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IDENTIFICATION CURVES FOR HEAVY-MESON AND HYPERON DECAYS

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IDENTIFICATION CURVES FOR HEAVY-MESON AND HYPERON DECAYS

Howard S. White

September 19, 1956

Printed for the U. S. Atomic Energy Commission

IDENTIFICATION CURVES FOR HEAVY-MESON AND HYPERON DECAYS

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Radiation Laboratory
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ABSTRACT

Curves are presented for the purpose of facilitating identification of heavy-meson and hyperon decays.

IDENTIFICATION CURVES FOR HEAVY-MESON AND HYPERON DECAYS

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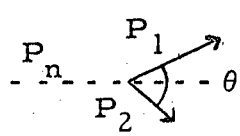
The curves contained in this report were designed to facilitate the rapid identification of a primary particle which is observed to decay into two particles within a cloud chamber or similar experimental medium. The momentum vectors of the two charged particles involved and the angle included between the vectors will usually be measurable. An assumption as to the identity of the particles involved may immediately be determined to be either consistent or inconsistent with the observed momenta and angle by reference to the appropriate graph.

The kinematic properties of the decay of either a neutral or charged primary may be used to derive the equation

$$E_1 E_2 - P_1 P_2 \cos \theta = C ,$$

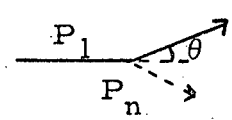
where the meaning of the quantities is indicated below for the separate cases of a neutral and a charged primary.

Neutral Primary



$$C = \frac{1}{2}(M_n^2 - M_1^2 - M_2^2)$$

Charged Primary



$$C = \frac{1}{2}(M_1^2 + M_2^2 - M_n^2)$$

Throughout this report, the units are expressed as Bev for energy, and Bev/c for momentum. The masses used for the different particles are given in Table I.

The evaluation of the equation to find the plotted points was performed on the IBM Type 650 machine at Livermore.

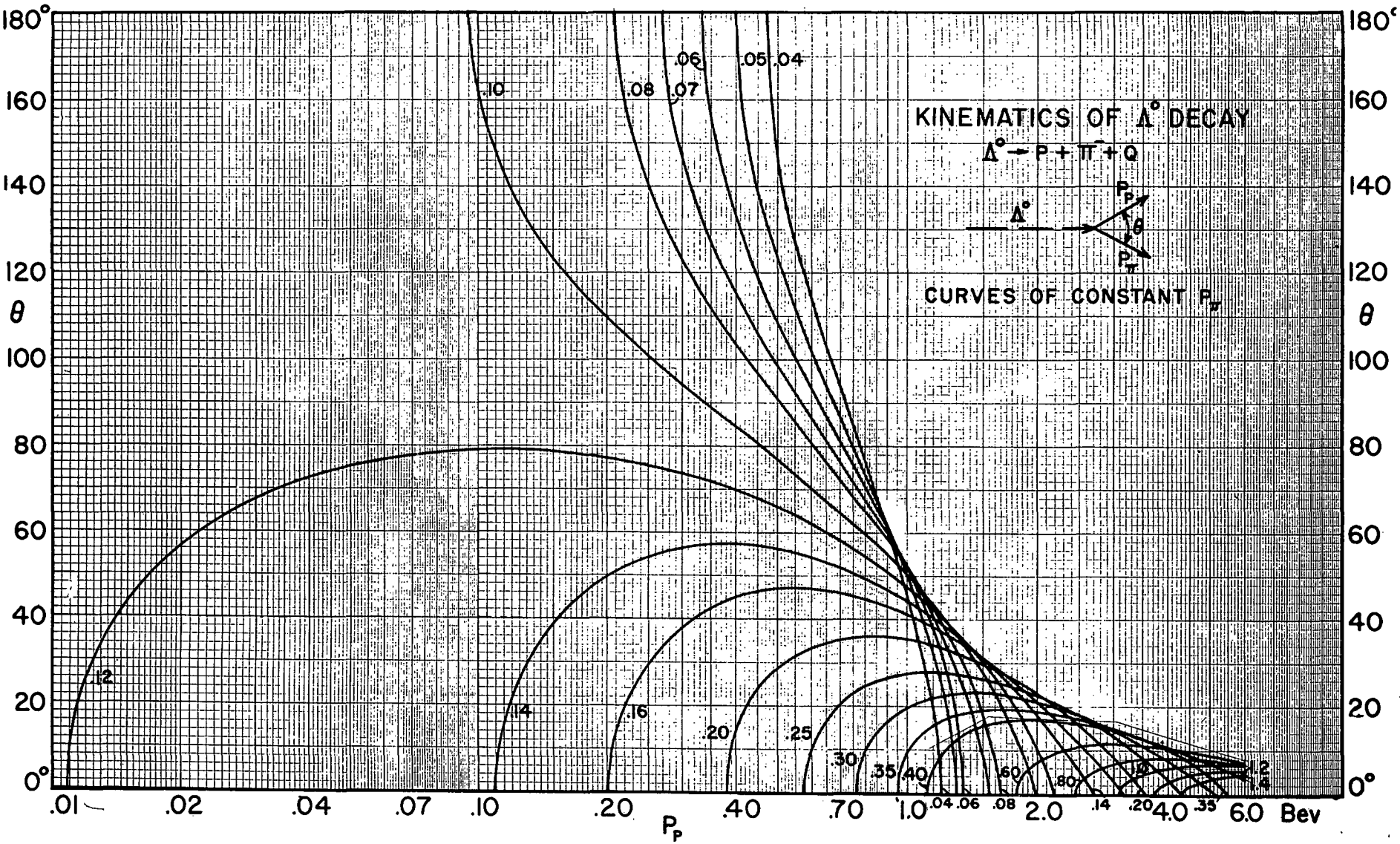
This work was undertaken at the suggestion of William B. Fowler. The table of masses was furnished by George Maenchen, and much of the drafting was done by Arthur Kemalyan and Mrs. Ruth Miller.

This work was done under the auspices of the U. S. Atomic Energy Commission.

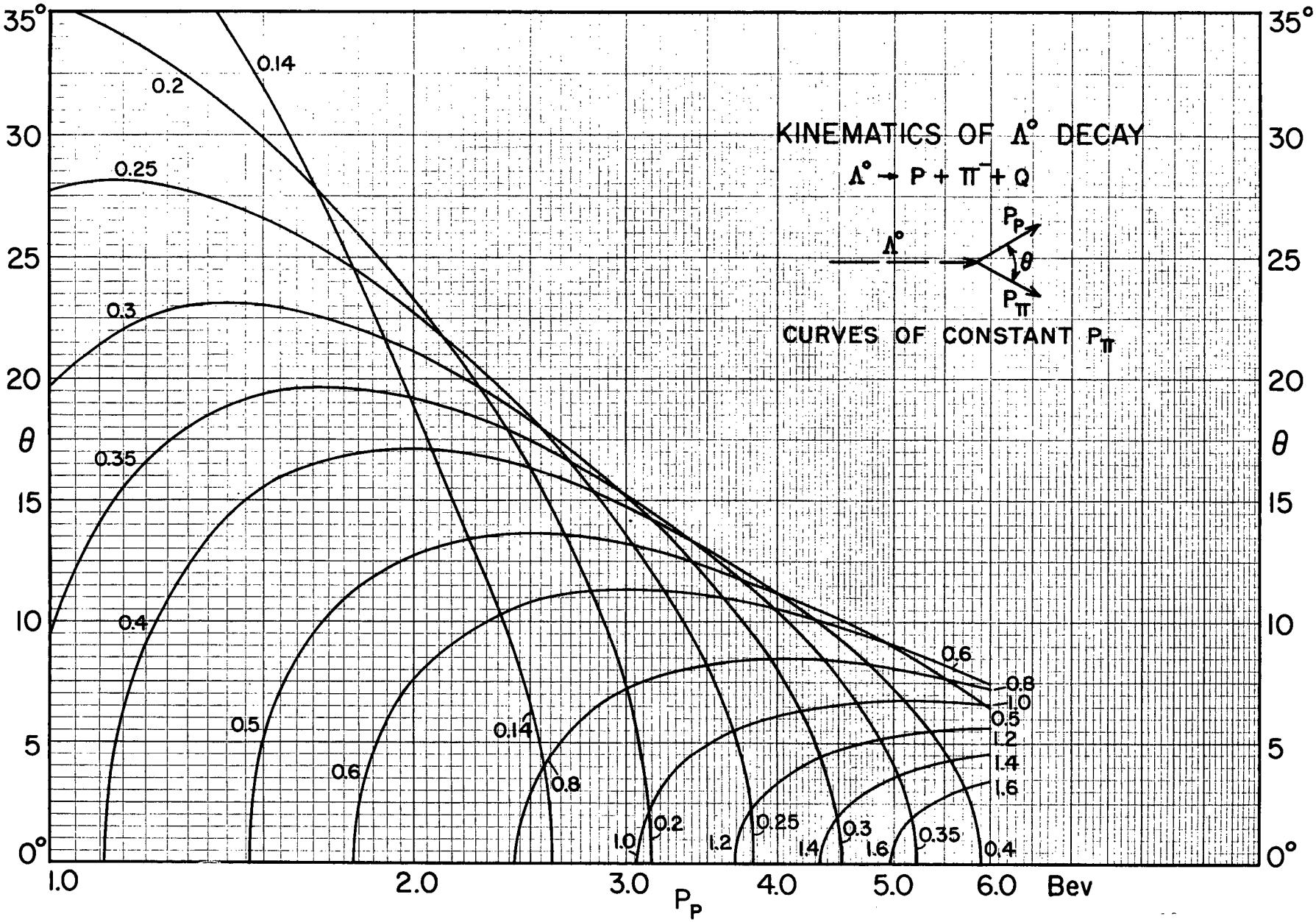
Table I

Masses Used in the Calculations

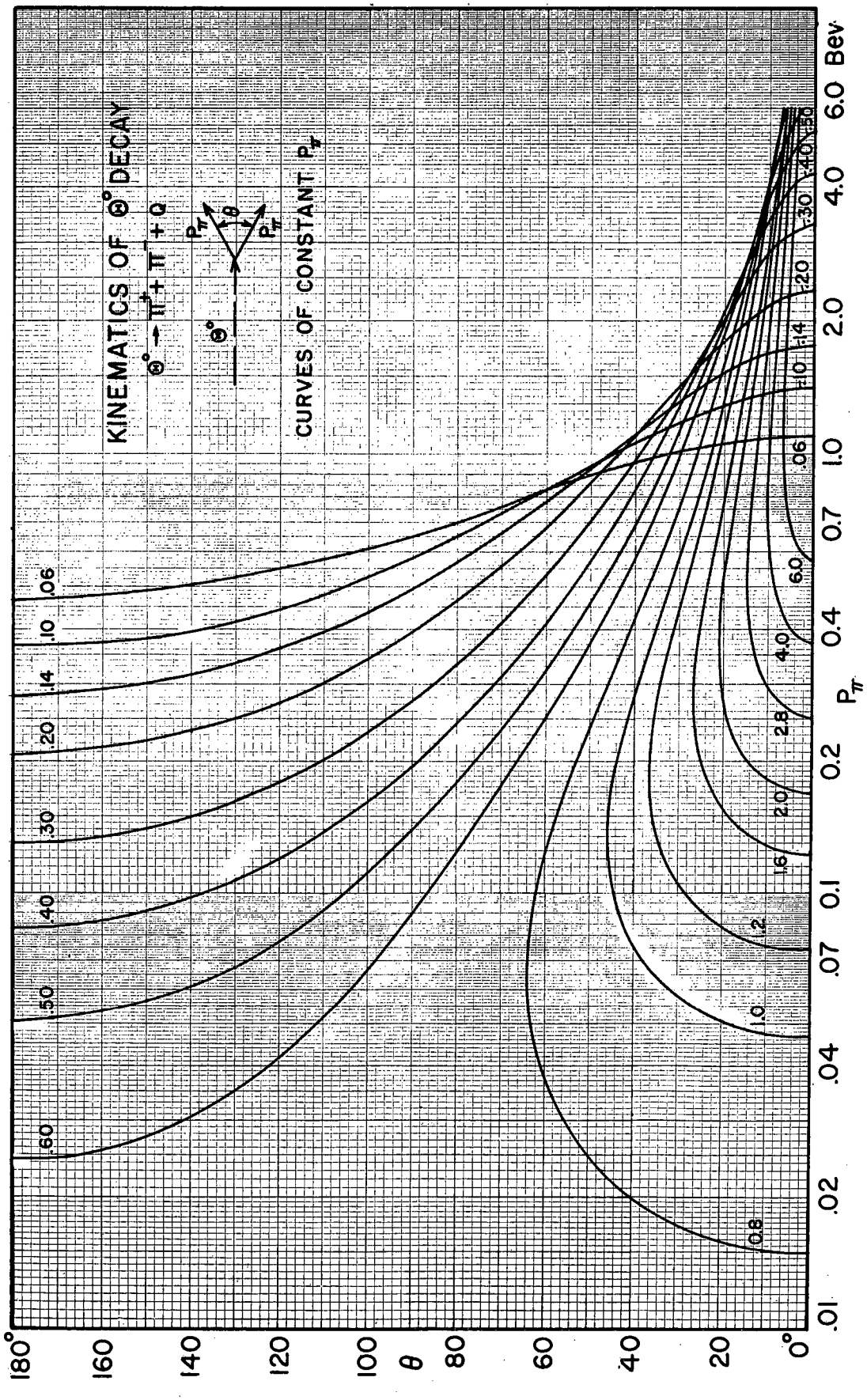
Particle	Mass (Bev.)	Particle	Mass (Bev.)
μ	0.10572	p	0.93823
π^{o}	0.13505	n	0.93953
$\pi^{\pm}$	0.13955	Λ^{o}	1.11470
$\theta^{o}, K^{\pm}$	0.49336	Σ^{+}	1.18906
		Ξ^{-}	1.3182


KINEMATICS OF Λ° DECAY
Λ° → P + π⁻ + Q
Λ°
P_P
θ
P_π
CURVES OF CONSTANT P_π
θ
180°
160
140
120
100
80
60
40
20
0°
.01
.02
.04
.07
.10
.20
.40
.70
1.0
2.0
4.0
6.0 Bev
P_P
.12
.14
.16
.20
.25
.30
.35
.40
.60
.80
1.0
1.2
1.4
.10
.08
.07
.06
.05
.04
.04
.06
.08
.14
.20
.35

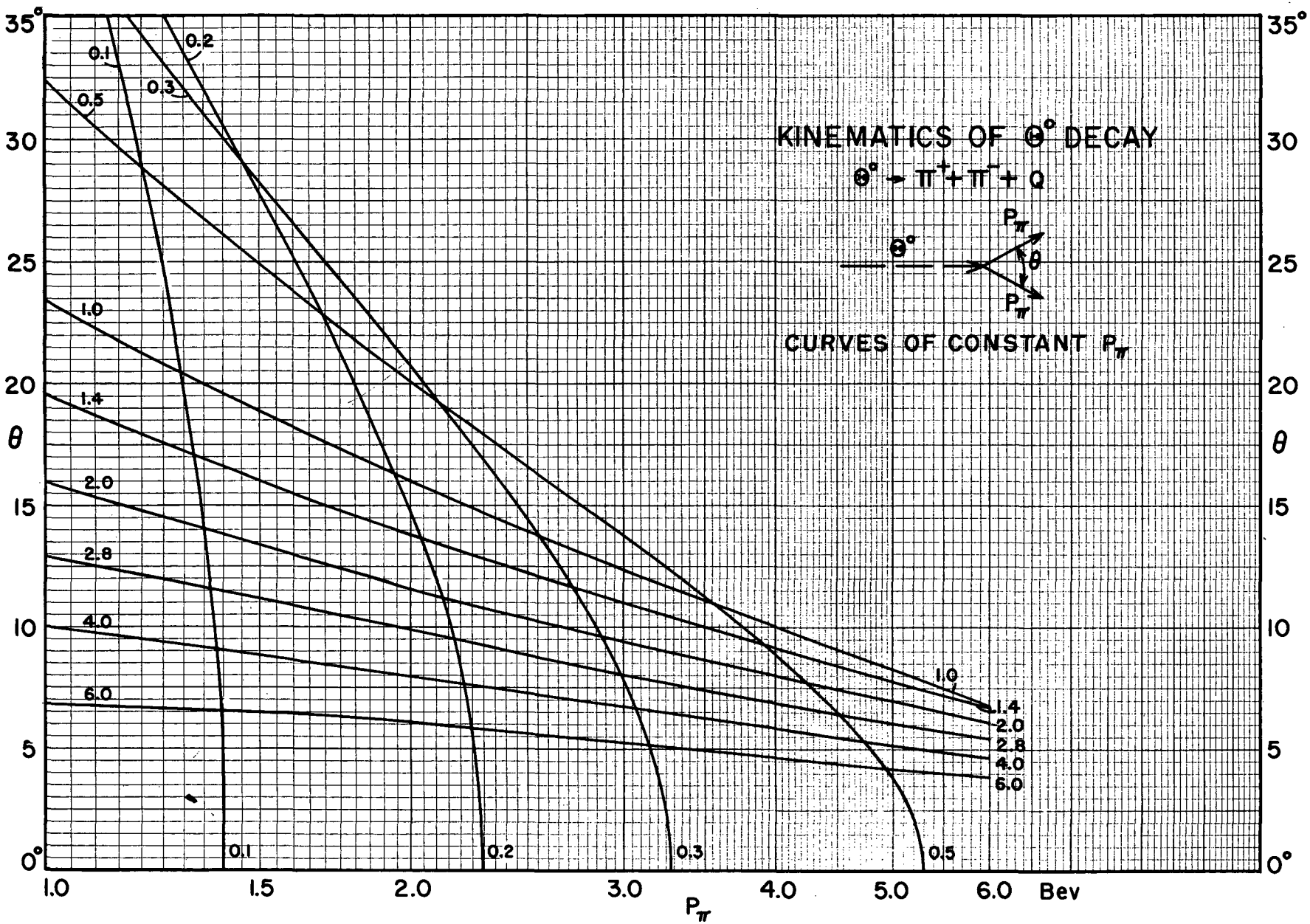
ZN-1564


KINEMATICS OF Λ° DECAY
Λ° → P + π⁻ + Q
Λ°
P_P
θ
P_π
CURVES OF CONSTANT P_π
35°
30
25
20
θ
15
10
5
0°
1.0
2.0
3.0
4.0
5.0
6.0
Bev
P_P
0.14
0.2
0.25
0.3
0.35
0.4
0.5
0.6
0.8
1.0
1.2
1.4
1.6

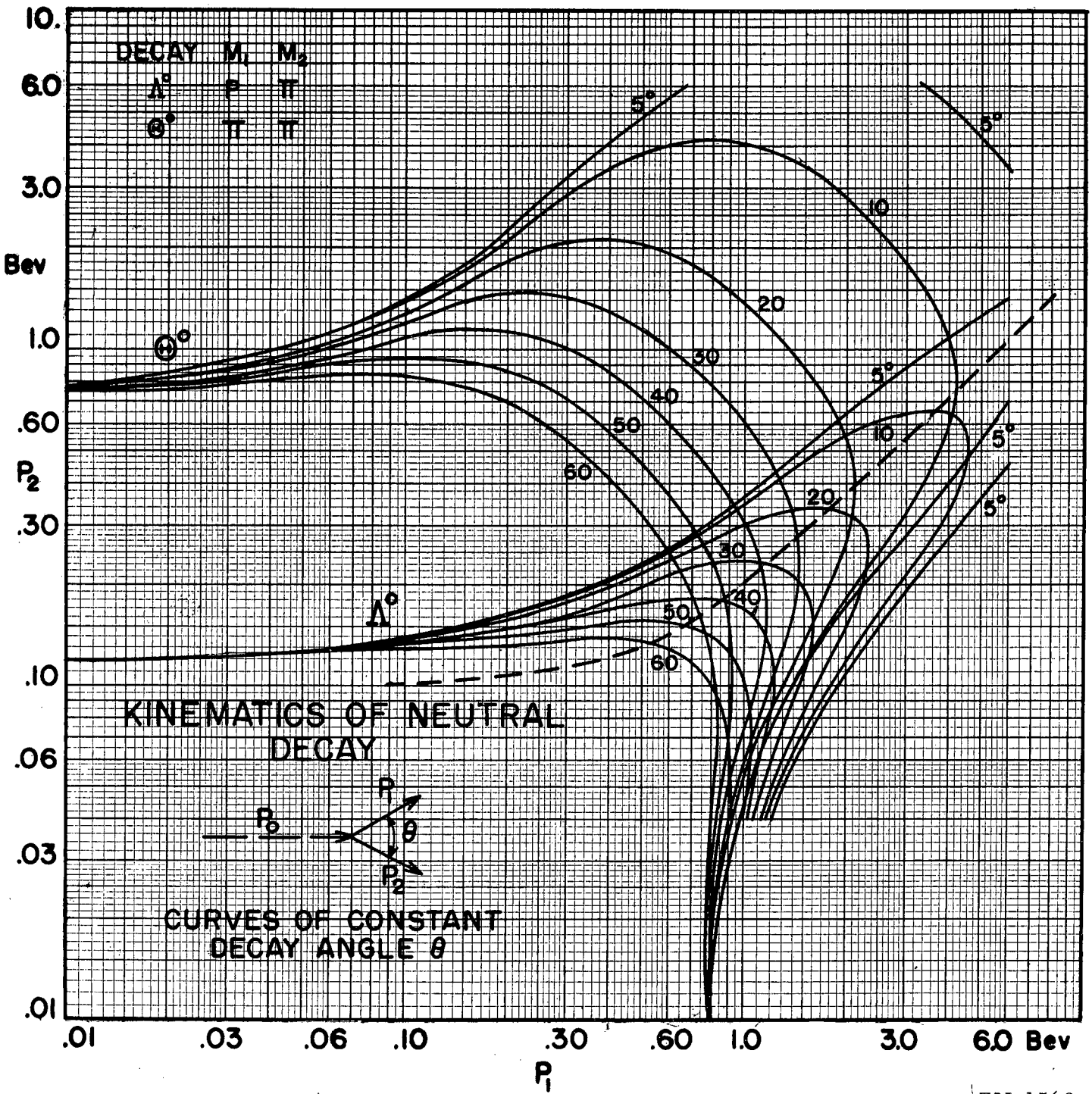
ZN-1565


KINEMATICS OF Θ° DECAY
Θ° → π⁺ + π⁻ + Q
CURVES OF CONSTANT P_π
P_π
θ
Θ°
.06
.10
.14
.20
.30
.40
.50
.60
.8
1.0
.2
1.6
2.0
2.8
4.0
6.0
.06
.10
.14
.20
.30
.40
.50
6.0 Bev
4.0
2.0
1.0
0.7
0.4
0.2
0.1
.07
.04
.02
.01
P_π
180°
160
140
120
100
80
60
40
20
0°
θ

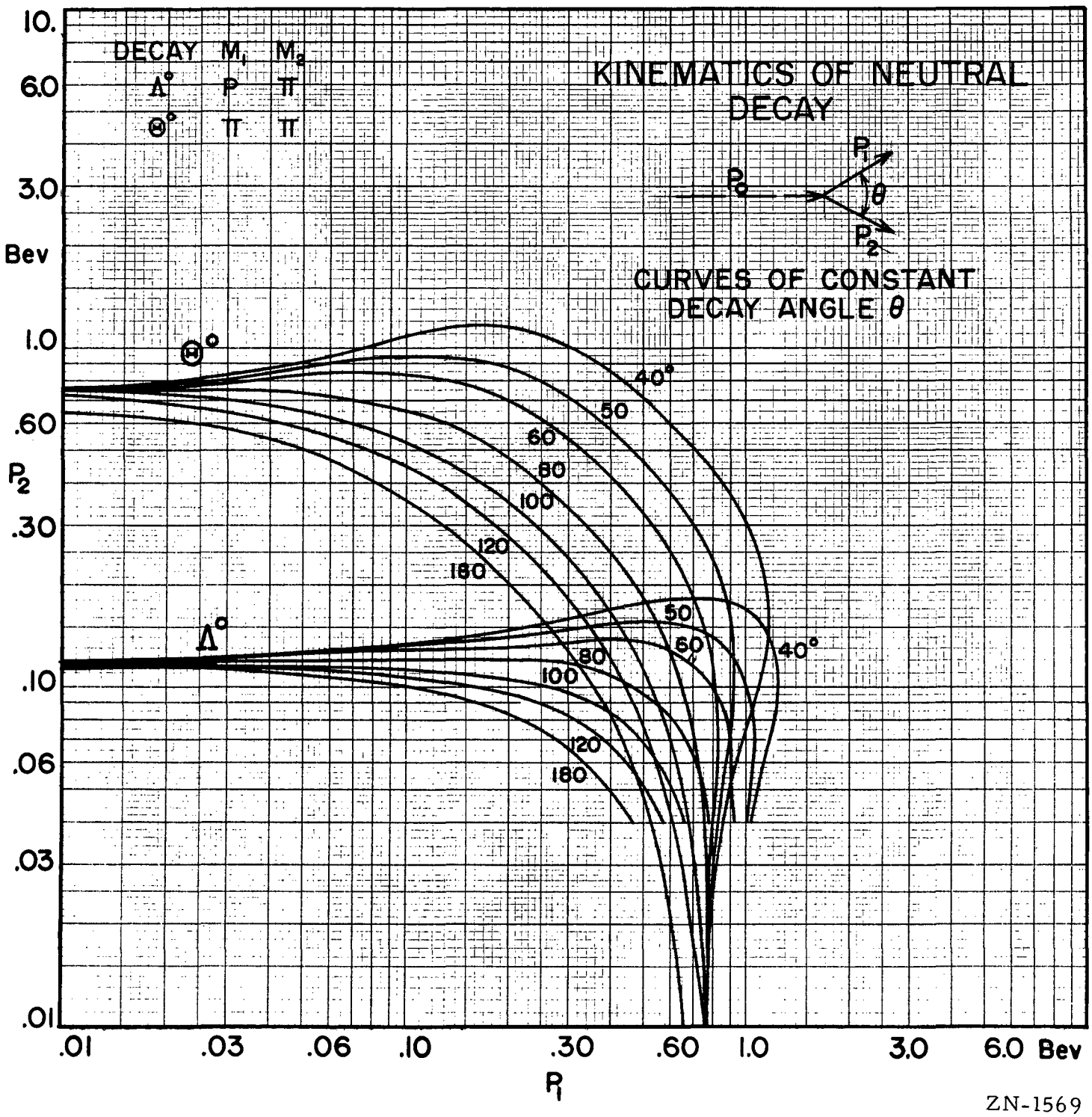
ZN-1566


KINEMATICS OF Θ° DECAY
Θ° → π⁺ + π⁻ + Q
Θ°
P_π
θ
P_π
CURVES OF CONSTANT P_π
0.1
0.2
0.3
0.5
1.0
1.4
2.0
2.8
4.0
6.0
θ
35°
30
25
20
15
10
5
0°
1.0
1.5
2.0
3.0
4.0
5.0
6.0
Bev
P_π

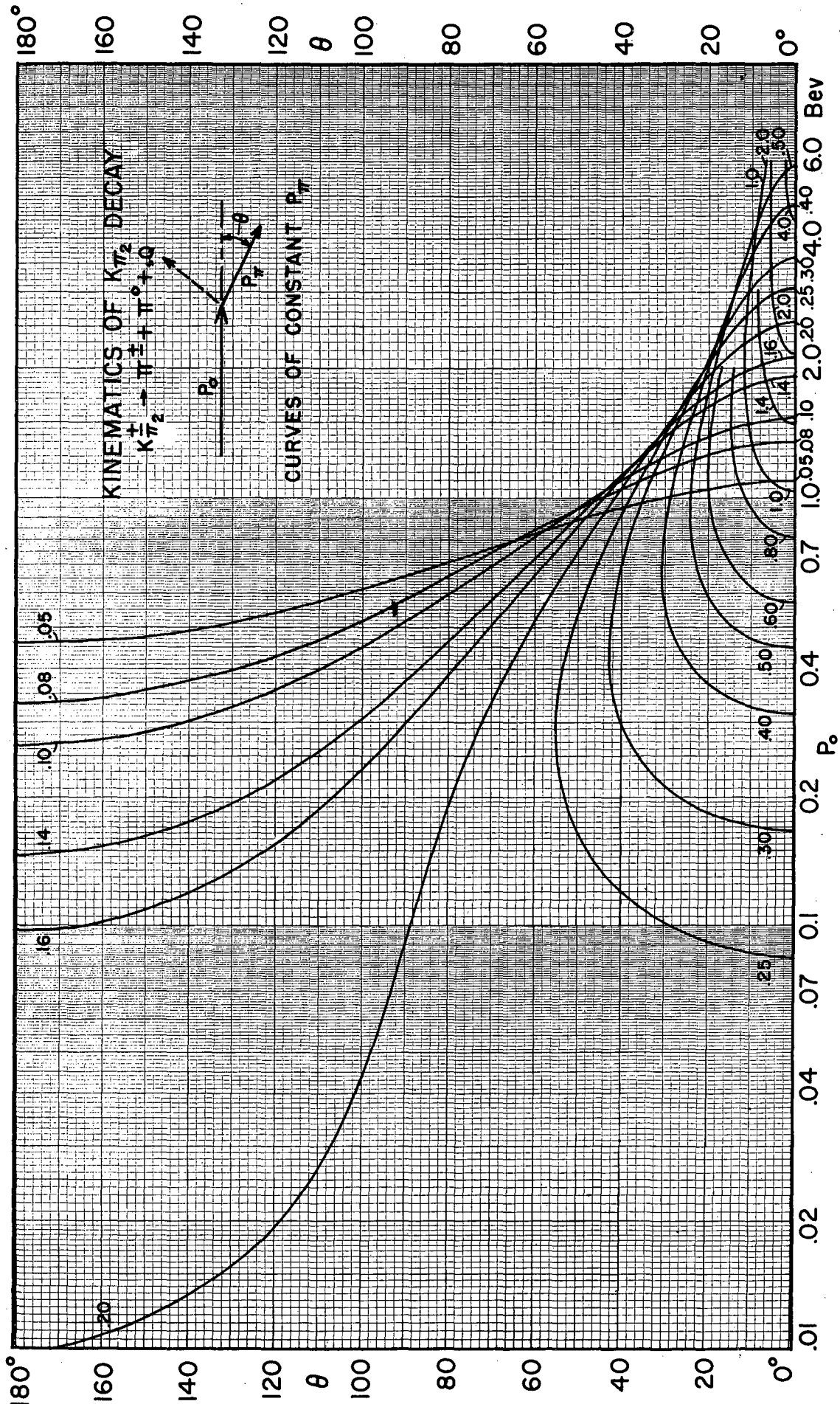
ZN-1567

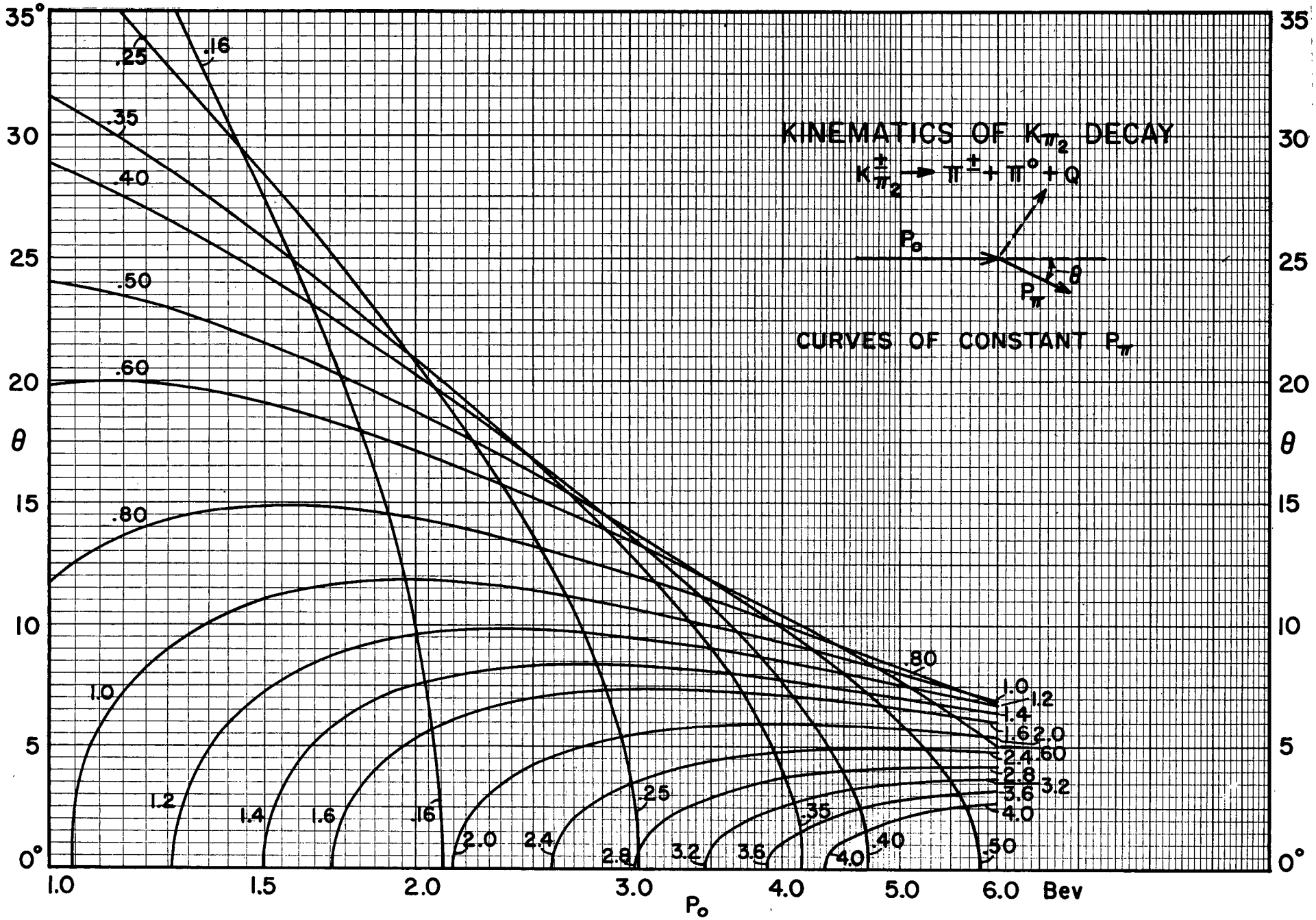

DECAY M1 M2
Λ° P π
Θ° π π
KINEMATICS OF NEUTRAL DECAY
CURVES OF CONSTANT DECAY ANGLE θ
P1
P2
P0
θ
Λ°
Θ°
5°
10
20
30
40
50
60
10.
6.0
3.0
1.0
.60
.30
.10
.06
.03
.01
Bev
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev

ZN-1568

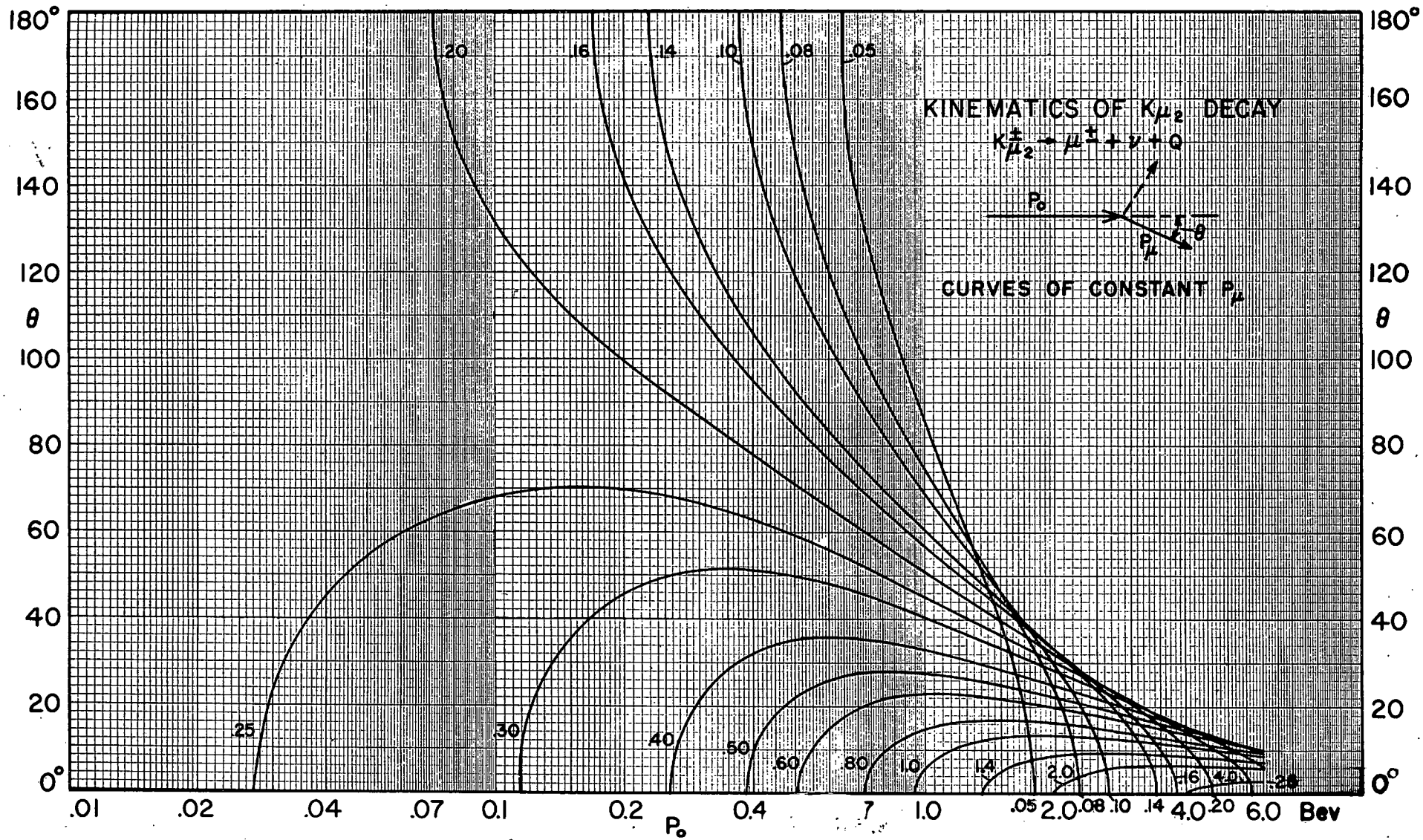

DECAY M1 M2
Λ° P π
Θ° π π
KINEMATICS OF NEUTRAL DECAY
P0
P1
θ
P2
CURVES OF CONSTANT DECAY ANGLE θ
Θ°
Λ°
40°
50
60
80
100
120
180
10.
6.0
3.0
Bev
1.0
.60
P2
.30
.10
.06
.03
.01
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev
P1

ZN-1569

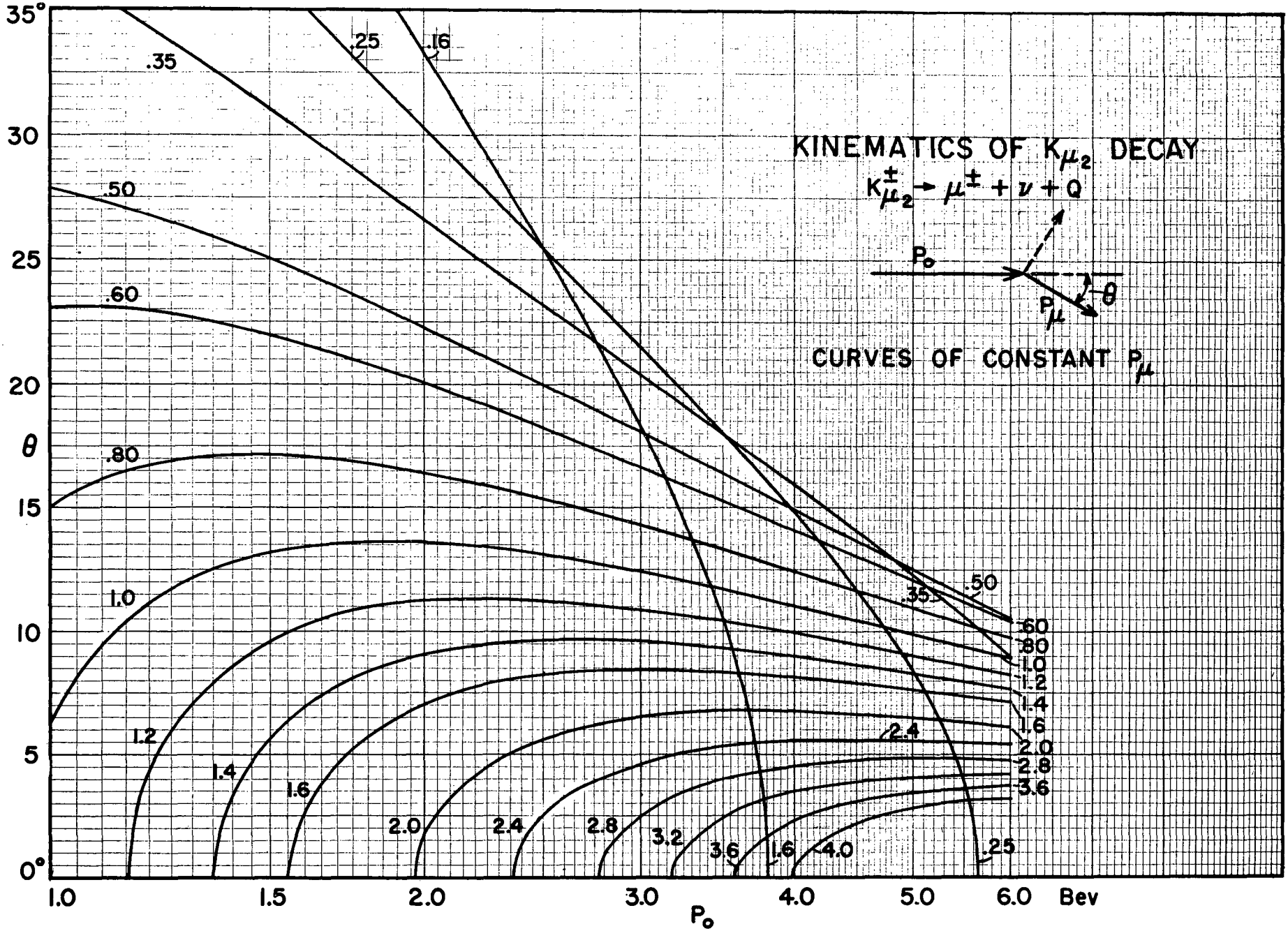

KINEMATICS OF K_{π_2} DECAY
$K^{\pm}_{\pi_2} \rightarrow \pi^{\pm} + \pi^{0} + Q$
P_0
P_π
θ
CURVES OF CONSTANT P_π
P_0
θ
Bev
ZN-1570


KINEMATICS OF K_{π_2} DECAY
$K^{\pm}_{\pi_2} \rightarrow \pi^{\pm} + \pi^{0} + Q$
P_o
P_π
θ
CURVES OF CONSTANT P_π
θ
P_o
Bev
35°
30
25
20
15
10
5
0°
1.0
1.5
2.0
3.0
4.0
5.0
6.0
.25
.16
.35
.40
.50
.60
.80
1.0
1.2
1.4
1.6
2.0
2.4
2.8
3.2
3.6
4.0

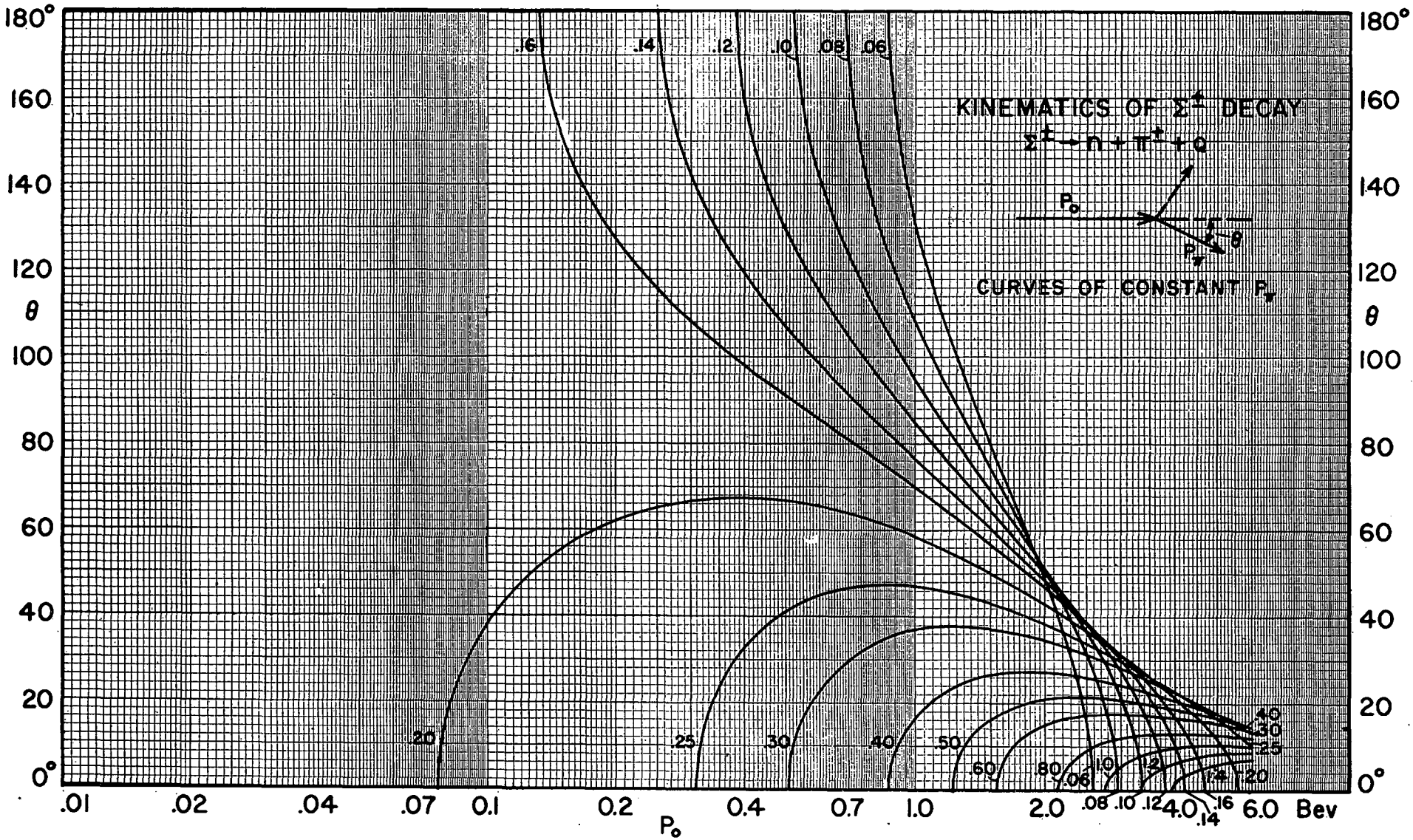
ZN-1571


KINEMATICS OF K_{μ_2} DECAY
$K^{\pm}_{\mu_2} \rightarrow \mu^{\pm} + \nu + Q$
P_o
P_μ
θ
CURVES OF CONSTANT P_μ
180°
160
140
120
100
80
60
40
20
0°
θ
.01
.02
.04
.07
0.1
0.2
0.4
.7
1.0
2.0
4.0
6.0
Bev
P_o
.20
.16
.14
.10
.08
.05
.25
.30
.40
.50
.60
.80
1.0
1.4
2.0
4.0
.28

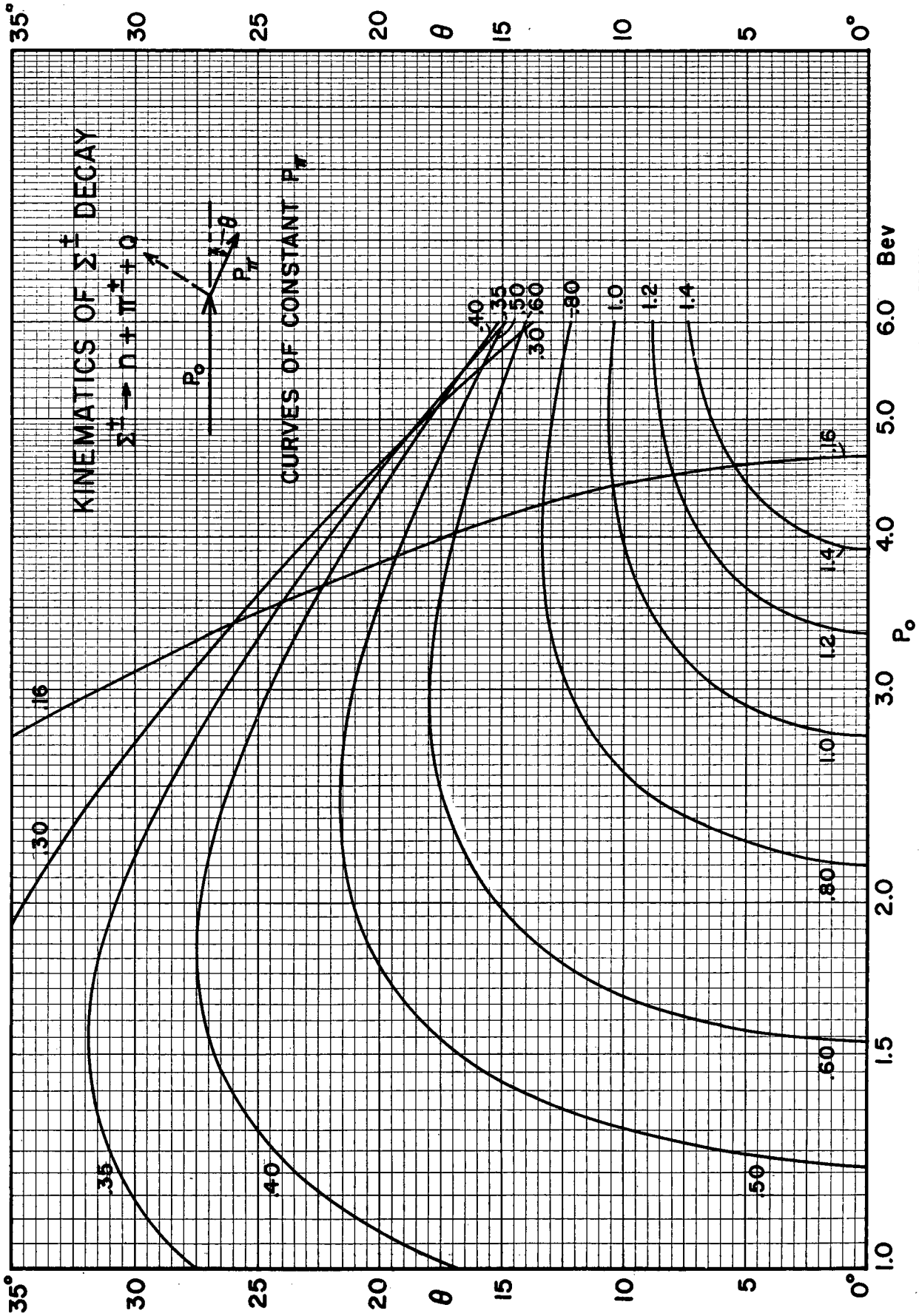
ZN-1572


KINEMATICS OF K_{μ_2} DECAY
$K^{\pm}_{\mu_2} \rightarrow \mu^{\pm} + \nu + Q$
P_o
P_μ
θ
CURVES OF CONSTANT P_μ
35°
30
25
20
θ
15
10
5
0°
1.0
1.5
2.0
3.0
4.0
5.0
6.0
Bev
P_o
.35
.25
.16
.50
.60
.80
1.0
1.2
1.4
1.6
2.0
2.4
2.8
3.2
3.6
1.6
4.0
.25
.35
.50
.60
.80
1.0
1.2
1.4
1.6
2.4
2.0
2.8
3.6

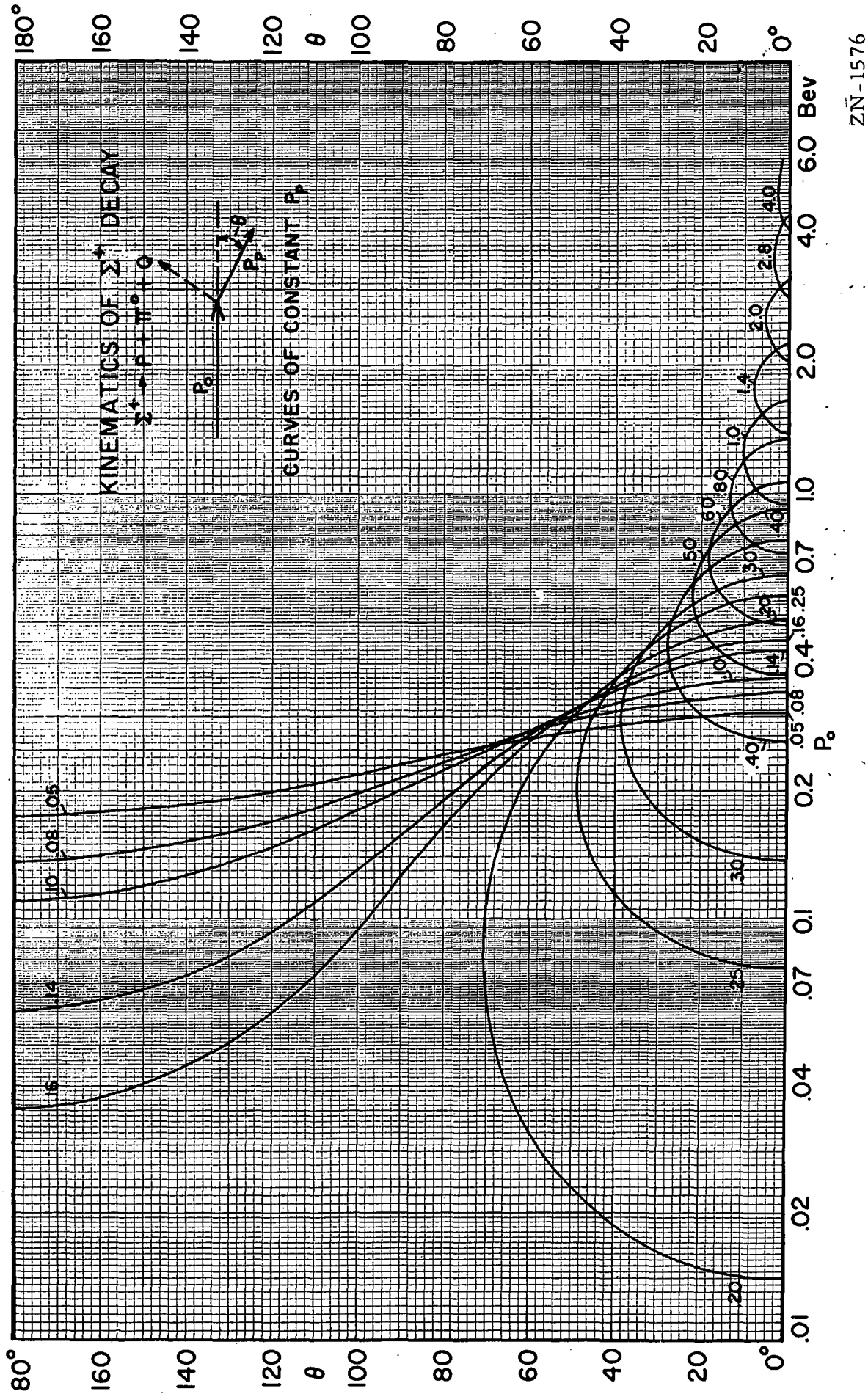
ZN-1573


KINEMATICS OF $\Sigma^{\pm}$ DECAY
$\Sigma^{\pm} \rightarrow n + \pi^{\pm} + Q$
P_o
P_π
θ
CURVES OF CONSTANT P_π
180°
160
140
120
θ
100
80
60
40
20
0°
.01
.02
.04
.07
0.1
0.2
0.4
0.7
1.0
2.0
4.0
6.0 Bev
P_o
.16
.14
.12
.10
.08
.06
.20
.25
.30
.40
.50
.60
.80
1.0
1.2
1.4
1.6
2.0
2.5
3.0
4.0

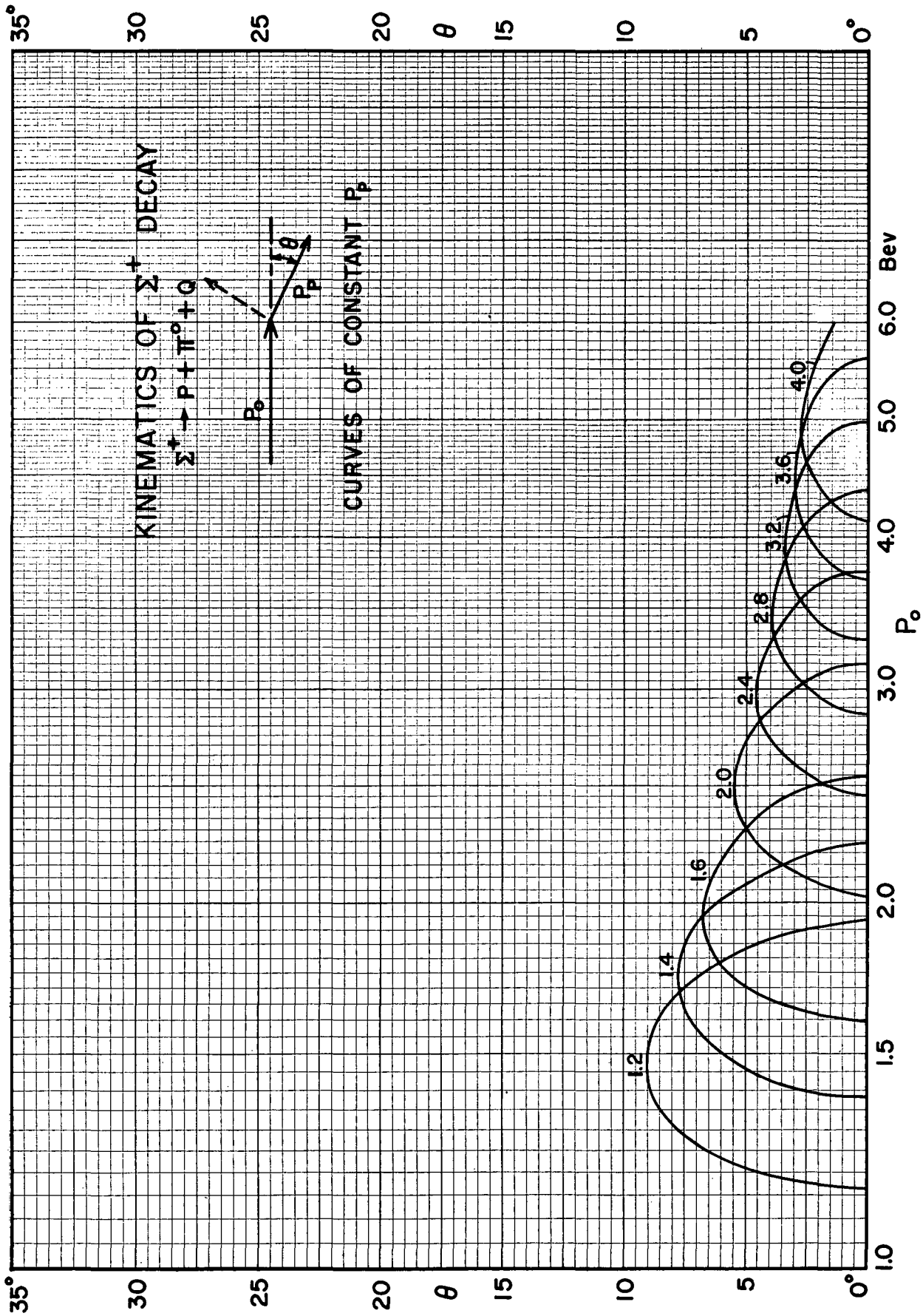
ZN-1574


KINEMATICS OF Σ± DECAY
Σ± → n + π± + Q
P₀
Pπ
θ
CURVES OF CONSTANT Pπ
.16
.30
.35
.40
.50
.60
.80
1.0
1.2
1.4
θ
P₀
Bev
35°
30
25
20
15
10
5
0°
1.0
1.5
2.0
3.0
4.0
5.0
6.0

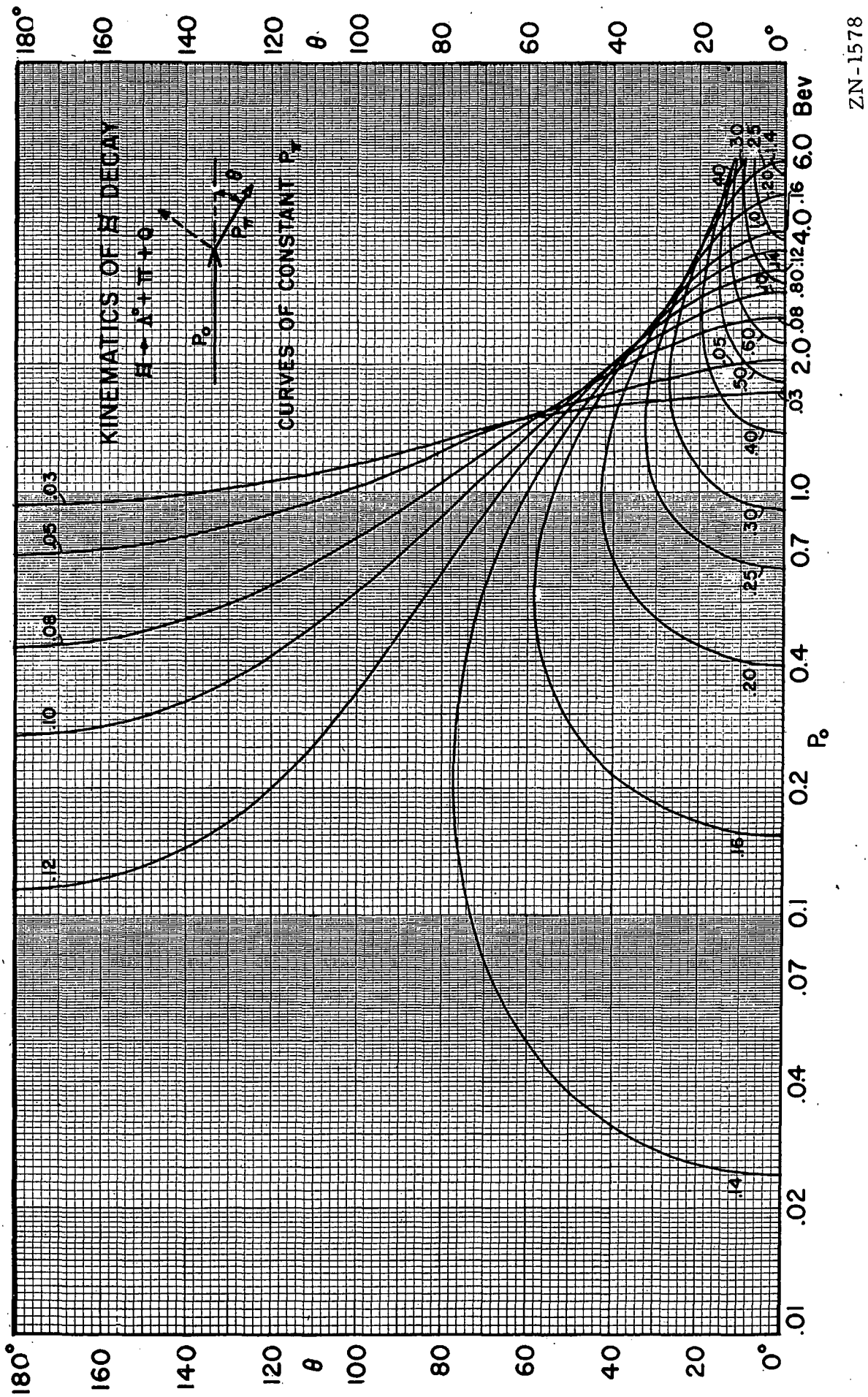
ZN-1575


KINEMATICS OF Σ+ DECAY
Σ+ → p + π° + Q
P0
Pp
θ
CURVES OF CONSTANT Pp
180°
160
140
120
100
80
60
40
20
0°
θ
.01
.02
.04
.07
0.1
0.2
.05
.08
0.4
.16
.25
0.7
1.0
2.0
4.0
6.0 Bev
P0
.05
.08
.10
.14
.16
.20
.25
.30
.40
.50
.60
.80
1.0
1.4
2.0
2.8
4.0

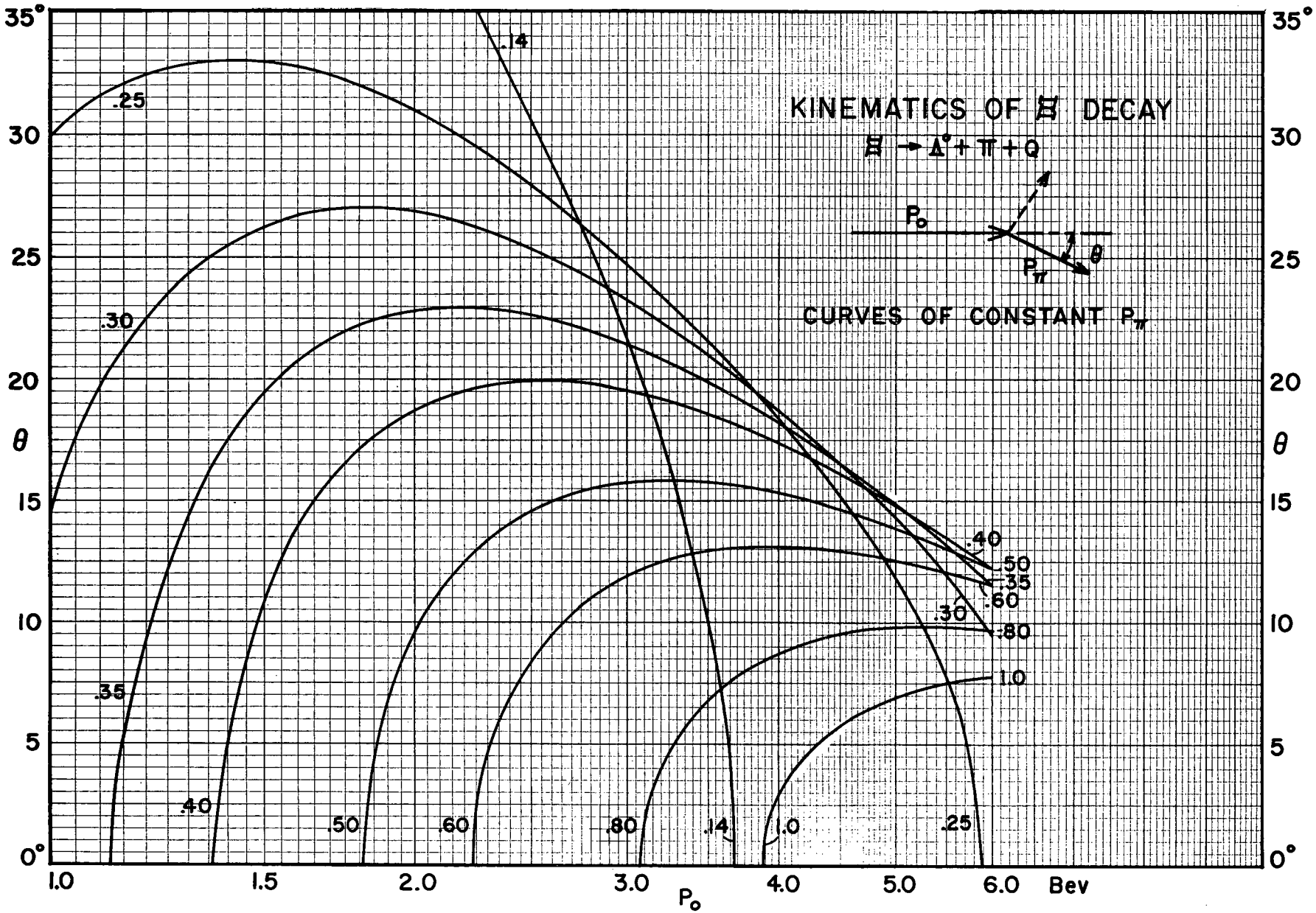
ZN-1576


KINEMATICS OF Σ+ DECAY
Σ+ → P + π° + Q
P0
PP
θ
CURVES OF CONSTANT PP
1.2
1.4
1.6
2.0
2.4
2.8
3.2
3.6
4.0
P0
1.0
1.5
2.0
3.0
4.0
5.0
6.0
Bev
θ
0°
5
10
15
20
25
30
35°

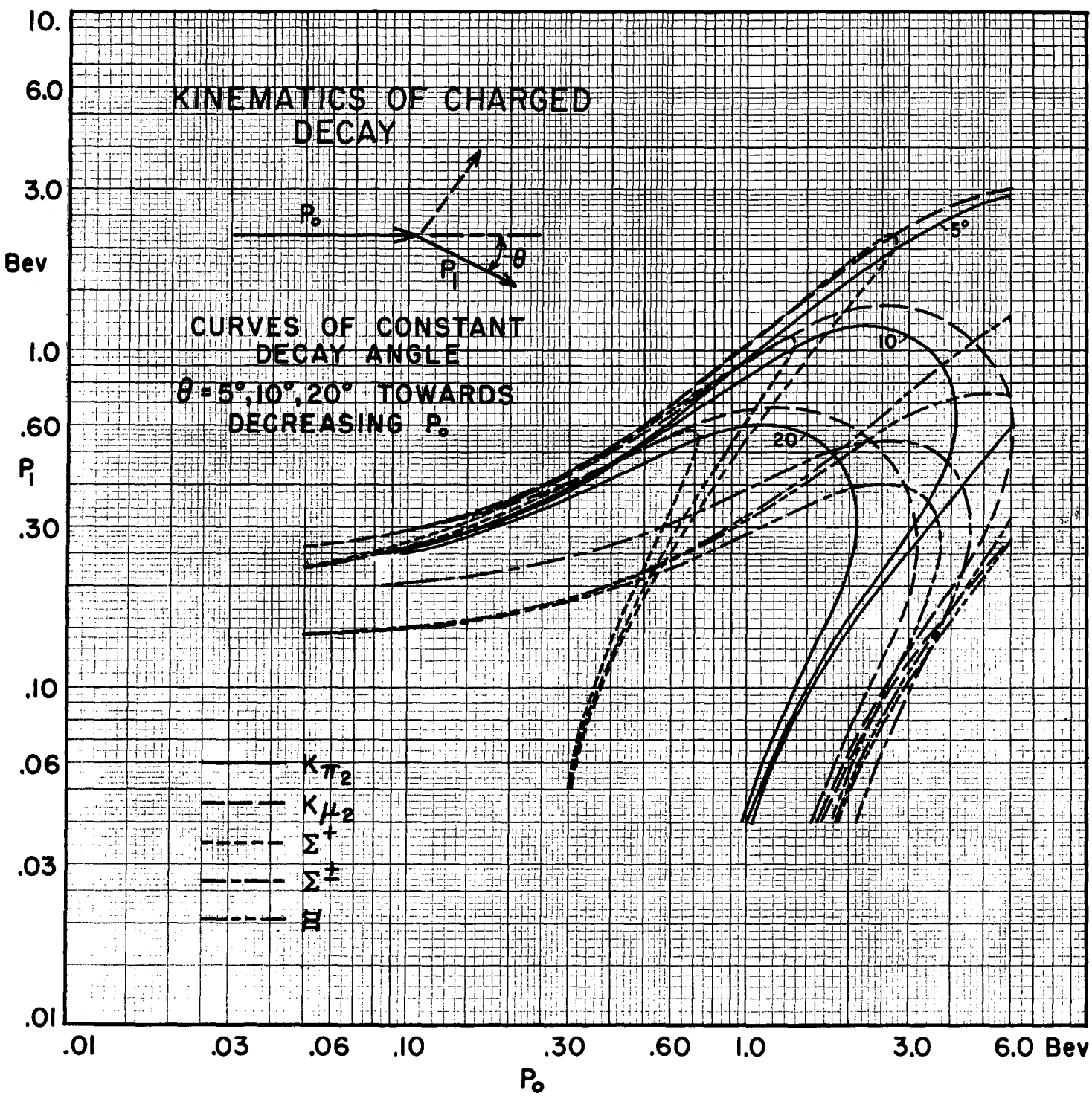
ZN-1577


KINEMATICS OF Ξ DECAY
Ξ → Λ° + π + Q
CURVES OF CONSTANT P_π
P_0
P_π
θ
P_0
Bev
0.01
.02
.04
.07
0.1
0.2
0.4
0.7
1.0
2.0
4.0
6.0
0°
20
40
60
80
100
120
140
160
180°

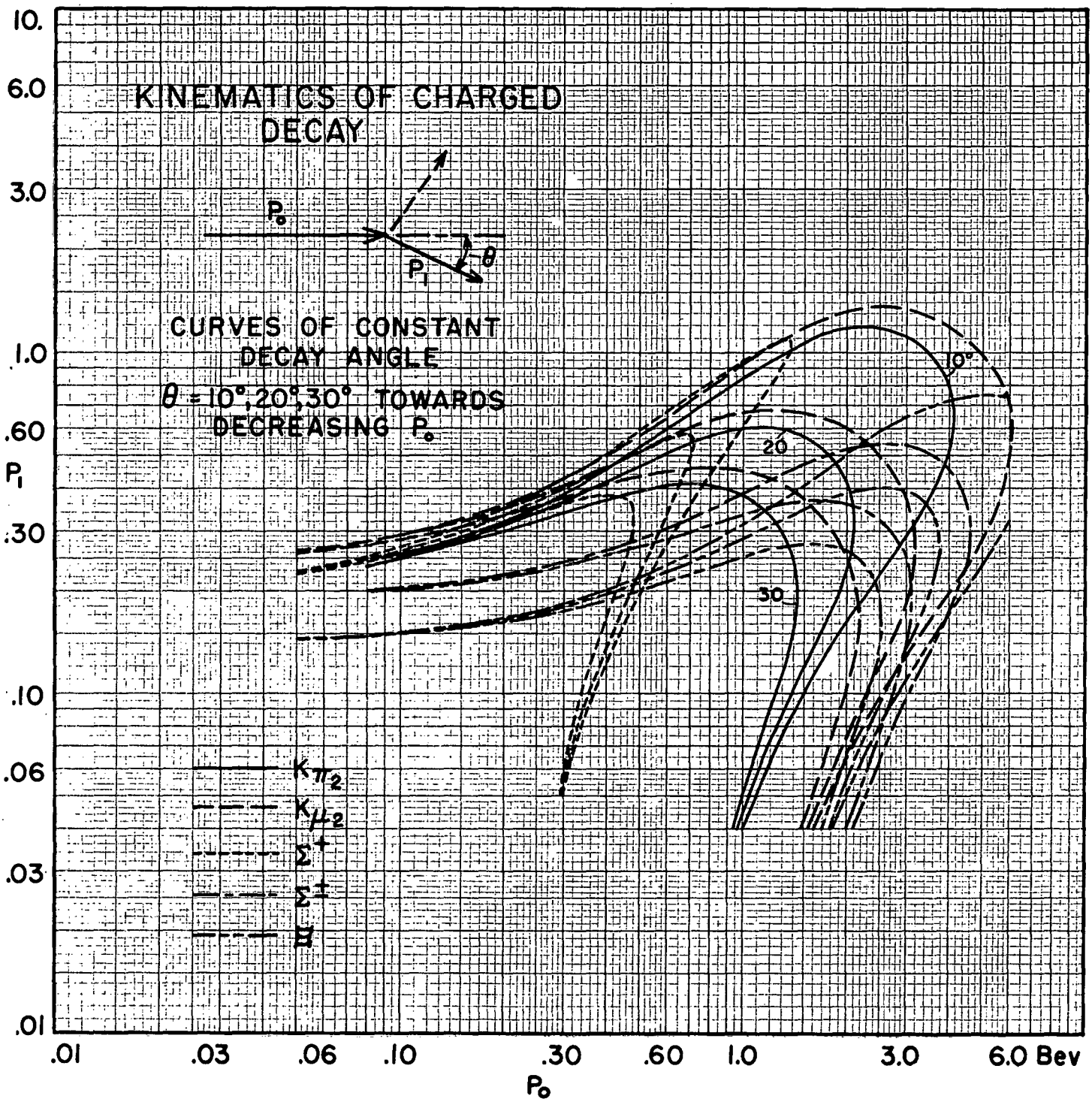
ZN-1578


KINEMATICS OF Ξ DECAY
Ξ → Λ° + π + Q
P₀
P_π
θ
CURVES OF CONSTANT P_π
35°
30
25
20
θ
15
10
5
0°
1.0
1.5
2.0
3.0
4.0
5.0
6.0
Bev
P₀
.14
.25
.30
.35
.40
.50
.60
.80
1.0

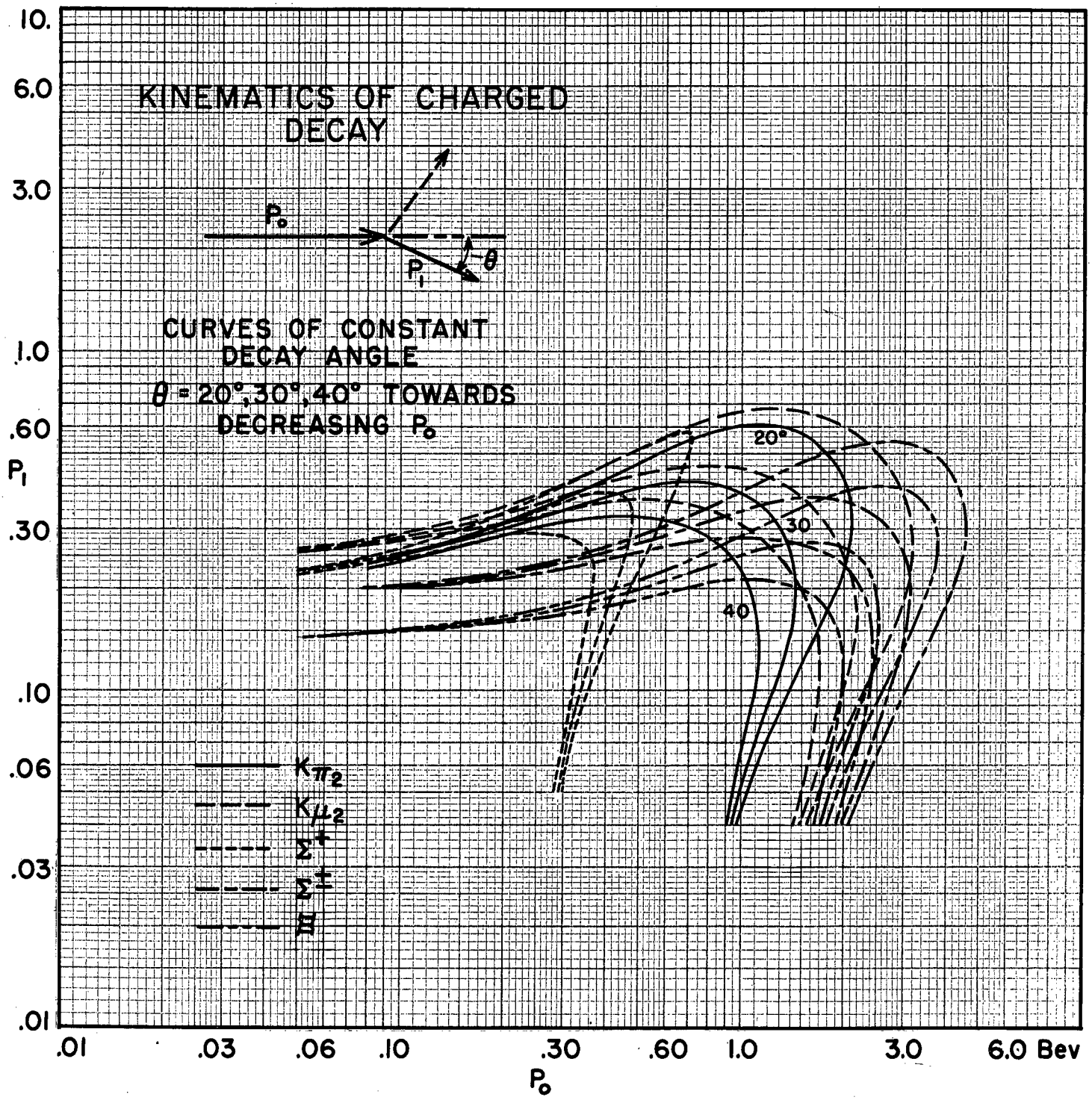
ZN-1579


KINEMATICS OF CHARGED DECAY
P_o
P_1
θ
CURVES OF CONSTANT DECAY ANGLE
θ = 5°, 10°, 20° TOWARDS DECREASING P_o
5°
10°
20°
K_{π_2}
K_{μ_2}
Σ^+
$\Sigma^\pm$
Ξ
10.
6.0
3.0
Bev
1.0
.60
P_1
.30
.10
.06
.03
.01
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev
P_o

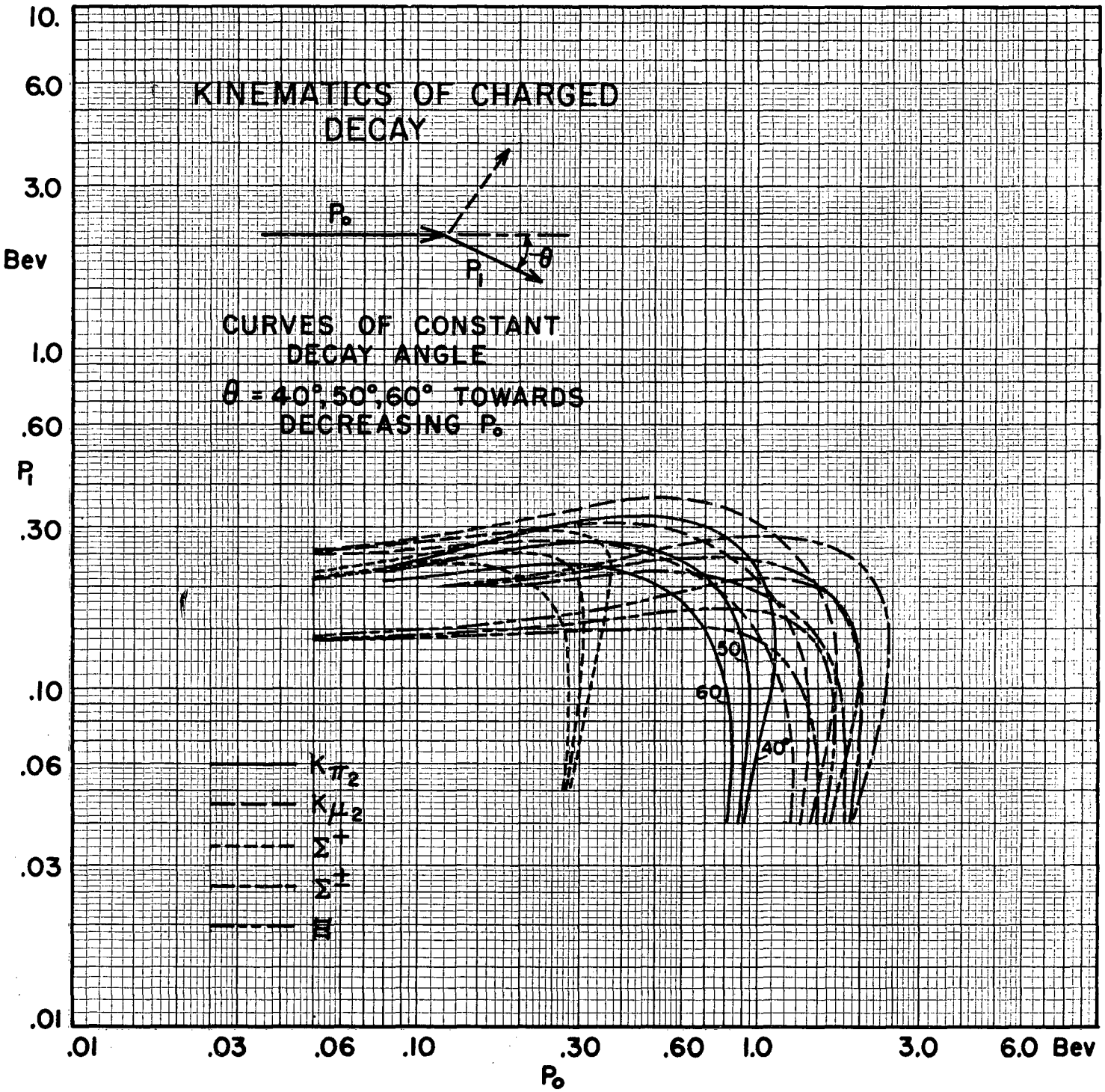
ZN-1580


KINEMATICS OF CHARGED DECAY
P_o
P_1
θ
CURVES OF CONSTANT DECAY ANGLE
θ = 10°, 20°, 30° TOWARDS DECREASING P_o
10°
20
30
K_{π_2}
K_{μ_2}
Σ^+
$\Sigma^\pm$
Ξ
10.
6.0
3.0
1.0
.60
.30
.10
.06
.03
.01
P_1
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev
P_o

ZN-1581


KINEMATICS OF CHARGED DECAY
P_o
P_1
θ
CURVES OF CONSTANT DECAY ANGLE
θ = 20°, 30°, 40° TOWARDS DECREASING P_o
20°
30
40
$K_{\pi 2}$
$K_{\mu 2}$
Σ^+
$\Sigma^\pm$
Ξ
10.
6.0
3.0
1.0
.60
.30
.10
.06
.03
.01
P_1
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev
P_o

ZN-1582


KINEMATICS OF CHARGED DECAY
P_o
P_1
θ
CURVES OF CONSTANT DECAY ANGLE
θ = 40°, 50°, 60° TOWARDS DECREASING P_o
50
60
40
K_{π_2}
K_{μ_2}
Σ^+
$\Sigma^\pm$
Ξ
10.
6.0
3.0
Bev
1.0
.60
P_1
.30
.10
.06
.03
.01
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev
P_o

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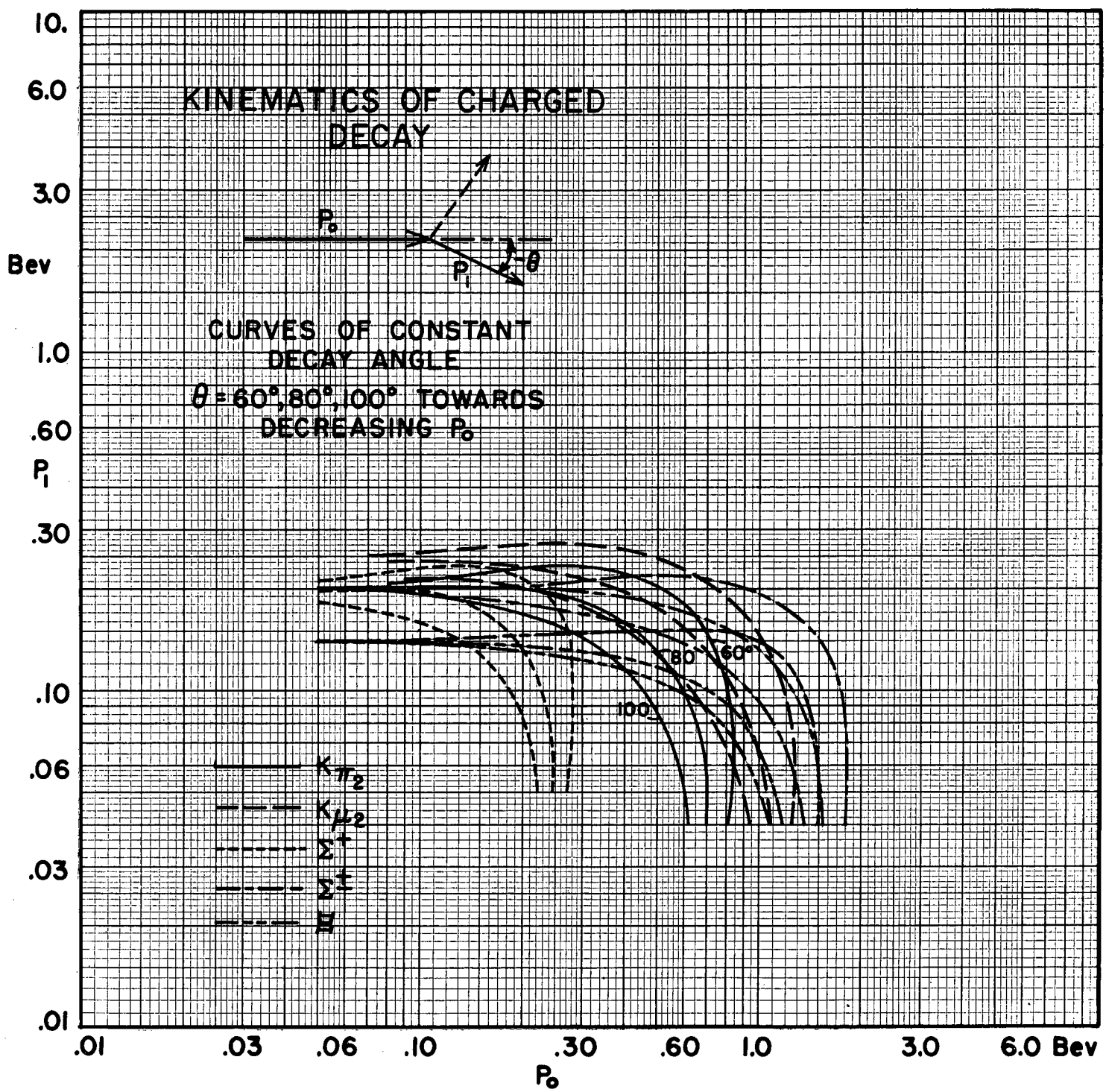
KINEMATICS OF CHARGED DECAY
P_0
P_1
θ
CURVES OF CONSTANT DECAY ANGLE
θ = 60°, 80°, 100° TOWARDS DECREASING P_0
80°
60°
100
$K_{\pi 2}$
$K_{\mu 2}$
Σ^+
$\Sigma^\pm$
Ξ
10.
6.0
3.0
Bev
1.0
.60
P_1
.30
.10
.06
.03
.01
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev
P_0

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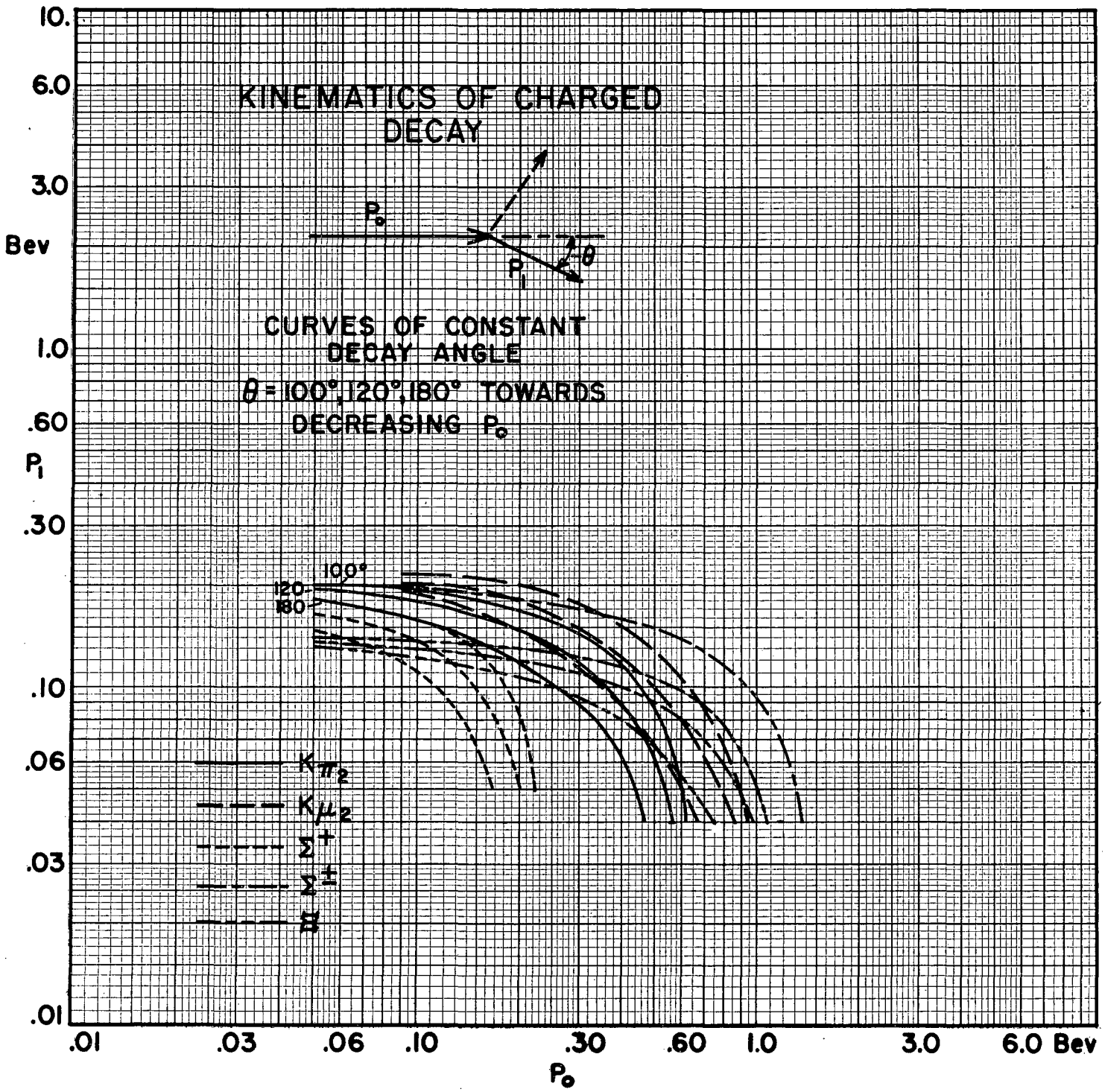
KINEMATICS OF CHARGED DECAY
P_o
P_1
θ
CURVES OF CONSTANT DECAY ANGLE
θ = 100°, 120°, 180° TOWARDS DECREASING P_o
100°
120
180
$K\pi_2$
$K\mu_2$
Σ^+
$\Sigma^\pm$
Ξ
10.
6.0
3.0
Bev
1.0
.60
P_1
.30
.10
.06
.03
.01
.01
.03
.06
.10
.30
.60
1.0
3.0
6.0 Bev
P_o

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