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R. S. Jones: KINEMATIC TABLES FOR PHOTOPRODUCTION OF A TWO-BODY SYSTEM.

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R. S. Jones: KINEMATIC TABLES FOR PHOTOPRODUCTION OF A COMPOUND TWO BODY SYSTEM.

In this note, we present a brief tabulation of the kinematics for the reaction:

$$\gamma + p \longrightarrow p + x$$
$$a)\ x \longrightarrow \pi + \pi$$
$$b)\ x \longrightarrow \gamma + \gamma$$

i. e. photoproduction in hydrogen of a compound system, x, which immediately decays into either a) two pions, or b) two photons. Separate tables are given for the pion and photon decay modes, for incident photon energies less than 2000 MeV, and for masses of x between 300 and 800 MeV.

The meaning of all symbols used in the tables is as follows:

θ_p = recoil proton angle in the Lab
P_p = recoil proton momentum in the Lab
E_p = recoil proton total energy in the Lab
m_x = mass of the compound system, x
θ_x = production angle of x in the Lab
P_x = momentum of the compound system , x, in the Lab
β = velocity/c of x in the Lab
α = maximum or minimum angle between the decay products of x, (π, π) or (γ, γ), in the Lab [α takes a maximum value for $\beta > \beta^*$ and a minimum for $\beta < \beta^*$ (the latter is always the case for photons)].

θ_1^{max} = maximum decay angle of one of the pions in the Lab for $\beta^* < \beta$ (when $\beta^* > \beta$ which can occur for pions and which is always the case for photons, this angle is 180°).
E_γ = incident photon energy in the Lab
β^* = velocity/c of either pion in the pion CMS (= 1 in the photon case)
q^* = momentum of either pion in the pion CMS (= $m_x/2$ " " ").

In the tables, mass and energy are given in MeV, momentum in MeV/c, and angles in degrees.

There follows the kinematical formulas and constants used in the calculations, which were carried out on the Frascati IBM 1620:

$$\theta_x = \arctan\left[\frac{P_p \sin\theta_p}{E_x - (P_p \cos\theta_p - T_p)}\right] \qquad \text{where } E_x = E_\gamma - T_p,\ P_x = \sqrt{E_x^2 - m_x^2},\ T_p = E_p - M_p$$

$$\alpha = \arctan\left[\frac{1}{\beta\gamma\sqrt{1-(\beta^*/\beta)^2}}\right] = \alpha^{MAX} \quad \text{for } \beta^* < \beta,\ \beta^* > \frac{\beta}{\sqrt{1+\beta^2}}$$

$$= \arctan\left[\frac{2\beta\gamma}{\beta^2\gamma^2 - 1}\right] = \alpha^{MAX} \quad \text{for } \beta^* < \beta,\ \beta^* \leq \frac{\beta}{\sqrt{1+\beta^2}}$$

$$= \alpha^{MIN} \quad \text{for } \beta^* > \beta$$

where $\beta = P_x/E_x$, $\gamma = E_x/m_x$, $\beta^* = 2q^*/m_x$, $q^* = \sqrt{\frac{m_x^2}{4} - \mu^2}$, $\mu = m_\pi$, or 0 for photons

$$\theta_1^{MAX} = \arctan\left[\frac{\beta^*/\beta}{\gamma\sqrt{1-(\beta^*/\beta)^2}}\right] \qquad \beta^* < \beta$$

$$E_\gamma = \frac{\mu T_p + m_x^2/2}{P_p \cos\theta_p - T_p}, \qquad \mu = m_\pi, \text{ or } 0 \text{ for photons}$$

M_p = 938.2 MeV
M_π = 139.6 MeV

The formulas for θ_1^{max} and α, for the various relative values of β and β^* are derived in the appendix which follows the tables.

$$X \longrightarrow \pi + \pi$$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 10^o$; $P_p = 300$; $E_p = 985$						
300	40.0	81.6	.2608	107.0		357.6
350	22.2	137.7	.3661	113.7		422.9
400	14.4	209.4	.4639	107.6		498.3
450	10.2	293.0	.5456	100.6		583.8
500	7.7	387.4	.6124	93.9		679.3
550	6.1	492.2	.6668	87.8		784.9
600	4.9	607.3	.7114	82.3		900.5
650	4.1	732.6	.7480	77.4		1026.2
700	3.4	868.0	.7784	73.0		1161.9
750	3.0	1013.6	.8039	69.0		1307.7
800	2.6	1169.3	.8253	65.3		1463.5
$\theta_p = 10^o$; $P_p = 350$; $E_p = 1001$						
300	67.1	66.0	.2147	117.9		370.3
350	36.1	103.2	.2827	127.9		428.0
400	22.1	161.8	.3750	121.1		494.6
450	15.1	233.5	.4606	113.0		570.1
500	11.1	315.7	.5339	105.4		654.5
550	8.6	407.6	.5954	98.6		747.7
600	6.9	508.8	.6468	92.4		849.9
650	5.6	619.6	.6897	86.9		960.9
700	4.7	738.6	.7258	82.0		1080.7
750	4.0	867.0	.7563	77.5		1209.5
800	3.5	1004.3	.7822	73.5		1347.1

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 10^o$; $P_p = 400$; $E_p = 1020$						
300	93.5	69.8	.2260	115.2		389.7
350	55.5	84.3	.2342	136.4		441.7
400	32.8	128.3	.3054	131.7		501.8
450	21.5	189.1	.3875	123.6		569.8
500	15.4	261.4	.4633	115.6		646.0
550	11.7	343.1	.5293	108.2		730.0
600	9.2	433.7	.5858	101.5		822.0
650	7.5	532.8	.6399	95.5		922.1
700	6.2	640.1	.6748	91.2		1030.2
750	5.3	755.6	.7097	85.3		1146.4
800	4.5	879.3	.7397	80.9		1270.5
$\theta_p = 10^o$; $P_p = 450$; $E_p = 1041$						
300	110.6	83.5	.2681	105.4		413.7
350	76.9	80.2	.2234	138.4		461.4
400	46.8	107.1	.2586	139.0		516.4
450	30.0	156.5	.3285	132.2		578.8
500	20.8	219.7	.4022	124.2		648.5
550	15.5	292.9	.4701	116.5		725.5
600	12.3	374.9	.5299	109.6		809.8
650	9.7	465.0	.5818	103.2		901.5
700	8.0	562.8	.6266	97.5		1000.5
750	6.7	668.3	.6653	92.3		1106.9
800	5.7	781.3	.6987	87.6		1220.6
$\theta_p = 10^o$; $P_p = 500$; $E_p = 1063$						
300	120.4	100.7	.3182	94.8		441.4
350	94.5	87.1	.2414	135.1		485.6
400	63.0	97.4	.2366	142.4		536.6
450	40.4	134.0	.2853	138.4		594.4
500	27.5	187.9	.3518	131.3		659.1
550	20.0	253.4	.4185	123.7		730.5
600	15.3	328.0	.4797	116.6		808.7
650	12.2	410.6	.5341	109.0		893.8
700	10.0	500.8	.5818	104.1		985.6
750	8.3	598.2	.6235	98.7		1084.2
800	7.1	702.7	.6599	93.7		1189.7

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 10^o$; $P_p = 550$; $E_p = 1087$						
300	126.2	118.3	.3668	88.0	84.5	471.8
350	106.6	99.6	.2738	129.4		513.2
400	78.5	97.4	.2367	142.4		561.0
450	52.4	120.5	.2587	142.3		615.2
500	35.5	164.6	.3127	136.7		675.7
550	25.4	222.5	.3750	129.7		742.6
600	19.2	290.4	.4357	122.7		815.9
650	15.1	366.6	.4912	116.0		895.6
700	12.2	450.2	.5410	109.9		981.6
750	10.2	540.8	.5849	104.3		1074.0
800	8.6	638.3	.6237	99.2		1172.8
$\theta_p = 10^o$; $P_p = 600$; $E_p = 1113$						
300	129.7	135.3	.4111	78.0	60.5	504.5
350	114.4	114.4	.3106	123.1		543.7
400	91.2	104.2	.2521	141.0		588.8
450	64.8	115.1	.2479	143.9		639.9
500	44.4	148.8	.2852	140.5		697.1
550	31.6	198.9	.3400	134.5		760.3
600	23.6	260.4	.3981	127.8		829.5
650	18.4	330.7	.4534	121.2		904.7
700	14.8	408.6	.5041	135.1		986.0
750	12.2	493.5	.5496	109.3		1073.2
800	10.3	585.0	.5902	104.1		1166.5
$\theta_p = 10^o$; $P_p = 650$; $E_p = 1141$						
300	131.8	151.4	.4505	71.8	51.1	539.2
350	119.5	129.6	.3473	116.9		576.4
400	100.5	114.8	.2758	136.3		619.3
450	76.2	116.2	.2501	143.5		667.9
500	53.9	139.6	.2689	142.8		722.3
550	38.4	181.7	.3135	138.1		782.4
600	28.4	236.7	.3669	132.0		848.2
650	22.0	301.5	.4207	125.6		919.7
700	17.6	374.2	.4714	119.5		996.9
750	14.4	454.0	.5178	113.8		1079.9
800	12.1	540.3	.5597	108.4		1168.5

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 10^o$; $P_p = 700$; $E_p = 1170$						
300	133.1	166.5	.4854	66.7	45.0	575.5
350	122.8	144.6	.3818	111.2		611.0
400	107.1	127.1	.3029	132.1		652.1
450	85.7	121.9	.2614	141.9		698.6
500	63.3	136.1	.2626	143.7		750.5
550	45.7	169.8	.2950	140.6		808.0
600	33.8	218.4	.3421	135.3		870.9
650	25.9	277.9	.3931	129.3		939.3
700	20.6	345.8	.4429	123.4		1013.1
750	16.8	421.0	.4895	117.7		1092.4
800	14.0	502.8	.5321	112.3		1177.2
$\theta_p = 10^o$; $P_p = 750$; $E_p = 1201$						
300	133.9	180.8	.5161	62.5	40.6	613.2
350	126.0	159.0	.4136	106.0		647.4
400	111.7	140.1	.3307	127.9		686.8
450	93.2	130.4	.2783	139.4		731.4
500	71.8	137.1	.2644	143.4		781.4
550	53.0	162.9	.2840	142.1		836.6
600	39.4	205.0	.3234	137.8		897.0
650	30.2	259.2	.3704	132.4		962.7
700	23.8	322.5	.4184	126.6		1033.6
750	19.3	393.4	.4645	121.1		1109.9
800	16.0	471.1	.5074	115.7		1191.3
$\theta_p = 10^o$; $P_p = 800$; $E_p = 1233$						
300	134.3	194.2	.5434	58.9	37.3	652.1
350	126.5	172.8	.4426	101.4		685.1
400	115.0	153.2	.3577	123.7		723.1
450	98.9	140.6	.2982	136.6		766.2
500	79.2	141.4	.2721	142.4		814.4
550	60.1	160.2	.2796	142.6		867.6
600	45.2	195.8	.3103	139.5		925.9
650	34.6	244.7	.3523	134.7		989.3
700	27.2	303.5	.3978	129.4		1057.8
750	22.0	370.4	.4428	124.0		1131.3
800	18.2	444.3	.4855	118.7		1209.9

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 15^o$, $P_p = 300$; $E_p = 985$						
300	45.6	108.7	.3407	90.5		365.9
350	28.5	162.7	.4215	104.7		432.8
400	19.4	233.4	.5040	101.6		509.9
450	14.2	317.2	.5762	96.1		597.4
500	10.8	412.7	.6366	90.3		695.1
550	8.6	519.2	.6865	84.8		803.2
600	7.0	636.4	.7276	79.7		921.5
650	5.8	764.3	.7617	75.0		1050.1
700	4.9	902.5	.7902	70.8		1189.0
750	4.2	1051.3	.8141	67.0		1338.2
800	3.6	1210.4	.8342	63.5		1497.6
$\theta_p = 15^o$; $P_p = 350$; $E_p = 1001$						
300	65.6	99.5	.3147	95.6		379.2
350	42.1	135.1	.3601	114.7		438.3
400	28.3	191.3	.4314	112.5		506.5
450	20.2	261.9	.5030	106.8		583.8
500	15.3	344.3	.5671	100.6		670.2
550	11.9	437.1	.6222	94.6		765.7
600	9.7	539.8	.6689	90.9		870.3
650	8.0	652.2	.7083	84.0		983.9
700	6.7	773.9	.7416	79.3		1106.7
750	5.7	905.0	.7700	75.1		1238.6
800	5.0	1316.4	.7941	71.3		1379.5
$\theta_p = 15^o$; $P_p = 400$; $E_p = 1020$						
300	82.9	104.3	.3284	92.8		399.3
350	57.3	122.9	.3314	119.6		452.7
400	39.0	164.5	.3803	120.3		514.2
450	27.6	223.1	.4441	115.4		583.9
500	20.6	294.3	.5073	109.3		661.9
550	16.0	376.2	.5645	103.1		748.1
600	12.8	467.7	.6148	97.3		842.4
650	10.5	568.1	.6581	91.9		945.0
700	8.8	677.4	.6954	86.9		1055.8
750	7.5	795.2	.7275	82.4		1174.8
800	6.5	921.4	.7551	78.3		1302.0

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 15^o$; $P_p = 450$; $E_p = 1040$						
300	95.1	116.9	.3631	86.3		424.3
350	71.7	122.7	.3307	119.7		473.2
400	50.8	150.3	.3516	124.6		529.6
450	36.2	197.0	.4010	121.7		593.6
500	26.8	258.1	.4587	116.2		665.0
550	20.6	330.5	.5151	110.2		744.0
600	16.4	412.6	.5666	104.3		830.5
650	13.4	503.5	.6124	98.8		924.6
700	11.1	602.8	.6525	93.6		1026.1
750	9.4	710.1	.6875	88.9		1135.2
800	8.1	825.4	.7181	84.5		1251.8
$\theta_p = 15^o$; $P_p = 500$; $E_p = 1063$						
300	103.1	132.8	.4048	79.1	62.5	453.0
350	83.2	130.3	.3489	116.6		498.4
400	62.4	146.1	.3430	126.0		550.8
450	45.5	181.4	.3739	125.6		610.1
500	33.8	232.7	.4220	121.4		676.4
550	25.9	296.5	.4745	115.9		749.7
600	20.4	370.4	.5253	110.2		830.0
650	16.6	453.2	.5719	104.7		917.3
700	13.8	544.2	.6138	99.4		1011.6
750	11.6	643.0	.6509	94.5		1112.8
800	9.9	749.3	.6836	90.0		1221.0
$\theta_p = 15^o$; $P_p = 550$; $E_p = 1087$						
300	108.2	149.8	.4467	72.4	51.8	484.6
350	91.7	142.4	.3768	112.0		527.2
400	72.5	149.3	.3496	125.0		576.3
450	54.7	174.3	.3612	127.4		631.9
500	41.1	216.3	.3970	124.9		694.1
550	31.6	271.8	.4430	120.3		762.8
600	24.9	338.2	.4911	116.0		838.1
650	20.1	413.9	.5371	109.6		919.2
700	16.6	497.8	.5795	104.4		1008.3
750	14.0	589.4	.6179	99.5		1103.2
800	11.9	688.3	.6522	94.9		1204.8

$\Pi' + \Pi'' \longleftarrow X$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 15^o$; $P_p = 600$; $E_p = 1113$						
300	111.4	166.8	.4859	66.6	44.9	518.7
350	97.6	156.6	.4085	106.8		558.9
400	80.6	157.4	.3661	122.4		605.3
450	63.2	173.9	.3605	127.5		657.9
500	48.6	207.1	.3827	126.9		716.7
550	37.5	254.8	.4204	123.5		781.6
600	29.6	314.2	.4639	118.8		852.8
650	23.9	383.4	.5080	113.7		930.1
700	19.7	461.0	.5500	108.6		1013.6
750	16.5	546.3	.5887	103.8		1103.3
800	14.1	638.8	.6240	99.1		1199.2
$\theta_p = 15^o$; $P_p = 650$; $E_p = 1141$						
300	113.5	183.4	.5216	61.7	39.9	554.8
350	101.7	171.8	.4406	101.7		593.0
400	86.8	168.4	.3881	119.1		637.2
450	70.6	178.4	.3685	126.4		687.2
500	55.6	203.9	.3776	127.6		743.2
550	43.5	244.2	.4059	125.5		805.0
600	34.5	297.0	.4436	121.6		872.7
650	27.8	360.1	.4846	117.0		946.2
700	22.9	431.9	.5251	112.1		1025.7
750	19.2	511.6	.5635	107.4		1111.1
800	16.3	598.6	.5991	102.8		1202.3
$\theta_p = 15^o$; $P_p = 700$; $E_p = 1170$						
300	114.8	199.5	.5537	57.6	36.2	592.6
350	104.5	187.1	.4715	96.9		629.2
400	91.5	181.2	.4126	115.4		671.5
450	76.6	186.2	.3824	124.4		719.4
500	61.9	205.3	.3799	127.3		772.9
550	49.3	239.0	.3985	126.5		832.0
600	39.4	285.5	.4297	123.5		896.8
650	31.9	342.8	.4665	119.4		967.2
700	26.3	409.4	.5048	115.0		1043.3
750	22.0	484.0	.5422	110.4		1125.0
800	18.7	566.0	.5775	105.9		1212.3

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 15^o$; $P_p = 750$; $E_p = 1201$						
300	115.5	215.0	.5825	54.0	33.2	632.0
350	106.4	202.3	.5005	92.4		667.2
400	94.9	194.8	.4378	111.6		707.8
450	81.4	196.3	.3998	121.8		753.9
500	67.4	210.3	.3876	126.2		805.3
550	54.6	238.0	.3971	126.7		862.2
600	44.1	278.7	.4213	124.6		924.5
650	35.9	330.7	.4535	121.2		992.2
700	29.7	392.3	.4889	117.1		1065.4
750	24.8	462.2	.5246	112.8		1143.9
800	21.1	539.5	.5591	108.5		1227.9
$\theta_p = 15^o$; $P_p = 800$; $E_p = 1233$						
300	115.8	229.9	.6083	51.0	30.8	672.7
350	107.7	217.3	.5274	88.3		706.7
400	97.4	208.7	.4626	107.8		746.0
450	85.1	207.8	.4192	119.0		790.4
500	72.0	217.7	.3992	124.6		840.1
550	59.4	240.4	.4005	126.2		895.0
600	48.6	275.9	.4178	125.1		955.2
650	39.9	322.9	.4449	122.4		1020.6
700	33.0	379.8	.4769	118.8		1091.2
750	27.7	445.3	.5105	114.8		1167.0
800	23.5	518.4	.5438	110.7		1248.1
$\theta_p = 20^o$; $P_p = 300$; $E_p = 985$						
300	46.8	140.6	.4245	75.9	56.8	378.1
350	31.8	194.6	.4859	94.6		447.2
400	22.7	265.7	.5533	94.3		527.0
450	17.0	350.8	.6148	90.3		617.4
500	13.2	448.4	.6676	85.5		718.4
550	10.6	557.6	.7119	80.7		830.0
600	8.7	678.2	.7490	76.1		952.3
650	7.3	809.8	.7797	71.9		1085.2
700	6.2	952.4	.8058	68.0		1228.8
750	5.3	1105.8	.8276	64.4		1382.9
800	4.6	1270.0	.8461	61.1		1547.8

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 20^o$; $P_p = 350$; $E_p = 1001$						
300	62.1	135.4	.4115	78.0	60.4	392.3
350	43.9	172.7	.4426	101.4		453.5
400	31.5	228.9	.4967	102.7		524.0
450	23.5	300.0	.5547	99.3		604.0
500	18.2	383.6	.6087	94.5		693.4
550	14.9	478.5	.6563	89.4		792.1
600	11.8	583.8	.6974	84.6		900.3
650	9.9	699.3	.7325	80.0		1017.9
700	8.3	824.8	.7624	75.8		1144.9
750	7.2	959.9	.7880	71.9		1281.3
800	6.2	1104.8	.8099	68.3		1427.2
$\theta_p = 20^o$; $P_p = 400$; $E_p = 1020$						
300	74.6	141.9	.4275	75.4	56.1	413.6
350	55.8	165.4	.4272	103.8		468.8
400	41.1	208.0	.4613	108.0		532.5
450	30.8	266.7	.5098	105.9		604.8
500	23.8	338.5	.5606	101.6		685.5
550	18.9	421.7	.6084	96.7		774.7
600	15.4	515.1	.6514	91.8		872.5
650	12.8	618.1	.6891	87.0		978.7
700	10.8	730.5	.7220	82.6		1093.4
750	9.2	851.8	.7505	78.5		1216.7
800	8.0	982.1	.7753	74.7		1348.4
$\theta_p = 20^o$; $P_p = 450$; $E_p = 1041$						
300	83.7	154.8	.4586	70.6	49.5	439.9
350	66.2	168.1	.4330	102.9		490.6
400	50.6	199.0	.4455	110.3		549.1
450	38.6	246.5	.4804	110.1		615.4
500	30.0	307.9	.5243	106.8		689.5
550	23.8	381.0	.5694	102.4		771.4
600	19.3	464.5	.6121	97.7		861.1
650	16.0	557.4	.6510	93.0		958.6
700	13.5	659.2	.6856	88.5		1063.9
750	11.5	769.7	.7162	84.3		1177.0
800	10.0	888.4	.7432	80.3		1297.9

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 20^o$; $P_p = 500$; $E_p = 1063$						
300	89.9	171.0	.4952	65.3	43.5	470.2
350	74.5	177.4	.4522	99.9		517.3
400	59.2	199.0	.4454	110.4		571.7
450	46.3	236.5	.4653	112.3		633.3
500	36.4	288.4	.4997	110.4		702.1
550	29.0	352.6	.5397	106.7		778.2
600	23.6	427.4	.5802	102.3		861.6
650	19.5	511.7	.6186	97.8		952.2
700	16.4	604.8	.6538	93.4		1050.0
750	14.0	706.3	.6856	89.2		1155.1
800	12.1	815.7	.7140	85.2		1267.5
$\theta_p = 20^o$; $P_p = 550$; $E_p = 1088$						
300	94.0	188.5	.5321	60.3	38.6	503.7
350	80,6	190.6	.4783	95.8		547.9
400	66.4	205.2	.4564	108.8		598.9
450	53.4	234.4	.4619	112.8		656.7
500	42.6	277.8	.4857	112.4		721.3
550	34.3	333.9	.5190	109.7		792.8
600	28.0	401.0	.5556	105.9		871.0
650	23.2	477.7	.5922	101.7		956.0
700	19.5	563.3	.6270	97.5		1047.8
750	16.6	657.1	.6590	93.3		1146.5
800	14.4	758.8	.6882	89.3		1251.9
$\theta_p = 20^o$; $P_p = 600$; $E_p = 1114$						
300	96.7	206.6	.5672	55.9	34.7	539.7
350	85.1	205.9	.5071	91.4		581.5
400	72.2	215.5	.4743	106.1		629.8
450	59.5	238.0	.4676	112.0		684.5
500	48.4	274.2	.4808	113.1		745.7
550	39.4	323.0	.5064	111.4		813.3
600	32.4	383.1	.5381	108.4		887.3
650	26.9	453.1	.5718	104.7		967.8
700	22.7	532.0	.6051	100.7		1054.7
750	19.4	619.2	.6366	96.7		1148.0
800	16.7	714.1	.6659	92.8		1247.8

$x \longrightarrow \pi + \pi$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 20^o$; $P_p = 650$; $E_p = 1141$						
300	98.4	224.7	.5995	52.0	31.6	578.0
350	88.2	222.4	.5363	87.0		617.8
400	76.6	228.5	.4960	102.8		663.8
450	64.7	245.9	.4795	110.3		716.0
500	53.7	275.9	.4831	112.7		774.2
550	44.3	318.3	.5009	112.3		838.6
600	36.7	372.0	.5270	110.0		909.1
650	30.7	435.9	.5570	106.8		985.8
700	25.9	508.9	.5880	103.2		1068.6
750	22.1	590.1	.6184	99.4		1157.5
800	19.1	679.2	.6472	95.7		1252.6
$\theta_p = 20^o$; $P_p = 700$; $E_p = 1171$						
300	99.4	242.6	.6288	48.6	29.0	618.2
350	90.3	239.4	.5645	82.8		656.4
400	79.9	243.1	.5194	99.3		700.5
450	68.8	256.7	.4954	107.9		750.4
500	58.2	281.7	.4908	111.6		806.2
550	48.7	318.5	.5012	112.2		867.9
600	40.8	366.6	.5214	110.8		935.5
650	34.3	425.0	.5472	108.2		1009.0
700	29.1	492.6	.5755	105.0		1088.3
750	24.9	568.5	.6041	101.5		1173.5
800	21.5	652.3	.6319	98.0		1264.6
$\theta_p = 20^o$; $P_p = 750$; $E_p = 1201$						
300	99.9	260.3	.6554	45.7	26.9	660.1
350	91.8	256.6	.5912	78.9		696.9
400	82.3	258.8	.5432	95.8		739.3
450	72.1	269.5	.5137	105.3		787.4
500	62.0	290.5	.5023	110.0		841.2
550	52.6	322.7	.5060	111.5		900.6
600	44.5	365.8	.5206	110.9		965.7
650	37.7	419.2	.5420	108.9		1036.4
700	32.2	481.9	.5670	106.2		1112.8
750	27.6	553.1	.5935	103.1		1194.9
800	23.9	632.1	.6200	99.7		1282.5

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 20^o$; $P_p = 800$; $E_p = 1233$						
300	100.0	277.8	.6794	43.1	25.1	703.6
350	92.6	273.9	.6162	80.8	74.9	739.2
400	84.1	275.0	.5666	92.3		780.2
450	74.7	283.6	.5332	102.4		826.7
500	65.1	301.6	.5165	108.0		878.7
550	56.0	329.9	.5144	110.3		936.1
600	47.9	368.7	.5236	110.5		999.0
650	40.9	417.7	.5406	109.1		1067.4
700	35.1	476.0	.5623	106.9		1141.2
750	30.2	542.8	.5863	104.1		1220.6
800	26.3	617.5	.6110	101.1		1305.4
$\theta_p = 25^o$; $P_p = 300$; $E_p = 985$						
300	45.9	176.7	.5074	63.6	41.8	394.9
350	33.0	232.8	.5538	84.4		467.1
400	24.5	306.0	.6076	86.2		550.4
450	18.8	393.9	.6586	83.7		644.8
500	14.8	494.9	.7035	79.9		750.3
550	12.0	608.4	.7418	75.8		866.9
600	9.9	733.8	.7741	71.8		994.7
650	8.4	870.9	.8014	68.0		1133.5
700	7.1	1019.4	.8244	64.4		1283.4
750	6.2	1179.4	.8438	61.1		1444.5
800	5.4	1350.7	.8604	58.1		1616.6
$\theta_p = 25^o$; $P_p = 350$; $E_p = 1001$						
300	57.8	174.8	.5034	64.2	42.4	410.4
350	43.3	215.8	.5248	88.7		474.3
400	32.6	274.2	.5654	92.5		548.1
450	25.2	347.6	.6113	90.9		631.8
500	19.9	434.0	.6555	87.4		725.2
550	16.1	532.3	.6954	83.3		828.6
600	13.3	641.8	.7305	79.2		941.7
650	11.2	762.0	.7608	75.2		1064.7
700	9.5	892.7	.7869	71.4		1197.6
750	8.2	1033.7	.8094	67.9		1340.2
800	7.2	1184.3	.8288	64.6		1492.8

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 25^o$; $P_p = 400$; $E_p = 1020$						
300	67.3	183.2	.5212	61.8	40	433.2
350	52.7	212.4	.5187	89.6		491.1
400	40.9	258.3	.5425	95.9		557.9
450	32.0	319.4	.5788	95.7		633.5
500	25.4	393.7	.6186	93.0		718.1
550	20.6	479.8	.6574	89.3		811.6
600	17.0	576.7	.6930	85.3		914.0
650	14.3	683.9	.7348	81.3		1025.2
700	12.2	800.9	.7529	77.4		1145.4
750	10.5	927.5	.7776	73.8		1274.5
800	9.14	1063.5	.7991	70.4		1412.5
$\theta_p = 25^o$; $P_p = 450$; $E_p = 1040$						
300	74.2	197.6	.5500	58.0	36.6	461.6
350	60.7	218.1	.5289	88.1		514.7
400	48.5	253.9	.5359	96.9		576.1
450	38.6	304.5	.5604	98.4		645.7
500	31.1	368.4	.5932	96.8		723.4
550	25.3	444.2	.6283	93.7		809.3
600	21.0	530.8	.6626	91.0		903.4
650	17.6	627.4	.6945	86.2		1005.7
700	15.0	733.4	.7234	82.4		1116.2
750	12.9	848.6	.7493	78.7		1234.8
800	11.3	972.6	.7723	75.3		1361.7
$\theta_p = 25^o$; $P_p = 500$; $E_p = 1063$						
300	79.0	215.2	.5829	54.0	33.2	494.1
350	66.8	229.8	.5489	85.1		543.6
400	55.1	257.7	.5416	97.0		600.7
450	44.8	299.5	.5541	99.4		665.5
500	36.6	354.5	.5784	99.0		737.8
550	30.1	421.4	.6082	96.7		817.8
600	25.0	499.1	.6395	93.6		905.4
650	21.1	586.8	.6701	90.0		1000.6
700	18.0	683.7	.6987	86.4		1103.4
750	15.5	789.5	.7250	82.8		1213.8
800	13.5	903.8	.7488	79.4		1331.9

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 25^o$; $P_p = 550$; $E_p = 1087$						
300	82.2	234.5	.6159	50.1	30.1	530.1
350	71.4	245.2	.5738	81.4		576.7
400	60.4	267.2	.5555	94.0		630.4
450	50.3	301.9	.5572	98.9		691.2
500	41.7	349.3	.5727	99.8		759.3
550	34.7	408.5	.5962	98.5		834.4
600	29.1	478.5	.6235	96.0		916.8
650	24.6	558.4	.6517	92.9		1006.3
700	21.0	647.6	.6791	89.5		1102.9
750	18.2	745.4	.7049	86.1		1206.7
800	15.8	851.6	.7288	82.7		1317.7
$\theta_p = 25^o$; $P_p = 600$; $E_p = 1113$						
300	84.3	254.7	.6473	46.6	27.5	569.0
350	74.7	262.8	.6005	77.5		613.2
400	64.6	280.6	.5743	91.2		664.1
450	54.9	309.7	.5670	97.5		721.7
500	46.3	350.8	.5743	99.6		786.2
550	38.9	403.3	.5913	99.2		857.5
600	32.9	466.6	.6139	97.4		935.5
650	28.0	539.8	.6389	94.8		1020.4
700	24.0	622.2	.6643	91.8		1111.9
750	20.8	713.2	.6891	88.6		1210.4
800	18.2	812.4	.7125	85.4		1315.6
$\theta_p = 25^o$; $P_p = 650$; $E_p = 1141$						
300	85.6	275.5	.6764	43.4	25.3	610.5
350	77.0	281.9	.6272	77.4	69.7	652.6
400	67.8	296.6	.5956	88.0		701.1
450	58.7	321.5	.5813	95.3		756.2
500	50.2	357.3	.5815	98.5		817.7
550	42.8	404.3	.5922	99.1		885.7
600	36.5	461.7	.6098	98.0		960.2
650	31.3	529.0	.6312	96.0		1041.2
700	27.0	605.4	.6541	93.4		1128.7
750	23.4	690.4	.6773	90.5		1222.6
800	20.5	783.6	.6997	87.5		1323.0

$x \longrightarrow x + \Delta x$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 25^o$; $P_p = 700$; $E_p = 1171$						
300	86.2	296.4	.7029	40.6	23.4	654.1
350	78.5	301.8	.6531	71.6	61.2	694.5
400	70.2	314.4	.6180	84.6		741.2
450	61.6	336.1	.5984	92.8		794.0
500	53.5	367.8	.5926	96.9		853.1
550	46.2	410.0	.5977	98.3		918.4
600	39.8	462.4	.6104	97.1		989.9
650	34.3	524.5	.6280	96.4		1067.6
700	29.8	595.7	.6481	94.3		1151.5
750	26.0	675.4	.6692	91.7		1241.7
800	22.8	763.3	.6903	89.0		1338.1
$\theta_p = 25^o$; $P_p = 750$; $E_p = 1201$						
300	86.4	317.5	.7269	38.1	21.8	699.8
350	79.4	322.3	.6775	67.2	55.1	738.8
400	71.8	333.5	.6404	81.3		783.7
450	63.9	352.8	.6169	90.0		834.7
500	56.2	381.2	.6063	94.8		891.7
550	49.1	419.5	.6065	97.0		954.7
600	42.7	467.6	.6147	97.3		1023.6
650	37.1	525.2	.6285	96.4		1098.6
700	32.4	591.8	.6456	94.7		1179.6
750	28.4	666.9	.6645	92.5		1266.6
800	25.0	750.0	.6839	90.0		1359.5
$\theta_p = 25^o$; $P_p = 800$; $E_p = 1233$						
300	86.2	338.8	.7486	35.9	20.3	747.3
350	79.9	343.3	.7003	63.5	50.4	785.0
400	73.0	353.5	.6622	78.0		828.6
450	65.7	371.0	.6361	87.1		878.0
500	58.4	397.0	.6218	92.5		933.2
550	51.5	432.1	.6178	95.3		994.2
600	45.2	476.6	.6220	96.2		1061.0
650	39.6	530.3	.6321	95.8		1133.6
700	34.8	592.8	.6463	94.6		1212.1
750	30.6	663.8	.6627	92.7		1296.3
800	27.1	742.7	.6804	90.5		1386.4

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 30^o$; $P_p = 300$; $E_p = 985$						
300	43.6	217.5	.5870	53.5	32.8	417.3
350	32.7	277.8	.6216	79.0	72.2	493.6
400	25.0	355.0	.6638	77.8		581.6
450	19.6	447.5	.7051	76.5		681.4
500	15.7	553.8	.7422	73.7		792.9
550	12.9	673.2	.7744	70.3		916.1
600	10.7	805.3	.8019	66.8		1051.1
650	9.1	949.9	.8253	63.4		1197.8
700	7.8	1106.6	.8451	60.2		1356.2
750	6.8	1275.4	.8620	57.2		1526.4
800	5.9	1456.2	.8764	54.5		1708.3
$\theta_p = 30^o$; $P_p = 350$; $E_p = 1001$						
300	53.1	218.8	.5892	53.2	32.6	434.5
350	41.3	265.0	.6037	87.7	86.2	502.2
400	32.3	327.8	.6338	82.3		580.3
450	25.6	405.4	.6694	82.1		668.9
500	20.6	496.6	.7047	79.7		767.8
550	16.9	600.2	.7372	76.6		877.2
600	14.1	715.6	.7663	73.2		997.0
650	12.0	842.5	.7917	69.7		1127.3
700	10.3	980.5	.8139	66.4		1267.9
750	8.9	1129.4	.8331	63.3		1419.0
800	7.8	1289.2	.8497	60.3		1580.4
$\theta_p = 30^o$; $P_p = 400$; $E_p = 1020$						
300	60.5	229.8	.6080	51.0	30.8	459.6
350	48.9	265.4	.6043	87.0	85.0	521.0
400	39.2	316.5	.6205	84.3		591.8
450	31.6	382.1	.6473	85.4		672.1
500	25.7	461.0	.6778	83.9		761.8
550	21.2	552.0	.7084	81.3		861.0
600	17.8	654.4	.7371	78.1		969.6
650	15.1	767.7	.7632	74.8		1087.6
700	13.0	891.4	.7865	71.5		1215.1
750	11.2	1025.3	.8071	68.3		1352.0
800	9.8	1169.2	.8253	65.3		1498.4

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 30^o$; $P_p = 450$; $E_p = 1040$						
300	65.8	246.6	.6349	47.9	28.5	490.7
350	55.0	274.6	.6173	80.4	74.3	547.2
400	45.3	316.6	.6206	84.3		612.4
450	37.2	372.3	.6374	86.9		686.4
500	30.7	441.0	.6615	86.5		769.0
550	25.5	521.6	.6881	84.5		860.4
600	21.5	613.4	.7149	81.8		960.4
650	18.3	715.7	.7403	78.7		1069.1
700	15.8	828.0	.7637	75.6		1186.6
750	13.7	950.0	.7849	72.5		1312.7
800	12.0	1081.5	.8039	69.5		1447.5
$\theta_p = 30^o$; $P_p = 500$; $E_p = 1063$						
300	69.5	266.8	.6646	44.7	26.2	526.4
350	59.7	289.5	.6374	74.9	66.0	579.1
400	50.4	324.5	.6300	82.9		640.0
450	42.2	372.3	.6375	86.9		709.0
500	35.3	432.5	.6542	87.6		786.0
550	29.7	504.5	.6759	86.4		871.2
600	25.2	587.3	.6995	84.2		964.5
650	21.6	680.5	.7231	81.6		1066.0
700	18.6	783.4	.7457	78.7		1175.5
750	16.2	895.7	.7667	75.7		1293.2
800	14.2	1017.0	.7860	72.8		1418.9
$\theta_p = 30^o$; $P_p = 550$; $E_p = 1087$						
300	71.9	289.2	.6940	41.5	24.1	566.0
350	63.1	308.3	.6609	70.1	59.1	615.7
400	54.4	338.1	.6455	80.5		673.1
450	46.4	379.9	.6448	85.8		738.0
500	39.4	432.9	.6545	87.6		810.7
550	33.6	497.5	.6708	87.2		890.9
600	28.7	572.8	.6905	85.7		978.9
650	24.7	658.3	.7116	83.4		1074.4
700	21.4	753.3	.7325	80.9		1177.6
750	18.7	857.4	.7527	78.1		1288.5
800	16.5	970.4	.7716	75.4		1407.0

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 30^o$; $P_p = 600$; $E_p = 1114$						
300	73.4	313.0	.7219	38.6	22.1	609.0
350	65.5	329.6	.6855	65.8	53.4	656.2
400	57.5	355.6	.6644	77.7		710.7
450	49.9	392.2	.6571	83.9		772.4
500	43.0	440.0	.6605	86.6		841.4
550	37.0	498.4	.6715	87.1		917.7
600	31.9	567.3	.6870	86.2		1001.2
650	27.7	646.2	.7050	84.5		1092.0
700	24.1	734.4	.7239	82.3		1190.0
750	21.1	831.7	.7426	79.8		1295.4
800	18.7	937.6	.7607	77.3		1407.9
$\theta_p = 30^o$; $P_p = 650$; $E_p = 1141$						
300	74.2	337.7	.7476	36.0	20.4	654.9
350	67.1	352.7	.7098	62.0	48.6	700.0
400	59.8	376.0	.6849	74.6		752.1
450	52.6	408.9	.6725	81.6		811.2
500	46.0	452.1	.6706	85.1		877.2
550	40.0	505.5	.6767	86.3		950.2
600	34.8	569.1	.6881	86.0		1030.1
650	30.4	642.3	.7029	84.8		1117.0
700	26.6	724.7	.7193	83.1		1210.8
750	23.5	816.1	.7363	80.9		1311.5
800	20.8	915.9	.7531	78.6		1419.2
$\theta_p = 30^o$; $P_p = 700$; $E_p = 1171$						
300	74.5	363.2	.7710	33.6	18.9	703.4
350	68.1	377.1	.7330	58.5	44.5	746.9
400	61.4	398.6	.7058	71.4		797.0
450	54.7	428.7	.6898	78.9		853.9
500	48.4	468.3	.6836	83.1		917.4
550	42.5	517.6	.6853	84.9		987.6
600	37.4	576.6	.6929	85.3		1064.5
650	32.9	645.0	.7044	84.6		1148.1
700	29.0	722.5	.7182	83.2		1238.3
750	25.6	808.7	.7332	81.4		1335.3
800	22.8	903.2	.7486	79.4		1438.9

$x \longrightarrow \pi + \pi$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 30^o$; $P_p = 750$; $E_p = 1201$						
300	74.4	389.3	.7921	31.4	17.6	754.4
350	68.6	402.7	.7548	55.3	41.0	796.5
400	62.5	422.8	.7264	79.9	76.0	845.0
450	56.3	450.8	.7078	76.1		899.9
500	50.2	487.6	.6982	80.8		961.4
550	44.6	533.6	.6963	83.2		1029.2
600	39.5	588.8	.7004	84.1		1103.6
650	35.0	653.2	.7088	83.9		1184.4
700	31.1	726.4	.7201	82.9		1271.7
750	27.6	808.2	.7330	81.5		1365.5
800	24.7	898.2	.7467	79.7		1465.7
$\theta_p = 30^o$; $P_p = 800$; $E_p = 1233$						
300	74.0	416.1	.8112	29.5	16.4	807.7
350	68.7	429.2	.7750	52.4	38.0	848.6
400	63.1	448.4	.7462	72.5	66.2	895.7
450	57.4	474.9	.7259	73.2		949.0
500	51.7	509.6	.7138	78.3		1008.7
550	46.3	552.9	.7090	81.2		1074.6
600	41.4	605.0	.7101	82.5		1146.9
650	36.9	666.0	.7156	82.8		1225.4
700	32.9	735.5	.7244	82.2		1310.1
750	29.4	813.4	.7352	81.1		1401.2
800	26.4	899.5	.7472	79.6		1498.5
$\theta_p = 35^o$; $P_p = 300$; $E_p = 985$						
300	40.6	264.6	.6615	45.0	26.4	446.8
350	31.3	330.9	.6871	65.6	53.0	528.5
400	24.5	414.4	.7195	84.1	81.9	622.7
450	19.6	513.4	.7520	69.0		729.5
500	15.9	627.2	.7819	66.9		848.9
550	13.2	754.9	.8082	64.2		980.8
600	11.1	896.2	.8310	61.3		1125.3
650	9.4	1050.8	.8504	58.4		1282.4
700	8.1	1218.4	.8671	55.6		1452.0
750	7.1	1399.0	.8813	52.9		1634.2
800	6.2	1592.5	.8936	50.4		1828.9

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 35^o$; $P_p = 350$; $E_p = 1001$						
300	48.2	269.3	.6681	61.0	25.9	466.3
350	38.5	322.4	.6775	67.2	55.1	539.0
400	30.8	391.5	.6995	72.4		622.9
450	24.9	475.6	.7264	73.1		717.9
500	20.5	573.7	.7539	71.7		824.2
550	17.0	684.9	.7797	69.3		941.6
600	14.4	808.7	.8031	66.6		1070.2
650	12.3	944.8	.8238	63.7		1209.9
700	10.6	1092.8	.8421	60.9		1360.9
750	9.2	1252.5	.8579	58.1		1523.1
800	8.1	1423.9	.8718	55.5		1696.4
$\theta_p = 35^o$; $P_p = 400$; $E_p = 1020$						
300	54.0	283.7	.6871	42.2	24.5	494.6
350	44.6	326.9	.6826	66.3	54.0	560.7
400	36.6	385.0	.6935	73.3		636.9
450	30.1	457.3	.7128	75.3		723.3
500	25.0	543.0	.7356	74.7		819.8
550	20.9	641.3	.7591	72.9		926.6
600	17.8	751.6	.7815	70.5		1043.4
650	15.2	873.4	.8022	67.8		1170.5
700	13.2	1006.5	.8210	65.1		1307.7
750	11.5	1150.5	.8377	62.3		1455.1
800	10.1	1305.2	.8526	59.7		1612.6
$\theta_p = 35^o$; $P_p = 450$; $E_p = 1040$						
300	58.1	304.1	.7119	39.6	22.8	529.5
350	49.3	340.3	.6971	63.9	51.0	590.5
400	41.4	389.9	.6980	72.6		660.0
450	34.7	452.8	.7093	75.8		740.7
500	29.2	528.5	.7264	76.2		829.9
550	24.7	616.4	.7462	75.1		928.5
600	21.1	715.9	.7664	73.1		1036.4
650	18.2	826.5	.7860	70.8		1153.8
700	15.8	947.7	.8044	68.2		1280.5
750	13.8	1079.3	.8212	65.6		1416.6
800	12.2	1221.1	.8365	63.1		1562.1

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 35^o$; $P_p = 500$; $E_p = 1063$						
300	60.8	328.4	.7383	36.9	21.0	569.7
350	52.9	359.7	.7167	60.9	47.3	626.8
400	45.4	402.9	.7097	70.8		692.7
450	38.7	458.4	.7136	75.2		767.3
500	33.0	526.1	.7249	76.5		850.7
550	28.3	605.5	.7402	76.1		942.9
600	24.3	696.1	.7575	74.7		1043.9
650	21.1	797.4	.7751	72.7		1153.7
700	18.4	909.0	.7923	70.5		1272.2
750	16.2	1030.7	.8085	68.1		1399.6
800	14.3	1162.0	.8237	65.7		1535.7
$\theta_p = 35^o$; $P_p = 550$; $E_p = 1087$						
300	62.5	355.4	.7642	34.3	19.3	614.5
350	55.4	383.3	.7385	57.7	43.6	668.4
400	48.4	421.8	.7256	80.3	76.5	730.6
450	42.0	471.6	.7235	73.6		801.2
500	36.3	532.8	.7393	75.8		880.0
550	31.4	605.3	.7401	76.1		967.2
600	27.3	688.5	.7539	75.3		1062.6
650	23.8	782.2	.7691	73.8		1166.3
700	20.9	885.9	.7846	71.8		1278.4
750	18.4	999.2	.7998	69.7		1398.7
800	16.3	1122.0	.8142	67.5		1527.3
$\theta_p = 35^o$; $P_p = 600$; $E_p = 1113$						
300	63.5	384.5	.7884	31.8	17.8	663.1
350	57.0	410.0	.7606	54.5	40.2	714.6
400	50.6	445.1	.7438	73.2	67.2	773.9
450	44.5	490.5	.7369	71.5		841.1
500	39.0	546.6	.7379	74.4		916.2
550	34.1	613.4	.7445	75.4		999.3
600	29.9	690.6	.7549	75.1		1090.3
650	26.3	777.8	.7673	74.1		1189.1
700	23.2	874.9	.7808	72.5		1295.9
750	20.5	981.4	.7945	70.7		1410.6
800	18.3	1097.0	.8080	68.7		1533.2

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 35^o$; $P_p = 650$; $E_p = 1141$						
300	63.9	415.2	.8106	29.6	16.5	715.4
350	58.1	439.2	.7821	51.3	37.0	764.8
400	52.2	471.8	.7628	67.9	60.4	821.7
450	46.5	513.9	.7523	68.9		886.2
500	41.2	566.0	.7494	72.5		958.4
550	36.4	628.1	.7523	74.1		1038.1
600	32.2	700.3	.7594	74.3		1125.4
650	28.5	782.3	.7691	73.7		1220.3
700	25.3	873.8	.7804	72.6		1322.7
750	22.5	974.4	.7924	71.1		1432.8
800	20.1	1084.1	.8046	69.3		1550.5
$\theta_p = 35^o$; $P_p = 700$; $E_p = 1170$						
300	63.8	447.4	.8306	27.5	15.3	771.1
350	58.6	470.4	.8023	48.3	34.2	818.7
400	53.2	501.3	.7816	63.3	54.9	873.7
450	47.9	540.9	.7687	66.2		936.0
500	42.9	589.8	.7628	70.2		1005.6
550	38.3	648.3	.7626	72.3		1082.6
600	34.1	716.4	.7667	73.1		1166.9
650	30.4	794.0	.7738	72.9		1258.5
700	27.1	880.8	.7829	72.2		1357.4
750	24.3	976.6	.7931	71.0		1463.7
800	21.8	1081.1	.8039	69.5		1577.3
$\theta_p = 35^o$; $P_p = 750$; $E_p = 1201$						
300	63.4	481.1	.8485	25.7	14.2	829.9
350	58.7	503.5	.8211	45.5	31.7	876.1
400	53.8	533.1	.7999	59.3	50.3	929.4
450	48.9	570.9	.7854	85.9	84.8	989.9
500	44.2	617.5	.7772	67.8		1057.5
550	39.7	673.1	.7744	70.3		1132.2
600	35.7	737.9	.7759	71.5		1213.9
650	32.0	811.8	.7806	71.7		1302.9
700	28.7	894.6	.7876	71.3		1398.9
750	25.9	986.3	.7960	70.4		1502.0
800	23.3	1086.6	.8053	69.2		1612.3

x $\longrightarrow \pi + \pi$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 35^o$; $P_p = 800$; $E_p = 1233$						
300	62.7	516.1	.8645	24.0	13.2	891.7
350	58.5	538.2	.8383	42.8	29.4	936.8
400	54.0	567.1	.8172	55.6	46.3	988.8
450	49.5	603.7	.8017	74.4	70.4	1047.7
500	45.0	648.4	.7919	65.2		1113.6
550	40.8	701.7	.7871	68.1		1186.4
600	36.9	763.8	.7864	69.6		1266.1
650	33.3	834.7	.7890	70.2		1352.7
700	30.1	914.4	.7940	70.1		1446.3
750	27.2	1002.6	.8007	69.5		1546.9
800	24.7	1099.3	.8085	68.6		1654.3
$\theta_p = 40^o$; $P_p = 300$; $E_p = 985$						
300	37.0	320.4	.7299	37.8	21.6	485.7
350	29.2	394.9	.7484	56.2	42.0	574.5
400	23.3	486.9	.7727	65.4	57.4	676.9
450	18.9	595.3	.7977	76.3	72.8	793.0
500	15.5	719.2	.8211	59.9		922.8
550	13.0	858.3	.8419	57.8		1066.2
600	11.0	1011.9	.8602	55.4		1223.2
650	9.4	1179.9	.8759	52.9		1394.0
700	8.1	1362.2	.8894	50.5		1578.3
750	7.1	1558.5	.9011	48.1		1776.4
800	6.3	1768.8	.9111	45.9		1988.1
$\theta_p = 40^o$; $P_p = 350$; $E_p = 1001$						
300	43.1	329.3	.7392	36.8	20.9	508.6
350	35.1	390.9	.7450	56.7	42.6	587.9
400	28.7	468.7	.7606	68.4	61.1	679.3
450	23.6	561.8	.7805	64.3		783.0
500	19.6	669.6	.8013	63.5		898.9
550	16.5	791.4	.8212	61.8		1026.9
600	14.0	926.7	.8394	59.6		1167.2
650	12.1	1075.3	.8558	57.3		1319.6
700	10.5	1236.7	.8703	54.9		1484.3
750	9.2	1411.0	.8830	52.5		1661.1
800	8.1	1597.9	.8942	50.3		1850.1

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 40^o$; $P_p = 400$; $E_p = 1020$						
300	47.6	348.2	.7576	34.9	19.8	541.3
350	39.9	400.6	.7530	55.5	41.3	613.6
400	33.3	467.6	.7599	68.6	61.3	697.1
450	27.9	549.1	.7734	65.4		791.6
500	23.5	644.4	.7900	65.5		897.3
550	20.0	752.9	.8075	64.4		1014.1
600	17.1	874.2	.8245	62.5		1142.0
650	14.8	1007.9	.8404	60.4		1281.1
700	12.9	1153.8	.8550	58.2		1431.3
750	11.3	1311.5	.8681	55.9		1592.6
800	10.0	1481.0	.8798	53.7		1765.0
$\theta_p = 40^o$; $P_p = 450$; $E_p = 1040$						
300	50.7	373.9	.7799	32.7	18.4	581.7
350	43.6	419.6	.7679	53.4	39.1	648.7
400	37.2	478.6	.7673	66.7	59.0	726.1
450	31.7	551.0	.7745	65.3		813.7
500	27.0	636.4	.7864	66.2		911.7
550	23.2	734.5	.8005	65.6		1020.0
600	20.0	844.9	.8153	64.3		1138.6
650	17.4	967.0	.8299	62.5		1267.5
700	15.2	1100.6	.8438	60.5		1406.7
750	13.4	1245.5	.8567	58.4		1556.2
800	11.9	1401.5	.8685	56.3		1716.0
$\theta_p = 40^o$; $P_p = 500$; $E_p = 1063$						
300	52.6	404.2	.8030	30.3	16.9	628.3
350	46.2	445.2	.7862	50.7	36.4	691.3
400	40.2	498.3	.7798	63.7	55.4	763.9
450	34.7	563.7	.7815	64.1		846.2
500	30.1	641.4	.7887	65.8		938.2
550	26.1	731.2	.7992	65.9		1039.9
600	22.7	832.7	.8113	65.1		1151.3
650	19.9	945.5	.8241	63.7		1272.3
700	17.5	1069.4	.8367	61.9		1403.1
750	15.5	1204.1	.8488	60.1		1543.5
800	13.8	1349.4	.8602	58.1		1693.6

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 40^o$; $P_p = 550$; $E_p = 1087$						
300	53.8	438.2	.8252	28.1	15.6	680.4
350	47.9	476.0	.8056	47.8	33.7	740.1
400	42.4	524.6	.7952	60.3	51.4	809.1
450	37.2	584.7	.7925	79.3	76.5	887.2
500	32.6	656.4	.7955	64.6		974.5
550	28.6	739.5	.8024	65.3		1070.9
600	25.1	833.9	.8117	65.0		1176.6
650	22.1	939.2	.8223	64.0		1291.5
700	19.6	1055.2	.8333	62.6		1415.6
750	17.4	1181.6	.8443	61.0		1548.8
800	15.5	1318.2	.8549	59.3		1691.3
$\theta_p = 40^o$; $P_p = 600$; $E_p = 1114$						
300	54.2	475.2	.8456	26.0	14.3	737.5
350	49.0	510.8	.8249	44.9	31.2	794.6
400	43.9	556.3	.8119	56.7	47.5	860.6
450	39.0	612.4	.8058	72.6	68.2	935.4
500	34.6	679.3	.8054	62.8		1018.9
550	30.6	757.2	.8091	64.1		1111.3
600	27.1	845.8	.8156	64.2		1212.4
650	24.1	945.0	.8239	63.7		1322.4
700	21.4	1054.5	.8331	62.7		1441.1
750	19.2	1174.1	.8427	61.3		1568.7
800	17.2	1303.7	.8523	59.8		1705.0
$\theta_p = 40^o$; $P_p = 650$; $E_p = 1141$						
300	54.2	515.0	.8641	24.0	13.2	799.2
350	49.5	549.1	.8432	42.0	28.8	854.3
400	44.8	592.3	.8287	53.3	43.8	917.9
450	40.3	645.4	.8203	67.2	61.8	989.9
500	36.1	708.7	.8171	60.7		1070.5
550	32.3	782.4	.8181	62.4		1159.6
600	28.8	866.5	.8221	63.0		1257.1
650	25.8	960.7	.8282	62.8		1363.1
700	23.1	1064.9	.8356	62.2		1477.6
750	20.7	1179.0	.8437	61.1		1600.5
800	18.7	1302.8	.8522	59.8		1732.0

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 40^o$; $P_p = 700$; $E_p = 1170$						
300	53.8	557.4	.8805	22.2	12.2	865.3
350	49.6	590.5	.8602	39.3	26.6	918.8
400	45.4	632.2	.8451	50.0	40.4	980.5
450	41.2	683.2	.8351	62.4	56.3	1050.4
500	37.2	743.8	.8299	87.3	86.8	1128.6
550	33.5	814.2	.8287	60.4		1214.9
600	30.2	894.6	.8305	61.4		1309.5
650	27.2	984.8	.8346	61.6		1412.3
700	24.5	1084.8	.8402	61.2		1523.4
750	22.1	1194.3	.8469	60.5		1642.7
800	20.2	1313.3	.8540	59.4		1770.2
$\theta_p = 40^o$; $P_p = 750$; $E_p = 1201$						
300	53.1	602.4	.8951	20.6	11.3	935.9
350	49.4	635.0	.8758	36.7	24.6	988.0
400	45.5	675.7	.8605	46.8	37.4	1048.2
450	41.6	725.2	.8497	58.2	51.6	1116.4
500	37.9	783.7	.8430	74.4	71.3	1192.6
550	34.5	851.7	.8401	58.2		1276.8
600	31.2	929.2	.8401	59.5		1369.0
650	28.3	1016.3	.8424	60.0		1469.3
700	25.7	1112.8	.8464	59.9		1577.6
750	23.3	1218.7	.8516	59.5		1693.9
800	21.2	1333.8	.8576	58.7		1818.2
$\theta_p = 40^o$; $P_p = 800$; $E_p = 1233$						
300	52.3	650.1	.9080	19.1	10.4	1010.7
350	48.9	682.6	.8898	34.3	22.8	1061.8
400	45.3	722.7	.8749	43.9	34.6	1120.8
450	41.8	771.1	.8637	54.3	47.5	1187.6
500	38.4	828.2	.8561	67.7	63.7	1262.2
550	35.1	894.4	.8518	55.8		1344.7
600	32.0	969.7	.8504	57.4		1435.1
650	29.2	1054.3	.8512	58.2		1533.3
700	26.6	1148.1	.8538	58.4		1639.4
750	24.3	1251.0	.8577	58.2		1753.4
800	22.2	1363.0	.8624	57.6		1875.2

$x \longrightarrow x + z$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 45^o$; $P_p = 300$; $E_p = 985$						
300	33.1	388.5	.7915	31.5	17.6	537.6
350	26.6	473.8	.8044	48.0	33.9	635.9
400	21.5	577.4	.8220	54.6	45.3	749.3
450	17.7	698.6	.8407	60.8	54.5	877.8
500	14.7	836.6	.8584	66.7	62.6	1021.4
550	12.4	990.9	.8743	72.9	70.3	1180.1
600	10.5	1161.4	.8884	80.5	79.2	1354.0
650	9.1	1347.6	.9007	47.1		1543.0
700	7.9	1549.5	.9113	45.0		1747.1
750	6.9	1766.9	.9205	43.0		1966.3
$\theta_p = 45^o$; $P_p = 350$; $E_p = 1001$						
300	37.9	402.9	.8021	30.4	17.0	565.5
350	31.4	475.5	.8054	47.8	33.8	653.6
400	26.0	564.9	.8161	55.9	46.6	755.3
450	21.7	670.4	.8303	63.9	58.0	870.6
500	18.2	791.5	.8454	73.0	69.7	999.4
550	15.5	927.9	.8602	54.1		1141.8
600	13.3	1078.9	.8739	52.4		1297.7
650	11.5	1244.5	.8864	50.5		1467.2
700	10.0	1424.4	.8975	48.5		1650.3
750	8.8	1618.4	.9073	46.5		1846.9
$\theta_p = 45^o$; $P_p = 400$; $E_p = 1020$						
300	41.3	428.5	.8192	28.7	15.9	604.7
350	35.1	492.0	.8149	46.4	32.5	685.5
400	29.7	570.8	.8189	55.3	45.9	778.7
450	25.2	664.6	.8281	64.6	58.8	884.4
500	21.5	773.1	.8397	76.5	73.8	1002.4
550	18.4	895.8	.8522	55.7		1132.9
600	15.9	1032.4	.8646	54.4		1275.8
650	13.8	1182.6	.8763	52.8		1431.2
700	12.1	1346.1	.8872	51.0		1598.9
750	10.7	1522.7	.8971	49.1		1779.1
800	9.5	1712.4	.9060	47.3		1971.7

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 45^o$; $P_p = 450$; $E_p = 1040$						
300	43.5	461.9	.8386	26.7	14.8	653.1
350	37.8	519.1	.8291	44.2	30.6	728.4
400	32.6	590.1	.8277	53.5	44.0	815.2
450	28.1	675.1	.8321	63.3	57.4	913.6
500	24.3	773.8	.8399	76.3	73.6	1023.6
550	21.0	886.1	.8496	56.3		1145.2
600	18.3	1011.5	.8601	55.4		1278.4
650	16.1	1149.8	.8705	54.1		1423.1
700	14.2	1300.7	.8806	52.5		1579.4
750	12.6	1464.1	.8900	50.8		1747.3
800	11.2	1639.7	.8987	49.1		1926.8
$\theta_p = 45^o$; $P_p = 500$; $E_p = 1063$						
300	44.8	501.4	.8581	24.7	13.6	709.2
350	39.6	554.1	.8455	41.7	28.5	780.3
400	34.8	619.5	.8401	51.0	41.5	862.3
450	30.4	697.8	.8404	60.8	54.6	955.2
500	26.6	789.1	.8447	73.4	70.2	1059.1
550	23.3	893.2	.8515	55.9		1173.8
600	20.5	1009.9	.8597	55.5		1299.6
650	18.1	1138.9	.8685	54.5		1436.2
700	16.0	1280.0	.8774	53.3		1583.8
750	14.3	1433.0	.8860	51.8		1742.3
800	12.8	1597.7	.8941	50.3		1911.8
$\theta_p = 45^o$; $P_p = 550$; $E_p = 1087$						
300	45.4	546.1	.8765	22.7	12.4	772.4
350	40.7	595.7	.8622	39.0	26.3	840.2
400	36.3	656.9	.8541	48.1	38.6	918.5
450	32.2	730.3	.8513	57.7	51.1	1007.2
500	28.5	815.9	.8526	69.3	65.5	1106.2
550	25.2	913.7	.8567	54.8		1215.8
600	22.3	1023.5	.8627	54.8		1335.8
650	19.8	1145.2	.8697	54.3		1466.2
700	17.7	1278.6	.8771	53.3		1607.0
750	15.8	1423.4	.8847	52.1		1758.3
800	14.2	1579.6	.8921	50.8		1920.0

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 45^o$; $P_p = 600$; $E_p = 1113$						
300	45.4	595.5	.8931	20.8	11.4	842.2
350	41.3	643.0	.8783	36.3	24.3	907.5
400	37.2	701.3	.8686	45.2	35.8	982.8
450	33.4	771.1	.8637	54.3	47.5	1068.2
500	29.8	852.4	.8625	64.9	60.6	1163.7
550	26.7	945.3	.8643	82.1	80.8	1269.1
600	23.8	1049.8	.8682	53.7		1384.6
650	21.3	1165.8	.8734	53.4		1510.2
700	19.1	1293.1	.8794	52.8		1645.8
750	17.2	1431.4	.8858	51.9		1791.5
800	15.6	1580.8	.8922	50.7		1947.2
$\theta_p = 45^o$; $P_p = 650$; $E_p = 1141$						
300	45.0	649.4	.9078	19.2	10.4	918.5
350	41.3	695.6	.8933	33.7	22.3	981.8
400	37.7	752.0	.8829	42.3	33.1	1054.9
450	34.1	819.1	.8764	50.9	44.0	1137.8
500	30.8	897.3	.8735	60.6	55.8	1230.4
550	27.8	986.6	.8734	73.5	71.1	1332.7
600	25.0	1087.0	.8755	52.1		1444.8
650	22.5	1198.5	.8790	52.2		1566.6
700	20.4	1320.9	.8836	51.8		1698.1
750	18.4	1454.3	.8888	51.1		1839.5
800	16.7	1598.3	.8942	50.3		1990.5
$\theta_p = 45^o$; $P_p = 700$; $E_p = 1170$						
300	44.4	707.9	.9207	17.6	9.6	1001.2
350	41.1	753.4	.9069	31.3	20.5	1063.1
400	37.7	808.6	.8963	39.4	30.5	1134.4
450	34.5	873.9	.8891	47.5	40.6	1215.3
500	31.4	949.8	.8849	56.5	51.4	1305.8
550	28.5	1036.4	.8833	67.4	64.2	1405.7
600	25.9	1133.8	.8839	50.2		1515.1
650	23.5	1241.9	.8860	50.6		1634.1
700	21.3	1360.7	.8892	50.5		1762.6
750	19.4	1490.1	.8932	50.1		1900.6

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 45^o$; $P_p = 750$; $E_p = 1201$						
300	43.4	771.3	.9320	16.2	8.8	1090.5
350	40.5	816.5	.9191	29.0	18.9	1151.2
400	37.5	870.9	.9087	36.7	28.1	1221.3
450	34.5	935.2	.9011	44.3	37.4	1300.8
500	31.7	1009.6	.8961	52.6	47.3	1389.6
550	29.0	1094.4	.8935	62.2	58.5	1487.7
600	26.5	1189.5	.8928	75.4	73.6	1595.2
650	24.2	1295.2	.8938	48.8		1712.0
700	22.1	1411.2	.8958	48.9		1838.2
750	20.2	1537.7	.8988	48.7		1973.8
$\theta_p = 45^o$; $P_p = 800$; $E_p = 1233$						
300	42.3	839.8	.9417	14.9	8.1	1186.6
350	39.7	885.1	.9299	26.8	17.4	1246.5
400	37.0	939.3	.9201	34.1	25.9	1315.7
450	34.3	1003.3	.9124	41.3	34.5	1394.1
500	31.7	1076.5	.9070	48.9	43.6	1481.8
550	29.2	1160.1	.9036	57.5	53.6	1578.6
600	26.8	1253.8	.9020	68.0	65.5	1684.7
650	24.6	1357.7	.9020	46.8		1800.0
700	22.6	1471.8	.9031	47.1		1924.6
$\theta_p = 50^o$; $P_p = 300$; $E_p = 985$						
300	28.9	475.0	.8455	26.0	14.3	608.6
350	23.6	574.9	.8542	40.3	27.4	719.9
400	19.3	694.5	.8665	45.6	36.2	848.2
450	16.0	833.1	.8799	50.0	43.0	993.7
500	13.4	990.4	.8927	53.8	48.6	1156.3
550	11.4	1166.0	.9044	57.2	53.2	1336.0
600	9.7	1359.5	.9149	60.2	57.1	1532.8
650	8.4	1570.7	.9240	62.9	60.4	1746.7
700	7.3	1799.6	.9320	65.3	63.4	1977.7

$x \rightarrow x + 2x$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 50^o$; $P_p = 350$; $E_p = 1001$						
300	32.6	497.4	.8563	24.8	13.7	644.1
350	27.3	584.6	.8580	39.7	26.9	744.5
400	22.9	689.6	.8650	46.0	36.5	860.3
450	19.3	812.1	.8747	51.3	44.4	991.6
500	16.4	951.9	.8853	56.4	51.3	1138.3
550	14.0	1108.4	.8958	61.1	57.3	1300.5
600	12.1	1281.5	.9056	65.6	62.9	1478.1
650	10.5	1470.8	.9147	70.2	68.3	1671.2
700	9.2	1676.3	.9228	75.0	73.7	1879.7
$\theta_p = 50^o$; $P_p = 400$; $E_p = 1020$						
300	35.1	533.1	.8715	23.2	12.8	693.4
350	30.1	611.2	.8678	38.1	25.6	786.0
400	25.7	705.7	.8700	44.9	35.5	892.9
450	22.0	816.5	.8758	51.1	44.1	1014.0
500	18.9	943.3	.8836	57.0	51.9	1149.4
550	16.4	1085.9	.8921	62.9	59.2	1299.0
600	14.3	1244.0	.9007	69.0	66.5	1462.8
650	12.5	1417.3	.9090	76.0	74.6	1640.9
700	11.0	1605.6	.9167	43.6		1833.3
$\theta_p = 50^o$; $P_p = 450$; $E_p = 1040$						
300	36.5	578.7	.8878	21.4	11.7	754.2
350	32.0	650.6	.8806	35.9	24.0	841.1
400	27.9	737.6	.8790	43.1	33.8	941.4
450	24.2	839.7	.8814	49.6	42.6	1055.0
500	21.1	957.0	.8863	56.0	50.9	1182.1
550	18.4	1089.1	.8926	62.6	59.0	1322.4
600	16.2	1235.9	.8996	69.8	67.4	1476.2
650	14.3	1397.2	.9067	79.0	77.9	1643.3
700	12.7	1572.8	.9136	44.4		1823.9

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 50^o$; $P_p = 500$; $E_p = 1063$						
300	37.2	632.8	.9036	19.6	10.7	825.3
350	33.1	700.4	.8945	33.5	22.2	907.9
400	29.3	782.1	.8903	40.7	31.6	1003.3
450	25.9	877.9	.8899	47.3	40.4	1111.5
500	22.8	988.1	.8923	53.9	48.7	1232.3
550	20.1	1112.4	.8964	60.8	57.0	1365.8
600	17.8	1250.8	.9016	68.3	65.8	1512.1
650	15.8	1403.0	.9073	78.1	76.8	1671.2
700	14.1	1568.9	.9132	44.5		1842.9
$\theta_p = 50^o$; $P_p = 550$; $E_p = 1087$						
300	37.3	694.8	.9181	17.9	9.8	906.1
350	33.7	759.6	.9082	31.0	20.4	985.7
400	30.2	837.5	.9024	38.1	29.3	1077.5
450	27.0	928.9	.8999	44.6	37.7	1181.5
500	24.0	1033.9	.9002	51.2	45.9	1297.8
550	21.4	1152.4	.9025	58.0	54.1	1426.3
600	19.1	1284.5	.9060	65.4	62.7	1567.0
650	17.1	1429.9	.9103	74.4	72.8	1719.9
700	15.4	1588.5	.9151	44.0		1885.2
$\theta_p = 50^o$; $P_p = 600$; $E_p = 1113$						
300	36.9	764.5	.9309	16.3	8.9	996.7
350	33.7	827.5	.9210	28.6	18.6	1074.0
400	30.6	903.1	.9143	35.5	27.0	1163.1
450	27.6	991.4	.9106	41.8	35.0	1264.2
500	24.9	1092.7	.9093	48.2	42.8	1377.1
550	22.4	1207.1	.9100	54.7	50.6	1501.9
600	20.1	1334.5	.9121	61.8	58.8	1638.7
650	18.1	1474.9	.9151	69.8	67.9	1787.3
700	16.4	1628.2	.9187	81.9	81.2	1947.8

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 50^o$; $P_p = 650$; $E_p = 1141$						
300	36.2	842.3	.9420	14.8	8.0	1097.3
350	33.4	904.4	.9326	26.3	17.0	1172.9
400	30.6	978.5	.9256	32.8	24.8	1260.3
450	27.9	1064.9	.9211	38.8	32.3	1359.2
500	25.3	1163.8	.9188	45.0	39.6	1469.8
550	23.0	1275.4	.9182	51.2	47.0	1592.1
600	20.8	1399.6	.9191	57.8	54.6	1725.9
650	18.9	1536.5	.9210	65.1	62.8	1871.5
$\theta_p = 50^o$; $P_p = 700$; $E_p = 1170$						
300	35.3	928.6	.9516	13.5	7.3	1208.2
350	32.8	990.5	.9429	24.0	15.5	1282.9
400	30.3	1063.9	.9360	30.3	22.7	1369.0
450	27.8	1149.3	.9312	36.0	29.6	1466.6
500	25.5	1246.9	.9281	41.8	36.5	1575.7
550	23.3	1356.7	.9267	47.7	43.5	1696.3
600	21.2	1478.1	.9266	53.9	50.5	1828.4
650	19.4	1613.6	.9276	60.4	57.8	1972.0
$\theta_p = 50^o$; $P_p = 750$; $E_p = 1201$						
300	34.1	1024.4	.9597	12.2	6.6	1330.3
350	31.9	1086.5	.9518	22.0	14.1	1404.5
400	29.7	1160.0	.9454	27.8	20.7	1490.0
450	27.5	1245.1	.9405	33.2	27.2	1586.9
500	25.3	1342.2	.9371	38.7	33.6	1695.2
550	23.3	1451.3	.9351	44.3	40.0	1814.9
600	21.4	1572.6	.9343	50.0	46.5	1946.1

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 50^o$; $P_p = 800$; $E_p = 1233$						
300	32.8	1130.6	.9665	11.1	6.0	1464.5
350	30.9	1193.5	.9596	20.0	12.8	1538.6
400	28.9	1267.6	.9536	25.5	18.9	1624.0
450	26.9	1353.1	.9489	30.6	24.8	1720.7
500	25.0	1450.4	.9453	35.7	30.8	1828.9
550	23.1	1559.6	.9431	40.9	36.7	1948.5
$\theta_p = 55^o$; $P_p = 300$; $E_p = 985$						
300	24.6	590.8	.8916	21.0	11.5	709.4
350	20.2	710.8	.8971	33.1	21.8	839.1
400	16.7	852.7	.9053	37.5	28.7	988.7
450	14.0	1016.3	.9144	40.7	34.0	1158.3
500	11.8	1201.1	.9232	43.5	38.2	1347.8
550	10.1	1406.7	.9313	45.8	41.6	1557.2
600	8.6	1633.1	.9386	47.8	44.3	1786.7
$\theta_p = 55^o$; $P_p = 350$; $E_p = 1001$						
300	27.2	626.1	.9018	19.8	10.8	757.4
350	23.0	733.0	.9024	32.1	21.1	875.5
400	19.5	860.1	.9067	37.2	28.5	1011.7
450	16.5	1006.9	.9130	41.1	34.4	1166.1
500	14.1	1173.4	.9200	44.6	39.3	1338.6
550	12.2	1359.1	.9270	47.6	43.4	1529.3
600	10.6	1563.9	.9336	50.3	46.8	1738.2
650	9.2	1787.6	.9398	52.7	49.8	1965.2

$x \longrightarrow \pi + \pi$

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 55^o$; $P_p = 400$; $E_p = 1020$						
300	28.9	678.2	.9145	18.4	10.0	823.3
350	25.0	776.3	.9116	30.4	19.9	933.2
400	21.5	892.9	.9126	35.8	27.3	1060.1
450	18.6	1028.0	.9161	40.2	33.6	1203.9
500	16.1	1181.5	.9209	44.2	38.9	1364.6
550	14.0	1353.0	.9264	47.9	43.6	1542.2
600	12.3	1542.5	.9320	51.2	47.7	1736.8
650	10.8	1749.7	.9374	54.1	51.3	1948.3
$\theta_p = 55^o$; $P_p = 450$; $E_p = 1040$						
300	29.7	744.3	.9275	16.7	9.1	904.9
350	26.1	836.5	.9225	28.3	18.4	1009.1
400	22.9	946.0	.9210	33.9	25.7	1129.5
450	20.1	1072.9	.9222	38.5	32.0	1265.8
500	17.6	1217.2	.9250	42.9	37.6	1418.2
550	15.5	1378.7	.9288	46.9	42.6	1586.7
600	13.7	1557.2	.9331	50.6	47.1	1771.1
650	12.1	1752.7	.9376	54.0	51.2	1971.7
$\theta_p = 55^o$; $P_p = 500$; $E_p = 1063$						
300	29.8	823.7	.9396	15.2	8.2	1001.6
350	26.7	912.1	.9336	26.0	16.8	1101.9
400	23.7	1016.9	.9306	31.6	23.8	1217.7
450	21.1	1138.3	.9300	36.3	30.0	1348.9
500	18.7	1276.2	.9311	40.8	35.6	1495.6
550	16.6	1430.6	.9334	45.0	40.7	1657.6
600	14.8	1601.6	.9364	48.9	45.4	1835.2

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 55^o$; $P_p = 550$; $E_p = 1087$						
300	29.4	916.4	.9504	13.6	7.4	1113.6
350	26.7	1002.7	.9441	23.8	15.3	1211.3
400	24.1	1104.6	.9402	29.2	21.8	1324.1
450	21.6	1222.5	.9384	33.8	27.7	1452.0
500	19.4	1356.3	.9383	38.3	33.2	1594.9
550	17.4	1506.2	.9393	42.5	38.3	1752.8
600	15.6	1672.0	.9412	46.5	43.0	1925.8
$\theta_p = 55^o$; $P_p = 600$; $E_p = 1113$						
300	28.7	1023.3	.9596	12.2	6.6	1241.9
350	26.3	1108.8	.9536	21.5	13.8	1338.1
400	24.0	1209.3	.9494	26.7	19.8	1449.2
450	21.8	1325.4	.9469	31.2	25.4	1575.1
500	19.7	1457.0	.9458	35.5	30.6	1715.8
550	17.8	1604.3	.9459	39.7	35.6	1871.4
$\theta_p = 55^o$; $P_p = 650$; $E_p = 1141$						
300	27.7	1146.2	.9674	10.9	5.9	1388.0
350	25.6	1231.8	.9619	19.4	12.4	1483.7
400	23.6	1332.2	.9578	24.3	17.9	1594.1
450	21.6	1447.8	.9549	28.6	23.1	1719.3
500	19.7	1578.8	.9533	32.7	28.1	1859.2
$\theta_p = 55^o$; $P_p = 700$; $E_p = 1170$						
300	26.4	1287.1	.9739	9.7	5.2	1554.0
350	24.7	1373.8	.9690	17.5	11.1	1650.0
400	22.9	1475.2	.9651	22.0	16.1	1760.8
450	21.1	1591.6	.9623	26.0	20.9	1886.3

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 55^o$; $P_p = 750$; $E_p = 1201$						
300	25.1	1449.2	.9792	8.6	4.7	1742.8
350	23.5	1537.7	.9751	15.6	9.9	1839.9
400	22.0	1640.9	.9715	19.8	14.5	1952.0
$\theta_p = 55^o$; $P_p = 800$; $E_p = 1233$						
300	23.6	1636.2	.9836	7.7	4.1	1958.2
$\theta_p = 60^o$; $P_p = 300$; $E_p = 985$						
300	20.1	756.9	.9296	16.5	8.9	861.0
350	16.6	906.4	.9329	26.2	16.9	1018.4
400	13.9	1081.6	.9379	29.8	22.3	1200.0
450	11.7	1282.3	.9436	32.2	26.3	1405.8
500	9.9	1508.3	.9492	34.3	29.5	1635.8
550	8.5	1759.3	.9544	36.0	32.0	1890.0
$\theta_p = 60^o$; $P_p = 350$; $E_p = 1001$						
300	21.8	815.1	.9384	15.3	8.3	931.7
350	18.6	951.4	.9385	25.0	16.1	1076.9
400	15.8	1111.5	.9409	29.0	21.7	1244.4
450	13.5	1295.2	.9446	31.9	26.0	1434.3
500	11.6	1502.4	.9488	34.4	29.6	1646.6
550	10.1	1732.8	.9531	36.6	32.6	1881.2
$\theta_p = 60^o$; $P_p = 400$; $E_p = 1020$						
300	22.7	897.4	.9484	13.9	7.5	1027.9
350	19.7	1025.4	.9464	13.2	14.9	1165.2
400	17.1	1175.7	.9467	27.5	20.4	1323.6
450	14.9	1348.3	.9486	30.7	24.9	1503.2
500	13.0	1543.1	.9513	33.5	28.8	1703.8
550	11.3	1760.0	.9545	36.0	32.0	1925.6

m_x	θ_x	p_x	β	α	θ_1^{max}	E_γ
$\theta_p = 60^o$; $P_p = 450$; $E_p = 1040$						
300	22.9	1002.6	.9580	12.5	6.7	1148.9
350	20.2	1125.8	.9549	21.2	13.6	1281.3
400	17.9	1270.2	.9538	25.5	18.8	1434.0
450	15.7	1436.0	.9542	28.8	23.3	1607.2
500	13.9	1623.1	.9557	31.8	27.2	1800.7
$\theta_p = 60^o$; $P_p = 500$; $E_p = 1063$						
300	22.5	1131.8	.9666	11.1	6.0	1295.8
350	20.2	1252.8	.9631	19.1	12.2	1425.7
400	18.1	1394.3	.9612	23.3	17.1	1575.5
450	16.1	1556.6	.9607	26.6	21.4	1745.2
500	14.4	1739.6	.9611	29.6	25.3	1934.9
$\theta_p = 60^o$; $P_p = 550$; $E_p = 1087$						
300	21.7	1288.0	.9739	9.7	5.2	1471.8
350	19.8	1408.8	.9705	17.0	10.8	1601.0
400	17.9	1550.0	.9683	21.0	15.3	1750.1
450	16.1	1711.5	.9671	24.2	19.4	1919.0
$\theta_p = 60^o$; $P_p = 600$; $E_p = 1113$						
300	20.6	1475.9	.9800	8.5	4.6	1681.5
350	19.0	1598.6	.9769	15.0	9.5	1811.9
400	17.4	1741.5	.9746	18.7	13.6	1962.3
$\theta_p = 60^o$; $P_p = 650$; $E_p = 1141$						
300	19.3	1702.7	.9848	7.4	4.0	1932.1

$2\pi + 2\pi \longleftarrow X$

$$X \longrightarrow \pi + \pi$$

m_X	β^*	q^*
300	.3654	54.8
350	.6028	105.5
400	.7160	143.2
450	.7841	176.4
500	.8295	207.4
550	.8615	236.9
600	.8851	265.5
650	.9030	293.5
700	.9170	320.9
750	.9281	348.0
800	.9371	374.8

$$X \longrightarrow \gamma + \gamma$$

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 10^o$; $P_p = 200$; $E_p = 959$					
300	11.5	174.8	.5035	119.5	368.3
350	7.5	266.0	.6051	105.5	460.7
400	5.4	371.9	.6810	94.2	567.3
450	4.0	492.4	.7382	84.8	688.1
500	3.2	627.1	.7819	77.1	823.1
550	2.6	776.2	.8159	70.6	972.4
600	2.1	939.5	.8428	65.1	1135.9
650	1.8	1117.1	.8643	60.4	1313.5
700	1.5	1308.9	.8818	56.3	1505.4
750	1.3	1515.0	.8962	52.7	1711.5
800	1.1	1735.2	.9081	49.5	1931.8
$\theta_p = 10^o$; $P_p = 250$; $E_p = 970$					
300	21.8	116.8	.3629	137.4	354.7
350	13.2	189.6	.4764	123.1	430.8
400	9.0	275.9	.5677	110.8	518.6
450	6.6	374.5	.6397	100.5	618.2
500	5.1	485.2	.6964	91.7	729.4
550	4.1	607.8	.7415	84.3	852.4
600	3.3	742.2	.7776	77.9	987.1
650	2.8	888.3	.8070	72.4	1133.5
700	2.4	1046.3	.8311	67.6	1291.6
750	2.0	1216.0	.8511	63.3	1461.4
800	1.8	1397.4	.8678	59.6	1642.9

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 10^o$; $P_p = 300$; $E_p = 985$					
300	40.0	81.1	.2608	149.8	357.5
350	22.2	137.7	.3661	137.1	422.9
400	14.4	209.4	.4639	124.7	498.3
450	10.2	293.0	.5456	113.9	583.8
500	7.7	387.4	.6124	104.5	679.3
550	6.1	492.2	.6668	96.4	784.9
600	4.9	607.3	.7114	89.3	900.5
650	4.1	732.6	.7480	83.2	1026.2
700	3.4	868.0	.7784	77.8	1161.9
750	2.9	1013.6	.8039	73.0	1307.7
800	2.6	1169.3	.8253	68.8	1463.5
$\theta_p = 10^o$; $P_p = 350$; $E_p = 1001$					
300	67.1	65.9	.2147	155.2	370.3
350	36.1	103.1	.2827	147.2	428.0
400	22.1	161.8	.3750	136.0	494.6
450	15.1	233.5	.4605	125.2	570.1
500	11.1	315.7	.5339	115.5	654.5
550	8.6	106.9	.5954	106.9	747.7
600	6.9	508.8	.6468	99.4	849.8
650	5.6	619.2	.6897	92.8	960.8
700	4.7	738.5	.7258	86.9	1080.7
750	4.0	866.9	.7563	81.7	1209.5
800	3.5	1004.3	.7822	77.1	1347.1
$\theta = 10^o$; $P_p = 400$; $E_p = 1020$					
300	93.5	69.6	.2259	153.9	389.7
350	55.5	84.3	.2342	152.9	441.7
400	32.8	128.3	.3054	144.4	501.8
450	21.5	189.1	.3874	134.4	569.8
500	15.4	261.4	.4633	124.8	645.9
550	11.7	343.1	.5293	116.1	730.0
600	9.2	433.7	.5858	108.3	822.1
650	7.5	532.8	.6339	101.3	922.2
700	6.2	640.1	.6748	95.1	1030.3
750	5.3	755.6	.7097	89.6	1146.4
800	4.5	879.3	.7397	84.6	1270.5

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 10^o$; $P_p = 450$; $E_p = 1040$					
300	110.7	83.5	.2681	148.9	413.7
350	76.8	80.2	.2234	154.2	461.4
400	46.8	107.1	.2596	150.0	516.5
450	29.9	156.5	.3285	141.7	578.8
500	20.8	219.6	.4022	131.6	648.5
550	15.5	292.9	.4701	123.9	725.5
600	12.0	374.9	.5299	114.0	809.8
650	9.7	465.0	.5818	108.9	901.5
700	8.0	562.8	.6266	102.4	1000.5
750	6.7	668.3	.6653	96.6	1106.9
800	5.7	781.3	.6987	91.6	1220.6
$\theta_p = 10^o$; $P_p = 500$; $E_p = 1063$					
300	120.5	100.7	.3182	142.9	441.4
350	94.5	87.1	.2414	152.1	485.6
400	63.0	97.4	.2366	152.6	536.6
450	40.4	133.9	.2853	146.9	594.4
500	27.5	187.9	.3518	138.8	659.1
550	20.0	253.4	.4185	130.5	730.5
600	15.3	328.0	.4797	122.7	808.7
650	12.2	410.6	.5341	115.4	893.8
700	10.0	500.8	.5818	108.8	985.6
750	8.3	598.2	.6235	102.9	1084.2
800	7.1	702.7	.6599	97.4	1189.7
$\theta_p = 10^o$; $P_p = 550$; $E_p = 1087$					
300	126.2	118.3	.3668	137.0	471.8
350	106.6	99.6	.2738	148.2	513.2
400	78.5	97.4	.2366	152.6	561.0
450	52.4	120.5	.2587	150.0	615.2
500	35.4	164.6	.3127	143.6	675.7
550	25.4	222.5	.3750	136.0	742.6
600	19.2	290.4	.4357	128.4	815.9
650	15.1	366.6	.4912	121.1	895.6
700	12.2	450.2	.5409	114.5	981.6
750	10.2	540.8	.5849	108.4	1074.0
800	8.6	638.3	.6237	102.2	1172.8

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 10^o$; $P_p = 600$; $E_p = 1113$					
300	129.7	135.3	.4111	131.5	504.5
350	114.4	114.4	.3106	143.8	543.7
400	91.2	104.2	.2520	150.8	588.8
450	64.8	115.1	.2479	151.3	639.9
500	44.4	148.8	.2852	146.9	697.1
550	31.6	198.9	.3400	140.2	760.3
600	23.6	260.4	.3981	133.1	829.5
650	18.4	330.7	.4534	126.1	904.7
700	14.8	408.6	.5041	119.5	986.0
750	12.2	493.4	.5496	113.3	1073.2
800	10.3	584.9	.5902	107.7	1166.5
$\theta_p = 10^o$; $P_p = 650$; $E_p = 1141$					
300	131.8	151.4	.4505	126.5	539.2
350	119.5	129.6	.3472	139.4	576.4
400	100.5	114.7	.2758	148.0	619.3
450	76.2	116.2	.2501	151.0	667.9
500	53.9	139.6	.2689	148.8	722.3
550	38.4	181.6	.3135	143.5	782.4
600	28.5	236.7	.3669	137.0	848.1
650	22.0	301.5	.4207	130.2	919.6
700	17.5	374.2	.4714	123.8	996.9
750	14.4	453.9	.5178	117.6	1079.9
800	12.1	540.3	.5597	111.9	1168.5
$\theta_p = 10^o$; $P_p = 700$; $E_p = 1170$					
300	133.1	166.5	.4854	121.9	575.5
350	122.8	144.6	.3818	135.1	611.0
400	107.1	127.1	.3029	144.7	652.1
450	85.6	121.9	.2614	149.7	698.6
500	63.3	136.1	.2626	149.6	750.5
550	45.7	169.8	.2950	145.7	807.9
600	33.8	218.4	.3421	140.0	870.9
650	25.9	277.9	.3931	133.7	939.3
700	20.6	345.8	.4429	127.4	1013.1
750	16.8	421.0	.4895	121.4	1092.4
800	14.0	502.8	.5321	115.7	1177.2

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 10^o$; $P_p = 750$; $E_p = 1201$					
300	133.9	180.8	.5161	117.9	613.2
350	125.0	159.0	.4136	131.1	647.4
400	111.7	140.1	.3307	141.4	686.8
450	93.2	130.4	.2783	147.7	731.4
500	71.8	137.0	.2644	149.4	781.4
550	53.0	162.9	.2840	147.0	836.6
600	39.4	205.4	.3234	142.3	897.0
650	30.2	259.2	.3704	136.5	962.7
700	23.8	322.5	.4184	130.5	1033.6
750	19.3	393.4	.4645	124.7	1109.8
800	16.0	471.1	.5074	119.0	1191.3
$\theta_p = 10^o$; $P_p = 800$; $E_p = 1233$					
300	134.3	194.2	.5434	114.2	652.1
350	126.5	172.8	.4426	127.5	685.1
400	115.0	153.2	.3577	138.1	723.1
450	98.9	140.6	.2982	145.3	766.2
500	79.2	141.4	.2721	148.4	814.4
550	60.1	160.2	.2796	147.5	867.6
600	45.2	195.8	.3103	143.9	925.9
650	34.6	244.7	.3523	138.7	989.3
700	27.2	303.5	.3978	133.1	1057.7
750	22.0	370.4	.4428	127.4	1131.3
800	18.2	444.3	.4855	121.9	1209.8
$\theta_p = 15^o$; $P_p = 200$; $E_p = 959$					
300	15.8	190.4	.5358	115.2	376.4
350	10.6	282.4	.6279	102.2	470.8
400	7.6	390.0	.6981	91.5	579.7
450	5.8	512.6	.7515	82.5	703.2
500	4.6	650.1	.7927	75.1	841.2
550	3.7	802.2	.8248	68.9	993.7
600	3.1	969.0	.8502	63.5	1160.8
650	2.6	1150.3	.8706	58.9	1342.3
700	2.2	1346.2	.8872	54.9	1538.4
750	1.9	1556.7	.9009	51.4	1749.1
800	1.7	1781.8	.9123	48.4	1974.2

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 15^o$; $P_p = 250$; $E_p = 970$					
300	28.1	137.4	.4164	130.8	362.7
350	18.0	209.3	.5132	118.2	440.5
400	12.6	296.0	.5949	107.0	530.4
450	9.4	396.0	.6606	97.3	632.2
500	7.3	508.6	.7131	89.0	745.9
550	5.9	633.5	.7551	81.9	871.7
600	4.8	770.6	.7890	75.8	1009.4
650	4.0	919.9	.8167	70.5	1159.1
700	3.4	1081.2	.8394	65.8	1320.8
750	3.0	1254.6	.8583	61.7	1494.4
800	2.6	1440.0	.8742	58.1	1680.1
$\theta_p = 15^o$; $P_p = 300$; $E_p = 985$					
300	45.6	108.7	.3407	140.2	365.9
350	28.5	162.7	.4215	130.1	432.8
400	19.4	233.4	.5040	119.5	509.9
450	14.2	317.2	.5762	109.6	597.4
500	10.8	412.7	.6366	100.9	695.1
550	8.6	519.2	.6865	93.3	803.2
600	7.0	636.4	.7276	86.6	921.5
650	5.8	764.3	.7617	80.8	1050.1
700	4.9	902.5	.7902	75.6	1189.0
750	4.2	1051.3	.8141	71.0	1338.2
800	3.7	1210.4	.8342	66.9	1497.6
$\theta_p = 15^o$; $P_p = 350$; $E_p = 1001$					
300	65.6	99.5	.3147	143.3	379.2
350	42.1	135.1	.3601	137.8	438.3
400	28.3	191.3	.4314	128.9	506.5
450	20.2	261.9	.5030	119.6	583.8
500	15.2	344.3	.5671	110.9	670.2
550	12.0	437.1	.6222	103.1	765.7
600	9.7	539.8	.6689	96.1	870.3
650	8.0	652.2	.7083	89.8	983.9
700	6.7	773.9	.7416	84.3	1106.7
750	5.7	905.0	.7700	79.3	1238.6
800	5.0	1045.4	.7941	74.8	1379.5

$\alpha + \beta \rightarrow \chi$

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 15^o$; $P_p = 400$; $E_p = 1020$					
300	82.9	104.3	.3284	141.7	399.3
350	57.4	122.9	.3313	141.3	452.7
400	39.0	164.5	.3803	135.3	514.2
450	27.6	223.1	.4441	127.3	583.9
500	20.6	294.3	.5073	119.0	661.9
550	16.0	376.2	.5646	111.3	748.1
600	12.8	467.7	.6147	104.1	842.4
650	10.5	582.7	.6750	96.3	945.0
700	8.8	677.4	.6954	91.9	1055.8
750	7.5	795.2	.7275	86.6	1174.8
800	6.4	921.4	.7551	81.9	1302.0
$\theta_p = 15^o$; $P_p = 450$; $E_p = 1040$					
300	95.1	116.9	.3631	137.4	424.3
350	71.7	122.7	.3307	141.4	473.2
400	50.8	150.3	.3516	138.8	529.6
450	36.2	197.0	.4010	132.7	593.6
500	26.8	258.1	.4587	125.4	665.0
550	20.6	330.5	.5151	118.0	744.0
600	16.4	412.6	.5666	111.0	830.5
650	13.4	503.5	.6124	104.5	924.5
700	11.1	602.8	.6525	98.5	1026.1
750	9.4	710.1	.6875	93.1	1135.2
800	8.1	825.4	.7181	91.8	1251.8
$\theta_p = 15^o$; $P_p = 500$; $E_p = 1063$					
300	103.1	132.8	.4048	132.3	453.0
350	83.2	130.3	.3489	139.2	498.4
400	62.3	146.1	.3430	139.9	550.7
450	45.5	181.4	.3739	136.1	610.1
500	33.8	232.7	.4220	130.1	676.4
550	25.9	296.5	.4745	123.4	749.7
600	20.4	370.4	.5253	116.6	830.0
650	16.6	453.2	.5719	110.2	917.3
700	13.7	544.2	.6138	104.3	1011.6
750	11.6	643.0	.6509	98.8	1112.8
800	9.9	749.3	.6836	93.8	1221.0

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 15^o$; $P_p = 550$; $E_p = 1087$					
300	108.1	149.8	.4466	127.0	484.6
350	91.7	142.4	.3768	135.7	527.2
400	72.4	149.3	.3496	139.1	576.3
450	54.7	174.3	.3612	137.7	631.9
500	41.2	216.3	.3970	133.3	694.1
550	31.6	271.8	.4430	127.4	762.8
600	24.9	338.2	.4911	121.2	838.1
650	20.1	413.9	.5371	115.0	919.9
700	16.6	497.8	.5795	109.2	1008.3
750	14.0	589.4	.6179	103.7	1103.2
800	11.9	688.3	.6522	98.6	1204.6
$\theta_p = 15^o$; $P_p = 600$; $E_p = 1113$					
300	111.4	166.8	.4859	121.9	518.7
350	97.6	156.6	.4085	131.8	559.0
400	80.6	157.4	.3661	137.1	605.3
450	63.2	173.9	.3604	137.8	657.9
500	48.6	207.1	.3827	135.0	716.6
550	37.5	254.8	.4204	130.3	781.6
600	29.6	314.2	.4639	124.7	852.7
650	23.9	383.4	.5080	118.9	930.1
700	19.7	461.0	.5500	113.3	1013.6
750	16.5	546.3	.5887	107.9	1103.3
800	14.1	638.8	.6240	102.8	1199.2
$\theta_p = 15^o$; $P_p = 650$; $E_p = 1141$					
300	113.5	183.4	.5216	117.1	554.8
350	101.7	171.8	.4406	127.7	593.0
400	86.8	168.5	.3881	134.3	637.2
450	70.6	178.4	.3685	136.8	687.2
500	55.6	203.9	.3776	135.6	743.1
550	43.5	244.2	.4059	132.1	805.0
600	34.5	297.0	.4436	127.3	872.7
650	27.8	360.1	.4846	122.0	946.2
700	22.9	431.9	.5251	116.7	1025.7
750	19.2	511.6	.5635	111.4	1111.1
800	16.3	598.6	.5991	106.4	1202.3

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 15^o$; $P_p = 700$; $E_p = 1170$					
300	114.8	199.5	.5537	112.8	592.6
350	104.5	187.1	.4715	123.7	629.2
400	91.5	181.2	.4126	131.3	671.5
450	76.6	186.2	.3824	135.0	719.4
500	61.9	205.3	.3799	135.3	772.9
550	49.3	239.0	.3985	133.0	832.0
600	39.4	285.5	.4297	129.1	896.8
650	31.9	342.8	.4665	124.4	967.2
700	26.3	409.4	.5048	119.4	1043.3
750	22.0	484.0	.5422	114.3	1125.0
800	18.7	565.9	.5775	109.5	1212.3
$\theta_p = 15^o$; $P_p = 750$; $E_p = 1201$					
300	115.5	215.0	.5825	108.8	632.0
350	106.4	202.3	.5005	119.9	667.2
400	94.9	194.8	.4378	128.1	707.8
450	81.4	196.2	.3998	132.9	753.9
500	67.4	210.3	.3876	134.4	805.3
550	54.6	238.0	.3971	133.2	862.2
600	44.1	278.7	.4213	130.2	924.5
650	35.9	330.7	.4535	126.1	992.2
700	29.6	392.3	.4889	121.5	1065.3
750	24.8	462.2	.5246	116.7	1143.9
800	21.1	539.5	.5591	112.0	1227.9
$\theta_p = 15^o$; $P_p = 800$; $E_p = 1233$					
300	115.8	229.9	.6083	105.1	672.7
350	107.7	217.3	.5274	116.3	706.7
400	97.4	208.7	.4626	124.9	745.9
450	85.1	207.8	.4192	130.4	790.4
500	72.0	217.7	.3992	133.0	840.1
550	59.4	240.4	.4005	132.8	895.0
600	48.6	275.9	.4178	130.6	955.2
650	39.9	322.9	.4449	127.2	1020.6
700	33.0	379.8	.4769	123.0	1091.2
750	27.7	445.3	.5105	118.6	1167.0
800	23.5	518.4	.5438	114.1	1248.1

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 20^o$; $P_p = 200$; $E_p = 959$					
300	18.9	211.6	.5764	109.6	388.2
350	12.9	305.4	.6575	97.8	485.6
400	9.5	415.7	.7206	87.8	598.0
450	7.3	541.7	.7692	79.4	725.3
500	5.7	683.1	.8069	72.4	867.6
550	4.7	839.8	.8366	66.4	1025.0
600	3.9	1011.6	.8601	61.3	1197.3
650	3.3	1198.5	.8790	56.9	1384.5
700	2.8	1400.5	.8945	53.1	1586.8
750	2.4	1617.5	.9072	49.7	1804.0
800					
$\theta_p = 20^o$; $P_p = 250$; $E_p = 971$					
300	31.5	163.6	.4789	122.8	374.5
350	21.2	235.9	.5590	112.0	454.8
400	15.3	324.1	.6296	102.0	547.6
450	11.6	426.4	.6878	93.1	652.7
500	9.1	542.0	.7350	85.4	770.2
550	7.3	670.5	.7732	78.7	899.9
600	6.1	811.7	.8042	72.9	1042.1
650	5.1	965.6	.8295	67.9	1196.7
700	4.3	1131.9	.8505	63.5	1363.6
750	3.7	1310.8	.8680	59.6	1542.9
800	3.3	1502.1	.8826	56.1	1734.6
$\theta_p = 20^o$; $P_p = 300$; $E_p = 985$					
300	46.8	140.6	.4245	129.8	378.1
350	31.8	194.6	.4859	121.9	447.2
400	22.7	265.7	.5533	112.8	527.0
450	17.0	350.8	.6148	104.1	617.4
500	13.2	448.4	.6676	96.2	718.4
550	10.6	557.6	.7120	89.2	830.0
600	8.7	678.2	.7490	83.0	952.3
650	7.3	809.8	.7799	77.5	1085.2
700	6.2	952.4	.8058	72.6	1228.8
750	5.3	1105.8	.8276	68.3	1382.9
800	4.6	1270.0	.8461	64.4	1547.8

$\alpha + \beta \longleftarrow x$

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 20^o$; $P_p = 350$; $E_p = 1001$					
300	62.1	135.4	.4115	131.4	392.3
350	43.8	172.7	.4426	127.5	453.5
400	31.5	228.9	.4967	120.4	524.0
450	23.5	300.0	.5547	112.6	604.0
500	18.2	383.6	.6087	105.0	693.4
550	14.5	478.4	.6563	98.0	792.1
600	11.8	583.8	.6974	91.6	900.3
650	9.8	699.3	.7325	85.8	1017.9
700	8.3	824.8	.7624	80.6	1144.9
750	7.2	959.9	.7880	76.0	1281.3
800	6.2	1104.8	.8099	71.8	1427.2
$\theta_p = 20^o$; $P_p = 400$; $E_p = 1020$					
300	74.6	141.9	.4275	129.4	413.6
350	55.8	165.4	.4272	129.4	468.8
400	41.1	208.0	.4613	125.1	532.5
450	30.8	266.6	.5098	118.7	604.8
500	23.8	338.5	.5606	111.8	685.5
550	18.9	421.7	.6084	105.1	774.7
600	15.4	515.1	.6514	98.7	872.5
650	12.8	618.1	.6891	92.9	978.7
700	10.8	730.5	.7220	87.6	1093.4
750	9.2	851.8	.7505	82.7	1216.7
800	8.0	982.1	.7753	78.3	1348.4
$\theta_p = 20^o$; $P_p = 450$; $E_p = 1040$					
300	83.7	154.8	.4586	125.4	439.9
350	66.2	168.1	.4330	128.7	490.6
400	50.6	199.0	.4455	127.1	549.2
450	38.6	246.5	.4804	122.6	615.4
500	30.0	307.9	.5243	116.8	689.5
550	23.8	381.0	.5694	110.6	771.4
600	19.3	464.5	.6121	104.5	861.1
650	16.0	557.4	.6510	98.8	958.6
700	13.5	659.2	.6856	93.4	1063.9
750	11.5	769.6	.7162	88.5	1177.0
800	10.0	888.4	.7431	84.0	1297.9

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 20^o$; $P_p = 500$; $E_p = 1063$					
300	89.9	171.0	.4951	120.6	470.2
350	74.5	177.4	.4522	126.2	517.3
400	59.2	199.0	.4454	127.1	571.7
450	46.3	236.5	.4653	124.6	633.3
500	36.3	288.4	.4997	120.1	702.1
550	29.0	352.6	.5397	114.7	778.2
600	23.6	427.4	.5802	109.1	861.6
650	19.5	511.7	.6186	103.6	952.2
700	16.4	604.8	.6538	98.3	1050.0
750	14.0	706.3	.6856	93.4	1155.1
800	12.1	815.7	.7139	88.9	1267.5
$\theta_p = 20^o$; $P_p = 550$; $E_p = 1087$					
300	94.0	188.5	.5321	115.7	503.6
350	80.6	190.6	.4783	122.9	547.9
400	66.4	205.2	.4564	125.7	598.9
450	53.4	234.4	.4619	125.0	656.7
500	42.6	277.8	.4857	121.9	721.3
550	34.3	333.9	.5189	117.5	792.8
600	28.0	401.0	.5556	112.5	871.0
650	23.2	477.7	.5922	107.4	956.0
700	19.5	563.3	.6269	102.4	1047.8
750	16.6	657.1	.6590	97.6	1146.5
800	14.3	758.8	.6882	93.0	1251.9
$\theta_p = 20^o$; $P_p = 600$; $E_p = 1113$					
300	96.7	206.6	.5672	110.9	539.7
350	85.1	205.9	.5071	119.1	581.5
400	72.2	215.5	.4743	123.4	629.8
450	59.5	238.0	.4676	124.3	684.5
500	48.4	274.2	.4808	122.5	745.7
550	39.4	323.0	.5064	119.2	813.3
600	32.4	383.1	.5381	114.9	887.3
650	26.9	453.1	.5718	110.3	967.8
700	22.7	532.0	.6051	105.5	1054.7
750	19.3	619.1	.6366	100.9	1148.0
800	16.7	714.0	.6659	96.5	1247.8

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 20^o$; $P_p = 650$; $E_p = 1141$					
300	98.4	224.7	.5995	106.3	578.0
350	88.2	222.4	.5363	115.1	617.8
400	76.6	228.5	.4960	120.5	663.8
450	64.7	245.9	.4795	122.7	716.0
500	53.7	275.9	.4831	122.2	774.2
550	44.3	318.3	.5009	119.9	838.6
600	36.7	372.0	.5270	116.4	909.1
650	30.7	435.9	.5570	112.3	985.8
700	25.9	508.9	.5880	108.0	1068.6
750	22.1	590.2	.6184	103.6	1157.5
800	19.1	679.2	.6472	99.4	1252.6
$\theta_p = 20^o$; $P_p = 700$; $E_p = 1170$					
300	99.4	242.6	.6288	102.1	618.2
350	90.3	239.4	.5645	111.3	656.4
400	79.9	243.1	.5194	117.4	700.5
450	68.8	256.7	.4954	120.6	750.4
500	58.2	281.7	.4908	121.2	806.2
550	48.7	318.5	.5011	119.9	867.9
600	40.8	366.6	.5214	117.2	935.5
650	34.2	425.0	.5472	113.7	1009.0
700	29.1	492.6	.5755	109.7	1088.3
750	24.9	568.6	.6041	105.7	1173.5
800	21.5	652.3	.6319	101.6	1264.6
$\theta_p = 20^o$; $P_p = 750$; $E_p = 1201$					
300	99.9	260.3	.6554	98.1	660.1
350	91.8	256.6	.5912	107.5	696.9
400	82.3	258.8	.5432	114.2	739.3
450	72.1	269.5	.5137	118.2	787.4
500	62.0	290.5	.5023	119.7	841.2
550	52.6	322.7	.5060	119.3	900.6
600	44.5	365.8	.5206	117.3	965.7
650	37.7	419.2	.5420	114.4	1036.4
700	32.1	481.9	.5670	110.9	1112.8
750	27.6	553.1	.5935	107.2	1194.8
800	23.9	632.1	.6199	103.4	1282.5

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 20^o$; $P_p = 800$; $E_p = 1233$					
300	100.0	277.8	.6794	94.4	703.6
350	92.6	273.9	.6162	103.9	739.2
400	84.1	275.0	.5666	111.0	780.2
450	74.7	283.6	.5332	115.6	826.7
500	65.1	301.6	.5165	117.8	878.7
550	56.0	329.9	.5144	118.1	936.1
600	47.9	368.7	.5236	116.9	999.0
650	40.9	417.7	.5406	114.6	1067.4
700	35.1	476.0	.5623	111.6	1141.3
750	30.3	542.8	.5863	108.2	1220.6
800	26.3	617.5	.6110	104.7	1305.4
$\theta_p = 25^o$; $P_p = 200$; $E_p = 959$					
300	20.7	238.6	.6224	103.0	404.4
350	14.6	335.4	.6919	92.5	505.8
400	10.8	449.6	.7471	83.3	622.9
450	8.4	580.4	.7903	75.6	755.5
500	6.7	727.4	.8241	69.0	903.8
550	5.4	890.4	.8508	63.4	1067.7
600	4.5	1069.2	.8721	58.6	1247.1
650	3.8	1263.8	.8893	54.4	1442.2
700	3.3	1474.1	.9033	50.8	1652.9
750	2.8	1700.0	.9149	47.6	1879.2
$\theta_p = 25^o$; $P_p = 250$; $E_p = 971$					
300	32.8	195.1	.5451	113.9	390.6
350	23.1	269.4	.6099	104.8	474.4
400	17.0	360.4	.6693	96.0	571.1
450	13.1	466.3	.7196	88.0	680.8
500	10.4	586.3	.7609	80.9	803.3
550	8.4	719.9	.7946	74.8	938.7
600	7.0	866.9	.8223	69.4	1087.0
650	5.9	1027.1	.8450	64.7	1248.2
700	5.0	1200.4	.8638	60.5	1422.3
750	4.4	1386.8	.8796	56.8	1609.3
800	3.8	1586.1	.8929	53.5	1809.2

$\alpha + \alpha \leftarrow x$

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 25^o$; $P_p = 300$; $E_p = 985$					
300	45.8	176.7	.5074	119.0	394.9
350	33.0	232.8	.5538	112.8	467.1
400	24.5	306.0	.6076	105.2	550.4
450	18.8	393.9	.6586	97.6	644.8
500	14.8	494.9	.7035	90.6	750.3
550	12.0	608.4	.7418	84.2	866.9
600	9.9	733.8	.7741	78.5	994.7
650	8.4	870.9	.8014	73.5	1133.5
700	7.1	1019.4	.8244	68.9	1283.4
750	6.2	1179.4	.8438	64.9	1444.4
800	5.4	1350.6	.8604	61.3	1616.6
$\theta_p = 25^o$; $P_p = 350$; $E_p = 1001$					
300	57.8	174.8	.5034	119.6	410.4
350	43.3	215.8	.5247	116.7	474.3
400	32.6	274.2	.5654	111.1	548.1
450	25.2	347.6	.6113	104.6	631.8
500	19.9	434.0	.6555	98.1	725.2
550	16.1	532.3	.6954	91.9	828.6
600	13.3	641.8	.7305	86.1	941.7
650	11.2	762.0	.7608	80.9	1064.7
700	9.5	892.7	.7869	76.2	1197.6
750	8.2	1033.7	.8094	71.9	1340.2
800	7.2	1184.8	.8288	68.1	1492.8
$\theta_p = 25^o$; $P_p = 400$; $E_p = 1020$					
300	67.3	183.2	.5212	117.2	433.2
350	52.7	212.3	.5187	117.5	491.1
400	40.9	258.3	.5425	114.3	557.9
450	31.9	319.4	.5788	109.3	633.5
500	25.4	393.7	.6186	103.6	718.1
550	20.6	479.8	.6574	97.8	811.6
600	17.0	576.7	.6930	92.3	913.9
650	14.3	683.9	.7248	87.1	1025.2
700	12.2	800.9	.7529	82.3	1145.4
750	10.5	927.5	.7776	77.9	1274.5
800	9.1	1063.5	.7991	73.9	1412.5

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 25^o$; $P_p = 450$; $E_p = 1040$					
300	74.2	197.6	.5500	113.3	461.6
350	60.7	218.1	.5289	116.1	514.7
400	48.5	253.9	.5359	115.2	576.1
450	38.6	304.5	.5604	111.8	645.7
500	31.1	368.4	.5932	107.2	723.4
550	25.3	444.2	.6283	102.2	809.3
600	21.0	530.8	.6626	97.0	903.4
650	17.6	627.4	.6945	93.0	1005.7
700	15.0	733.4	.7234	87.3	1116.2
750	12.9	848.5	.7493	82.9	1234.8
800	11.3	972.6	.7723	78.9	1361.7
$\theta_p = 25^o$; $P_p = 500$; $E_p = 1063$					
300	79.0	215.2	.5829	108.7	494.1
350	66.8	229.8	.5489	113.4	543.6
400	55.1	257.7	.5416	114.6	600.7
450	44.9	299.5	.5541	112.7	665.5
500	36.6	354.5	.5784	109.3	737.8
550	30.1	421.4	.6082	105.1	817.8
600	25.0	499.1	.6395	100.5	905.4
650	21.1	586.8	.6701	95.9	1000.6
700	18.0	683.7	.6987	91.4	1103.4
750	15.5	789.5	.7250	87.1	1213.8
800	13.5	903.8	.7488	83.0	1331.9
$\theta_p = 25^o$; $P_p = 550$; $E_p = 1087$					
300	82.2	234.5	.6159	104.0	530.1
350	71.4	245.2	.5738	110.0	576.7
400	60.4	267.2	.5555	112.5	630.4
450	50.3	301.9	.5571	112.3	691.2
500	41.7	349.3	.5727	110.1	759.2
550	34.7	408.5	.5962	106.8	834.4
600	29.1	478.5	.6235	102.9	916.8
650	24.6	558.4	.6517	98.7	1006.3
700	21.0	647.6	.6791	94.5	1102.9
750	18.2	745.4	.7049	90.4	1206.7
800	15.8	851.6	.7288	86.4	1317.7

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 25^o$; $P_p = 600$; $E_p = 1113$					
300	84.3	254.8	.6473	99.3	569.0
350	74.7	262.8	.6005	106.2	613.1
400	64.6	280.6	.5743	109.9	664.1
450	54.9	309.7	.5670	110.9	721.7
500	46.3	350.8	.5743	109.9	786.2
550	38.9	403.3	.5913	107.5	857.5
600	32.9	466.6	.6139	104.3	935.5
650	28.0	539.8	.6389	100.6	1020.4
700	24.0	622.2	.6643	96.7	1112.0
750	20.8	713.2	.6891	92.9	1210.4
800	18.2	812.4	.7125	89.1	1315.6
$\theta_p = 25^o$; $P_p = 650$; $E_p = 1141$					
300	85.6	275.5	.6767	94.9	610.5
350	77.0	281.9	.6273	102.3	652.6
400	67.8	296.6	.5956	106.9	701.1
450	58.7	321.5	.5813	108.9	756.2
500	50.2	357.3	.5815	108.9	817.7
550	42.8	404.3	.5922	107.4	885.7
600	36.5	461.7	.6098	104.9	960.2
650	31.3	529.0	.6312	101.7	1041.2
700	27.0	605.4	.6542	98.3	1128.7
750	23.4	690.4	.6773	94.7	1222.6
800	20.5	783.6	.6997	91.2	1323.0
$\theta_p = 25^o$; $P_p = 700$; $E_p = 1170$					
300	86.2	296.4	.7029	90.7	654.1
350	78.5	301.8	.6531	98.5	694.5
400	70.2	314.4	.6180	103.7	741.2
450	61.6	336.1	.5984	106.5	794.0
500	53.5	367.8	.5926	107.3	853.1
550	46.2	410.0	.5977	106.6	918.4
600	39.8	462.4	.6104	104.8	989.9
650	34.3	524.5	.6280	102.2	1067.6
700	29.8	595.7	.6481	99.2	1151.5
750	26.0	675.4	.6692	96.0	1241.7
800	22.8	763.3	.6903	92.7	1338.1

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 25^o$; $P_p = 750$; $E_p = 1201$					
300	86.4	317.5	.7269	86.7	699.8
350	79.4	322.3	.6775	94.7	738.8
400	71.8	333.5	.6404	100.4	783.7
450	63.9	352.8	.6169	103.8	834.7
500	56.2	381.2	.6063	105.4	891.7
550	49.1	419.5	.6065	105.3	954.7
600	42.7	467.6	.6147	104.1	1023.6
650	37.1	525.2	.6285	102.1	1098.6
700	32.4	591.8	.6456	99.6	1179.6
750	28.4	666.9	.6645	96.7	1266.6
800	25.0	750.0	.6839	93.7	1359.5
$\theta_p = 25^o$; $P_p = 800$; $E_p = 1233$					
300	86.2	338.8	.7486	83.1	747.3
350	79.9	343.3	.7002	91.1	785.0
400	73.0	353.5	.6622	97.1	828.6
450	65.7	371.0	.6361	101.0	878.0
500	58.4	397.0	.6218	103.1	933.2
550	51.5	432.1	.6178	103.7	994.2
600	45.2	476.6	.6220	103.1	1061.0
650	39.6	530.3	.6321	101.6	1133.6
700	34.8	592.8	.6463	99.5	1212.1
750	30.6	663.8	.6627	97.0	1296.3
800	27.1	742.7	.6804	94.3	1386.4
$\theta_p = 30^o$; $P_p = 200$; E_p 959					
300	21.6	271.6	.6712	95.7	425.8
350	15.5	373.0	.7293	86.3	532.6
400	11.7	492.9	.7765	78.1	655.8
450	9.1	630.3	.8139	71.0	795.5
500	7.3	784.8	.8434	65.0	951.6
550	6.0	956.2	.8668	59.8	1124.2
600	5.0	1144.3	.8856	55.3	1313.2
650	4.2	1349.1	.9009	51.5	1518.6
700	3.6	1570.4	.9134	48.0	1740.4
750	3.2	1808.2	.9237	45.0	1978.7

x ↓ 2 + 2

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 30^o$; $P_p = 250$; $E_p = 971$					
300	32.6	232.0	.6117	104.6	412.0
350	23.8	310.2	.6632	96.9	500.4
400	17.9	405.6	.7120	89.2	602.4
450	14.0	516.9	.7542	82.1	718.0
500	11.2	643.0	.7894	75.7	847.3
550	9.2	783.6	.8185	70.1	990.1
600	7.6	938.4	.8425	65.2	1146.5
650	6.5	1107.1	.8624	60.8	1316.6
700	5.6	1289.8	.8789	57.0	1500.2
750	4.8	1486.2	.8928	53.6	1697.5
800	4.2	1696.4	.9045	50.5	1908.3
$\theta_p = 30^o$; $P_p = 300$; $E_p = 985$					
300	43.6	217.5	.5870	108.1	417.3
350	32.7	277.8	.6216	103.1	493.6
400	25.0	355.0	.6638	96.8	581.6
450	19.6	447.5	.7051	90.3	681.4
500	15.7	553.8	.7422	84.2	792.9
550	12.9	673.2	.7744	78.5	916.1
600	10.7	805.3	.8019	73.4	1051.1
650	9.1	949.9	.8253	68.8	1197.8
700	7.8	1106.6	.8451	64.6	1356.2
750	6.7	1275.4	.8620	60.9	1526.4
800	5.9	1456.2	.8764	57.6	1708.3
$\theta_p = 30^o$; $P_p = 350$; $E_p = 1001$					
300	53.1	218.8	.5892	107.8	434.4
350	41.3	265.0	.6037	105.7	502.2
400	32.3	327.8	.6338	101.3	580.3
450	25.6	405.5	.6694	96.0	668.9
500	20.6	496.6	.7047	90.4	767.8
550	16.9	600.2	.7372	85.0	877.2
600	14.1	715.6	.7663	79.9	997.0
650	12.0	842.5	.7917	75.3	1127.3
700	10.3	980.5	.8139	71.0	1267.9
750	8.9	1129.5	.8331	67.2	1419.0
800	7.8	1289.2	.8497	63.6	1580.4

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 30^o$; $P_p = 400$; $E_p = 1020$					
300	60.5	229.8	.6080	105.1	459.6
350	48.9	265.4	.6043	105.7	521.0
400	39.2	316.5	.6205	103.3	591.8
450	31.5	382.1	.6473	99.3	672.1
500	25.7	461.0	.6778	94.7	761.8
550	21.2	552.0	.7084	89.8	861.0
600	17.8	654.4	.7371	85.0	969.6
650	15.1	767.7	.7632	80.5	1087.6
700	13.0	891.4	.7865	76.3	1215.1
750	11.2	1025.3	.8071	72.4	1352.0
800	9.8	1169.2	.8253	68.8	1498.4
$\theta_p = 30^o$; $P_p = 450$; $E_p = 1040$					
300	65.8	246.6	.6349	101.2	490.7
350	55.0	274.6	.6173	103.8	547.2
400	45.3	316.5	.6206	103.3	612.4
450	37.2	372.3	.6374	100.8	686.4
500	30.7	441.0	.6615	97.2	769.0
550	25.5	521.6	.6881	93.0	860.4
600	21.5	613.4	.7149	88.7	960.4
650	18.3	715.7	.7402	84.5	1069.1
700	15.8	828.0	.7637	80.4	1186.6
750	13.7	950.0	.7849	76.6	1312.7
800	12.0	1081.4	.8039	73.0	1447.5
$\theta_p = 30^o$; $P_p = 500$; $E_p = 1063$					
300	69.5	266.8	.6646	96.7	526.4
350	59.7	289.5	.6374	100.8	579.1
400	50.4	324.5	.6300	101.9	640.0
450	42.2	372.3	.6375	100.8	709.0
500	35.3	432.5	.6542	98.3	786.0
550	29.7	504.5	.6759	95.0	871.2
600	25.2	587.3	.6995	91.2	964.5
650	21.5	680.5	.7231	87.4	1065.9
700	18.6	783.4	.7457	83.6	1175.5
750	16.2	895.7	.7667	79.9	1293.2
800	14.2	1017.1	.7860	76.4	1418.9

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 30^o$; $P_p = 550$; $E_p = 1087$					
300	71.9	289.2	.6940	92.1	566.0
350	63.1	308.3	.6609	97.3	615.7
400	54.4	338.1	.6455	99.6	673.1
450	46.4	379.6	.6448	99.7	738.0
500	39.4	432.9	.6545	98.2	810.7
550	33.5	497.5	.6708	95.7	890.9
600	28.7	572.8	.6905	92.7	978.9
650	24.7	658.3	.7115	89.3	1074.4
700	21.4	753.3	.7325	85.8	1177.6
750	18.7	857.4	.7527	82.3	1288.5
800	16.5	970.4	.7716	79.0	1407.0
$\theta_p = 30^o$; $P_p = 600$; $E_p = 1113$					
300	72.4	313.0	.7219	87.6	609.0
350	65.5	329.6	.6855	93.5	656.2
400	57.5	355.6	.6644	96.3	710.7
450	49.9	392.2	.6571	97.9	772.4
500	43.0	439.9	.6605	97.3	841.4
550	37.0	498.4	.6715	95.6	917.7
600	31.9	567.3	.6870	93.2	1001.2
650	27.7	646.2	.7050	90.3	1092.0
700	24.1	734.4	.7239	87.2	1190.0
750	21.1	831.7	.7426	84.1	1295.4
800	18.7	937.6	.7607	80.9	1407.9
$\theta_p = 30^o$; $P_p = 650$; $E_p = 1141$					
300	74.2	337.7	.7476	83.2	654.9
350	67.1	352.7	.7098	89.6	700.0
400	59.8	376.0	.6849	93.6	752.1
450	52.6	408.9	.6725	95.5	811.2
500	45.9	452.1	.6706	95.8	877.2
550	40.0	505.5	.6767	94.8	950.2
600	34.8	569.0	.6881	93.0	1030.1
650	30.4	642.3	.7029	90.7	1117.0
700	26.6	724.7	.7193	88.0	1210.8
750	23.5	816.1	.7363	85.2	1311.5
800	20.8	915.9	.7531	82.3	1419.2

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 30^o$; $P_p = 700$; $E_p = 1170$					
300	74.5	363.2	.7710	79.1	703.4
350	68.1	377.1	.7330	85.7	746.9
400	61.4	398.6	.7058	90.2	797.0
450	54.7	428.7	.6897	92.8	853.9
500	48.4	468.3	.6836	93.8	917.4
550	42.5	517.6	.6853	93.5	987.6
600	37.4	576.6	.6929	92.3	1064.5
650	32.9	645.0	.7044	90.5	1148.1
700	29.0	722.5	.7182	88.2	1238.3
750	25.6	808.7	.7332	85.7	1335.3
800	22.8	903.2	.7486	83.1	1439.0
$\theta_p = 30^o$; $P_p = 750$; $E_p = 1201$					
300	74.4	389.3	.7921	75.2	754.4
350	68.6	402.7	.7548	82.0	796.5
400	62.5	422.8	.7264	86.8	845.0
450	56.3	450.8	.7078	89.9	899.9
500	50.2	487.6	.6982	91.4	961.4
550	44.6	533.6	.6963	91.7	1029.2
600	39.5	588.8	.7004	91.1	1103.6
650	35.0	653.2	.7088	89.7	1184.4
700	31.1	726.4	.7201	87.9	1271.7
750	27.6	808.2	.7330	85.7	1365.5
800	24.7	898.2	.7467	83.4	1465.7
$\theta_p = 30^o$; $P_p = 800$; $E_p = 1233$					
300	74.0	416.1	.8112	71.6	807.7
350	68.7	429.2	.7750	78.4	848.6
400	63.1	448.4	.7462	83.5	895.7
450	57.4	474.9	.7259	86.9	949.0
500	51.7	509.6	.7138	88.9	1008.7
550	46.3	552.9	.7090	89.7	1074.6
600	41.4	605.0	.7101	89.5	1146.9
650	36.9	666.0	.7156	88.6	1225.3
700	32.9	735.5	.7244	87.2	1310.1
750	29.4	813.4	.7352	85.3	1401.2
800	26.4	899.5	.7472	83.3	1498.5

x → $\alpha + \beta$

m_x	θ_x	p_x	β	α	E_x
$\theta_p = 35^o$; $P_p = 300$; $E_p = 985$					
300	40.5	264.6	.6615	97.2	446.8
350	31.3	331.0	.6871	93.2	528.5
400	24.5	414.4	.7195	88.0	622.7
450	19.6	513.4	.7520	82.5	729.5
500	15.9	627.2	.7819	77.1	848.9
550	13.2	754.9	.8082	72.1	980.8
600	11.1	896.2	.8310	67.6	1125.3
650	9.4	1050.8	.8504	63.5	1282.4
700	8.1	1218.4	.8671	59.7	1452.0
750	7.1	1399.0	.8813	56.4	1634.2
800	6.2	1592.5	.8936	53.3	1828.9
$\theta_p = 35^o$; $P_p = 350$; $E_p = 1001$					
300	48.2	269.3	.6681	96.2	466.3
350	38.5	322.4	.6775	94.7	539.0
400	30.8	391.5	.6995	91.2	622.9
450	25.0	475.6	.7264	86.8	717.9
500	20.5	573.7	.7539	82.1	824.2
550	17.0	684.9	.7797	77.5	941.6
600	14.4	808.7	.8031	73.1	1070.2
650	12.3	944.8	.8239	69.0	1209.9
700	10.6	1092.8	.8420	65.3	1360.9
750	9.2	1252.5	.8579	61.8	1523.0
800	8.1	1423.9	.8718	58.7	1696.4
$\theta_p = 35^o$; $P_p = 400$; $E_p = 1020$					
300	54.0	283.7	.6871	93.2	494.6
350	44.5	327.0	.6826	93.9	560.7
400	36.6	385.0	.6935	92.2	636.9
450	30.1	457.3	.7128	89.1	723.3
500	25.0	543.0	.7356	85.3	819.8
550	21.0	641.3	.7591	81.2	926.6
600	17.8	751.6	.7815	77.2	1043.4
650	15.2	873.5	.8022	73.3	1170.5
700	13.2	1006.5	.8210	69.6	1307.7
750	11.5	1150.5	.8377	66.2	1455.1
800	10.1	1305.2	.8526	63.0	1612.6

m_x	θ_x	p_x	β	α	E_x
$\theta_p = 35^o$; $P_p = 450$; $E_p = 1040$					
300	58.1	304.1	.7119	89.2	529.5
350	49.3	340.3	.6971	91.6	590.5
400	41.4	389.9	.6980	91.5	660.9
450	34.7	452.8	.7093	89.6	740.7
500	29.2	528.5	.7264	86.8	829.9
550	24.7	616.4	.7462	83.5	928.5
600	21.1	715.9	.7664	79.9	1036.4
650	18.2	826.5	.7860	76.4	1153.8
700	15.8	947.7	.8044	72.9	1280.5
750	13.8	1079.3	.8212	69.6	1416.6
800	12.2	1221.1	.8365	66.5	1562.1
$\theta_p = 35^o$; $P_p = 500$; $E_p = 1063$					
300	60.8	328.4	.7383	84.8	569.7
350	52.9	359.7	.7167	88.4	626.8
400	45.4	402.9	.7097	89.6	692.7
450	38.7	458.4	.7136	88.9	767.3
500	33.0	526.1	.7249	87.1	850.7
550	28.3	605.5	.7402	84.5	942.9
600	24.3	696.1	.7575	81.5	1043.9
650	21.1	797.4	.7751	78.4	1153.7
700	18.4	909.0	.7923	75.2	1272.2
750	16.1	1030.7	.8086	72.1	1399.6
800	14.3	1162.0	.8237	69.1	1535.7
$\theta_p = 35^o$; $P_p = 550$; $E_p = 1087$					
300	62.5	355.4	.7642	80.3	614.5
350	55.4	383.3	.7385	84.8	668.4
400	48.4	421.8	.7256	87.0	730.6
450	42.0	471.6	.7235	87.3	801.2
500	36.3	532.8	.7292	86.4	880.0
550	31.4	605.3	.7401	84.5	967.2
600	27.3	688.5	.7539	82.1	1062.6
650	23.8	782.2	.7691	79.4	1166.3
700	20.9	885.9	.7846	76.6	1278.4
750	18.4	999.2	.7998	73.8	1398.7
800	16.3	1122.0	.8142	71.0	1527.3

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 35^o$; $P_p = 600$; $E_p = 1113$					
300	63.5	384.5	.7884	75.9	663.1
350	57.0	410.0	.7606	81.0	714.6
400	50.6	445.1	.7438	83.9	773.9
450	44.5	490.5	.7369	85.1	841.1
500	39.0	546.6	.7379	84.9	916.2
550	34.1	613.4	.7445	83.8	999.3
600	29.9	690.6	.7549	82.0	1090.3
650	26.3	777.8	.7673	79.8	1189.1
700	23.2	874.9	.7808	77.3	1295.9
750	20.5	981.3	.7945	74.8	1410.6
800	18.3	1097.0	.8080	72.2	1533.2
$\theta_p = 35^o$; $P_p = 650$; $E_p = 1141$					
300	63.9	415.2	.8106	71.7	715.4
350	58.1	439.2	.7821	77.1	764.8
400	52.2	471.8	.7628	80.6	821.7
450	46.5	513.9	.7523	82.4	886.2
500	41.2	566.0	.7494	82.9	958.4
550	36.4	628.1	.7523	82.4	1038.1
600	32.2	700.3	.7594	81.2	1125.4
650	28.5	782.3	.7691	79.4	1220.3
700	25.3	873.7	.7804	77.4	1322.7
750	22.5	974.4	.7924	75.2	1432.8
800	20.1	1084.1	.8046	72.8	1550.5
$\theta_p = 35^o$; $P_p = 700$; $E_p = 1170$					
300	63.8	447.4	.8306	67.7	771.1
350	58.6	470.4	.8023	73.3	818.7
400	53.2	501.3	.7816	77.2	873.7
450	47.9	540.9	.7687	79.5	936.0
500	42.9	589.8	.7628	80.6	1005.6
550	38.2	648.3	.7626	80.6	1082.6
600	34.1	716.4	.7667	80.0	1166.9
650	30.4	794.0	.7738	78.6	1258.5
700	27.1	880.8	.7829	76.9	1357.4
750	24.3	976.6	.7931	75.0	1463.7
800	21.8	1081.1	.8038	73.0	1577.3

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 35^o$; $P_p = 750$; $E_p = 1201$					
300	63.4	481.1	.8485	64.0	829.9
350	58.7	503.5	.8211	69.6	876.1
400	53.8	533.1	.7999	73.8	929.4
450	48.9	570.9	.7854	76.5	989.9
500	44.1	617.5	.7772	78.0	1057.5
550	39.7	673.1	.7743	78.5	1132.2
600	35.7	737.9	.7759	78.2	1214.0
650	32.0	811.8	.7806	77.4	1302.9
700	28.7	894.6	.7876	76.1	1398.9
750	25.8	986.3	.7960	74.5	1502.0
800	23.3	1086.6	.8053	72.7	1612.3
$\theta_p = 35^o$; $P_p = 800$; $E_p = 1233$					
300	62.7	516.1	.8645	60.3	891.7
350	58.5	538.2	.8383	66.1	936.8
400	54.0	567.1	.8172	70.4	988.8
450	49.5	603.7	.8017	73.4	1047.7
500	45.0	648.4	.7919	75.3	1113.6
550	40.8	701.7	.7871	76.2	1186.4
600	36.9	763.8	.7864	76.3	1266.1
650	33.3	834.7	.7890	75.8	1352.7
700	30.1	914.4	.7940	74.9	1446.3
750	27.2	1002.6	.8007	73.6	1546.9
800	24.7	1099.3	.8085	72.1	1654.3
$\theta_p = 40^o$; $P_p = 300$; $E_p = 985$					
300	37.0	320.4	.7299	86.2	485.7
350	29.2	394.9	.7484	83.1	574.5
400	23.3	486.9	.7727	78.8	676.9
450	18.9	595.3	.7977	74.2	793.0
500	15.5	719.2	.8211	69.6	922.8
550	13.0	858.3	.8420	65.3	1066.2
600	11.0	1011.9	.8602	61.3	1223.2
650	9.4	1180.0	.8759	57.7	1394.0
700	8.1	1362.2	.8894	54.4	1578.3
750	7.1	1558.5	.9011	51.4	1776.4
800	6.3	1768.8	.9114	48.7	1988.1

$x \rightarrow 2 + 2$

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 40^o$; $P_p = 350$; $E_p = 1001$					
300	43.1	329.3	.7392	84.7	508.6
350	35.1	390.9	.7450	83.7	587.9
400	28.7	468.7	.7606	81.0	679.3
450	23.6	561.8	.7805	77.4	783.0
500	19.6	669.6	.8013	73.5	898.9
550	16.5	791.4	.8212	69.6	1026.9
600	14.0	926.7	.8394	65.8	1167.2
650	12.1	1075.3	.8558	62.3	1319.6
700	10.5	1236.7	.8703	59.0	1484.3
750	9.2	1411.0	.8830	56.0	1661.1
800	8.1	1597.9	.8942	53.2	1850.1
$\theta_p = 40^o$; $P_p = 400$; $E_p = 1020$					
300	47.6	348.2	.7576	81.5	541.3
350	39.9	400.6	.7530	82.3	613.6
400	33.3	467.6	.7599	81.1	697.1
450	27.9	549.1	.7734	78.7	791.6
500	23.5	644.4	.7900	75.6	897.3
550	19.9	752.9	.8075	72.3	1014.1
600	17.1	874.2	.8245	68.9	1142.0
650	14.8	1008.0	.8404	65.6	1281.1
700	12.9	1153.8	.8550	62.5	1431.3
750	11.3	1311.5	.8681	59.5	1592.6
800	10.0	1481.0	.8798	56.7	1765.0
$\theta_p = 40^o$; $P_p = 450$; $E_p = 1040$					
300	50.7	373.9	.7799	77.5	581.7
350	43.6	419.6	.7679	79.7	648.7
400	37.2	478.6	.7673	79.8	726.1
450	31.7	551.0	.7745	78.5	813.7
500	27.0	636.4	.7863	76.3	911.7
550	23.2	734.5	.8005	73.6	1020.0
600	20.0	844.9	.8153	70.8	1138.6
650	17.4	967.0	.8299	67.8	1267.5
700	15.2	1100.6	.8438	64.9	1406.7
750	13.4	1245.5	.8567	62.1	1556.2
800	11.9	1401.5	.8685	59.4	1716.1

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 40^o$; $P_p = 500$; $E_p = 1063$					
300	52.6	404.2	.8030	73.2	628.3
350	46.2	445.2	.7862	76.3	691.3
400	40.2	498.3	.7798	77.5	763.9
450	34.7	563.7	.7815	77.2	846.2
500	30.1	641.4	.7887	75.9	938.2
550	26.1	731.2	.7992	73.9	1039.9
600	22.7	832.7	.8113	71.5	1151.3
650	19.9	945.5	.8241	69.0	1272.3
700	17.5	1069.4	.8367	66.4	1403.1
750	15.5	1204.1	.8488	63.8	1543.5
800	13.8	1349.4	.8601	61.3	1693.6
$\theta_p = 40^o$; $P_p = 550$; $E_p = 1087$					
300	53.8	438.2	.8252	68.8	680.4
350	48.0	476.0	.8056	72.7	740.1
400	42.4	524.6	.7952	74.6	809.1
450	37.2	584.7	.7925	75.2	887.2
500	32.6	656.4	.7955	74.6	974.5
550	28.5	739.5	.8024	73.3	1071.0
600	25.1	833.9	.8117	71.5	1176.7
650	22.1	939.2	.8223	69.4	1291.5
700	19.6	1055.2	.8333	67.1	1415.6
750	17.4	1181.6	.8443	64.8	1548.8
800	15.5	1318.2	.8549	62.5	1691.3
$\theta_p = 40^o$; $P_p = 600$; $E_p = 1113$					
300	54.2	475.2	.8456	64.5	737.5
350	49.0	510.8	.8249	68.8	794.6
400	43.9	556.3	.8119	71.4	860.6
450	39.0	612.4	.8058	72.6	935.4
500	34.6	679.3	.8054	72.7	1018.9
550	30.6	757.2	.8091	72.0	1111.3
600	27.1	845.8	.8156	70.7	1212.4
650	24.1	945.0	.8239	69.0	1322.4
700	21.4	1054.5	.8331	67.1	1441.1
750	19.2	1174.1	.8427	65.1	1568.7
800	17.2	1303.7	.8523	63.1	1705.0

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 40^o$; $P_p = 650$; $E_p = 1141$					
300	54.2	515.0	.8641	60.4	799.2
350	49.5	549.1	.8432	65.0	854.3
400	44.8	592.3	.8287	68.1	917.9
450	40.3	645.4	.8203	69.8	989.9
500	36.1	708.7	.8171	70.4	1070.5
550	32.3	782.4	.8181	70.2	1159.6
600	28.8	866.5	.8221	69.4	1257.1
650	25.8	960.7	.8282	68.2	1363.1
700	23.1	1064.9	.8356	66.6	1477.6
750	20.7	1179.0	.8438	64.9	1600.5
800	18.7	1302.8	.8521	63.1	1731.9
$\theta_p = 40^o$; $P_p = 700$; $E_p = 1170$					
300	53.8	557.4	.8806	56.6	865.3
350	49.6	590.5	.8602	61.3	918.8
400	45.4	632.2	.8451	64.6	980.5
450	41.2	683.2	.8351	66.7	1050.4
500	37.2	743.8	.8299	67.8	1128.6
550	33.5	814.2	.8287	68.1	1214.9
600	30.2	894.6	.8305	67.7	1309.5
650	27.2	984.8	.8346	66.8	1412.4
700	24.5	1084.8	.8402	65.7	1523.4
750	22.1	1194.3	.8469	64.2	1642.7
800	20.0	1313.3	.8540	62.7	1770.2
$\theta_p = 40^o$; $P_p = 750$; $E_p = 1201$					
300	53.1	602.4	.8951	52.9	935.9
350	49.4	635.0	.8758	57.7	988.0
400	45.5	675.7	.8605	61.2	1048.2
450	41.7	725.2	.8497	63.6	1116.4
500	37.9	783.7	.8430	65.1	1192.6
550	34.5	851.7	.8401	65.7	1276.8
600	31.2	929.2	.8401	65.7	1369.0
650	28.3	1016.3	.8424	65.2	1469.3
700	25.7	1112.8	.8465	64.3	1577.6
750	23.3	1218.7	.8516	63.2	1693.9
800	21.2	1333.8	.8576	61.9	1818.2

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 40^o$; $P_p = 800$; $E_p = 1233$					
300	52.3	650.1	.9080	49.5	1010.8
350	48.9	682.6	.8898	54.3	1061.8
400	45.3	722.7	.8749	57.9	1120.8
450	41.8	771.1	.8637	60.5	1187.6
500	38.4	828.2	.8561	62.2	1262.2
550	35.1	894.4	.8518	63.2	1344.7
600	32.0	969.7	.8504	63.5	1435.1
650	29.2	1054.3	.8512	63.3	1533.3
700	26.6	1148.1	.8538	62.7	1639.4
750	24.3	1251.0	.8577	61.9	1753.4
800	22.2	1363.0	.8624	60.8	1875.2
$\theta_p = 45^o$; $P_p = 300$; $E_p = 985$					
300	33.1	388.4	.7915	75.4	537.6
350	26.6	473.8	.8044	72.9	635.9
400	21.5	577.5	.8220	69.4	749.3
450	17.7	698.6	.8407	65.6	877.8
500	14.7	836.6	.8584	61.7	1021.4
550	12.4	990.9	.8743	58.1	1180.1
600	10.5	1161.4	.8884	54.6	1354.0
650	9.1	1347.6	.9007	51.5	1543.0
700	7.9	1549.5	.9113	48.6	1747.1
750	6.9	1766.9	.9205	46.0	1966.3
800					
$\theta_p = 45^o$; $P_p = 350$; $E_p = 1001$					
300	37.9	402.9	.8021	73.3	565.5
350	31.4	475.5	.8054	72.7	653.6
400	26.0	564.9	.8161	70.6	755.3
450	21.7	670.4	.8303	67.7	870.6
500	18.2	791.5	.8454	64.6	999.4
550	15.5	927.9	.8602	61.3	1141.8
600	13.3	1079.0	.8740	58.2	1297.7
650	11.5	1244.5	.8864	55.1	1467.2
700	10.0	1424.4	.8975	52.3	1650.3
750	8.8	1618.4	.9073	49.7	1846.9

$\alpha + \alpha \longrightarrow x$

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 45^o$; $P_p = 400$; $E_p = 1020$					
300	41.3	428.5	.8192	70.0	604.8
350	35.1	492.0	.8149	70.8	685.5
400	29.7	570.8	.8189	70.0	778.7
450	25.2	664.6	.8281	68.2	884.4
500	21.5	773.1	.8397	65.8	1002.4
550	18.4	895.8	.8522	63.1	1132.9
600	15.9	1032.4	.8646	60.3	1275.8
650	13.8	1182.6	.8763	57.6	1431.2
700	12.1	1346.1	.8872	54.9	1598.9
750	10.7	1522.7	.8971	52.4	1779.1
800	9.5	1712.4	.9060	50.1	1971.7
$\theta_p = 45^o$; $P_p = 450$; $E_p = 1040$					
300	43.5	461.9	.8386	66.0	653.1
350	37.8	519.1	.8291	68.0	728.4
400	32.6	590.1	.8277	68.3	815.2
450	28.1	675.1	.8321	67.4	913.6
500	24.3	773.8	.8399	65.7	1023.6
550	21.0	886.1	.8496	63.7	1145.2
600	18.3	1011.5	.8601	61.3	1278.4
650	16.1	1149.8	.8705	59.0	1423.1
700	14.2	1300.7	.8806	56.6	1579.4
750	12.5	1464.1	.8900	54.2	1747.3
800	11.2	1639.7	.8987	52.0	1926.8
$\theta_p = 45^o$; $P_p = 500$; $E_p = 1063$					
300	44.8	501.4	.8581	61.8	709.2
350	39.6	554.1	.8455	64.6	780.3
400	34.8	619.5	.8401	65.7	862.3
450	30.4	697.8	.8404	65.6	955.2
500	26.6	789.1	.8447	64.7	1059.1
550	23.3	893.2	.8515	63.2	1173.9
600	20.5	1009.9	.8597	61.4	1299.6
650	18.1	1138.9	.8685	59.4	1436.2
700	16.0	1280.0	.8774	57.3	1583.8
750	14.3	1433.0	.8560	55.2	1742.3
800	12.8	1597.7	.8942	53.2	1911.8

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 45^o$; $P_p = 550$; $E_p = 1087$					
300	45.4	546.1	.8765	57.6	772.4
350	40.7	595.7	.8622	60.9	840.2
400	36.3	656.9	.8541	62.7	918.5
450	32.2	730.3	.8513	63.3	1007.1
500	28.5	815.9	.8526	63.0	1106.2
550	25.2	913.7	.8568	62.1	1215.8
600	22.3	1023.5	.8627	60.8	1335.8
650	19.8	1145.2	.8697	59.2	1466.2
700	17.7	1278.6	.8771	57.4	1607.0
750	15.8	1423.4	.8847	55.6	1758.3
800	14.2	1579.6	.8921	53.7	1920.0
$\theta_p = 45^o$; $P_p = 600$; $E_p = 1113$					
300	45.4	595.5	.8931	53.5	842.2
350	41.3	643.0	.8783	57.1	907.5
400	37.2	701.3	.8686	59.4	982.8
450	33.4	771.1	.8637	60.5	1068.2
500	29.8	852.4	.8625	60.8	1163.7
550	26.7	945.3	.8643	60.4	1269.1
600	23.8	1049.8	.8682	59.5	1384.7
650	21.3	1165.8	.8734	58.3	1510.2
700	19.1	1293.1	.8794	56.9	1645.8
750	17.2	1431.4	.8858	55.3	1791.5
800	15.6	1580.8	.8922	53.7	1947.2
$\theta_p = 45^o$; $P_p = 650$; $E_p = 1141$					
300	45.0	649.4	.9078	49.6	918.5
350	41.3	695.6	.8933	53.4	981.8
400	37.7	752.0	.8829	56.0	1054.9
450	34.1	819.1	.8764	57.6	1137.8
500	30.8	897.3	.8735	58.3	1230.4
550	27.8	986.6	.8734	58.3	1332.7
600	25.0	1087.0	.8755	57.8	1444.8
650	22.5	1198.5	.8790	56.9	1566.6
700	20.4	1321.0	.8836	55.8	1698.1
750	18.4	1454.3	.8888	54.6	1839.5
800	16.7	1598.3	.8942	53.2	1990.5

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 45^o$; $P_p = 700$; $E_p = 1170$					
300	44.4	707.9	.9207	45.9	1001.2
350	41.1	753.4	.9069	49.8	1063.1
400	37.7	808.6	.8963	52.6	1134.4
450	34.5	873.9	.8891	54.5	1215.3
500	31.4	949.8	.8849	55.5	1305.8
550	28.5	1036.4	.8833	55.9	1405.7
600	25.9	1133.8	.8839	55.8	1515.1
650	23.5	1241.9	.8860	55.2	1634.1
700	21.3	1360.7	.8892	54.4	1762.6
750	19.4	1490.1	.8932	53.4	1900.6
$\theta_p = 45^o$; $P_p = 750$; $E_p = 1201$					
300	43.4	771.2	.9320	42.5	1090.5
350	40.5	816.5	.9191	46.4	1151.2
400	37.5	871.0	.9087	49.3	1221.3
450	34.5	935.2	.9011	51.4	1300.8
500	31.7	1009.6	.8961	52.7	1389.6
550	29.0	1094.4	.8935	53.4	1487.7
600	26.5	1189.5	.8928	53.5	1595.2
650	24.2	1295.2	.8938	53.3	1712.0
700	22.1	1411.2	.8958	52.8	1838.2
750	20.2	1537.7	.8988	52.0	1973.8
$\theta_p = 45^o$; $P_p = 800$; $E_p = 1233$					
300	42.3	839.8	.9417	39.3	1186.6
350	39.7	885.1	.9299	43.1	1246.5
400	37.0	939.3	.9200	46.1	1315.7
450	34.3	1003.0	.9124	48.3	1394.1
500	31.7	1076.5	.9069	49.8	1481.8
550	29.2	1160.1	.9036	50.7	1578.6
600	26.8	1253.8	.9020	51.1	1684.7
650	24.6	1357.7	.9020	51.2	1800.0
700	22.6	1471.8	.9031	50.9	1924.6

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 50^o$; $P_p = 300$; $E_p = 985$					
300	28.9	475.0	.8455	64.5	608.6
350	23.6	574.9	.8542	62.7	719.9
400	19.3	694.5	.8665	59.9	848.2
450	16.0	833.1	.8799	56.7	993.7
500	13.4	990.4	.8927	53.6	1156.3
550	11.4	1166.0	.9044	50.5	1336.0
600	9.7	1359.5	.9149	47.6	1532.8
650	8.4	1570.7	.9240	45.0	1746.7
700	7.3	1799.6	.9320	42.5	1977.7
$\theta_p = 50^o$; $P_p = 350$; $E_p = 1001$					
300	32.6	497.5	.8563	62.2	644.1
350	27.3	584.6	.8580	61.8	744.5
400	22.9	689.6	.8650	60.2	860.3
450	19.3	812.1	.8747	58.0	991.6
500	16.4	951.9	.8853	55.4	1138.3
550	14.0	1108.4	.8958	52.8	1300.5
600	12.1	1281.5	.9056	50.2	1478.1
650	10.5	1470.8	.9147	47.7	1671.2
700	9.2	1676.3	.9228	45.3	1879.8
$\theta_p = 50^o$; $P_p = 400$; $E_p = 1020$					
300	35.1	533.1	.8715	58.7	693.4
350	30.1	611.2	.8678	59.6	786.0
400	25.7	705.7	.8700	59.1	892.9
450	22.0	816.5	.8758	57.7	1014.0
500	18.9	943.3	.8836	55.8	1149.4
550	16.4	1085.9	.8921	53.7	1299.0
600	14.3	1244.0	.9007	51.5	1462.8
650	12.5	1417.3	.9090	49.3	1640.9
700	11.0	1605.6	.9167	47.1	1833.3

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 50^o$; $P_p = 450$; $E_p = 1040$					
300	36.5	578.7	.8878	54.8	754.2
350	32.0	650.6	.8806	56.6	841.1
400	27.8	737.6	.8790	56.9	941.4
450	24.2	839.7	.8814	56.4	1055.0
500	21.1	957.0	.8863	55.2	1182.1
550	18.4	1089.1	.8926	53.6	1322.4
600	16.2	1235.9	.8996	51.8	1476.2
650	14.3	1397.2	.9067	49.9	1643.3
700	12.7	1572.8	.9136	48.0	1823.9
$\theta_p = 50^o$; $P_p = 500$; $E_p = 1063$					
300	37.2	632.8	.9036	50.7	825.3
350	33.1	700.4	.8945	53.1	907.9
400	29.3	782.1	.8903	54.2	1003.3
450	25.9	877.9	.8899	54.3	1111.5
500	22.8	988.1	.8923	53.7	1232.3
550	20.1	1112.4	.8964	52.6	1365.9
600	17.8	1250.8	.9016	51.2	1512.1
650	15.8	1403.0	.9073	49.7	1671.1
700	14.1	1568.9	.9132	48.1	1842.9
$\theta_p = 50^o$; $P_p = 550$; $E_p = 1087$					
300	37.3	694.8	.9181	46.7	906.1
350	33.7	759.6	.9082	49.5	985.7
400	30.2	837.5	.9024	51.1	1077.5
450	27.0	928.9	.8999	51.7	1181.5
500	24.0	1033.9	.9002	51.6	1297.8
550	21.4	1152.4	.9025	51.0	1426.3
600	19.1	1284.5	.9060	50.1	1567.0
650	17.1	1429.9	.9103	48.9	1720.0
700	15.4	1588.5	.9151	47.6	1885.2

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 50^o$; $P_p = 600$; $E_p = 1113$					
300	36.9	764.5	.9309	42.8	996.7
350	33.7	827.6	.9210	45.8	1074.0
400	30.6	903.1	.9143	47.8	1163.1
450	27.6	991.4	.9106	48.8	1264.2
500	24.9	1092.7	.9093	49.2	1377.1
550	22.4	1207.1	.9100	49.0	1502.0
600	20.1	1334.5	.9121	48.4	1638.7
650	18.1	1474.9	.9151	47.6	1787.3
700	16.4	1628.2	.9187	46.5	1947.8
$\theta_p = 50^o$; $P_p = 650$; $E_p = 1141$					
300	36.2	842.2	.9420	39.2	1097.3
350	33.4	904.4	.9326	42.3	1172.9
400	30.6	978.5	.9256	44.5	1260.3
450	27.9	1064.9	.9211	45.8	1359.2
500	25.3	1163.8	.9188	46.5	1469.8
550	23.0	1275.4	.9183	46.7	1592.1
600	20.8	1399.6	.9191	46.4	1726.0
650	18.9	1536.5	.9210	45.9	1871.5
$\theta_p = 50^o$; $P_p = 700$; $E_p = 1170$					
300	35.3	928.6	.9516	35.8	1208.2
350	32.8	990.5	.9429	38.9	1282.9
400	30.3	1063.9	.9360	41.2	1369.0
450	27.8	1149.3	.9312	42.8	1466.6
500	25.5	1246.9	.9281	43.7	1575.7
550	23.3	1356.7	.9267	44.1	1696.3
600	21.2	1479.0	.9266	44.2	1828.4
650	19.4	1613.6	.9276	43.9	1972.0

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 50^o$; $P_p = 750$; $E_p = 1201$					
300	34.1	1024.4	.9596	32.6	1330.3
350	31.9	1086.5	.9518	35.7	1404.4
400	29.7	1160.0	.9454	38.0	1490.0
450	27.5	1245.1	.9404	39.7	1586.9
500	25.3	1342.2	.9371	40.9	1695.2
550	23.3	1451.3	.9351	41.5	1814.9
600	21.4	1572.6	.9343	41.8	1946.1
$\theta_p = 50^o$; $P_p = 800$; $E_p = 1233$					
300	32.8	1130.6	.9666	29.7	1464.5
350	30.9	1193.5	.9596	32.7	1538.6
400	28.9	1267.6	.9536	35.0	1624.0
450	26.9	1353.1	.9489	36.8	1720.7
500	25.0	1450.4	.9454	38.0	1828.9
550	23.1	1559.5	.9430	38.8	1948.5
$\theta_p = 55^o$; $P_p = 300$; $E_p = 985$					
300	24.6	590.8	.8916	53.8	709.4
350	20.2	710.8	.8971	52.4	839.1
400	16.7	852.7	.9053	50.3	988.7
450	14.0	1016.3	.9144	47.8	1158.3
500	11.8	1201.1	.9232	45.2	1347.8
550	10.1	1406.7	.9313	42.7	1557.2
600	8.7	1633.1	.9387	40.3	1786.7

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 55^o$; $P_p = 350$; $E_p = 1001$					
300	27.2	626.1	.9018	51.2	757.4
350	23.0	733.0	.9024	51.0	875.5
400	19.5	860.1	.9067	49.9	1011.7
450	16.5	1006.9	.9130	48.2	1166.1
500	14.1	1173.4	.9200	46.2	1338.6
550	12.2	1359.1	.9270	44.1	1529.3
600	10.6	1563.9	.9336	42.0	1738.2
650	9.2	1787.6	.9398	39.9	1965.2
$\theta_p = 55^o$; $P_p = 400$; $E_p = 1020$					
300	28.9	678.2	.9145	47.7	823.3
350	25.0	776.3	.9116	48.5	933.2
400	21.5	892.9	.9126	48.3	1060.1
450	18.6	1028.0	.9161	47.3	1203.9
500	16.1	1181.5	.9209	45.9	1364.6
550	14.0	1353.0	.9264	44.2	1542.2
600	12.3	1542.5	.9320	42.5	1736.8
650	10.8	1749.7	.9374	40.8	1948.3
$\theta_p = 55^o$; $P_p = 450$; $E_p = 1040$					
300	29.7	744.3	.9275	43.9	904.9
350	26.1	836.5	.9225	45.4	1009.1
400	22.9	946.0	.9210	45.8	1129.5
450	20.1	1072.9	.9222	45.5	1265.8
500	17.6	1217.2	.9250	44.7	1418.2
550	15.5	1378.7	.9288	43.5	1586.7
600	13.7	1557.2	.9331	42.1	1771.1
650	12.1	1752.7	.9376	40.7	1971.7

$x \longrightarrow x + 2$

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 55^o$; $P_p = 500$; $E_p = 1063$					
300	29.8	823.7	.9396	40.0	1001.6
350	26.7	912.1	.9336	42.0	1101.9
400	23.7	1016.9	.9306	42.9	1217.7
450	21.1	1138.3	.9300	43.1	1348.9
500	18.7	1276.2	.9311	42.8	1495.6
550	16.6	1430.6	.9334	42.1	1657.6
600	14.8	1601.6	.9364	41.1	1835.2
$\theta_p = 55^o$; $P_p = 550$; $E_p = 1087$					
300	29.4	916.4	.9504	36.2	1113.6
350	26.7	1002.7	.9441	38.5	1211.3
400	24.1	1104.6	.9402	39.8	1324.1
450	21.6	1222.5	.9384	40.4	1452.0
500	19.4	1356.3	.9383	40.5	1594.9
550	17.4	1506.2	.9393	40.1	1752.8
600	15.6	1672.0	.9412	39.4	1925.8
$\theta_p = 55^o$; $P_p = 600$; $E_p = 1113$					
300	28.7	1023.3	.9596	32.7	1241.9
350	26.3	1108.8	.9536	35.0	1338.1
400	24.0	1209.3	.9494	36.6	1449.2
450	21.8	1325.4	.9469	37.5	1575.1
500	19.7	1457.0	.9458	37.9	1715.8
550	17.8	1604.3	.9459	37.8	1871.4

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 55^o$; $P_p = 650$; $E_p = 1141$					
300	27.7	1146.2	.9674	29.3	1388.0
350	25.6	1231.7	.9619	31.7	1483.7
400	23.5	1332.2	.9578	33.4	1594.1
450	21.6	1447.8	.9549	34.5	1719.3
500	19.7	1578.8	.9533	35.1	1859.2
$\theta_p = 55^o$; $P_p = 700$; $E_p = 1170$					
300	26.4	1287.1	.9739	26.2	1554.0
350	24.7	1373.8	.9690	28.6	1650.0
400	22.9	1475.2	.9651	30.3	1760.8
450	21.1	1591.6	.9623	31.6	1886.3
$\theta_p = 55^o$; $P_p = 750$; $E_p = 1201$					
300	25.1	1449.2	.9792	23.4	1742.8
350	23.5	1537.7	.9751	25.6	1839.9
400	22.0	1641.0	.9715	27.4	1952.0
$\theta_p = 55^o$; $P_p = 800$; $E_p = 1233$					
300	23.6	1636.2	.9836	20.8	1958.2
$\theta_p = 60^o$; $P_p = 300$; $E_p = 985$					
300	20.1	756.9	.9296	43.2	861.0
350	16.6	906.4	.9329	42.2	1018.4
400	13.9	1081.6	.9379	40.6	1200.0
450	11.7	1282.3	.9436	38.7	1405.8
500	9.9	1508.3	.9492	36.7	1635.8
550	8.5	1759.3	.9544	34.7	1890.0

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 60^o$; $P_p = 350$; $E_p = 1001$					
300	21.8	815.1	.9384	40.4	931.7
350	18.6	951.4	.9385	40.4	1076.9
400	15.8	1111.5	.9409	39.6	1244.4
450	13.5	1295.2	.9446	38.3	1434.3
500	11.6	1502.4	.9488	36.8	1646.6
550	10.1	1732.8	.9531	35.2	1881.2
$\theta_p = 60^o$; $P_p = 400$; $E_p = 1020$					
300	22.7	897.4	.9484	37.0	1027.9
350	19.7	1025.4	.9464	37.7	1165.2
400	17.1	1175.7	.9467	37.6	1323.6
450	14.9	1348.3	.9486	36.9	1503.2
500	13.0	1543.1	.9513	35.9	1703.8
550	11.3	1760.0	.9545	34.7	1925.6
$\theta_p = 60^o$; $P_p = 450$; $E_p = 1040$					
300	22.9	1002.6	.9580	33.3	1148.9
350	20.2	1125.8	.9549	34.5	1281.3
400	17.9	1270.2	.9538	35.0	1434.0
450	15.7	1436.0	.9542	34.8	1607.2
500	13.9	1623.1	.9557	34.2	1800.7
$\theta_p = 60^o$; $P_p = 500$; $E_p = 1063$					
300	22.5	1131.8	.9666	29.7	1295.8
350	20.2	1252.8	.9631	31.2	1425.7
400	18.1	1394.3	.9612	32.0	1575.5
450	16.1	1556.6	.9607	32.3	1745.2
500	14.4	1739.6	.9611	32.1	1934.9

m_x	θ_x	p_x	β	α	E_γ
$\theta_p = 60^o$; $P_p = 550$; $E_p = 1087$					
300	21.7	1287.9	.9739	26.2	1471.8
350	19.8	1408.8	.9705	27.9	1601.0
400	17.9	1550.0	.9683	28.9	1750.1
450	16.2	1711.5	.9671	29.5	1919.0
$\theta_p = 60^o$; $P_p = 600$; $E_p = 1113$					
300	20.6	1475.9	.9800	23.0	1681.5
350	19.0	1598.6	.9769	24.7	1811.9
400	17.4	1741.5	.9746	25.9	1962.3
$\theta_p = 60^o$; $P_p = 650$; $E_p = 1141$					
300	19.3	1702.7	.9848	20.0	1932.1

$x \rightarrow \alpha + \alpha$

APPENDIX

In this appendix we outline the derivation of the formulas for the maximum and minimum angles α and θ_1^{Max}, which have been tabulated. We begin with the well known geometrical construction(x) for the Lorentz transformation of the center-of-mass system into the laboratory system, in order to define all the relevant kinematical parameters. In the case of two equal-mass decay particles in their CMS system we have the diagram of fig. 1.

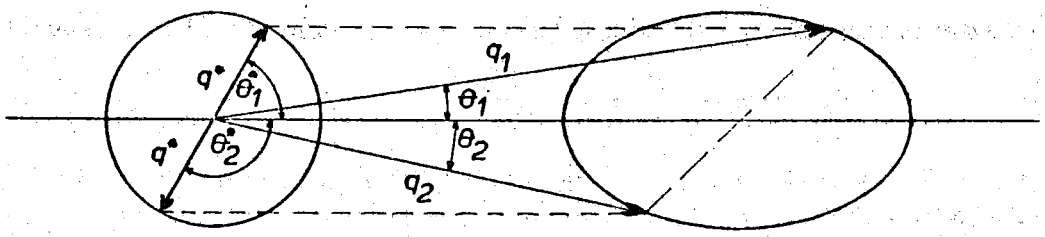

FIG. 1

In the CMS, $q_1^* = q_2^* = q^*$, $\beta_1^* = \beta_2^* = \beta^*$ because $m_1 = m_2$, and obviously $\theta_1^* + \theta_2^* = \pi$. In the Lab we define $\alpha = \theta_1 + \theta_2$ i. e. the decay angle between the two particles. We are interested in finding the maximum (or minimum) values of the Lab angles θ_1 and α. The Lorentz transformation can be written (we take $c = 1$)

$$q_1 \cos\theta_1 = \gamma q^* \cos\theta_1^* + \beta\gamma E_1^* \qquad q_1 \sin\theta_1 = q^* \sin\theta_1^*$$

$$q_2 \cos\theta_2 = \gamma q^* \cos\theta_2^* + \beta\gamma E_2^* \qquad q_2 \sin\theta_2 = q^* \sin\theta_2^*$$

where β and γ refer to the velocity of the CMS.

Using the facts that $\theta_1^* + \theta_2^* = \pi$ and $\beta^* E^* = q^*$, and defining $b = \beta/\beta^*$ and $x = \theta_1$ we find:

(1) $$\tan\theta_1 = \frac{\sin x}{\gamma(\cos x + b)}$$

(x) - Blaton, Det Danske Vid. Sels XXIV 24, 20 (1950)
P. G. Sona, Nota Interna (Frascati) nº T/32 (1957).

(2) $$\tan\theta_2 = \frac{\sin x}{\gamma(-\cos x + b)}$$

We note that for photons, $\beta^* = 1$ and $b = \beta$ and thus the calculation is equally valid in the case of the photon decay mode.

Differentiating (1) with respect to x and equating to zero, we find the condition for θ_1 to be an extremum:

(3) $$\frac{1 + b\cos x}{\gamma^2(\cos x + b)^2 + \sin^2 x} = 0$$

since the denominator of (3) cannot be zero, the condition is simply

(4) $$\cos x = -\frac{1}{b} = -\frac{\beta^*}{\beta}$$

Equation (4) is valid only when $\beta^* \leq \beta$, which is the condition we expect physically since there is no maximum angle in the event that the decay particles have a CMS velocity greater than the velocity of the CMS itself (i. e. for $\beta^* > \beta$, $\theta_1^{Max} = 180^o$).

Substituting (4) into (1), we find an expression for θ_1^{Max}:

(5) $$\tan\theta_1^{MAX} = \frac{1}{\gamma\sqrt{b^2-1}} = \frac{b}{\gamma\sqrt{1-b^2}}, \qquad \beta^* \leq \beta$$

It can easily be shown from (5) that an equivalent expression for θ_1^{Max} is

$$\sin\theta_1^{MAX} = \frac{\beta^*\gamma^*}{\beta\gamma}, \qquad \beta^* \leq \beta$$

When $\beta^* = \beta$, $\theta_1^{max} = 90^o$, as can be seen from the geometrical construction, for in this case the center of the CMS circle is tangent to the ellipse.

Now we consider the slightly more complicated problem of maximizing α. Applying the addition formula for tangents to (1) and (2), we find an expression for α.

(6) $$\tan\alpha = \frac{2\gamma b \sin x}{\gamma^2(b^2-1) + \sin^2 x(\gamma^2-1)}$$

which can be rewritten as follows:

(7) $$\tan\alpha = \frac{2a\sin x}{g^2 + a^2\sin^2 x} \qquad \text{where} \quad a = \gamma\beta/\beta^*, \quad g^2 = \gamma^2(\beta^2 - \beta^{*2})$$

We define $N = 2\,a \sin x$ and $D = g^2 + a^2 \sin^2 x$, giving the simple formula

$$\tan \alpha = N/D$$

to maximize α we differentiate with respect to x:

$$\frac{d \tan \alpha}{d\alpha} \frac{d\alpha}{dx} = \frac{\frac{dN}{dx} D - \frac{dD}{dx} N}{D^2}$$

obtaining the following expression for $d\alpha/dx$ which we equate to zero.

$$\frac{d\alpha}{dx} = \frac{\frac{dN}{dx} D - \frac{dD}{dx} N}{N^2 + D^2} = 0$$

Where we have used $\cos \alpha = D/\sqrt{D^2 + N^2}$. We note that $N^2 + D^2$ can never be zero, since such a sum can be zero only if N and D are simultaneously zero which can never occur.

So the condition for an extreme value of α is simply:

$$\frac{dN}{dx} D - \frac{dD}{dx} N = 2a \cos x (g - a^2 \sin^2 x) = 0$$

having solutions:

(8) $\cos x = 0, \qquad x = \theta_1^* = 90^\circ$

(9) $\sin^2 x = \sin^2 \theta_1^* = (b^2 - 1)/\beta^2$

Clearly (8) and (9) are not simultaneously valid, in fact (8) is a limiting case of (9) for $\beta = \beta^*$. But we shall see in the following that (8) has more significance than this. We note that $(b^2-1)/\beta^2$ may be less than zero or greater than one, but these values are impossible for $\sin^2 x$ and so we may divide the physically meaningful solutions into three categories:

I) $\frac{b^2-1}{\beta^2} < 0 \qquad$ or $\qquad \beta^* > \beta$

this is the case in which α has a minimum and the only meaningful solution is $\theta_1^* = 90^\circ$ given by (8) as we shall show later.

II) $0 < \frac{b^2-1}{\beta^2} < 1 \qquad$ or $\qquad \beta^* > \frac{\beta}{\sqrt{1+\beta^2}}$

In this case α has two extreme values: a maximum (actually two equal maxima) corresponding to (9) and a relative minimum at $\theta_1 = 90^\circ$ corresponding to (8). (see fig. 3).

III) $\frac{b^2-1}{\beta^2} \geq 1 \qquad$ or $\qquad \beta^* \leq \frac{\beta}{\sqrt{1+\beta^2}}$

This is the simplest case: α has a maximum corresponding to (8)

$[\theta_1^* = 90^\circ]$ and (9) has no physical significance (see fig. 4).

In fig. 2 we illustrate the regions of validity of the three cases discussed above. In figs. 3 and 4 respectively we exhibit α as a function of

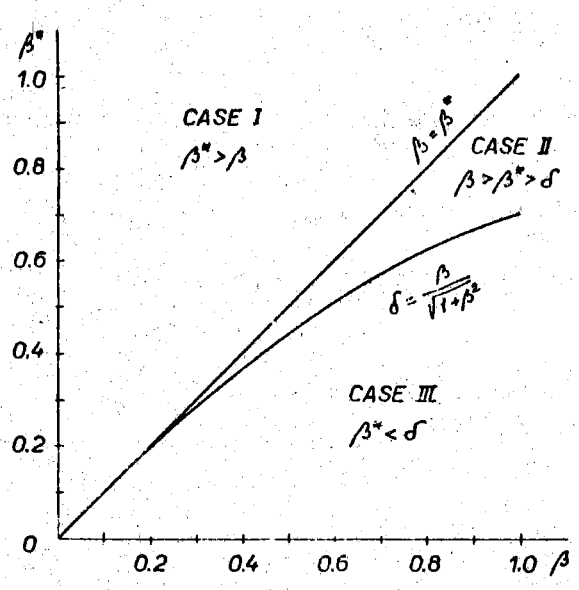

FIG. 2

θ_1^* for typical examples of cases II and III respectively.

In case II, by substituting (9) into (6) we obtain

(10) $$\tan\alpha^{MAX} = \frac{1}{\beta\gamma\sqrt{1-(\beta^*/\beta)^2}}, \qquad \beta > \beta^* > \frac{\beta}{\sqrt{1+\beta^2}}$$

while (8) gives the physically uninteresting relative minimum.

In case III, (8) substituted into (6) gives the maximum value of α :

(11) $$\tan\alpha^{MAX} = \frac{2\gamma b}{\gamma^2 b^2 - 1}$$

Equation (11) also gives α^{min} when $\beta^* > \beta$ since, as we shall see, this case always corresponds to $\theta_1^* = 90^\circ$. Indeed, that (8) in case I gives a minimum value for α can easily be demonstrated by plotting some typical examples, but it will be more instructive to consider the proof from another view point.

Thus, we consider in more detail case I for which $\beta^* > \beta$ and which always corresponds to a minimum value for α (also $\theta_1^{max} = 180^\circ$). We first assume $\beta^* = 1$ and treat the case of decay into two photons. In equation (7), we find that $g^2 = -1$, so we may rewrite (7) as follows

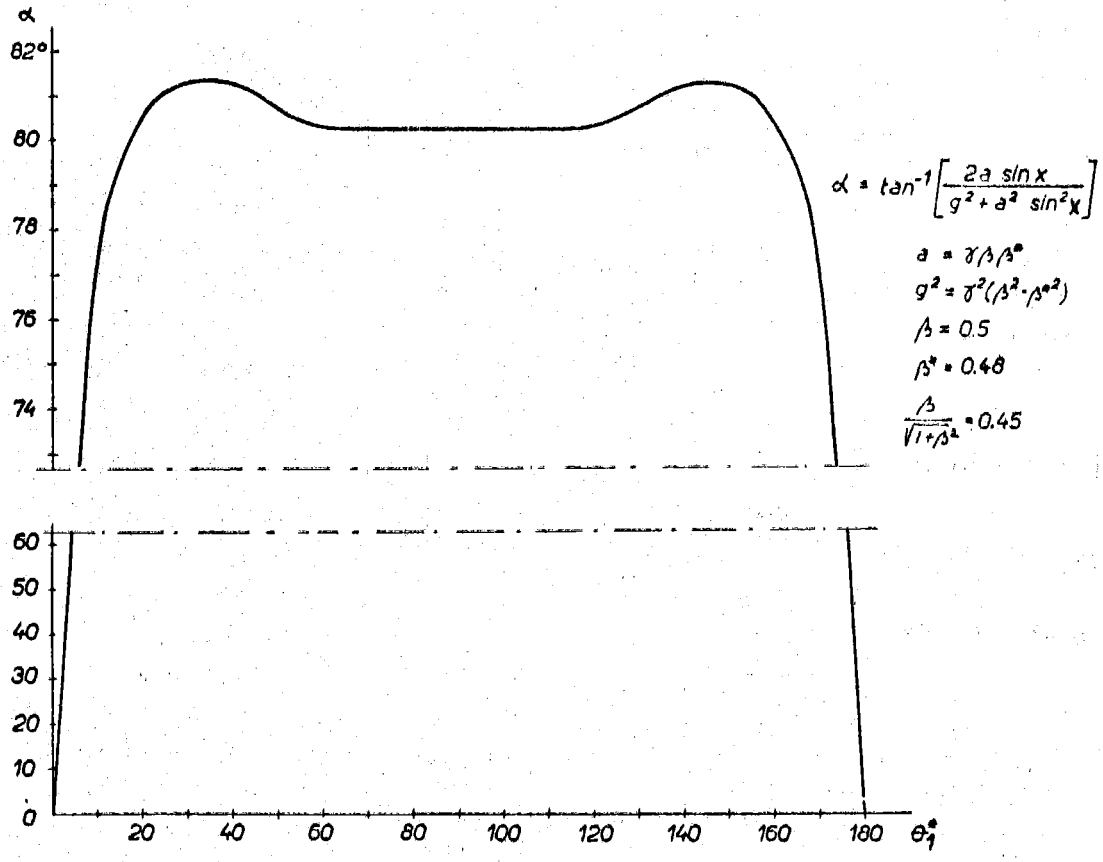
α
82°
80
78
76
74
60
50
40
30
20
10
0
20
40
60
80
100
120
140
160
180
θ₁°
α = tan⁻¹ [2a sin x / (g² + a² sin²x)]
a = γβ/β*
g² = γ²(β² - β*²)
β = 0.5
β* = 0.48
β/√(1+β²) = 0.45

FIG. 3

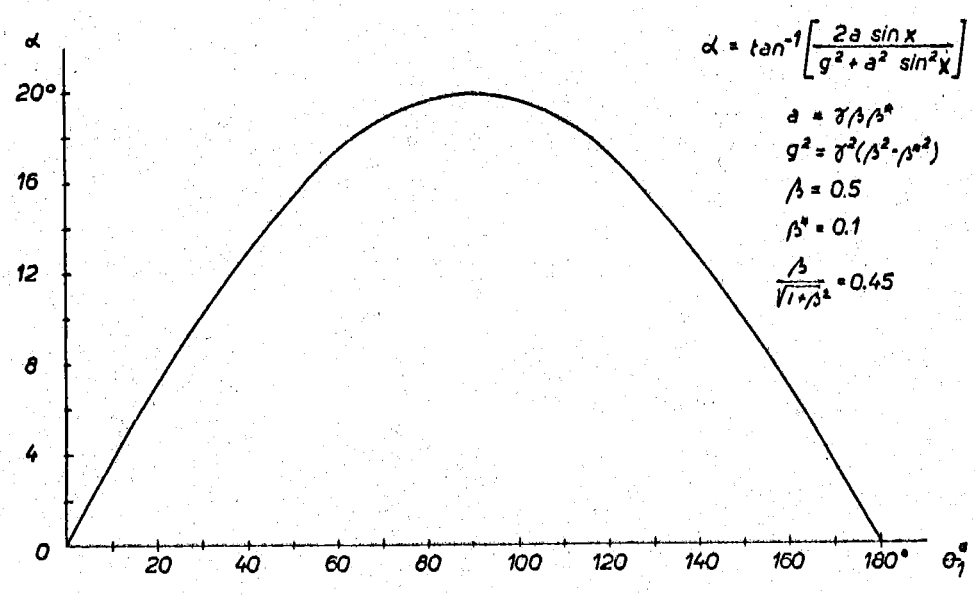
α
20°
16
12
8
4
0
20
40
60
80
100
120
140
160
180°
θ₁°
α = tan⁻¹ [2a sin x / (g² + a² sin²x)]
a = γβ/β*
g² = γ²(β² - β*²)
β = 0.5
β* = 0.1
β/√(1+β²) = 0.45

FIG. 4

(12) $$\tan\alpha = \frac{2a\sin x}{a^2\sin^2 x - 1}\,, \qquad a = \gamma\beta$$

which we then plot in fig. 5. As is seen in fig. 5, α monotonically decreases as a function of $u = a \sin x$, and thus for a fixed β, α in (12) takes a minimum value when $\sin x = 1$, $x = \theta_1^* = 90^o$, verifying the result (8) for case I.

We can thus write $\tan \alpha^{min}$ as a function of β by symply setting $\sin x = 1$ in (12):

(13) $$\tan\alpha^{MIN} = \frac{2\beta\gamma}{\beta^2\gamma^2 - 1}$$

we also obtain

(14) $$\sin\alpha^{MIN} = \frac{2\beta}{\gamma} \qquad \text{and} \qquad \operatorname{sen}\frac{\alpha^{MIN}}{2} = \frac{1}{\gamma}$$

Finally we see that in the general case of $\beta^* > \beta$, but $\beta^* \leq 1$ (which applies to the pionic as well as the photonic decay mode), g^2 in (7)

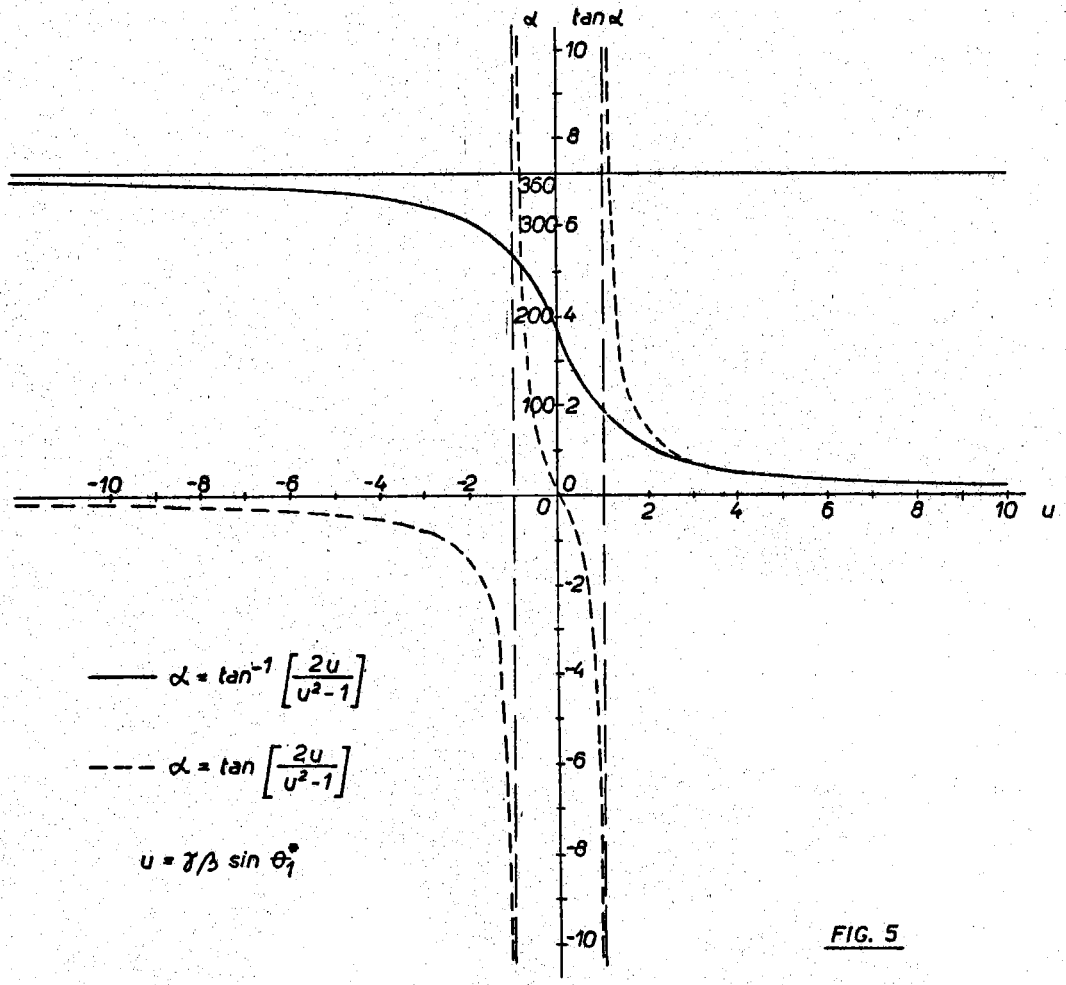

FIG. 5

is always a negative number and we may write (7) as follows

$$\tan\alpha = \frac{2a\sin x}{a^2\sin^2 x - h^2} \qquad a = \gamma/\gamma^*, \quad h^2 = -g^2 \geq 0$$

which has the same general form as equation (12), and α is a monotonically decreasing function very similar to that of fig. 5. Thus α takes a minimum as before when $\sin x = 1$, $x = \theta_1^* = 90^\circ$ and this minimum is again given by equations (13) and (14), if β is replaced by β/β^*.