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ABSTRACT. -

Evidence for a narrow bump in the isospin I = 1/2 πN system at M = 1130 MeV/c^2 (Γ = 80 MeV/c^2) has been found in the reaction $\alpha p \rightarrow \alpha X$ at incident α's momentum of 4.00 and 5.08 GeV/c. A strong t dependence of the cross section and a mass-slope correlation are seen as the main features of the data.

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In recent years experimental high energy nuclear physics has been developed intensively. The outcome of the experimental results in this field has been that the demarcation line between the two, up to now severely distinct theoretical branches, that of elementary particle physics and nuclear physics, is becoming less and less defined. In describing particle-nucleus collisions at high energy the concepts of elementary particle field are combining with the tools of nuclear physics. Hadron-nucleus reactions are treated relativistically, while our insights into nuclear structure are formulated at the present time in terms of non-relativistic wave functions. Baryonic excited states in nuclei[1], coupling constants of unstable resonances[2], large momentum transfer components[3], are different ways of approaching this ambiguity. On the other hand, particle-nucleus reaction are the opportune means of selecting states with specific quantum numbers. Pure isospin states and diffractive features of inclusive production have been investigated at very high energies following this approach[4].

Our study of the process

$$\alpha p \longrightarrow \alpha X$$

performed at medium energy, in the region of low produced masses, fits into this ambivalent domain. This reaction selects the pure isospin state I = 1/2 for the X system. Possible diagrams are shown in Fig. 1. At high energy these graphs interfere strongly. They represent the much-talked-about diffractive dissociation[5]. At the moderate energy of the present experiment and small four-momentum transfer, the diffraction dissociation is mainly exhausted by the Deck mechanism, through the exchange of a pion. The other diagrams, involving the nucleon pole, are negligible. In fact at this energy the for

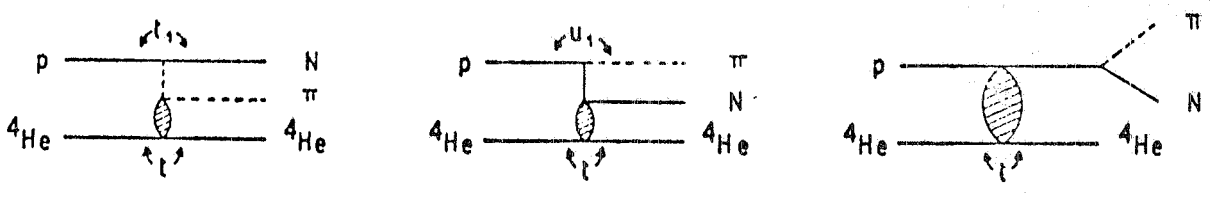

FIG. 1 - Graphs contributing to diffraction dissociation.

ward π-N elastic amplitude dominates over the N-N elastic one.

We have performed our experiment with an alpha beam of 3×10^{10} α/pulse extracted from the synchrotron "Saturne", incident on a liquid hydrogen target 5.9 cm thick. The use of an α particle, instead of a proton beam, has the great advantage that diffused α's leave the target at high energy, so that their unambiguous identification ensures the coherence of the reaction. Momentum spectra of the scattered α's have been measured by an achromatic double focusing spectrometer with a resolution of 1% FWHM. Details of the apparatus have been published elsewhere[6]. We have performed measurements at incident beam momentum of 4.00 GeV/c for fixed θ_{Lab} values of 4.1°, 5.1°, 5.6°, 6.1°, 7.1°, 8.1° and at incident beam momentum of 5.08 GeV/c at θ_{Lab} 4.6°, 5.6°, 6.6°, 7.1°. A typical experimental spectrum, obtained at $\theta_{Lab} = 7.1^{\circ}$, is shown in Fig. 2. Data are corrected for empty target background, nuclear absorption and

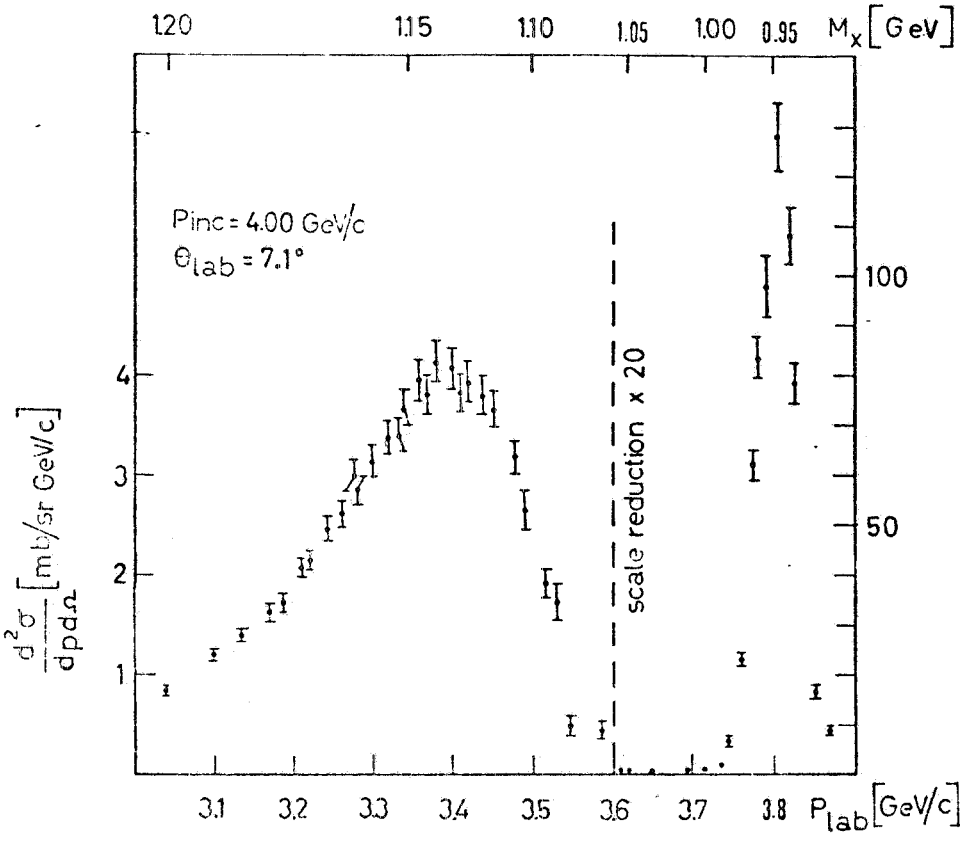

FIG. 2 - Laboratory momentum of ^{4}He scattered from αp collisions. Upper scale indicates the missing mass. Typical angular resolution is $\pm$ 0.3°.

spectrometer efficiency. The peak centered at 3.81 GeV/c corresponds to elastic αp scattering. The second structure, centered at $\sim$3.4 GeV/c, shows the signal of the coherent one pion production. The bulk of our data collected at 4.00 GeV/c in the inelastic region is presented in Fig. 3. A bump appears clearly at low values of the πN mass system. It is peaked around an invariant mass of 1130 MeV/c^2 and is 80 MeV/c^2

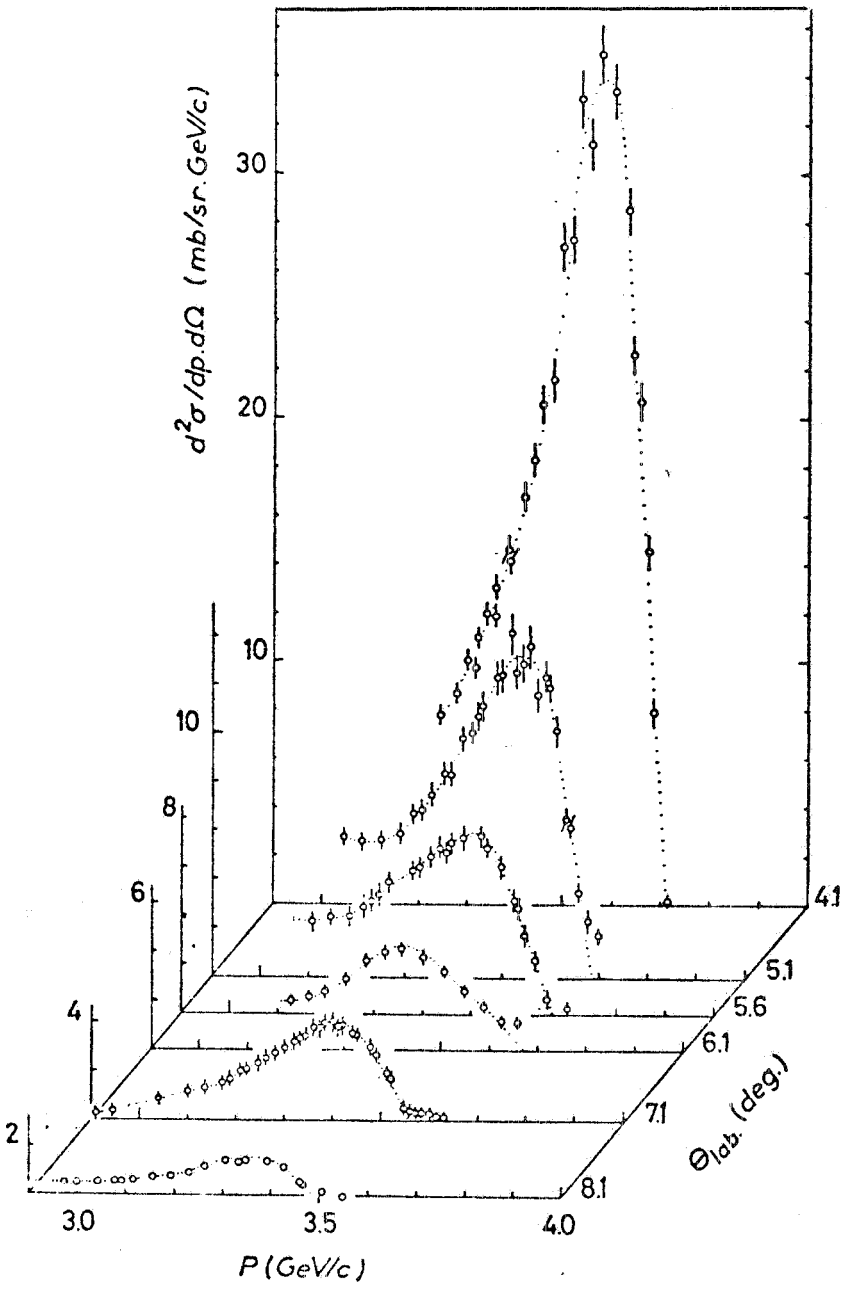

FIG. 3 - Momentum spectra of scattered ^{4}He at various angles. The dotted lines on each spectrum are drawn to guide eye. Quoted errors are statistical only. A systematic error of $\pm$5% due to normalization uncertainties, must be added.

wide, independently of the angles. The differential cross section $d^2\sigma/dt\ dM^2$ versus t at fixed values for the mass of the πN system is shown in Fig. 4. No apparent energy dependence, at fixed mass, emerges from data at 4.00 and 5.08 GeV/c. The cross section for fixed mass values, at small $|t|$ can be represented by an exponential function of the kind $(d^2\sigma/dt\ dM^2) \approx \exp(bt)$. The slope parameter varies linearly between 19 and 8 $(GeV/c)^{-2}$, when the squared mass ranges from 1.21 to 1.44 GeV^2. At larger $|t|$ a flatter distribution breaks this slope. This last feature is more evident for low masses and becomes less pronounced when one moves away from the peak value. These trends bring to mind the typical behaviour of the inclusive diffractive experiments performed at higher energies[7].

In conclusion the patterns of the reaction studied in this experiment are the following:

- The production of low πN masses is favoured, appearing as a pronounced bump at $M = 1130\ MeV/c^2$ with $\Gamma = 80\ MeV/c^2$;
- The cross section is strongly peaked forward and decreases rapidly with $|t|$.
- The shape of the enhancement and the value of the cross section are seemingly independent of energy;
- A strong mass-slope correlation is evident.

All these features agree with the ones provided by the diffractive Deck mechanisms. On the other hand, in the process $dp \rightarrow dX$, which also selects a $I = 1/2$ isospin state for X, a similar enhancement in the πN mass ($M = 1150\ MeV/c^2$, $\Gamma = 120\ MeV/c^2$), has already been observed by us in an earlier experiment[8]. An absolute prediction using a Deck-like π exchange model and a $\Delta(1236)$ excitation inside the deuteron, was very successful[9]. Although the phenomenological characteristics of the produced enhancements are very similar in both processes, a straightforward application[10] of the same model to αp data seems unlikely[11].

Intensive experimental investigation of coherent production on heavier nuclei will provide further indications about Deck-like nuclear

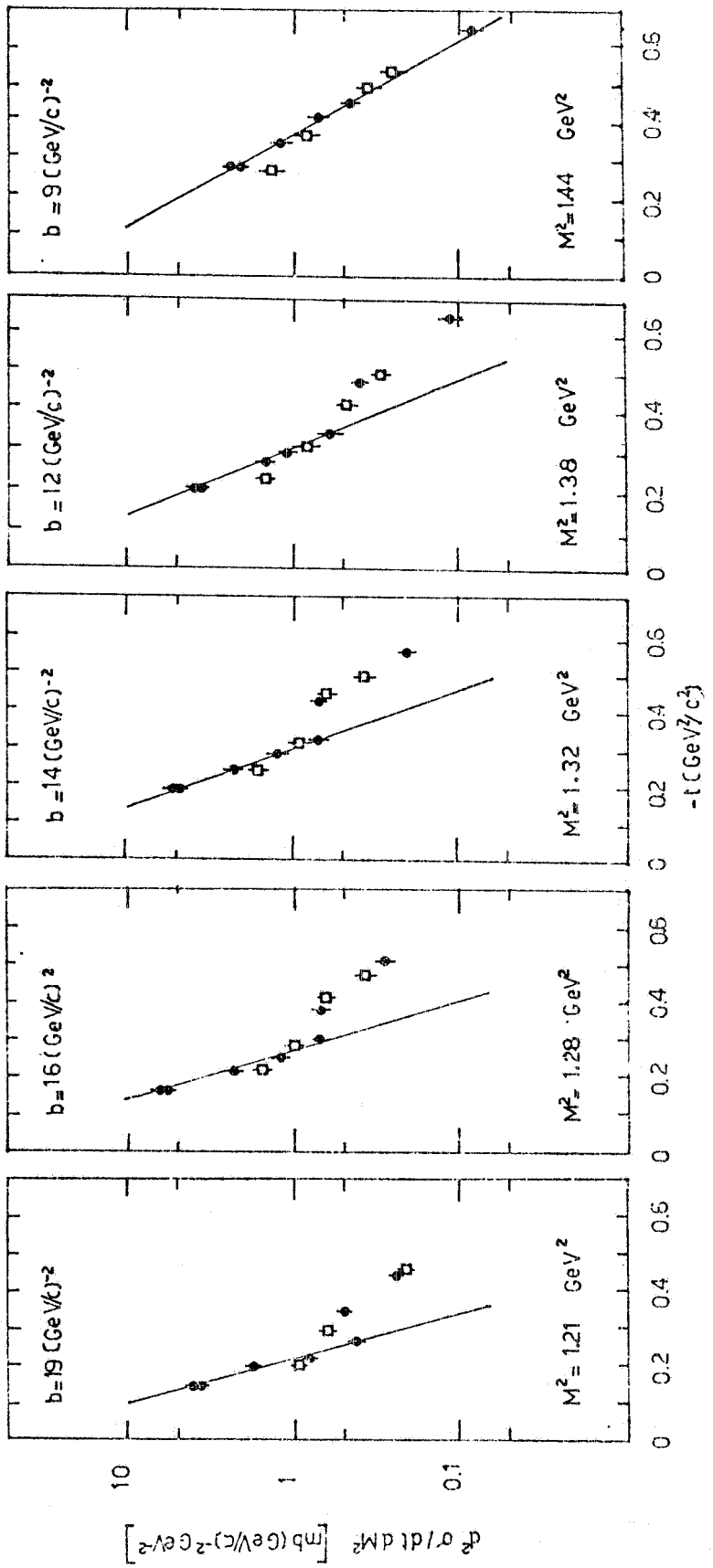

FIG. 4 - $d^2\sigma/dt\,dM^2$ versus t for fixed values of M^2. The mass resolution varies for each mass according to the momentum resolution of $\pm$ 0.5 %. Values range from $\pm$ 1 % to $\pm$ 1.5 %, with decreasing masses. Data at 4.00 GeV/c (⊕) and at 5.08 GeV/c (⊕) are plotted together. Only data at 4.00 GeV/c have been used in fitting exponential slopes.

effects and their energy behaviour.

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(11) - The study of dp $\rightarrow$ dX reaction using polarized deuteron beams, presently available, could add a wealthy new source of information on applicability of the model.