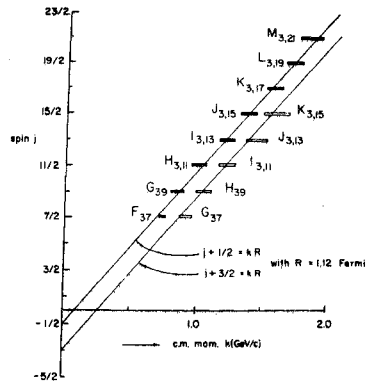

Fig.1. Spin j of resonances plotted against k, the πN c.m. momentum.

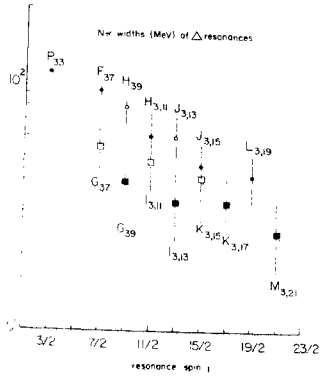

Fig.2. $N\pi$ widths plotted against resonance spin j.

INVESTIGATION OF THE NATURE OF ENHANCEMENTS OBSERVED IN Λp EFFECTIVE MASS SPECTRA

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The inclusive Λp effective mass spectrum from the interactions of 7 GeV/c average momentum neutrons with carbon nuclei has been investigated. Four enhancements have been discovered in it.

The comparison of physical and experimental conditions at which these peaks have been observed in this and other experiments /1-3/, suggests that they should be the manifestations of peculiarities of the Λp elastic scattering and $\Lambda\Sigma^-$ and $\Sigma\Lambda^-$ conversion effective cross sections.

To analyze this hypothesis, a model of creation and interactions of Λ^- and Σ^- hyperons in carbon nuclei, bombarded with 7 GeV/c average momentum neutrons, has been developed.

The model proposed is based on impulse approximation, which is valid in our case firstly because the neutron energy considerably exceeds the nucleon binding energy in the carbon nucleus and secondly because we consider only the low mass part (2053.859-- 2553.859) MeV/c^2 (or the relative momentum interval p_Λ = 0. - 2.0 GeV/c) of the whole Λp effective mass spectrum which extends in this experiment up to $\sim$ 4800 MeV/c^2.

The most important intranuclear cascade processes resulting in the Λp + (Anything) and Λpp + (Anything) final states, which form the statistical sample of this experiment, have been modelled. For this purpose all known experimental data on Λ^- and Σ^- hyperon production, their two-body interactions with nucleons and decay processes /1,4/ have been used. The geometrical and kinematical restrictions imposed by this experiment have been accounted for.

The expected smallness of the ratio of resonance widths to the difference of their masses permitted us to use the isolated resonances approximation [5] . For the same reasons and what is more, because the low energy and potential scattering amplitudes vary with the Λp effective mass in opposite ways, it turned out possible to neglect all interference terms.

Thus the Λp elastic scattering effective cross section has been expressed as a sum of four cross sections corresponding to the low energy scattering with scattering parameters $a_s = a_t = a$ and $r_s = r_t = r$, elastic resonance scattering with parameters M_2, Γ_2 and M_3, Γ_3 and of the potential scattering. The last cross section has been assumed to be proportional to the two-body Λp phase space volume $R_2(M_{\Lambda p})$. Namely, $\sigma_{pot}^{\Lambda p}(M_{\Lambda p}) = \pi R^2 R_2(M_{\Lambda p})$, where R is an average range of the Λp interaction forces. This experiment did not permit us to account for the elastic Λp scattering and $\Sigma\Lambda$ - conversion channels coupling effects. So the $\Lambda\Sigma$ - and $\Sigma\Lambda$ - conversion processes contributed independently of the elastic scattering. The least square analysis resulted in all above mentioned parameters and moreover the contributions A,B,C,D of the elastic Λp scattering, $\Lambda\Sigma$ - and $\Sigma\Lambda$ conversion processes as well as of the independent Λ and proton creation in intranuclear cascade processes. The results of fits presented in table I clearly show that the best fit parameters for the Λp effective mass spectrum fit $(M_{\Lambda p}\text{-fit})$ do not differ significantly from those for simultaneous Λp effective mass spectrum and elastic scattering effective cross section fit $((M_{\Lambda p} + \sigma_{\Lambda p}^{el}) - fit)$. We come to the following conclusions.

1. The analysis, performed in the frame of this model, permitted us to sucessfully describe not only the Λp effective mass spectrum with its enhancements, i.e., the results of the Λp enhancement production experiment but also the behaviour of the Λp elastic scattering effective cross section in the Λ - hyperon relative momentum interval P_Λ = (0.1-2.0) GeV/c, i.e., the results of the Λp enhancement formation experiments. This is demonstrated in Figs.1 and 2.

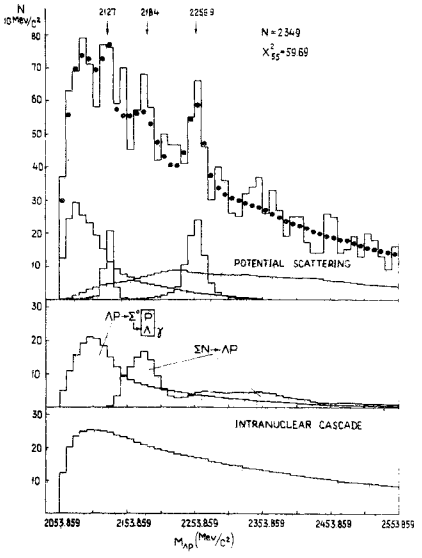

Fig. 1

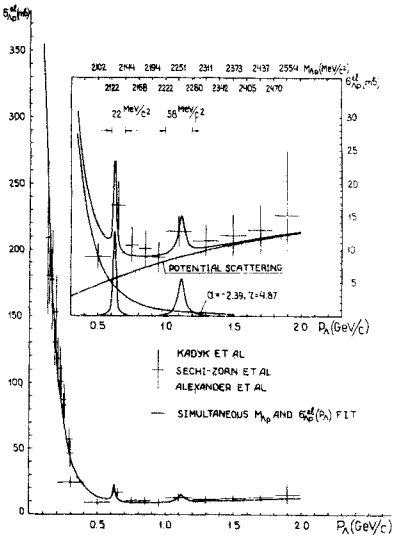

Fig. 2

2. The peak near the Λp threshold is due to the negative sign Λp scattering length effect at low energy. The negative scattering length excludes the possibility of the existence of (Λp) bound states. The unsuccessful up to now search for the Λ - hyperdeuteron confirms this result.

3. The peaks at 2127 MeV/c^2 and 2257 MeV/c^2 are due to the Λp elastic narrow resonances at 620 MeV/c and 1120 MeV/c of relative Λ hyperon momenta, respectively (fig.2).

4. The enhancement near 2184 MeV/c^2 is of kinematical origin and is due to the two-step process $n\,{}^{12}C \to (\Sigma N)$ +(Anything), $\Sigma N \to \Lambda p$.

5. The average range of the Λp interaction forces is about 0.66 fm.

6. The components of the average polarization of Λ- hyperons, presumed to be daughters of Λp - systems along the beam direction P_z, normal to the Λp -production plane - P_y and normal to both these directions - P_x, are zero within the limits of errors.

7. It is shown that all these results are very stable with respect to considerable changes of the Λp - and ΣN- c.m.s. angular distributions used to model various processes.

The neglect of interference terms in the expressions for the Λp scattering effective cross section, as well as the assumption $\Gamma_{tot} \approx \Gamma_{el} \approx \Gamma_R$ and the use of the isolated resonance approximation, are justified due to the narrowness of the resonance widths and the total precision of this experiment (Table 1, IVth col.).

8. It is shown that light nuclei, carbon nucleus at least, could be used as high density nucleon targets to study low energy scattering of unstable particles on nucleons in the absence of monoenergetic beams of such particles.

9. With the increase of the atomic number of nuclei one can expect the wearing perhaps even disapearing of enhancements because of the increasing probability of rescattering in heavy nuclei.

10. The effective cross sections of the observed Λp resonances have been estimated: $\sigma^{el}_{\Lambda p}(620)=12.80$ mb, $\sigma^{el}_{\Lambda p}(1120)=5.61$ mb (fig.2).

The authors are indebted to prof.A.M.Baldin for the continious interest and support of this work.

Table 1
The results of fitting

	$M_{\Lambda p}$ -fit	$(M_{\Lambda p}+\sigma^{el}_{\Lambda p})$ -fit	$(M_{\Lambda p}+\sigma^{el}_{\Lambda p})$ -fit for isotropic c.m.s. distributions over $\cos\theta_{\Lambda\Lambda}, \cos\theta_{\Lambda\Sigma}, \cos\theta_{\Sigma\Lambda}$
χ^2_n	$\chi^2_{34}=34.39$	$\chi^2_{55}=59.69$	$\chi^2_{55}=59.57$
C.L.(%)	44.92	31.56	31.92
a (fm)	-2.30±0.35	-2.39±0.04	-2.38±0.05
r (fm)	4.73±0.50	4.87±0.05	4.82±0.06
M_2(MeV/c^2)	2126.30±1.66	2127.00±3.38	2127.60±2.29
Γ_2 (MeV/c^2)	3.78±0.92	3.76±0.96	3.94±1.00
M_3(MeV/c^2)	2256.40±3.12	2256.90±1.33	2256.80±2.86
Γ_3 (MeV/c^2)	15.97±4.40	15.55±4.20	17.05±4.55
A($\Lambda p \to \Lambda p$)	0.332±0.008	0.336±0.005	0.345±0.018
B($\Lambda p \to \Sigma^0 p$)	0.117±0.005	0.109±0.003	0.099±0.021
C($\Sigma\Lambda$)	0.081±0.004	0.083±0.004	0.083±0.023
D(i.c.b.)*	0.469±0.004	0.471±0.005	0.471±0.026
R (fm)	0.656±0.020	0.664±0.015	0.666±0.025

*i.c.b. - intranuclear cascade background.

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KN SCATTERING AND THE PROBLEM OF THE S=+1 BARYON RESONANCES

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1. Introduction

This report will summarize the present situation on low energy KN scattering and will discuss in particular the following contributions to this conference:

1. BCRT coll.: Quasi two-body K^+N interactions below 1.5 GeV/c[1];
2. BCRT coll.: Phase shift analysis of $K^+p \to K^+\Delta$ below 1.5 GeV/c[2];
3. BEGPR coll.: Study of $K^0_L p \to K^0_S p$ in $1490 < E_{cm} < 1700$ MeV[3];
4. BP coll.: Angular distribution for the $K^0_L p \to K^0_S p$ in $1600 < E_{cm} < 1900$ MeV;
5. PNL Measurement of $K^+n \to K^0p$ at 0.7, 0.8 and 0.9 GeV/c[5].

Low energy KN scattering data have been discussed in terms of phase shift analysis of various complexity. We shall limit our considerations to the simplest ones, using the phase shift analyses as a method for searching for resonant states and/or for the parametrization of the experimental data.

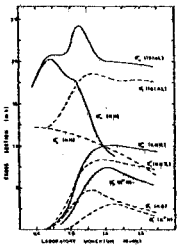

Fig. 1. Total, elastic and inelastic cross sections in I = 1 and I = 0 [1]. The curves are hand drawn through the experimental points.

Fig. 1 [1] illustrates the present knowledge on low energy K^+N scattering in both I = 1 and I = 0 states: the K^+p total cross section has an asymmetric structure at a lab. momentum of 1.25 GeV/c. The structure arises from a slowly varying elastic cross section and the opening up of inelastic channels, dominated by the $K^+p \to K^0\Delta^{++}$. The structure may thus be thought to be a threshold effect for the $K\Delta$ channel.

The K^+N, I = 0 total cross section has a shoulder at 0.8 GeV/c and a peak at 1.15 GeV/c. The shoulder corresponds to a peak in the elastic cross section, while the peak at 1.15 GeV/c is connected to the opening up of the $K^*(890)N$ channel.

The isospin structure of the various elastic channels is:

$$K^+p \to K^+p \qquad Z_1 \qquad (1)$$
$$K^+n \to K^+n \qquad \tfrac{1}{2}(Z_1 - Z_0) \qquad (2)$$
$$K^+n \to K^0p \qquad \tfrac{1}{2}(Z_1 + Z_0) \qquad (3)$$
$$K^0_L p \to K^0_S p \qquad \tfrac{1}{4}(Z_0 + Z_1 - 2Y_1) \qquad (4)$$

where Z_1, Z_0 denote the strangeness + 1, isospin 1 and 0 amplitudes, while Y_1 denotes the strangeness − 1, isospin 1 amplitude.

2. $K^+p \to K^+p$

The amount of data available on K^+p elastic scattering is quite large and of good accuracy[6]. No new data have been presented at this conference, It would be nice to have measurements of the P-parameter at 0.5 ÷ 0.8 GeV/c and some measurements of the A and R parameters.

The most recent phase shift analyses[7] go to 2.5 GeV/c and use many theoretical refinements. The analyses agree qualitatively, but there are quantitative disagreements. For instance at 0.8 GeV/c there are differences of up to a factor of two on the contribution of the $P_{3/2}$ cross section; the behaviour of the S-wave is not too well determined at high momenta.

It has been remarked long time ago [8] that the K^+p amplitudes are very similar to the background amplitudes in π^+p after the resonance contribution has been removed. In particular the behaviour of the $P_{3/2}$ amplitude, which has an appearance similar to a small resonance loop, is approximately reproduced in the π^+p amplitudes.

3. $K^+p \to K^0\Delta$

One of the difficulties connected with the study of the 1.25 GeV/c structure via the elastic scattering is its large inelasticity. One may thus hope to obtain new information from the study of the main enelastic channel in this energy region

$$K^+p \to K^0\Delta^{++}(1232) \hookrightarrow \pi^+p \qquad (5)$$

The detailed analysis of (5) involves considerable difficulties of practical and theoretical nature: the amount of data for reaction (5) is neither as abundant nor as accurate as that for the elastic reaction. All data come from bubble chamber experiments and have typical statistics of 500 events per angular distribution. Fig. 2 shows the integrated cross sections computed with the empirical interference model and with the P-wave interference model; the two calculations differ by about 30% at the higher energies.