CERN-EP/81-109
7 September 1981

INCLUSIVE PRODUCTION OF LAMBDA AND ANTI-LAMBDA IN γp INTERACTIONS,
FOR PHOTON ENERGIES BETWEEN 25 AND 70 GeV

Bonn¹-CERN²-Ecole Polytechnique³-Glasgow⁴-Lancaster⁵-Manchester⁶-
Orsay⁷-Paris VI⁸-Paris VII⁹-Rutherford¹⁰-Sheffield¹¹ Collaboration

D. Aston¹⁰, M. Atkinson¹⁰, R. Bailey¹¹, A.H. Ball⁶, B. Bouquet⁷,
G.R. Brookes¹¹, J. Bröring¹, P.J. Bussey⁴, D. Clarke¹⁰, A.B. Clegg⁵,
B. d'Almagne⁷, G. de Rosny³, B. Diekmann¹, A. Donnachie⁶, M. Draper⁴,
B. Drevillon³, I.P. Duerdoth⁶, J.-P. Dufey², R.J. Ellison⁶, D. Ezra⁶,
P. Feller¹, A. Ferrer⁷, P.J. Flynn⁵, F. Friese¹, W. Galbraith¹¹,
R. George⁸, S.D.M. Gill⁶, M. Goldberg⁸, S. Goodman⁸, W. Graves³,
B. Grossetête⁹, P.G. Hampson⁶, K. Heinloth¹, R.E. Hughes-Jones⁶,
J.S. Hutton¹⁰, M. Ibbotson⁶, M. Jung¹, S. Katsanevas³, M.A.R. Kemp¹⁰,
F. Kovacs⁹, B.R. Kumar¹⁰, G.D. Lafferty⁵, J.B. Lane⁶, J.-M. Lévy⁸,
V. Liebenau¹, J. Litt¹⁰, G. London⁸, D. Mercer⁶, J.V. Morris¹⁰,
K. Müller¹, D. Newton⁵, E. Paul¹, P. Petroff⁷, Y. Pons⁹, C. Raine¹¹,
F. Richard⁷, R. Richter¹, J.H.C. Roberts⁶, P. Roudeau⁷, A. Rougé³,
M. Sené⁸, J. Six⁷, I.O. Skillicorn⁴, J.C. Sleeman⁴, K.M. Smith⁴,
C. Steinhauer¹, K.M. Storr⁵, D. Treille², Ch. de la Vaissière⁸, H. Videau³,
I. Videau³, A.P. Waite³, A. Wijangco³, W. Wojcik⁷,
J.-P. Wuthrick³ and T.P. Yiou⁸

(Submitted to Nuclear Physics B)

ABSTRACT

Results are presented on the inclusive photo-production of Λ and $\bar{\Lambda}$ for incident photon energies between 25 and 70 GeV. The slope parameter of the p_T^2 distribution is found to be $2.83 \pm 0.1 \text{ GeV}^{-2}$ for Λ and $3.28 \pm 0.25 \text{ GeV}^{-2}$ for $\bar{\Lambda}$. The x_F distributions, measured in the range -0.2 to 0.7, show that while $\bar{\Lambda}$ are produced centrally, Λ production extends to more negative values of x_F ; the shapes show no energy dependence and are similar to those in pion induced reactions. The polarization of the produced Λ is less than 10%. The results are discussed in terms of vector dominance and quark fusion models.

1. INTRODUCTION

Inclusive Λ (and $\bar{\Lambda}$) production is accessible experimentally because of the clean V_0 signature allowing lambdas to be readily identified over a much wider range of energy and Feynman x , ($x_F = 2p_{11}^*/\sqrt{s}$), than other baryons. Inclusive baryon (antibaryon) production has been described, at least in the central region, by fusion models which relate the cross section $d\sigma/dx_F$ to the quark (antiquark) and di-quark (antiquark) distributions within the beam and target particles. There may be contributions from the sea as well as from the valence quarks (antiquarks). Moreover comparison of our photoproduction data with data on Λ ($\bar{\Lambda}$) production by pions is sensitive to whether the photon is behaving simply as a hadron, as described by the vector dominance model, or whether there is evidence for different behaviour.

We report on a study of inclusive Λ ($\bar{\Lambda}$) production by photons of energy 25 to 70 GeV. The data were obtained as part of a study of photoproduction using a tagged photon beam and the Omega Spectrometer (see fig. 1) at the CERN SPS (experiment WA4). The Omega system is well suited to an inclusive experiment because of its large acceptance over a large solid angle and enabled Λ ($\bar{\Lambda}$) to be studied down to a momentum of 1.5 GeV/c. The experimental details are discussed in more detail elsewhere⁽¹⁾. The sensitivity of the experiment to the reactions

$$\gamma + p \rightarrow \Lambda + X$$

$$\gamma + p \rightarrow \bar{\Lambda} + X$$

was about 30 nb^{-1} . Experimentally it is not possible to remove Λ ($\bar{\Lambda}$) coming from the decay $\Sigma^0(\bar{\Sigma}^0) \rightarrow \Lambda(\bar{\Lambda}) + \gamma$. $\Sigma^0(\bar{\Sigma}^0)$'s give rise to $\Lambda(\bar{\Lambda})$'s of almost the same x_F and p_T , so the data should be compared with the theoretical prediction for combined Λ and Σ^0 production. There is also a small contamination due to Λ 's coming from Ξ^- and Ξ^0 decay because these are only partially rejected in the data selection. The inclusive photo-production of hyperons, other than Λ and $\bar{\Lambda}$, is discussed in a separate paper⁽²⁾.

The experimental trigger (section 2) selected high multiplicity hadronic events. In the event reconstruction and data reduction (section 3), where rejection of electron-positron pairs is important, the selection criteria were the same for Λ and $\bar{\Lambda}$. Cuts were chosen which minimised the loss of signal and which had a precisely calculable effect on the acceptance. The remaining background was subtracted using a peak - minus - wings method separately for each kinematic region. Starting from some 5M hadronic events the final data sample contained $\sim 10,500$ Λ 's and $\sim 2,800$ $\bar{\Lambda}$'s. The $\bar{\Lambda}/\Lambda$ ratio is independent of acceptance, and the acceptance is independent of p_T^2 for $0 \leq p_T^2 \leq 4 \text{ GeV}^2$ at a given Λ ($\bar{\Lambda}$) momentum. As a function of x_F the acceptance (section 4) is high and slowly varying for $x_F \geq -0.1$. Section 5 presents the physics distributions: $\bar{\Lambda}/\Lambda$ ratio, p_T^2 and x_F distributions, an estimate of the absolute cross section and the measurement of the polarization. Finally in section 6 our photoproduction results are compared with previously published data on inclusive Λ ($\bar{\Lambda}$) production in pion interactions and are discussed in terms of vector dominance and quark fusion models.

2. TRIGGER

The trigger used in this experiment⁽¹⁾ was designed as a general purpose high multiplicity hadronic trigger. The features which are relevant for inclusive Λ ($\bar{\Lambda}$) data are:

- (a) Four or more hits were required in the detectors around the hydrogen target. These were a cylindrical scintillator hodoscope with 24 slats surrounding the sides of the target, combined with the wires of a multiwire proportional chamber (MWPC2) immediately down stream of it. The MWPC had horizontal wires with a spacing of 0.5 mm and a circular sensitive area.
- (b) At least three, and at most nine, hits were required in the vertical wires of MWPC4 (see fig. 1), while at least four and at most nine

hits were required in the horizontal wires. This chamber was 160 cm downstream of the centre of the hydrogen target and had 2 mm wire spacing.

- (c) Background from electromagnetic processes was reduced by requiring at least one hit away from the horizontal median plane of MWPC 5, i.e. one track had to make an angle of at least ~ 10 mrad to the horizontal.

Over the kinematic range of the experiment, and with the requirement that the Λ ($\bar{\Lambda}$) decay before MWPC 4, we assume that the trigger introduces no biases, and no corrections have been applied. In fact at least one and usually both tracks from the Λ ($\bar{\Lambda}$) decay contribute to the requirement at MWPC 4, and for low momentum Λ ($\bar{\Lambda}$) both tracks usually contribute to the target requirement. The invariant mass of X (which has charge $+1$) varies from 4 to 10 GeV/c^2 .

3. Event Reconstruction, Data Selection and Background Subtraction

Events were reconstructed using the program ROMEO. The vertex reconstruction software checked all possible secondary vertices (i.e. V_0 's) for consistency with γ , K^0 , Λ , $\bar{\Lambda}$ hypotheses using loose restrictions on the reconstructed mass. All ambiguities were treated as Λ ($\bar{\Lambda}$) candidates. Events with a reconstructed mass for the vee in the range 1115.5 ± 29.5 MeV were kept so that a background subtraction could be performed.

Data from the $\overset{V}{\text{Cerenkov}}$ counter were used to identify the particles of the vee. Events were rejected if either track was identified as being inconsistent with that from a Λ ($\bar{\Lambda}$). The rejected events showed no Λ ($\bar{\Lambda}$) signal and were mostly electron positron pairs.

The background was further reduced by making cuts which were chosen in such a way as to minimise the loss of signal and also to enable a precise acceptance calculation to be made.

- (a) The Λ ($\bar{\Lambda}$) decay vertex was required to be at least 5 cms from the main vertex. This cut reduces the bias introduced by ROMEO "pulling" some near Λ ($\bar{\Lambda}$) into the main vertex.
- (b) The Λ ($\bar{\Lambda}$) decay vertex was required to occur before MWPC 4 (i.e. upstream of a plane 160 cms from the centre of the hydrogen target), in order to minimise any bias caused by the multiplicity requirement in the trigger.
- (c) Each Λ ($\bar{\Lambda}$) was required to decay in a time less than 4.6 mean lives (corresponding to a 1% loss). This cut affects only lower momentum Λ ($\bar{\Lambda}$)'s because (b) is the more severe requirement at high momenta.
- (d) Both tracks from the Λ ($\bar{\Lambda}$) were required to have a momentum greater than 350 MeV/c, because below this momentum the ROMEO reconstruction efficiency begins to fall. In fact the momentum of the proton ($\bar{p}$) is always above this cut, so only the pions are affected. As the laboratory momentum is determined by $\cos\theta^*$, for a given lambda momentum, this cut implies zero acceptance for $-1 < \cos\theta^* < \cos\theta_C^*$, and 100% acceptance for $\cos\theta_C^* < \cos\theta^* < +1$. Here θ^* is the angle of the proton in the rest frame of the lambda, relative to the lambda direction, and θ_C^* is the angle which corresponds to a laboratory momentum of 350 MeV/c for the pion. For lambdas with momentum above 5.7 GeV/c this cut has no effect, and all lambdas with momentum below 1.3 GeV/c are rejected.
- (e) Vees which are in fact electromagnetic pairs are characterised by having a small opening angle and a decay plane perpendicular to the magnetic field. Translated into the lambda rest frame these correspond to $\cos\theta^* \sim -1$ and a clustering in the azimuthal angle ϕ^* . A cut was applied to $\cos\theta^*$ and ϕ^* which eliminated many of the e^+e^- pairs and which covered 1.8% of the solid angle.

The mass spectra for all the Λ ($\bar{\Lambda}$) after applying the above selection cuts are shown in fig. 2. The positions of the peaks are consistent with the known mass of the Λ and the FWHM are 4.1 MeV. The data sample includes approximately 10,500 lambdas and 2,800 anti-lambdas.

Although there are many more Λ 's than $\bar{\Lambda}$'s, the backgrounds are the same to about 10%. This applies before and after each selection cut and also to limited kinematic regions and is consistent with the dominant source of background being due to electron-positron pairs. About 15% of the background in the final sample are K^0 's.

The background under the Λ ($\bar{\Lambda}$) peak has been subtracted using the standard "peak-minus-wings" technique, assuming the background to be linear in the range 1086 to 1145 MeV. Below 1086 MeV there is excess background in some kinematic regions. The signal to background ratio and the slope of the background also vary with the kinematic variables x_F and p_T^2 . However there is no evidence for any change in the FWHM. The "peak" covered the mass range 1109.0 to 1122.0 MeV and the tails of the signal outside this range were ignored.

4. Acceptance

Provided that the trigger introduces no biases and that the efficiency for reconstructing the main vertex is high, the acceptance is independent of the momentum of the incident photon and depends only on the momentum of the lambda. Moreover, it is virtually independent of the transverse momentum of the lambda. Likewise the acceptance is the same for Λ and $\bar{\Lambda}$ of the same momentum.

The acceptance as a function of lambda momentum includes the following factors:-

- (1) The probability that the Λ travels 5 cms before decaying.
- (2) The probability that it decays before MWPC 4. This factor includes an average over positions of the main vertex along

the length of the hydrogen target. At low momenta this factor is superseded by the probability that the Λ decays within 4.6 mean lives.

- (3) Assuming isotropic decay in the lambda rest frame, the probability that $\cos\theta^*$ is within the range which gives the pion a momentum of at least 350 MeV/c. This solid angle factor has to be reduced by 0.018 to take account of the θ^* , ϕ^* cut for electron positron pairs.

It was checked that the observed distributions were constant in a) the azimuthal angle of the production plane and b) the decay angle $\cos\theta^*$.

If there were no other acceptance effects, the lifetimes of the observed lambdas would show the characteristic exponential distribution. Fig. 3 shows that at high momentum the lifetime is indeed well reproduced, but there is a loss of events at short lifetime at low momentum. This inefficiency comes from lambdas which decay near the upstream end of the hydrogen target and which give pions of momentum below 500 MeV/c. These may have only a short effective path length in the fiducial volume of the spark chambers. The performance of the spark chambers and of the reconstruction software are not sufficiently well understood to enable this loss to be simulated by Monte Carlo techniques. Therefore the loss was determined, as a function of momentum, from the lifetime distributions, and is $(33 \pm 10)\%$ at 2 GeV/c falling to less than 5% by 12 GeV/c.

The acceptance as a function of x_F , for extreme values of photon momentum, is shown in Fig. 4. The acceptance is large and slowly varying in the range $-0.2 < x_F < 0.7$. For $x_F > .7$ there are few events and near $x_F = 1.0$ the trigger efficiency must fall. For $x_F < -0.2$ the acceptance falls rapidly, primarily due to the requirement of a momentum of at least 350 MeV/c for each track and due to the short path length in spark chambers. Consequently we give acceptance corrected distributions only for the range $-0.2 < x_F < 0.7$, but other distributions which are less sensitive to acceptance cover a broader range.

5. RESULTS

5.1 The Anti-lambda to Lambda ratio

We consider first the ratio of $\bar{\Lambda}$ to Λ production for all p_T and all photon energies, because this is independent of the acceptance. A small correction, $\leq 5\%$, due to the additional nuclear absorption of $\bar{\Lambda}$ and $\bar{p}$ has not been applied to the data. Fig. 4 shows the raw, (i.e. uncorrected for acceptance) Λ and $\bar{\Lambda}$ distributions in x_F , and fig. 5 gives the ratio $N(\bar{\Lambda})/N(\Lambda)$. It is clear that Λ production extends to more negative x_F , even though the acceptance is low and uncertain beyond $x_F \sim -0.2$. In the range $0.1 < x_F < 0.4$ $\bar{\Lambda}$ production is almost 50% of Λ production.

5.2 The Transverse Momentum Distribution

The transverse-momentum-squared distributions for Λ and $\bar{\Lambda}$ (for which the data extends out to $p_T^2 \sim 3.0 \text{ GeV}/c^2$), indicate a slight change of slope at $p_T^2 \sim 1.5 \text{ GeV}/c^2$. Expressed in terms of the transverse mass, $m_T = (p_T^2 + m_\Lambda^2)^{1/2}$, these distributions are more nearly exponential and are shown in fig. 6. Fitting an exponential, $Ae^{-b'm_T}$, the slopes are found to be

$$b'(\Lambda) = 6.31 \pm 0.11 \text{ GeV}^{-1}$$

$$b'(\bar{\Lambda}) = 7.32 \pm 0.26 \text{ GeV}^{-1},$$

where the errors are purely statistical. The slopes, $b = b'/2m_\Lambda$, for the variable p_T^2 (for $p_T^2 \ll m_\Lambda^2$) are then:

$$b(\Lambda) = 2.83 \pm 0.1 \text{ GeV}^{-2}$$

$$b(\bar{\Lambda}) = 3.28 \pm 0.25 \text{ GeV}^{-2},$$

where allowance has also been made for systematic errors.

The data were also fitted to an exponential in p_T^2 , for $p_T^2 < 0.8$, for different ranges of x_F , see fig. 7. While the slope is consistent with being independent of x_F for lambdas, there may be a variation for anti-lambdas.

5.3 The Feynman x distributions

The differential cross section $d\sigma/dx_F$ is shown in figs. 8a and 8b for five ranges of incident photon energy. The data have been corrected for acceptance, as described above. The errors shown are purely statistical except for the points at $x_F = -0.15$ which includes an additional 15% because of the rapidly changing acceptance. The shape of the x_F distribution depends on the variation of acceptance with momentum. The relative normalisation between different beam energies assumes that the incident bremsstrahlung spectrum is proportional to p_Y^{-1} . In the range of the experiment 25 - 70 GeV any deviation is at most $\sim 10\%$ (3).

The overall normalisation depends on several factors including, the total number of tagged photons, the $\Lambda \rightarrow p\pi^-$ branching ratio, attenuation in the hydrogen target, fraction of events without double bremsstrahlung (70%), fraction of events with a well measured photon (75%), efficiency of the software program ROMEO to reconstruct the V_0 and at least two tracks of the main vertex (45%). There is estimated to be an uncertainty in the overall normalisation of 30 to 40%, but the relative normalisation is good to about 10%.

The $\bar{\Lambda}$ production is seen to be more central than Λ production. The cross section for the latter is still rising at negative x_F , towards the proton fragmentation region. There is no apparent change of shape with beam energy. The data also indicate that while the Λ production for $x_F \geq 0.1$ may be falling slightly with beam energy in the range 25 to 70 GeV, the $\bar{\Lambda}$ production cross section is more nearly constant.

5.4 Polarization

The Λ ($\bar{\Lambda}$) may be produced polarized in the direction normal to the production plane defined by the vector,

$$\hat{n} = \frac{\underline{k}_Y \wedge \underline{k}_\Lambda}{|\underline{k}_Y \wedge \underline{k}_\Lambda|}.$$

The polarization, P , was determined by fitting the distributions of $dN/d\cos\theta_p$ to the form $(1 + \alpha P \cos\theta_p)$ where $\cos\theta_p = \hat{n} \cdot \hat{k}_p$. Here $\underline{k}_\gamma$ and $\underline{k}_\Lambda$ ($\underline{k}_{\bar{\Lambda}}$) are the laboratory momenta of the incoming photon and outgoing Λ ($\bar{\Lambda}$) and $\hat{k}_p$ ($\hat{k}_{\bar{p}}$) is the direction of the proton (anti-proton) in the rest frame of the Λ ($\bar{\Lambda}$). We have assumed $\alpha(\Lambda) = 0.642 = -\alpha(\bar{\Lambda})^{(4)}$. Because of the large solid angle and large acceptance of the Omega Spectrometer, and because the data is averaged over the azimuthal angle of the production plane, the acceptance is an even function of $\cos\theta_p$ and acceptance effects cancel out. Moreover the selection cuts involving $\cos\theta^*$ and ϕ^* do not bias the measurement of the polarization. As the polarization must tend monotonically to zero as p_T^2 tends to zero we present the data as a function of p_T^2 (Fig. 9). The background was subtracted separately in each bin of p_T^2 and $\cos\theta_p$. The errors shown are statistical. Rotation of the Λ ($\bar{\Lambda}$) polarization in the magnetic field is negligible and was ignored.

The polarization is everywhere consistent with zero, the average being $+0.06 \pm 0.04$ for Λ and $+0.05 \pm 0.1$ for $\bar{\Lambda}$.

6. Discussion

In general form our results closely resemble the corresponding Λ and $\bar{\Lambda}$ inclusive cross sections in $\pi^\pm p$ interactions⁽⁵⁻⁸⁾. This is illustrated in Fig. 10 which compares the invariant cross section,

$$F_1(x) = \frac{2}{\pi\sqrt{s}} \int E^* \frac{d^2\sigma}{dp_T^2 dx} dp_T^2$$

for inclusive Λ production in $\pi^\pm p$ interactions with our results at the nearest possible energies^(5,6). The pion data have been scaled by a factor of 400 so that they are suitably normalised for the comparison. It is seen that the photon data closely follow the shape of the x distribution of the pion data. Both sets of data are consistent with zero polarization. The only observed difference is that the p_T^2 slope is slightly steeper in the pion induced reactions, having values of $3.67 \pm .15$ for Λ and

$3.95 \pm .4$ for $\bar{\Lambda}$ production⁽⁵⁾. This difference in slopes between photon and pion induced reactions has also been observed in inclusive ϕ production⁽¹⁰⁾.

This strong similarity between pion and photon induced reactions, in this inclusive channel, indicates that, as in other hadronic aspects, the photon is behaving like a meson. Consequently, apart from overall rate, models for inclusive baryon production in hadron-hadron collisions can be taken over to the photon case. One model which has been proposed (9) uses the idea that baryon production occurs through the fusion of a di-quark constituent from one hadron with a quark constituent from the other. This model provides an acceptable quantitative description of Λ , $\bar{\Lambda}$ and Σ production in pp and πp collisions, using reasonable di-quark distributions. The model can be extended to the present reaction if it is assumed that the photon is indeed interacting as a vector meson and that the structure functions are the same as those of the pion. The second assumption is eminently reasonable and has support from our data on inclusive ϕ production in γp interactions (10). However, the presence of s and $\bar{s}$ quarks in the photon must be included. Our cross section for $\bar{\Lambda}$ production appears to be energy independent, whereas $\bar{\Lambda}$ production in pion interactions is increasing with energy.

The ratio of the cross sections for $\gamma p \rightarrow \Lambda + X$ to $\pi p \rightarrow \Lambda + X$ is of the order of $1/400$ which, bearing in mind the uncertainty of the overall normalisation, is also consistent with the expectations of vector dominance.

Acknowledgements

We are grateful to the Omega group at CERN for their help in running the spectrometer and providing online and offline software. The work of the technical support staff in our home institutions has been invaluable. We thank the SRC (UK), BMFT (W. Germany) and the IN2P3 (France) for their financial support.

References

1. D. Aston et al, Nucl. Phys. B166 (1980) 1 - 24.
2. D. Aston et al, to be published.
3. D. Aston et al, to be published.
4. Particle Data Group, Rev. Mod. Phys. 52 (1980).
5. P.H. Stuntembeck et al, Phys. Rev. D9 (1974) 608.
6. O. Balea et al, Nucl. Phys. B79 (1974) 57.
7. P. Bosetti et al, Nucl. Phys. B94 (1975) 21.
8. D. Bogert et al, Phys. Rev. D16 (1977) 2098.
9. A. Donnachie, Z. Physik. C, Particles and Fields 4 (1980) 161.
10. D. Aston et al, Nucl. Phys. B179 (1981) 215.

Figure Captions

1. Schematic layout of the Omega Spectrometer as used with the tagged photon facility.
2. Invariant mass distribution of vees assuming $p\pi^-$ and $\bar{p}\pi^+$. The mass ranges used for the peak-minus-wings background subtraction are indicated.
3. Distribution of lifetimes of lambdas for different momentum ranges (in GeV/c). The vertical scale (which is logarithmic) is such that the number of events in the first bin is always close to 100. The lines correspond to the known lifetime and are drawn with arbitrary normalisation.
4. Distributions of observed Λ and $\bar{\Lambda}$ with $x_F = 2p_{11}^*/\sqrt{s}$, uncorrected for acceptance. The acceptance is shown for the extreme values of the incident photon momentum.
5. Ratio of the observed numbers of $\bar{\Lambda}$ to Λ as a function of x_F . The errors shown are purely statistical.
6. Distributions of Λ and $\bar{\Lambda}$ for the transverse mass variable,

$$m_T - m_\Lambda = (p_T^2 + m_\Lambda^2)^{1/2} - m_\Lambda$$
 Data below 4.0 GeV/c have not been included in order to ensure constant acceptance out to $p_T^2 \sim 3 \text{ GeV}^2$. The lines are the best fits to the form $Ae^{-b'm_T}$.
7. Variation with x_F of the p_T^2 slope parameter, b , obtained by fitting the form $Ae^{-bp_T^2}$ in the range $0 < p_T^2 < 0.8 \text{ GeV}^2$ for Λ and $\bar{\Lambda}$. The errors shown are purely statistical.
8. $d\sigma/dx_F(\mu\text{b})$ for Λ (8a) and $\bar{\Lambda}$ (8b) production for five ranges of incident photon momentum (GeV/c). The errors shown are statistical except for the point at $x_F = -0.15$ which has an additional 15% from uncertainties in the acceptance. The relative normalisation as a function of photon momentum is accurate to about 10%. The overall normalisation accuracy is 30 to 40%.
9. Distributions of the Λ and $\bar{\Lambda}$ polarization as a function of p_T^2 , the transverse momentum squared.

10. The invariant cross section $F_1(x) = 2/\pi\sqrt{s} \int E^* \frac{d^2\sigma}{dx_F dp_T^2} dp_T^2$ for Λ photo production for photons in the ranges 25 - 34 and 34 - 43 GeV/c ($\bullet$). Also shown, for comparison, are Λ production in $\pi^+p(\circ)$ and $\pi^-p(\square)$ interactions at 18.5 GeV/c (5) and $\pi^-p(\diamond)$ interactions at 40 GeV/c (6). For the purposes of comparison the pion cross sections have been reduced by a factor of 400.

Fig 1

Fig 3

Fig 5

$d\sigma/dx_F (\mu b)$

$d\sigma/dx_F (\mu b)$

Fig 8a

LAMBDA

Fig 8b

ANTI-LAMBDA

Fig 9

Fig 10