HIGH ENERGY INTERACTIONS ON NUCLEI

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ABSTRACT

Multihadrons production and coherent or semicoherent reactions on nuclei allow information about such intriguing topics as space--time development of particle production and interactions of resonances with nucleons. Some of the latest results are here summarized, with particular emphasis on the coherent and semicoherent channels, in connection with the criticisms and suggestions recently developed regarding the so called σ_2 cross-section (for the interactions of resonances with nucleons), as it is obtained from the A dependence of diffractive production on nuclei.

The two main lines, in which at present the nucleus is used as a tool to better understand elementary hadronic properties are:

a) the study of multiparticle production disregarding the final state of the nucleus, but looking at the number of emitted particles as a function of the rapidity y (or pseudorapidity η), p^2, Feynman's X_L, etc. for different nuclear sizes A (or $\bar{\nu} = \sigma_{hp}\cdot A/\sigma_{hA}$, the number of mean free paths in the nucleus from a "standard" point of view).

A comparison between the above quantities for different incident hadrons, at different energies (i.e. different "time of transit" in the nucleus) and with the equivalent distributions obtained on free proton, is an otherwise unavailable source of information about the space-time development of the elementary hadron-hadron processes and in regard to the way, and the extent to which nuclear matter reacts as a conglomerated target.

As it is known, different theoretical approaches on these subjects were developed: Multiperipheral models [1)], Energy Flux model [2)], Quark-Parton models [3)], all of these mainly concerning the space-time development; and cumulative effects [4)] or coherent tube models [5)] in which the other point of view is mainly taken into account.

b) the analysis of coherent and semicoherent interactions, i.e. the study of the production of well-defined hadronic systems when the nucleus is left in a well-known state (either fundamental or excited).

Besides the original interest in using the nucleus as a filter to select and study particular spin-parity systems, mainly in the diffractive channels,growing attention has been paid in recent years to the results of the measurement of the so called "σ_2" parameter.

In the Glauber-Kölbig and Margolis (GKM) [6)] formalism this parameter stands for the unstable produced system nucleon cross-section (a further quantity not otherwise available). Many different criticisms and suggestions were recently expressed about the above interpretation [7)]; as we are going to see later on, the peculiar trend of the results obtained so far has strengthened both criticisms and suggestions.

According to some of these views, the amount of space-time required by the elementary hadronic systems to develop themselves does not allow to obtain σ_2 with the meaning of interaction cross-section of a "fully developed" system.

Such criticism is supported by the observation that multiparticles production on nuclei display little or no cascading. Instead it is suggested that it should be possible to obtain more elementary information from σ_2 such as the distribution of cross sections for the eigenstates of diffraction, on the assumption that the eigenstates are parton states and the latter interact independently with the nuclear target (H.L. Miettinen and J. Pumplin [7d]).

Other views, though, suggest that σ_2 can be obtained from refining the GKM formalism: G. Fäldt and P. Osland [8] introduce, as corrections, spin flip terms in the production amplitudes to avoid or reduce the diminishing values of σ_2 with increasing produced masses.

In a paper presented at this Conference B.C. Kopeliovich et al. [9] argue that, when treating the inelastic diffraction on nuclei with a quark-parton eigenstate method, the inelastic diffractive amplitude turns out to have the opposite sign to the elastic amplitude. The authors' conclusion is that the neglecting of this correction is a reason for the diminishing values of σ_2.

Because of the space available I will try to discuss the recent findings concerning point b (coherent and semicoherent reactions) a little more extensively whereas, as far as point a (multiparticle production) is concerned, I shall confine myself to pointing out a few interesting features in three recent experiments. Extensive reviews on multiparticle production were recently made by W. Busza [10], A.M. Baldin [4], T. Ferbel[11].

I am also going to briefly discuss a recent result in the analysis and interpretation of the inelastic total hadronic cross-section on nuclei.

MULTIPARTICLE PRODUCTION

Two experiments were recently carried out at energies ranging between 20 and 50 GeV. For many aspects this is a not much explored region of transition, at higher energies many parameters being weakly or not at all depending on the energy. A remarkable example of this is given by the ratio $R = \langle n\rangle_A / \langle n\rangle_H$ where $\langle n\rangle_A$ is the mean multiplicity of shower particles in nuclei and $\langle n\rangle_H$ is the equivalent in free proton interactions [10].

In Fig. 1 this ratio R, for incident pions at 40 GeV/c, is given as a function of the nuclear size (using the already defined parameter $\bar{\nu}$), for different intervals of pseudorapidity $\eta = \ln[\mathrm{tg}(\theta_{lab}/2)]$.

The data were obtained, using optical spark chambers, from the Bologna, Dubna, Helsinki, Milan, Moscow, Warsaw and Wien Collaboration at the Serpukhov accelerator [12]. No magnetic field was used with the exception of a small percentage of pictures which were used to evaluate the subtraction of the slow protons (in Fig.1 the protons with $\beta \lesssim .7$ are subtracted).

It is evident that there are limited cascading effects at large angle, while there is no cascading effect at all, but absorption, at large η (in forward direction). Another interesting result from the same experiment comes from the analysis of the pseudorapidity distributions for different charged multiplicity and different nuclear targets. Normalized curves, obtained on carbon from propane bubble-chamber data, completely describe the distributions for all the different nuclei (see Fig.6 in ref.12): it is possible to deduce that the shape of the pseudorapidity distributions is independent from the target nucleus but is dependent only on the charged multiplicity of the events.

Furthermore this experiment confirms what has already been observed at other energies, namely the linear dependence of the multiplicity dispersion $D = \sqrt{\langle N^2\rangle - \langle N\rangle^2}$ on the mean multiplicity distribution $\langle N\rangle$.

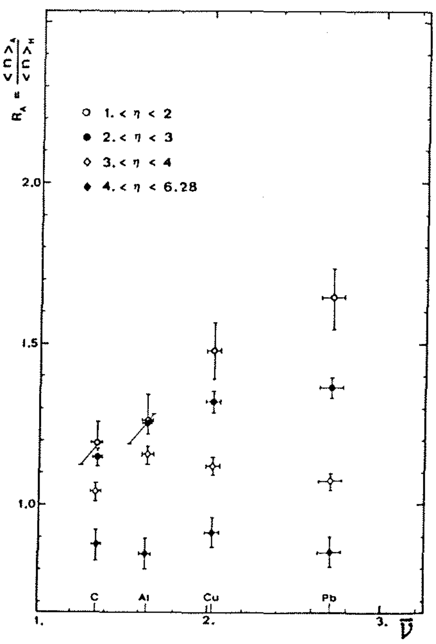


Fig. 1 - R vs $\bar{\nu}$ for different η region (from ref.12)

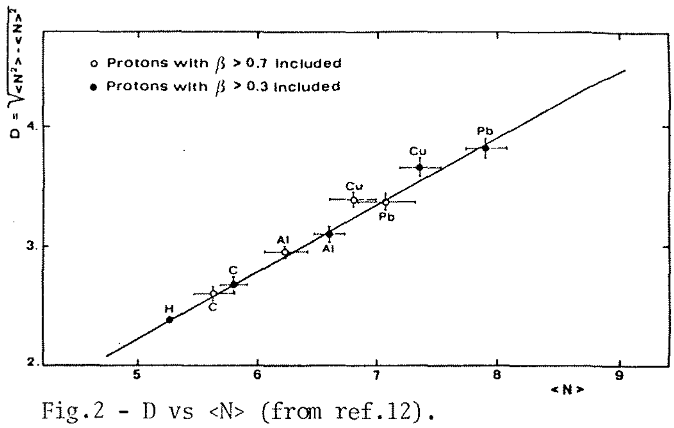


Fig.2 - D vs <N> (from ref.12).

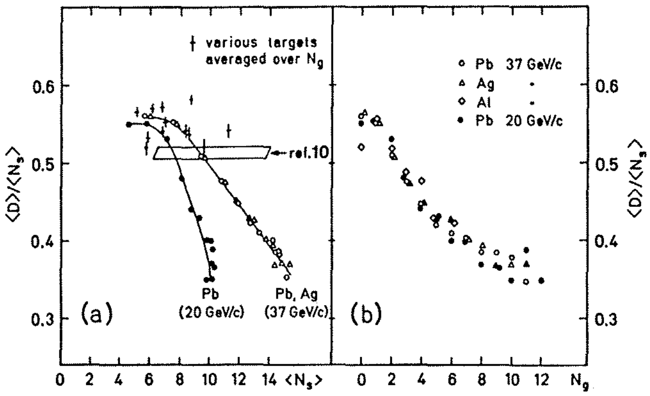


Fig.3 - Normalized dispersion <D>/<N>. a) as a function of <N> and b) as a function of Ng (N and N_s are here equivalent) (from ref.14).

As it is shown in Fig.2 the corresponding points for each nucleus lie on the straight line obtained as best fit to the π^-p world statistics by A. Wroblewski [13].

This result seems to support the hypothesis that in hadron nucleus interactions the multiplicity distribution scales in the same way as in the hadron nucleon ones. In particular this provides further indirect evidence for the validity of KNO scaling, also for hadron nucleus collisions (see e.g. W. Busza [10]), as predicted by the coherent tube model.

A systematic deviation from KNO scaling was observed instead in another experiment within the same range of energies: the one performed at CERN by M.A. Faessler et al. with π^-,K^- and $\bar{p}$ at 20 and 37 GeV/c [14].

The set-up was characterized by a non-magnetic detector (CsI(Tℓ) scintillation and Lucite Cerenkov detectors),which made it possible to distinguish between fast and slow particles ($\beta_{cut} \approx 0.7$), as in the emulsion data, but with the advantage of having a well-defined target nucleus. Interesting features are provided by the correlations between slow (N_g) and fast (N_s) particles angular and multiplicity distributions.

In particular the authors show that the ratio D/<N> is no longer constant,but is decreasing when <N> is increased as a function of N_g (and not as a function of the atomic weight A, as in the previous analysis), see Fig.3a,b.

Other interesting considerations allowed by the systematic measure of the gray (g) tracks in this experiment, result from the pseudorapidity distribution as a function of N_g and of incoming energy.

The authors found an upper region in η showing a depletion and a lower region showing an increase in the number of fast particles (see Fig.12 in ref.14); the border η_c depends both on the incoming energy and on the number of collisions. As the authors point out,this trend is quite different from the prediction of many of the present models.

The interest of a separate analysis of the energy dependent and the energy independent components of shower particles multiplicities has been shown by A. Andersson et al. in a paper presented at this Conference and by I. Otterlund in a previous paper [15].

Analysing the results of many $\pi^{\pm}A$ experiments they infer that the ratio between energy dependent components in hA and hp reactions is independent of energy and close to the $\bar{\nu}$ number of collisions between the incident hadron and the target nucleons.

The two above mentioned experiments were both performed in absence of magnetic fields, so pseudorapidity η,and not rapidity $y=\frac{1}{2}\ln(E+p_{\parallel})/(E-p_{\parallel})$ was used as main variable in the analysis of the results.

D. Chaney et al. (Rochester, Fermilab, Northwestern Coll. [16]) performed a study of neutron-nuclei multihadron production up to 400 GeV/c (max at $\sim$300 GeV/c) at the Fermilab, using a 80" x 24" x 72" magnet with scintillation counters and magnetostrictive-readout wire spark chambers. A major result of this detailed experiment to which I would like to draw attention is the observation that trends in the data differ markedly when examined in terms of rapidity y rather than pseudorapidity η.

Fig. 4 and Fig.5 show fits of the form A^{α} (A atomic weight) to the cross-sections presented as functions respectively of y and η.(One should keep in mind that $\alpha \simeq 2/3$ would imply that the multiplicity is independent of nuclear size and that there are neither cascading nor absorption effects of the hadronic system produced in the initial collision).

The comparison with the model predictions lead to contradictory results depending on whether y or η distributions are used: in the first case the data show a definite dependence on A, in that α falls well below a value of 2/3 at large rapidity (against the simple multi-peripheral and energy-flux cascade model predictions,but in favour of multi-Regge pole exchange models [1]); in the second case the data are consistent with a lack of dependence on A for $5 < \eta < 7$, followed by a large increase in α for $\eta > 7$. The authors suggest that this increase might be due, partially at least, to electromagnetic contamination,so the data might

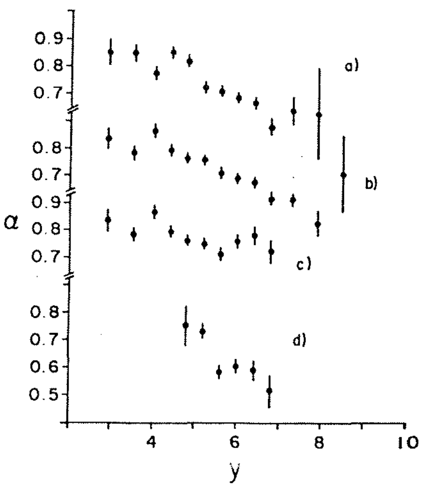


Fig. 4

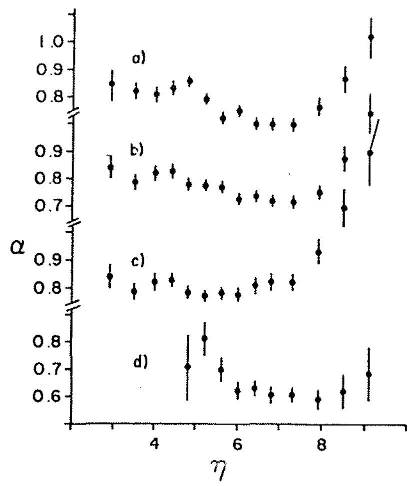


Fig. 5

Fig.4 - Atomic-weight dependence of the cross section as a function of rapidity. a) all negative particles b) all positive's (pion mass assumed) c) positive "pions" d) protons (from ref.16).

Fig.5 - The same as in Fig.4 but as a function of pseudorapidity (from ref.16).

agree with the Parton-Cascade model , which predicts a moderate increase at large η.

In conclusion from the general findings of the above three experiments there ensues a confirmation of the particular transparency of the nuclear matter to the forward produced particles.

There is qualitative agreement with the predictions of many of the current models, but, at least, at the present level of the analyses, none of these models seems to provide an understanding of all the production phenomena.

Some discrepancies in the experimental results (e.g. in the KNO scaling validity and in the η and y distributions which we have already been discussing) claim for further and perhaps more systematic and detailed investigations, including use of magnetic fields.

The decreasing of the inelastic total hadronic cross sections on nuclei, at increasing energies (observed in recent years with incident neutrons[17] and K_L^0[18]) was a further case of "à priori unexpected" transparency of nuclear matter to hadronic particle crossing. Recent measurements of γ nucleus hadronic total cross sections up to 140 GeV have shown similar behaviour (D.O. Calwell et al.[19]).

In Fig. 6 $A_{eff}/A = \sigma_{\gamma A}/(Z\sigma_{\gamma p} + (A-Z)\sigma_{\gamma n})$ is shown at increasing γ energies. The full line comes from L.Bertocchi's and D. Treleani's calculations[20]; they introduce large mass intermediate states into a Vector Dominance Model. This introduction, as in the case of the neutron and K_L^0 cross sections, produces screening effects; this fact can be interpreted as if the incident hadronic component of the γ dissociates into a possible higher mass state at one point and recombines at another within the nucleus. (Dotted lines correspond to simple VDM plus point-like photon).

COHERENT AND SEMICOHERENT INTERACTIONS

In the paper submitted to this Conference by T. Ferbel[11b,c] we find summarized the preliminary results of an experiment (Rochester-Minnesota-Fermilab Coll.) on coherent production with π^-, K^-, $\bar{p}$ at 156 and 260 GeV/c on C, Al, Cu and Pb targets, performed at the Fermilab with digit wire/PWC spectrometer. Fig. 7 shows the 3π invariant mass distribution at 156 GeV/c; beyond the usual $A_1(\rho_0\pi^-)$ low mass enhancement around 1100 MeV there is a possible structure in the A_2(1310 MeV) region.

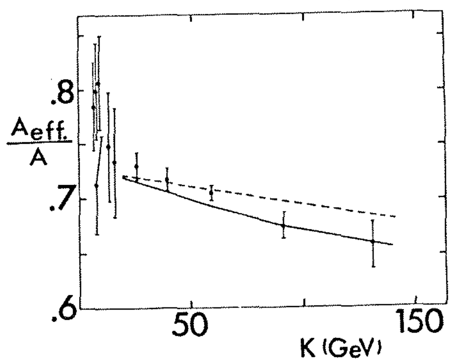


Fig.6 - E_{eff}/A vs γ energies (for Cu target). The data are from ref.19, the curves from ref.20.

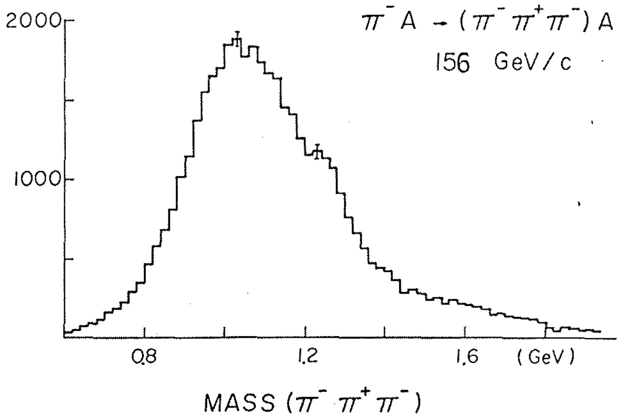


Fig.7 - Coherently produced 3π invariant mass (from ref.11b).

TABLE I

Meson	Radiat. Width
$\rho^- \to \pi^-\gamma$	50 ± 10 keV
$K^{*-} \to K^-\gamma$	∿ 50 keV
$A_2^- \to \pi^-\gamma$	∿ 450 keV
$A_1^- \to \pi^-\gamma$	∿ 600 keV

At these energies the Coulomb excitation becomes important and the authors can measure the radiative decay widths Γ_γ of unstable elementary particle $b \to a + \gamma$ by means of a generalization of the Primakoff formula for the production of a particle b in the Coulomb field of a nucleus. The results are summarized in Table I.

At the Serpukhov accelerator the Bologna, Dubna, Helsinki, Milan, Warsaw, Wien Coll. performed an experiment of coherent production $\pi^-A \to \pi^-\pi^-\pi^+A$ with incident pions at 40 GeV/c on 9 nuclear targets from Be to Pb.[21] The set-up consisted in the M.I.S. optical spectrometer (1.3 x 1.5 x 5 m^3 - $B_{max} \simeq$ 17 Kgauss), scintillation counters to define the forward acceptance cone and to anticoincide charged recoils at very large angle, and a large MWPC to select the charged multiplicity. About 700.000 pictures were collected; the present analysis is based on half the statistics.

The coherent sample of events is selected in the region of $d\sigma/dt$ (up to the first minimum) in which the ratio of coherent signal to incoherent background is more favourable.

Fig. 8a, b display the invariant mass distributions (obtained with light nuclei) for $\pi^+\pi^-$ systems, when the corresponding 3π masses are respectively in the A_1 and A_3 region.

As it is possible to see, ρ_0 and respectively, ρ_0 and f_0 productions are dominating. The corresponding 3π invariant mass distributions - always for the "coherent sample" - are shown in Fig.9a. In addition to the large accumulation in the A_1 region an accumulation in the A_3 (1640 MeV) region is evident.

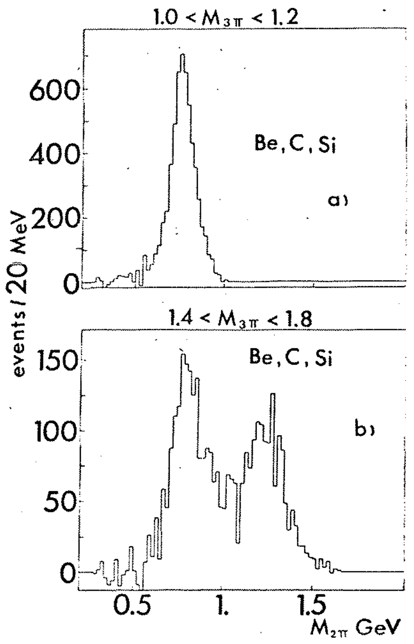


Fig.8- a) $M^*\pi^+\pi^-$ (for the "coherent sample" in light nuclei) when $1.0 \leq M^*_{3\pi} \leq 1.2$ GeV.
b) idem when $1.4 \leq M^*_{3\pi} \leq 1.8$ GeV (from ref.21).

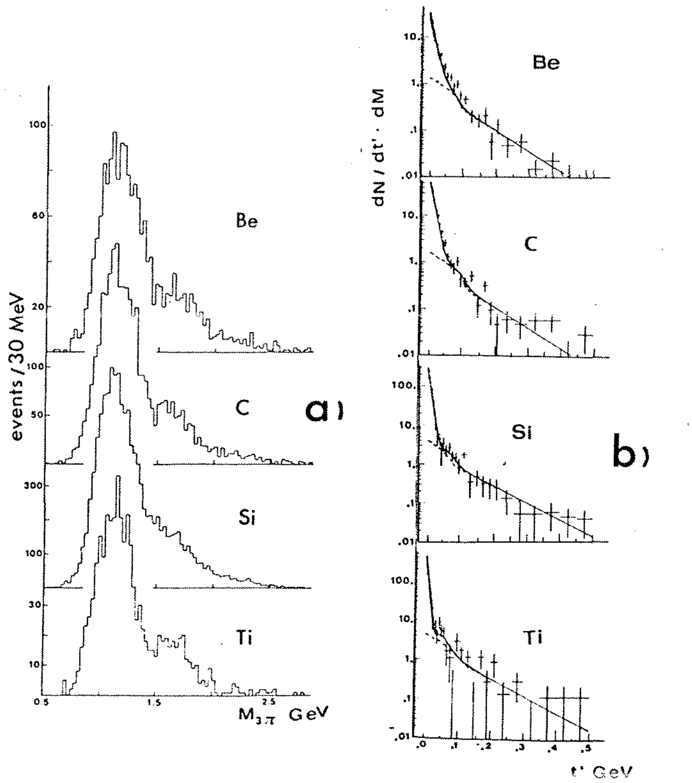


Fig.9- a) $\pi^+\pi^-\pi^-$ invariant mass distribution for the "coherent sample" separately for different light nuclei.
b) t' differential distribution for the same samples of events. Fitted curves are from the GKM model - see the text (from ref.11).

The equivalent distributions for heavier nuclei display the same trend with a light reduction at the highest masses due to the nuclear form factors. Fig.9b shows differential t' distributions ($t'=t-t_{min}$; $t_{min}=(M^*_{3\pi}-m_\pi)^2/4p^2_{inc}$) for the events with $1.<M^*_{3\pi}<1.2$ GeV.

The fit to the t' distribution is obtained from the relation:

$$\frac{d^2\sigma}{dt'dm^*} = \frac{d^2\sigma_{coh}}{dt'dm^*} + \frac{d^2\sigma_{incoh}}{dt'dm^*} \qquad (1)$$

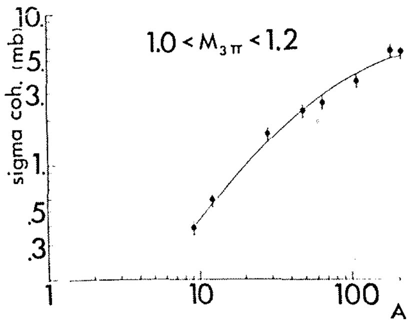


Fig.10- σ_{coh} vs A for $1.0\leq M^*3\pi\leq 1.2$ GeV. Fitted curve from form.(3) (from ref.21)

The incoherent term $d^2\sigma_{incoh}/dt'dm^*$ is proportional to the differential production on free proton and includes a factor of correction owing to the bias in the detection of low protons, introduced by the set-up.

In this first approach the coherent term is obtained from the old Glauber-Kölbig and Margolis formalism [6]:

$$\frac{d^2\sigma_{coh}}{dt'dm^*} = C_0 e^{-bt} A^2 |F(t',m^*,p_{inc},\sigma_1,\sigma_2,\alpha_1,\alpha_2)|^2 . \qquad (2)$$

where $C_0 = \left(\frac{d^2\sigma_{nucleon}}{dt'dm^*}\right)_{t'=0}$ and σ_2 (the unstable system-nucleon cross-section) are taken as free parameters, σ_1 is the incident pion-nucleon total cross-section, and α_1 and α_2 are the corresponding real to immaginary part ratios of the forward elastic scattering amplitude (σ_1 and α_1 are taken from the literature). After subtraction of the incoherent background it is possible to obtain:

$$\sigma_{coh}(\Delta m^*, \Delta t') = \int_{m_1^*}^{m_2^*}\int_0^{t'} \frac{d^2\sigma_{coh}}{dt'dm^*}\, dt'dm^* \qquad (3)$$

An overall fits of formula (1) or (3) to the data of the different nuclear targets yields the parameter σ_2 for different $M^*_{3\pi}$ intervals. Fig.10 shows σ_{coh} vs A with the fitted curve from formula (3).

Preliminary results obtained by the collaboration are:

$1.0\leq M^*\leq 1.2$ GeV, $\sigma_2=16.2$ mb ($\Delta\sigma_{2stat} = \pm\ 1.9$ mb, $\Delta\sigma_{2syst} = {}^{+\ 2.3}_{-\ 1.2}$ mb)

$1.6\leq M^*\leq 1.8$ GeV, $\sigma_2=15.7$ mb ($\Delta\sigma_{2stat} = \pm\ 1.9$ mb, $\Delta\sigma_{2syst} = \pm\ 4$ mb)(+)

Fig. 11a,b is a compilation of the world present data on σ_2 measures, respectively for incident pions and incident neutrons or protons. The data are displayed in function of the masses of the produced system. As it is possible to see the general trend in both cases is a decreasing of σ_2 with the increasing of M^* with some evidence of a small rise at

(+)The big systematic errors will be reduced in the near future with a more refined extimation of the overall efficiencies. Allowing the parameter α_2 to slightly variate around zero ($-.5\leq\alpha_2\leq.5$) or using the differential form.(1) instead of the integrated form.(3) in the fit, have no remarkable effects within the errors.

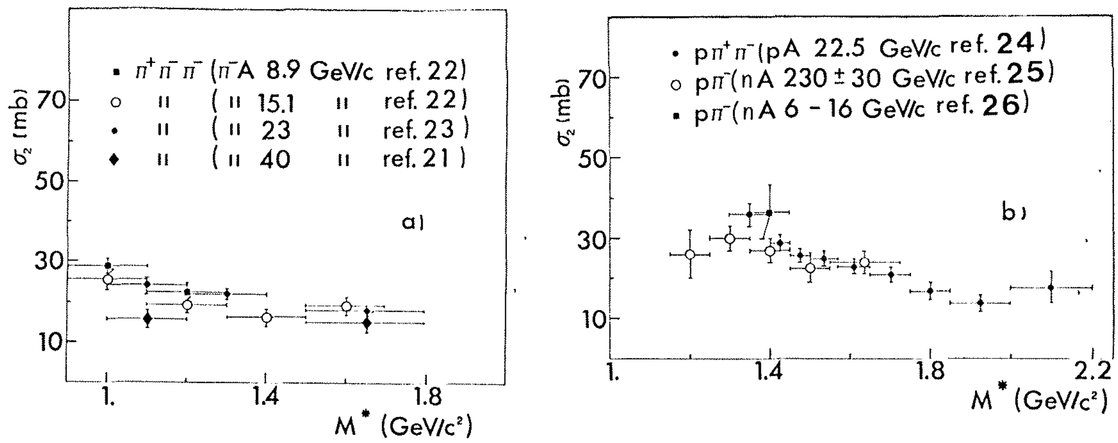


Fig. 11a,b - Compilation of σ_2 measures obtained, in the frame of the GKM formalism, from the A dependence of diffractive production on nuclei a) for incident pion beams b) for incident protons or neutrons.

the upper limit "allowed" for coherent production at each energies(+). Another feature is that, as far as the present data are concerned, there is a constant decrease of σ_2 at fixed M^*, with the increasing of the incident energy.

This last feature seems to be in evident and intuitive correlation with possible effects of the space-time evolution of the produced system. Furthermore it is of remarkable interest that, both for incident pions and nucleons, there are situations in which σ_2 is less than the incident hadron-nucleon cross-section(++).

As it was pointed out earlier, many theoretical ideas were developed in order to account for these features. When the different collaborations reanalyze their data - as they are planning to do[21,23] - by introducing at least such corrections as suggested by Fäldt and Osland [8], it will be very interesting to see whether and to what extent these corrections (which in principle seem to maintain the original meaning of σ_2) will change the σ_2 values.

At the Serpukhov accelerator semicoherent elastic scattering on carbon

$$\pi^- + {}^{12}C \rightarrow \pi^- + {}^{12}C^* \quad (J^P=2^+)$$
$$\hookrightarrow {}^{12}C + \gamma \ (4.44 \text{ MeV})$$

was investigated by the Dubna-Milan Collaboration[21,27]: the total elastic cross section was measured with 25 and 40 GeV/c incident pions; furthermore, the differential elastic cross section was also obtained at 40 GeV/c.

The experimental set-up was the same as the one used for the experiment on coherent interactions on nuclei [21], except for the vertex detector.

(+) M^*_{max} is related through t_{min}, as before, defined to the incident momentum; for large t_{min}, because of the nuclear form factor, the coherent production becomes negligible.

(++) I remember that other peculiarites in the σ_2 behaviour cames from the measures for different spin parity states (e.g. in the A_1 region σ_2, always in the GKM frame, is ranging between 15 and 25 mb for $J^P=1^+$ and between 50 and 60 mb for $J^P=0^-$)[22,23]. Not yet partial wave analysis is performed in the two recent experiments above discussed.

The experimental data were selected with a counter technique, looking at the coincidence between the scattered pion and the 4.44 MeV photon from the $J^P=2^+$ carbon excited state detected by a NaI counter. A polystyrene Live Target was used in order to reduce incoherent background.

The value obtained for the integrated cross section at 40 GeV/c in the $0.0032\leq|t|\leq 0.27$ $(GeV/c)^2$ four-momentum transfer range is

$$\sigma = (1.16 \pm 0.11)\ \text{mb}$$

According to the theoretical models, this t-range at 40 GeV/c covers more than 99% of the angular distribution, so the above value nearly corresponds to the total semicoherent elastic cross-section.

At 25 GeV/c the t-range was $0.0013\leq|t|\leq 0.10 (GeV/c)^2$; the corresponding integrated cross-section is

$$\sigma = (0.80 \pm 0.25)\ \text{mb}.$$

In this case the correction to be applied to obtain the total cross-section is model--dependent.

For a detailed analysis of the elastic semicoherent reaction the angular distribution of the scattered pions was measured at 40 GeV/c of incident momentum in 15.000 pictures taken with the M.I.S. optical spectrometer.

Fig. 12 gives the distribution of $d\sigma/dt$ for 760 selected "semicoherent" events.

The experimental data were compared with the recent theoretical calculations of L. Bertocchi and C. Troncon.[28] These parameter-free calculations were developed, in the frame of the Glauber theory, by using the hadron amplitudes obtained from hadron scattering on proton targets, and nuclear form factors from nuclear elastic and inelastic (for the 0^+-2^+ transition) electron scattering.

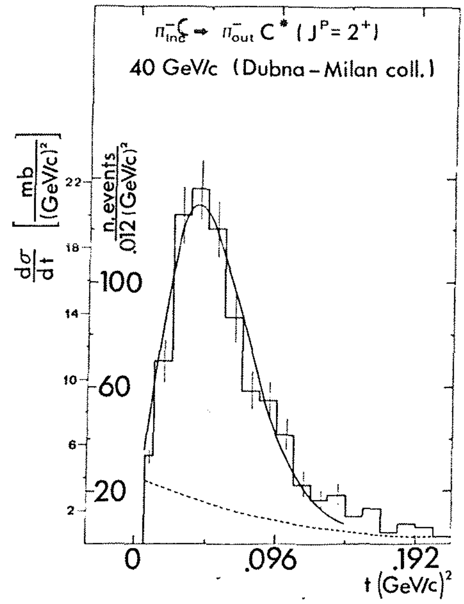


Fig.12 - $d\sigma/dt$ distribution for the "semicoherent" selected sample (from ref.21). Dotted line corresponds to an exponential background; full line corresponds to the Bertocchi-Troncon's[28] theoretical calculations.

The elastic semicoherent cross-section is calculated to be 1.20 mb at 40 GeV/c and 1.18 mb at 25 GeV/c (for the same t intervals as the experimental ones). In Fig.1 the theoretical curve, added to an exponential background(+), is superimposed to the experimental distribution in absolute value (without fit); the comparison yields χ^2/degrees of freedom = 8.2/8, corresponding to a confidence level of 40%.

The conclusion is that there exists a good agreement between the experimental data and this parameter-free theoretical calculation, not only

(+)The remaining incoherent background in the selected sample was estimated from the NaI pulse height distributions, and it was found to have an exponential "slope" consistent with elastic scattering on nucleon. In this experiment no use of time of flight measurement was made because of the particular set-up geometry. Such measurement would further reduce the already low background.

as far as the total elastic cross section is concerned but also the shape of the differential distributions, up to 40 GeV energy.

The previously found discrepancies[29,30] between experimental data and theoretical previsions no longer subsist. Consequently it is now possible to consider again the semicoherent channels, as originally proposed by L. Stodolski[31] and O.Piccioni[29], as channels in addition to or as an alternative to the coherent ones, useful to a better understanding of particular aspects of the elementary hadronic processes at high energy[(+)].

More generally it is clear that all the questions recently raised on the hadronic interactions on nuclei (absorption cross-sections, space-time development of the produced system etc.) should also be present in the studies of the semicoherent channels and that the particular clearness of these channels (due to the 4.44 γ's signature) would add useful information to the general experimental frame. For instance G. Fäldt and P. Osland suggested that their modifications to the GKM calculation to obtain the σ_2 parameter could be more easily tested in the semicoherent channels[8].

Another interesting experiment in which the nucleus (in this case the deuteron) is used as a useful tool ("a hadronic interference", as the authors put it ...) has been recently performed by G. Goggi et al.[34] at the CERN Intersecting Storage Rings; they used proton and deuteron colliding beams with the Split-Field Magnetic detector.

The experiment studies the coherent diffraction dissociation

$$pd \rightarrow (p\pi^+\pi^-)d \quad \text{at } \sqrt{s}=53 \text{ GeV}$$

and

$$nd \rightarrow (p\pi^-)d \quad \text{at } \sqrt{s}=37 \text{ GeV.}$$

(For comparison, an analysis is also made of the corresponding diffractive channels on protons).

The authors analyze the data in the frame of the "Glauber formalism" but with two different kinds of description of the elementary nucleon-nucleon production amplitude: a) in a standard hypothesis (central model) b) in a peripheral description.

Besides they include the elicity flip amplitude, following the suggestions of Hümble, Fäldt and Osland.

Fig.13 is an example of $d\sigma/dt$ experimental distribution for p-d reactions ($1.6<M_{p\pi^+\pi^-}<1.8$ GeV) - the continuous line corresponding to the peripheral model, the dashed curve to the "central" model. The agreement of experimental data with the first model is clear.

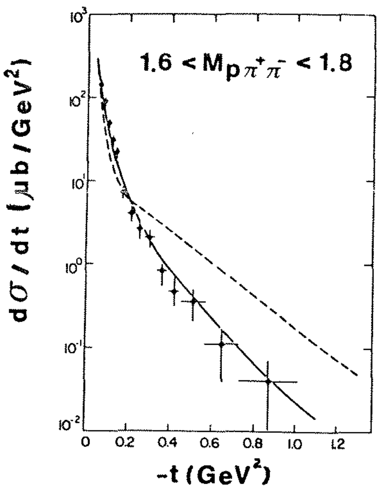
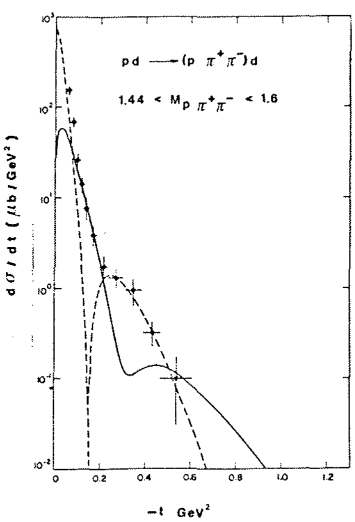


Fig. 13 - Comparison between peripheral and central model (see the text)(from ref.34).

(+) The 3π production on semicoherent channel had already been investigated with a low resolution magnetic spectrometer at 6 GeV/c by Ascoli et al. [32]; for a discussion of this channel see also V.V. Balashov et al.[33]

Fig.14, on the other hand, depicts the contribution of no spin-flip ($\Delta\lambda=0$) amplitude (dashed line) and of the $\Delta\lambda=1$ amplitude (full line) to the peripheral model (interval $1.44<M_{p\pi^+\pi^-}<1.6$ GeV is shown as an example). The effect of "dip filling" of this last curve is evident.



The authors also try to interpret the experimental results with the "central model" and to leave the σ_2 parameter free. They demonstrate that this leads to an underestimation of σ_2 with the increasing mass of the diffracted system.(This is evident also at a simple inspection to Figure 13).

This observation seems to fit in very well with the general frame of the previously discussed analysis.

Fig.14 - Comparison of contributions of no spin flip and spin flip amplitude in the peripheral model (from ref.34).

CONCLUSIONS

Both multiparticle production and coherent interactions seem to be deeply related to the space-time development of hadronic systems, even if no clear quantitative description of the phenomena is obtainable so far from this point of view.

In the coherent experiments, more careful analyses of the present data are in progress and it will be interesting to see the effects of the introduction of the suggested refinements to the previous theoretical frame.

Particular channels, such as the semicoherent ones, seem to provide the possibility of clear discrimination between different hypotheses.

A few discrepancies between phenomenological analyses in multiparticle production claim for further detailed and systematic measurements.

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