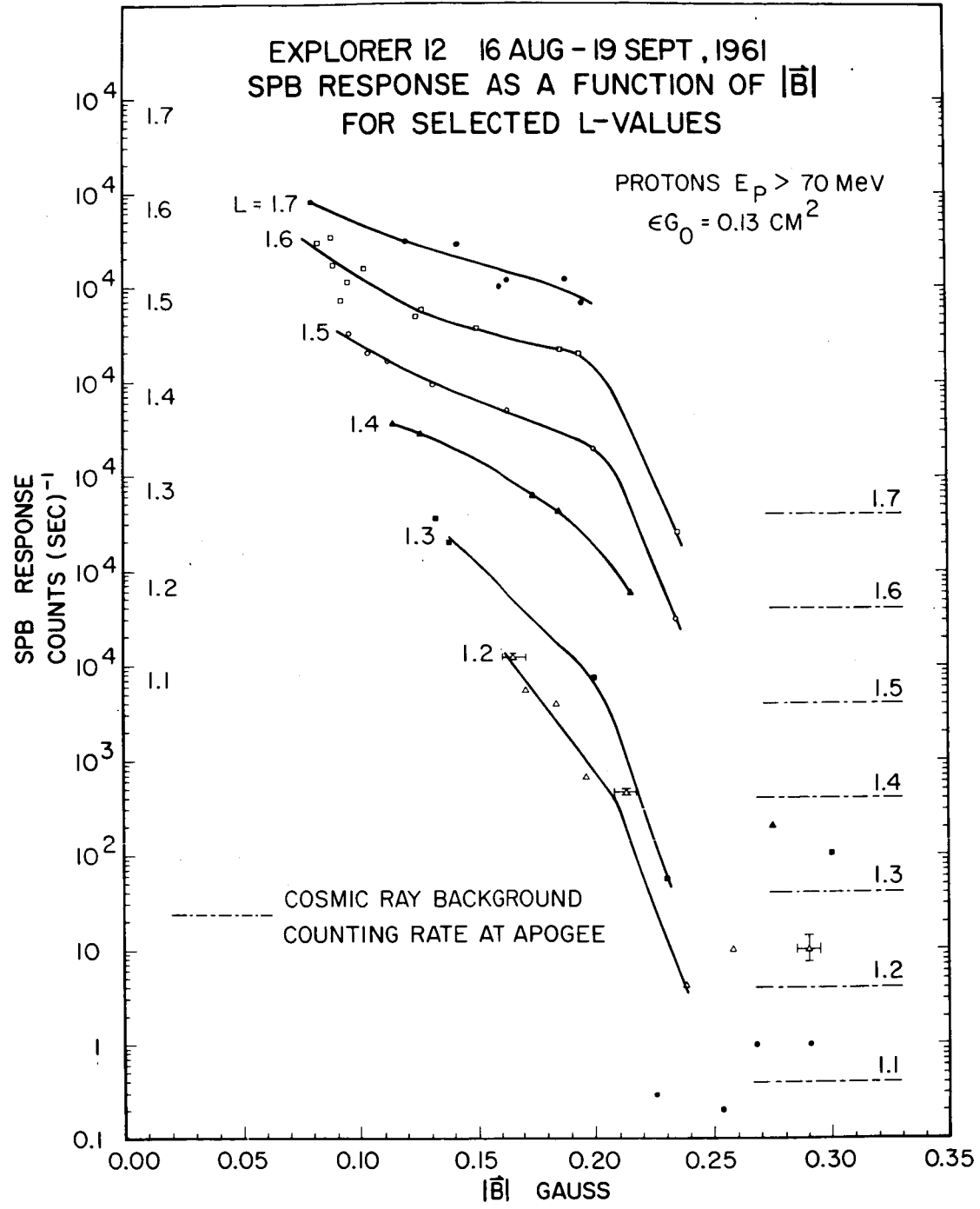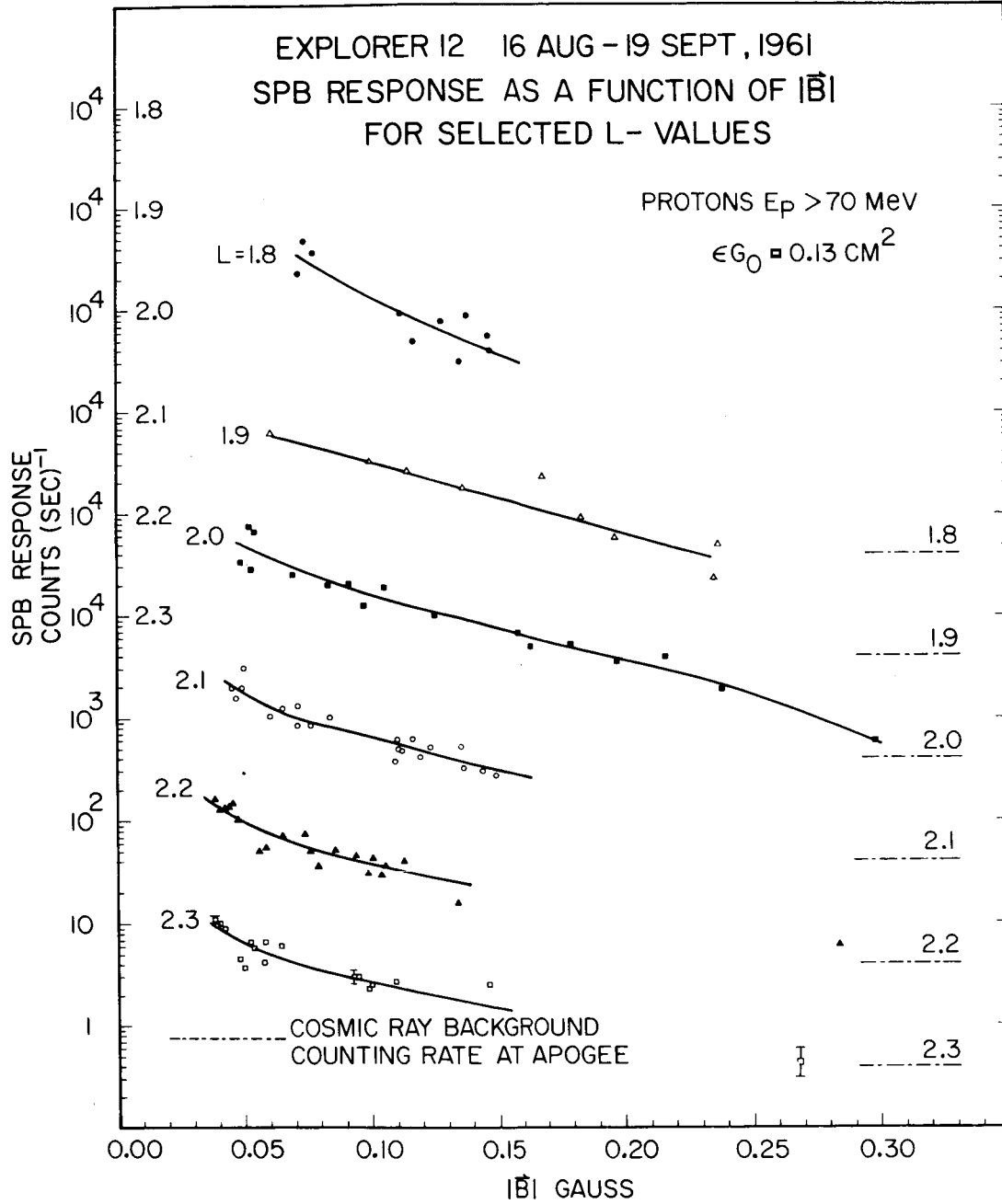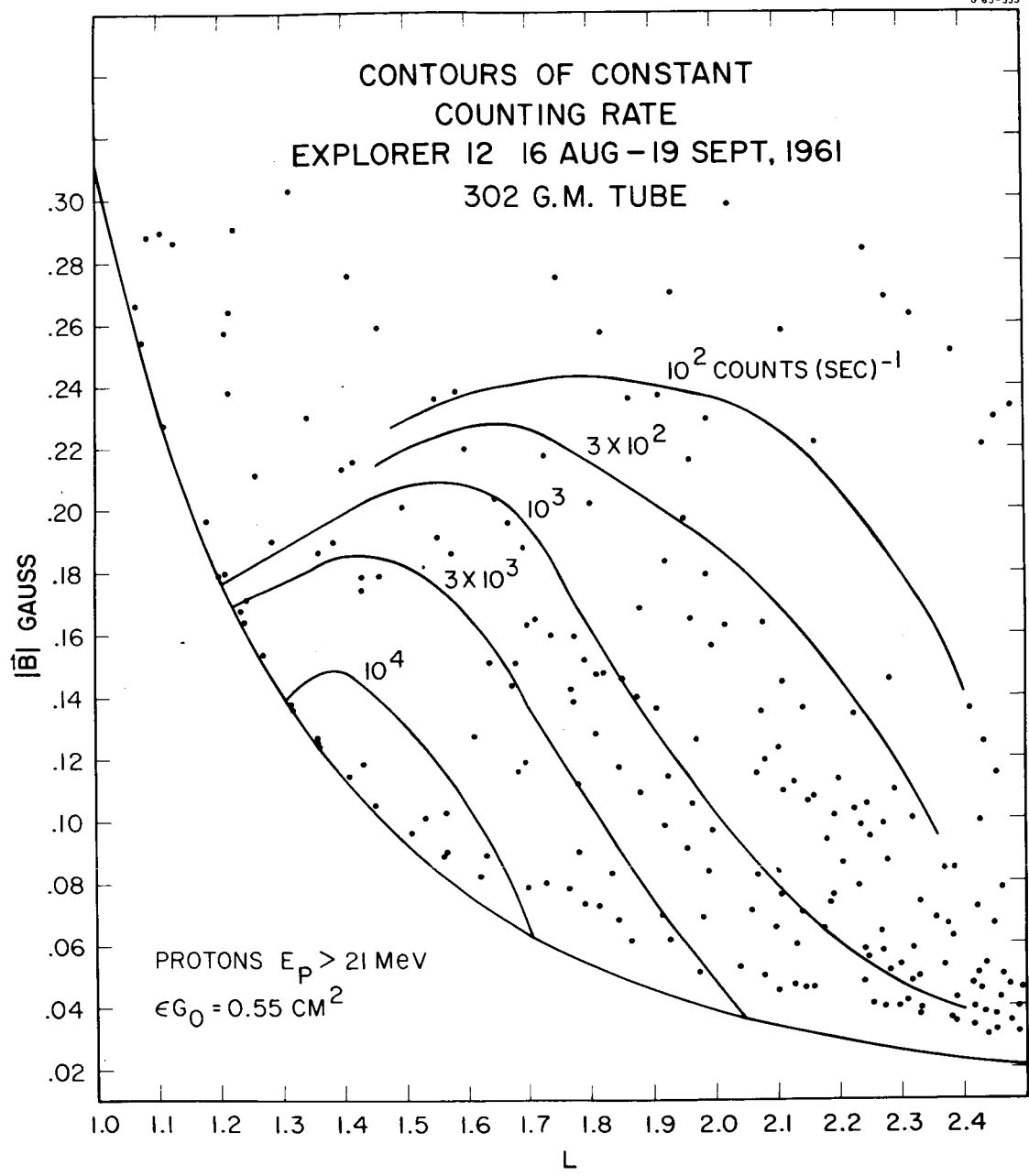
September, 1961).
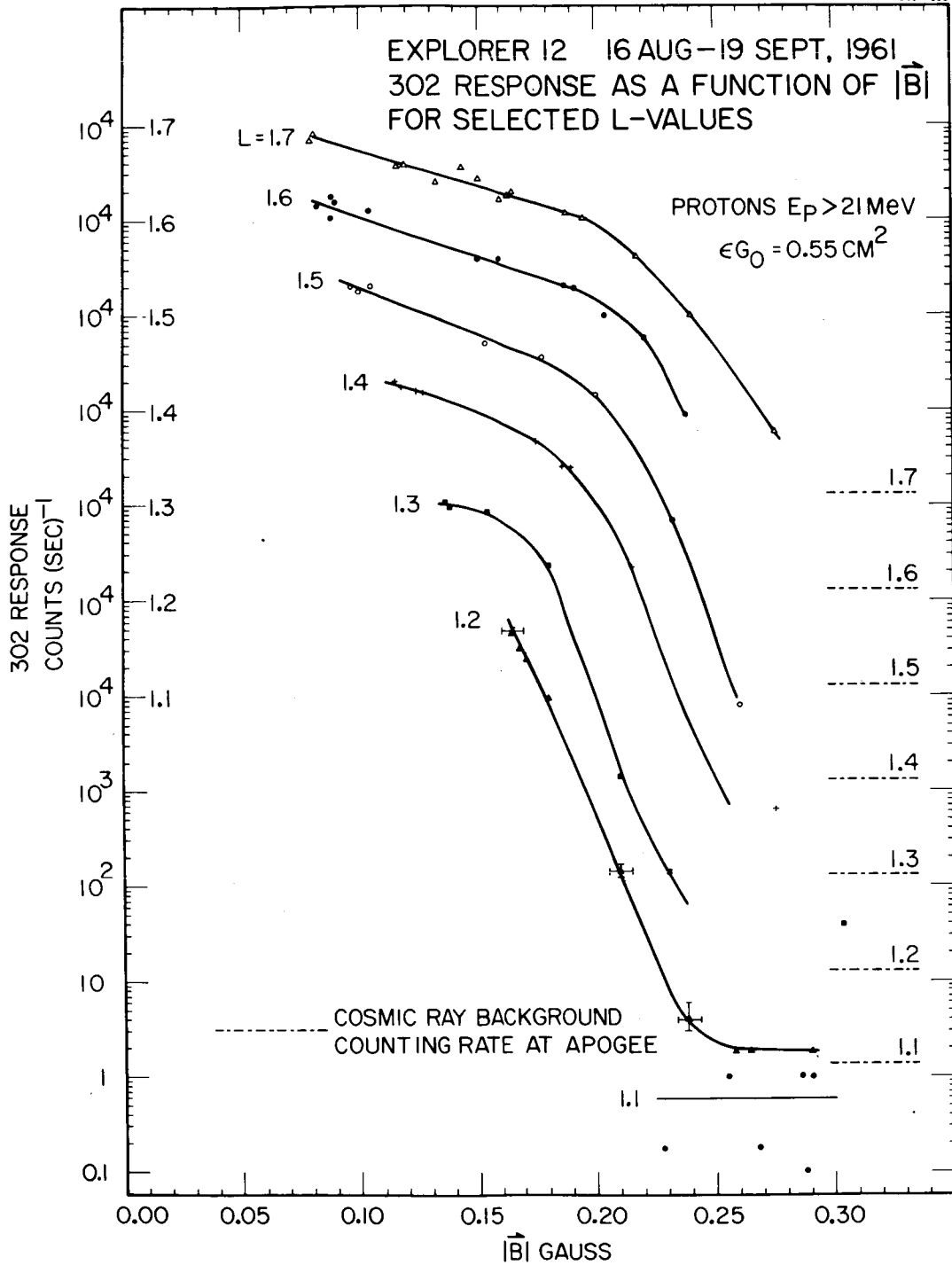
Figure 1
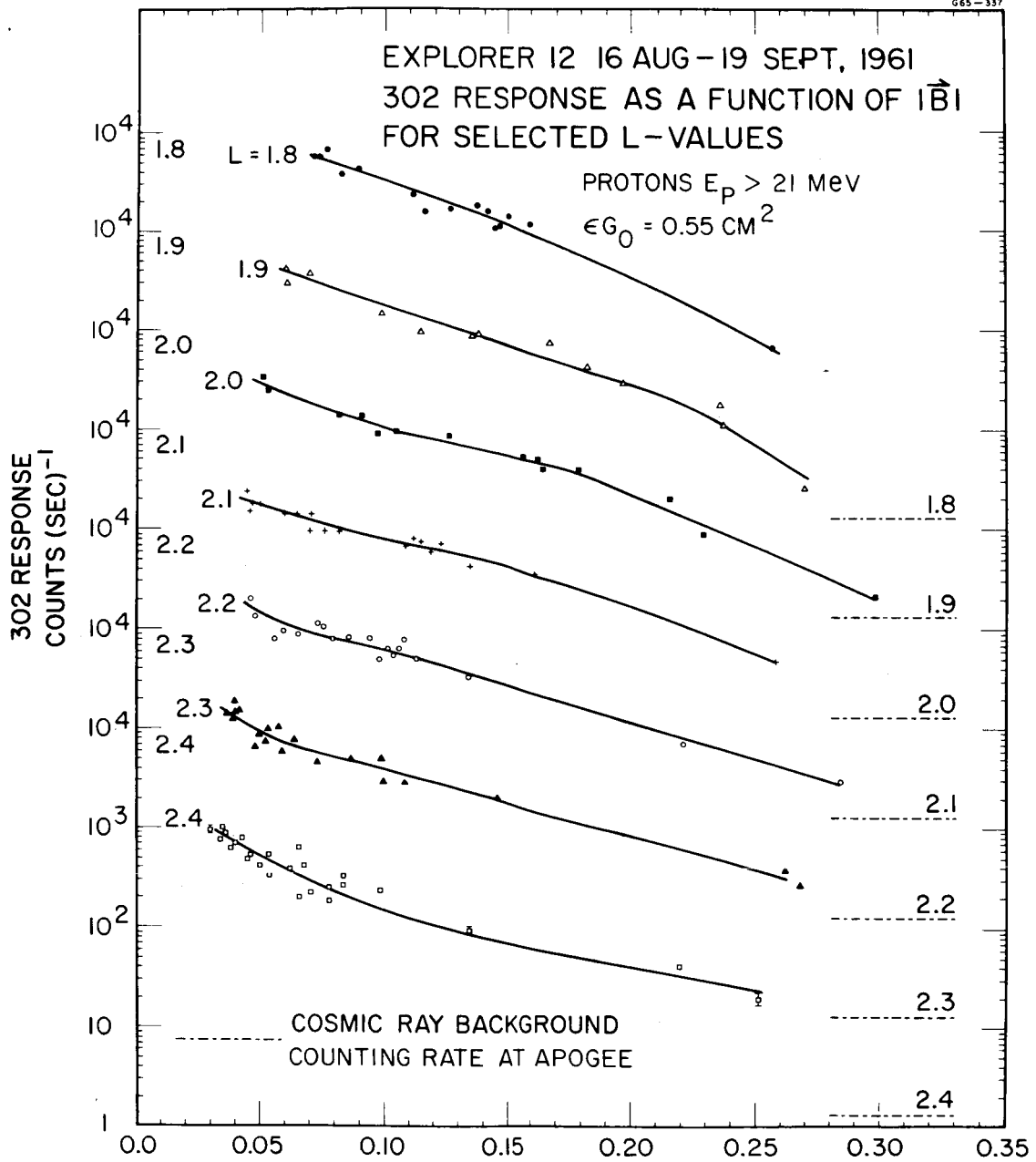
Figure 2

Figure 3

Figure 4

CONTOURS OF CONSTANT
COUNTING RATE
EXPLORER 12   16 AUG – 19 SEPT, 1961
302 G.M. TUBE

10^2 COUNTS (SEC)$^{-1}$

3×10^2

10^3

3×10^3

10^4

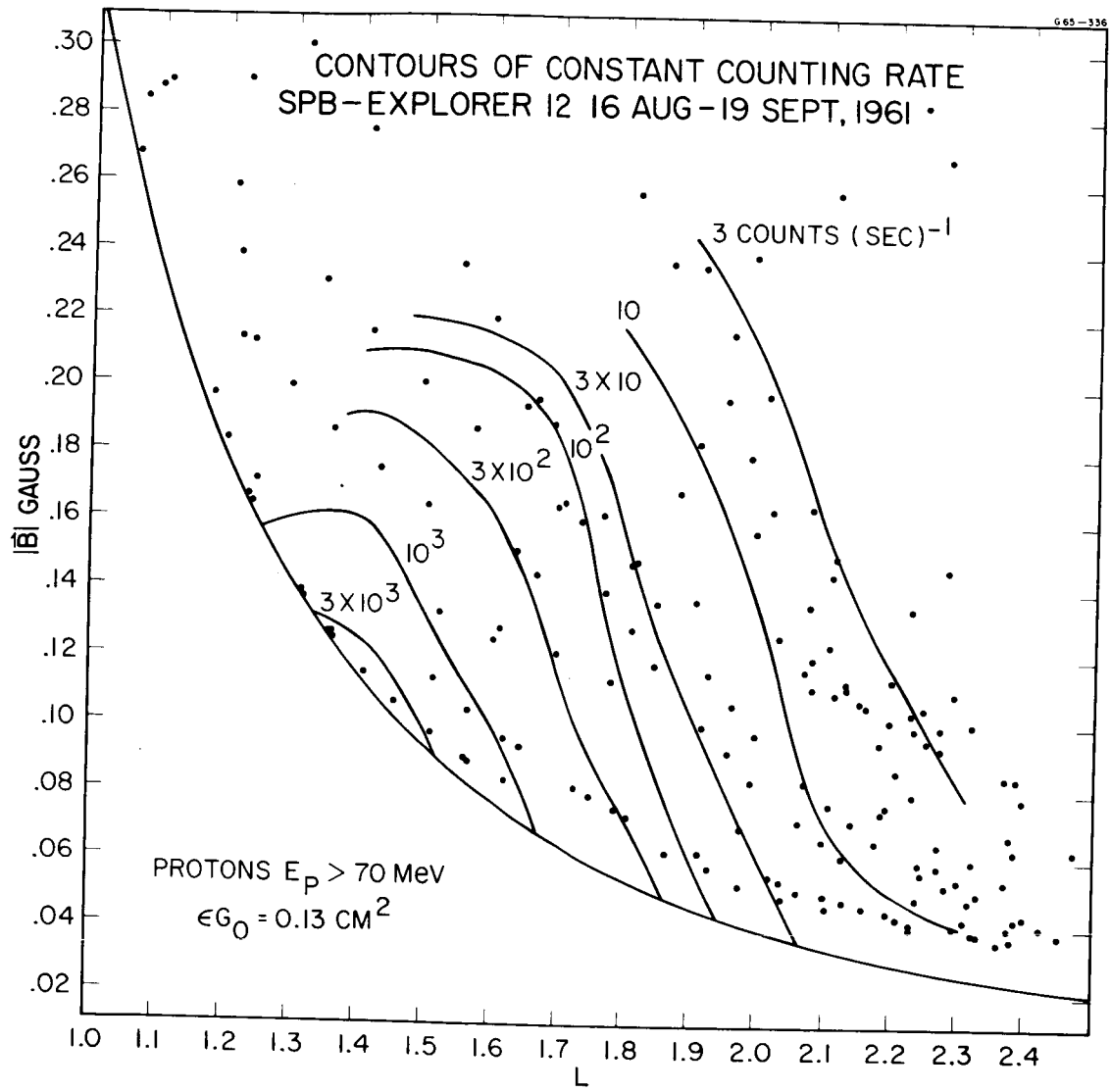$|\bar{B}|$ GAUSS

PROTONS $E_P > 21$ MeV

$\epsilon G_0 = 0.55$ CM^2

L

Figure 5

G 65-335

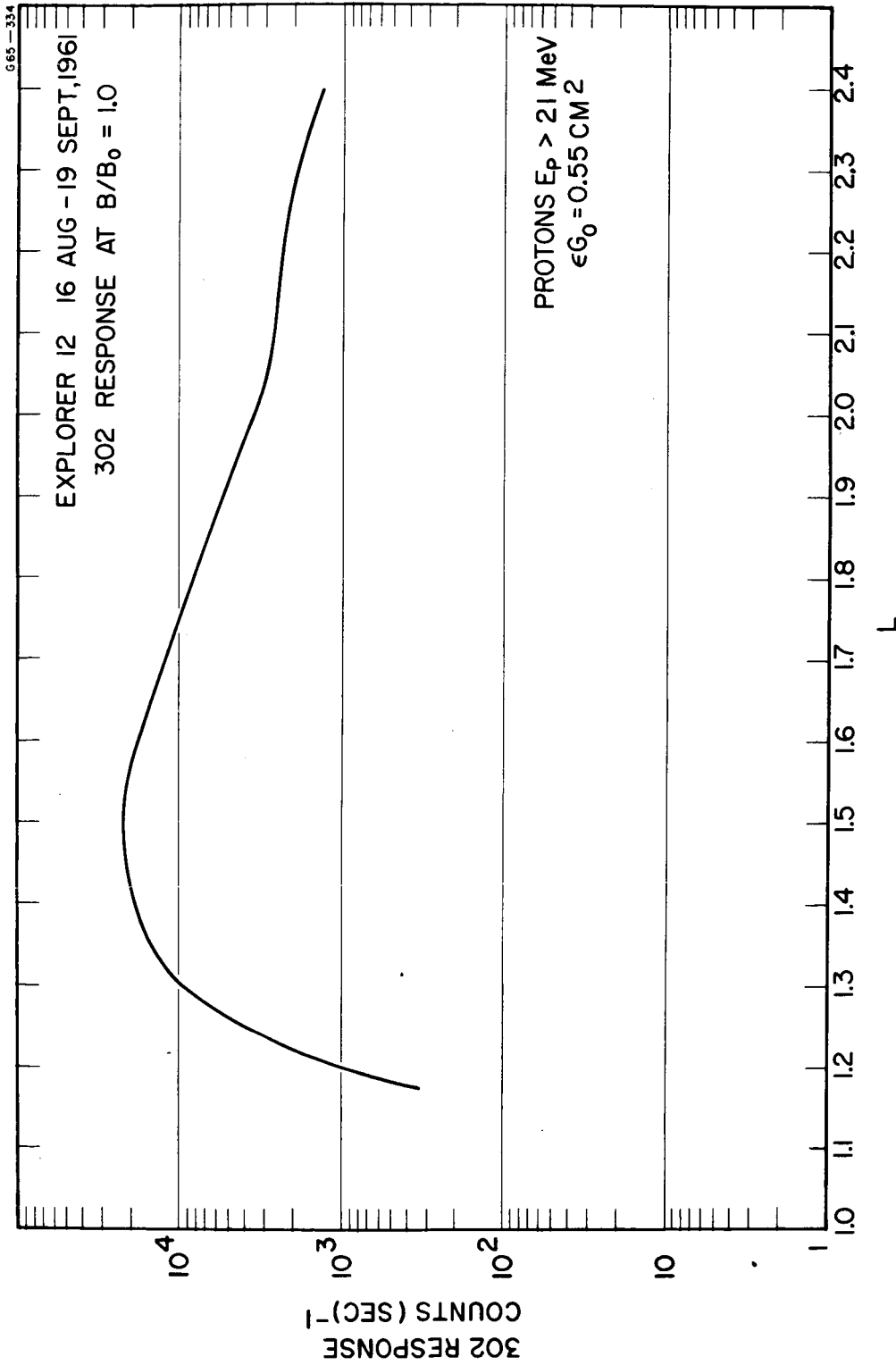Figure 6

Figure 7

Figure 8

Figure 9

L = 1.8

L = 2.0

● EXPLORER 12 $E_P > 70$ MeV (1961) SPB

△ FREDEN, BLAKE, & PAULIKAS (1964)

.05 .10 .15

$|\vec{B}|$
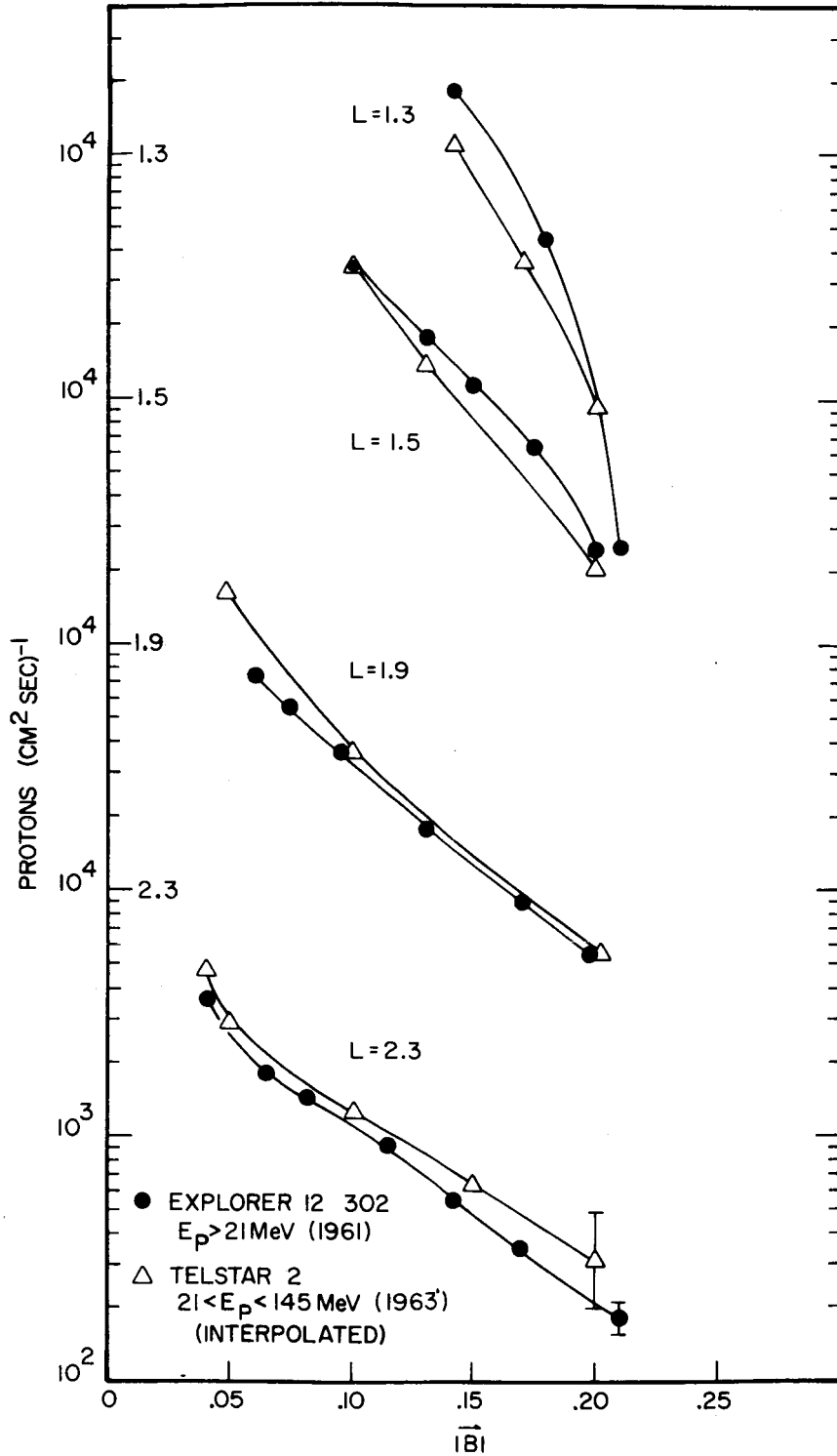
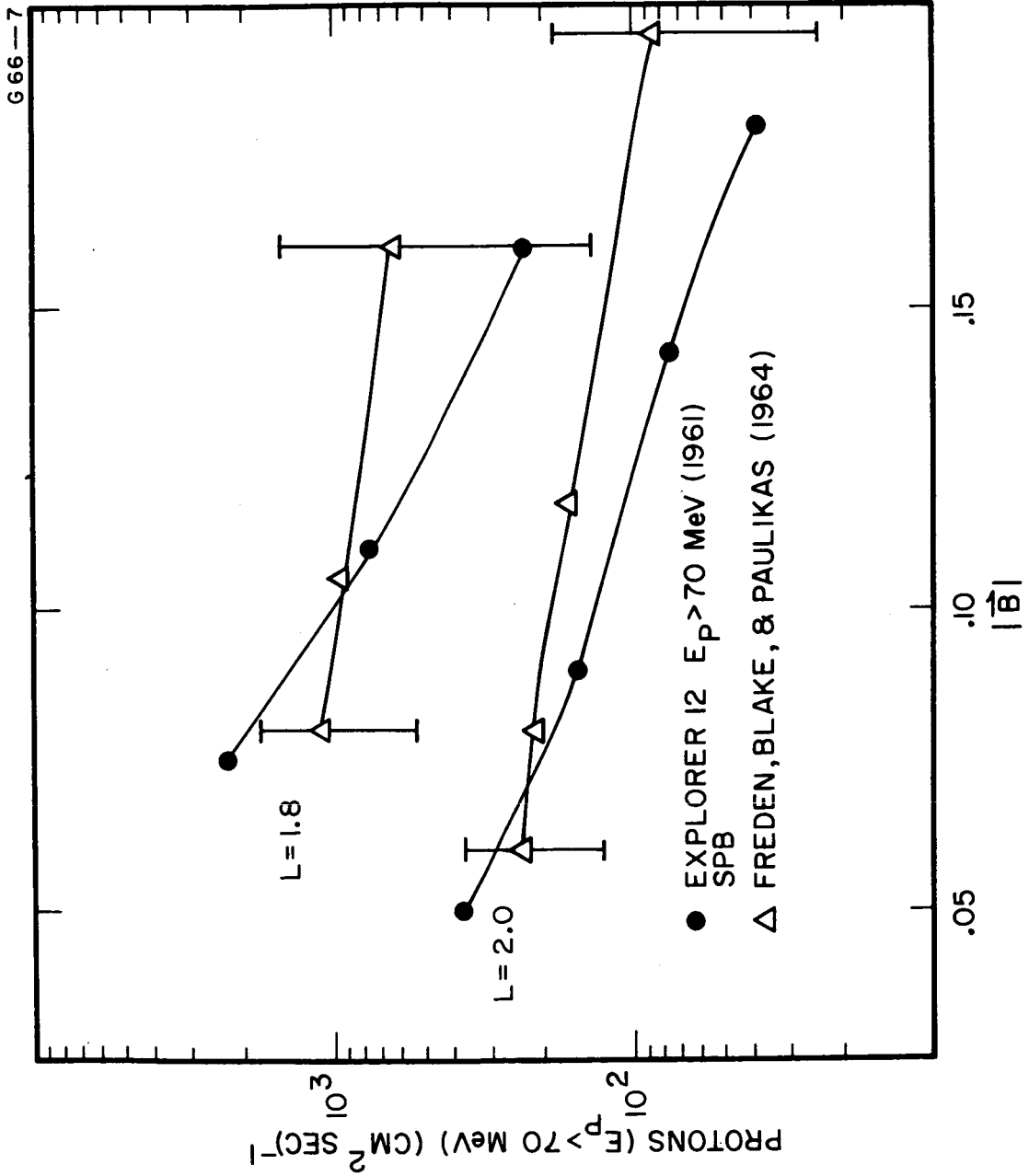PROTONS $(E_P > 70$ MeV) $(CM^2 SEC)^{-1}$
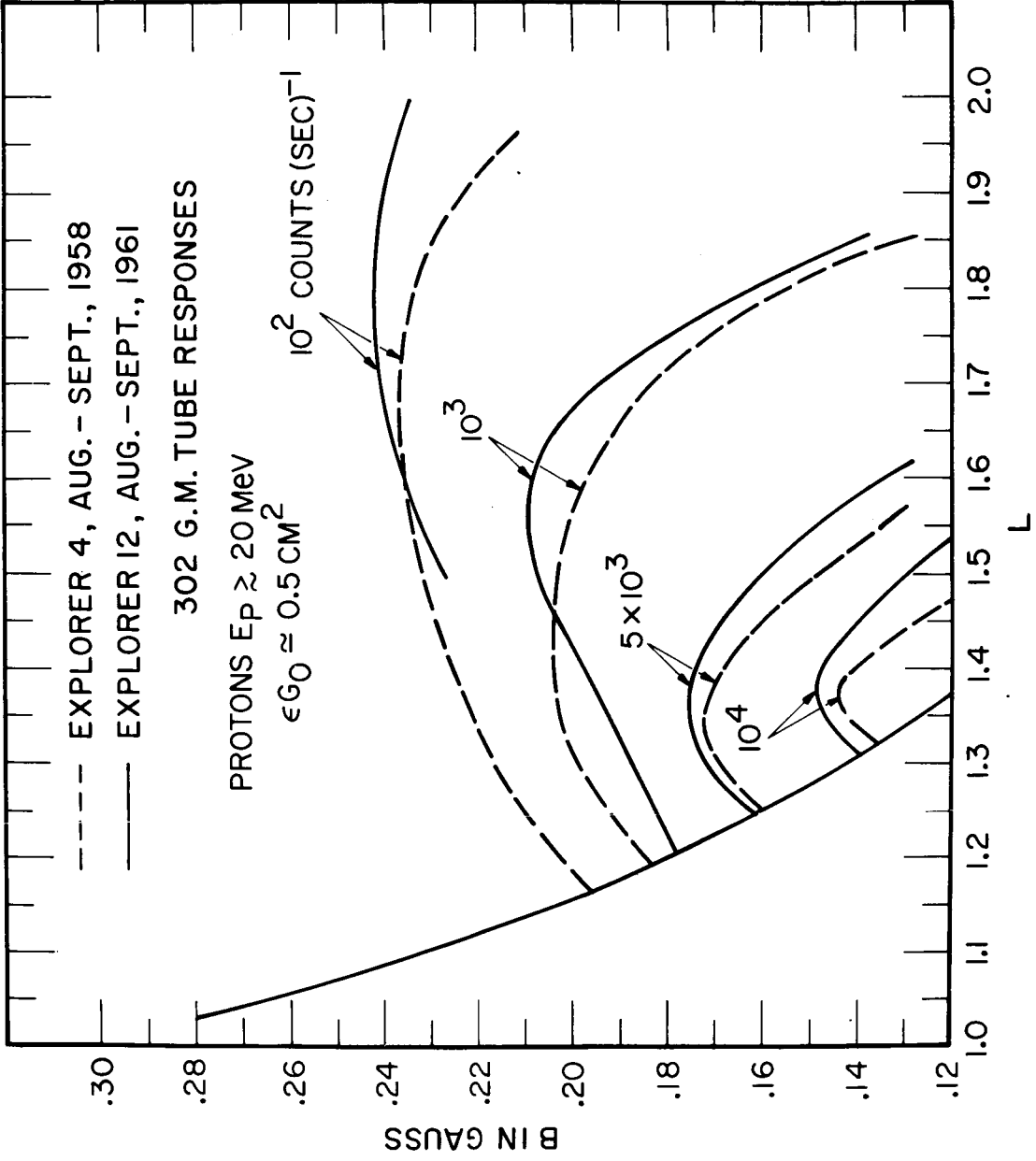
10^3

10^2
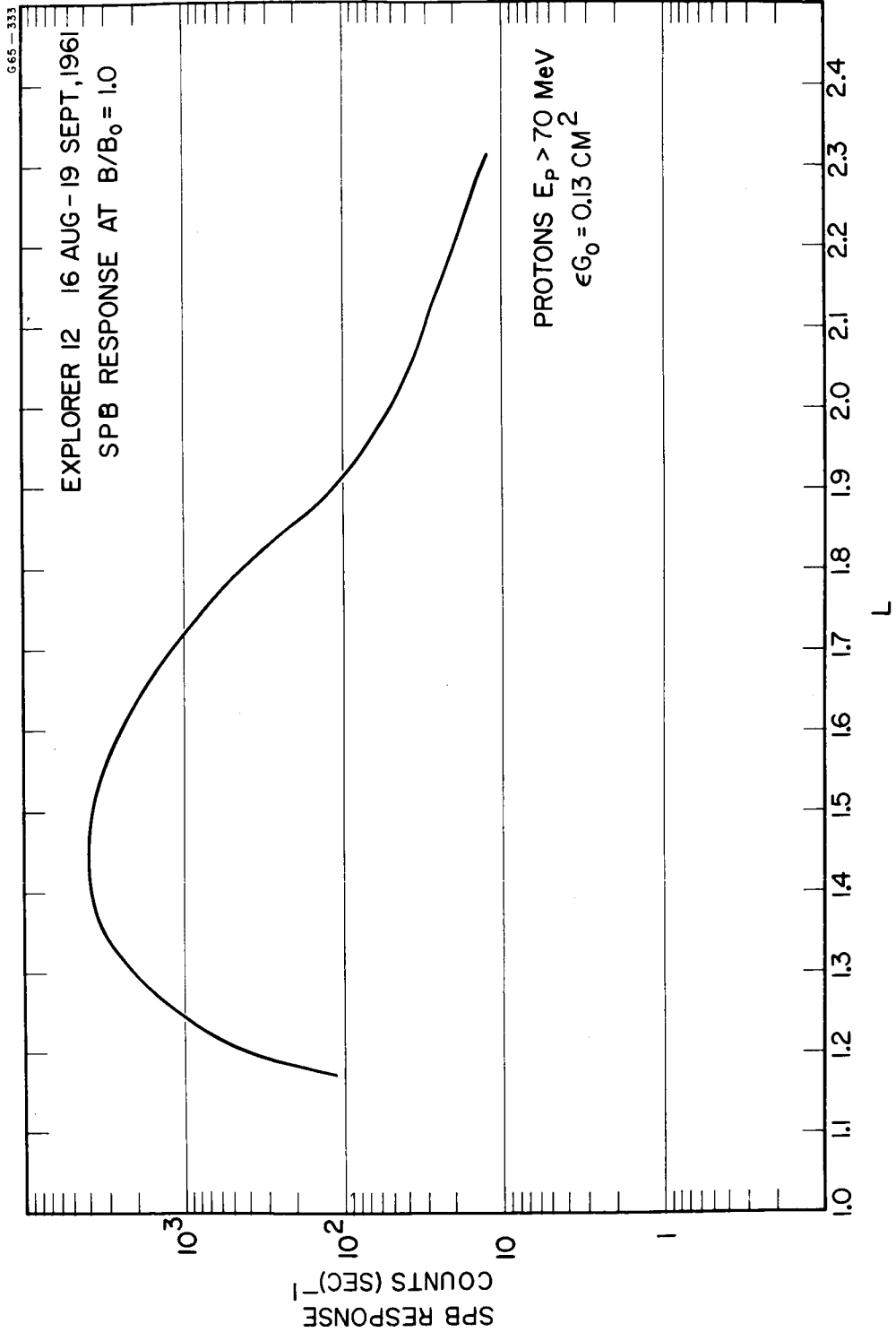
Figure 10

Figure 11

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University of Iowa, Department of Physics and Astronomy	UNCLASSIFIED
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3. REPORT TITLE

Explorer 12 Observations of Charged Particles in the Inner Radiation Zone

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Progress

5. AUTHOR(S) (Last name, first name, initial)

Ackerson, K. L. and L. A. Frank

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
June 1966	40	25

8a. CONTRACT OR GRANT NO. Nonr-1509(06)	9a. ORIGINATOR'S REPORT NUMBER(S)
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Measurements of energetic charged particles in the inner radiation zone with two shielded, omnidirectional Geiger-Mueller tubes flown on Explorer 12 have been used to construct B-L contours of the omnidirectional intensities of protons $E_p > 21$ Mev and $E_p > 70$ Mev for the period 16 August to 19 September, 1961, prior to the Starfish high-altitude nuclear burst on 9 July 1962. The values of proton ($E_p > 21$ Mev) omnidirectional intensities are in substantial agreement with the post-Starfish values from Telstar 2 and with other observations. Upper limits for the omnidirectional intensities of electrons $E_e > 1.6$ Mev at the geomagnetic equator before the Starfish test are $J_o < 10^4$ $(cm^2\text{-sec})^{-1}$ at $L = 1.2$, $< 4 \times 10^4$ $(cm^2\text{-sec})^{-1}$ at $L = 1.25$, $< 2.5 \times 10^5$ $(cm^2\text{-sec})^{-1}$ at $L = 1.5$, $\leq 8 \times 10^4$ $(cm^2\text{-sec})^{-1}$ at $L = 1.8$ and $< 1.5 \times 10^4 (cm^2\text{-sec})^{-1}$ at $L = 2.4$.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Inner radiation zone						
Starfish						
Radiation zones						

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