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# TOPOLOGICAL CHARACTERISTICS OF NEON-22 FRAGMENTATION AT 4.1 A GeV/c ON PHOTOEMULSION NUCLEI[1])

M. KARABOVÁ, E. SÍLEŠ, M. TÓTHOVÁ, S. VOKAL, Košice[2])

N. P. ANDREEVA, Z. V. ANZON, V. I. BUBNOV, I. Ya CHASNIKOV, L. E. EREMENKO, A. Sh. GAITINOV, G. S. KALYACHKINA, E. K. KANYGINA, A. M. SEITIMBETOV, Tc. I. SHAKHOVA, Alma-Ata[3])

M. GITSOK, M. HAIDUK, V. TOPOR, Bucharest[4])

E. GLADYSZ, R. HOLYNSKI, H. WILCTYNSKI, B. WOSIEK, Cracow[5])

S. A. KRASNOV, G. S. SHABRATOVA, K. D. TOLSTOV, A. VOKALOVA, Dubna[6])

R. A. KHOSHMUKHAMEDOV[7]), V. A. LESKIN[8]), A. MUKHTOROV[8]), Dj. A. SALOMOV[9]), Dyushambe

F. G. LEPEKHIN, B. B. SIMONOV, Gatchina[10]),

V. A. ANTONCHIK[11]), V. A. BAKAEV[11]), A. V. BELOUSOV[11]), S. D. BOGDANOV[11]), V. I. OSTROUMOV[11]), V. G. BOGDANOV[12]), V. A. PLYUSHCHEV[12]), Z. I. SOLOVIEVA[12]), Leningrad

M. I. ADAMOVICH, M. M. CHERNYAVSKY, S. P. KHARLAMOV, V. G. LARIOVA, N. V. MASLENIKOVA, G. I. ORLOVA, M. I. TRETYAKOVA, Moscow[13])

F. A. AVETIAN, V. M. KRISHCHIAN, N. A. MARUTIAN, L. G. SARKOSOVA, V. F. SARKISIAN, Yerevan[14])

Experimental data on neon-22 relativistic nuclei fragmentation in interactions with photoemulsion nuclei are given. The study of the topological content of relativistic nuclei fragments shows the existence of two types of disintegration of the projectile in dependence on the degree of its excitation.

## ТОПОЛОГИЧЕСКИЕ ХАРАКТЕРИСТИКИ ФРАГМЕНТАЦИИ НЕОНА-22 НА ЯДРАХ ФОТОЭМУЛЬСИИ ПРИ ПЕРЕДАННОМ ИМПУЛЬСЕ 4,1 ГэВ/с

В работе приводятся экспериментальные данные о фрагментации релятивистских ядер неона-22 при их взаимодействиях с ядрами фотоэмульсии. Изучение топологического содержания осколков релятивистских ядер обнаруживает наличие двух типов распада налетающего ядра в зависимости от степени его возбуждения.

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Alma-Ata — Bucharest — Cracow — Dubna — Dyushambe — Gatchina — Košice — Leningrad — Moscow — Yerevan Collaboration:

[2]) P. J. Šafárik University, KOŠICE, Czechoslovakia.

[3]) Institute of High Energy Physics, ALMA-ATA, USSR.

[4]) Central Institute of Physics, BUCHAREST, Romania.

[5]) Institute of Nuclear Physics, CRACOW, Poland.



## I. INTRODUCTION

The projectile and target nuclei are disintegrated in the interactions of relativistic nuclei. According to the geometrical picture, there are in such collisions an interaction area and nonoverlapping parts of both nuclei desintegrated to fragments due to the obtained excitation. As a result of an impact parameter variation, there appear events with the emission of secondaries of different types and energies within a wide range of multiplicity. An inclusive study of such reactions does not make it possible to find characteristics of the event from which the particle has been registered. This limits significantly a further analysis. The photoemulsion method allows to register all charged secondaries of the event and to determine their production area. Thus slow $b$ prongs (the energies of $b$ protons are up to 26 MeV) with the angular distribution close to the isotropic one are fragments of the target nucleus. As shown in paper [1], many-charged relativistic fragments of the projectile nucleus are concentrated in an angular cone of $\sim 3°$ relative to the primary direction. Their charges are determined by the delta-electron count or by measuring the integral length occupied by the developed grains with an accuracy of $\Delta Z \leq 1$. One-charged fragments are selected from prompt one-charged $s$ and $g$ prongs from the interaction area by measuring the momenta. The $s$ and $g$ prongs are mainly $\pi$-mesons and protons. Thus, the photoemulsion method allows to analyse the charge content of the projectile fragments together with the multiplicities and angular characteristics of the $s$, $g$ and $b$ prongs. Such a kind of analysis has been carried out previously for carbo-emulsion integrations at 4.5 A GeV/c [2]. A similar analysis of 4155 inelastic interactions between neon-22 and nuclei in emulsion at 4.1 GeV/c is performed in this paper.

## II. EXPERIMENTAL RESULTS

The summary charge distribution $\left(Q = \sum_i Z_f^i\right)$ of neon-22 fragments is shown in Fig. 1. The value of $Q$ characterizes the dimensions of the non-overlapping part of

[6]) Joint Institute for Nuclear Research, DUBNA, USSR.

[7]) Tadzhik State Medical Institute, DYUSHAMBE, USSR.

[8]) Physicotechnical Institute, DYUSHAMBE, USSR.

[9]) Tadzhik State University, DYUSHAMBE, USSR.

[10]) Leningrad Institute of Nuclear Physics, GATCHINA, USSR.

[11]) Leningrad Polytechnical Institute, LENINGRAD, USSR.

[12]) Radium Institute, LENINGRAD, USSR

[13]) Institute of Physics, Acad. Sci. of the USSR, Moscow, USSR.

[14]) Yerevan Physics Institute, YEREVAN, USSR.

the projectile nucleus. From the Figure it is seen that a lagre part of events is peripheral ($Q \geq 8$). The comparison with $^{12}C$ – Em collisions [3], where a flatter $Q$ distribution is observed, shows an increase of the probability of peripheral interactions.

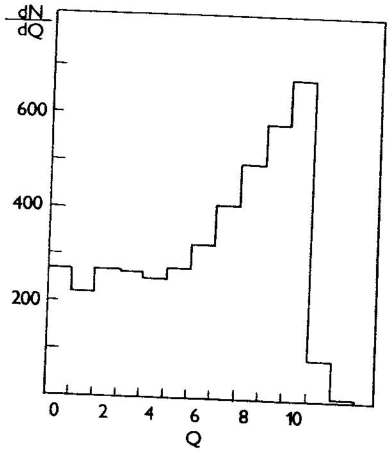


Fig. 1. The summary charged distribution for relativistic fragments $Q = \sum_f Z_f^i$

The topological graphs, characterizing the large content of the projectile nucleus fragments in events different $Q$ and $N_h = n_g + n_b$, are shown in Fig. 2. The value of $N_h$ indicates the desintegration degree of the target nucleus. The events with $N_h = 0 \div 1$ are considered as quasinucleon interactions; with $N_h = 2 \div 6$ as collisions with C, N. O and peripheral interactions with Br, Ag nuclei and with $N_h \geq 7$ as collisions with a large desintegration of the last.

From the graphs one can see that

1. The production of events with different $Q$ (dimensions of the nonoverlapping part of the projectile nucleus) depends strongly on $N_h$, i. e. on the target size and the topological content at given $Q$ depends slightly on $N_h$.
2. The projectile nucleus fragmentation occurs by two channel types: with the conservation of the many-charged fragments with $Z_f \geq 3$ and with the total destruction of the non-overlapping part to one- and two-charged fragments (in the following TD events). The relation between these two types of channels depends on $Q$: the percentage of the TD events is small at small overlaps (large $Q$), and it becomes decisive at small $Q$.
3. It is observed that channels with two-charged fragments are realized more frequently than channels without them. The largest probabilities are for the channels where the number of two-charged fragments is as large as possible at a given $Z_f$.

This picture gives evidence of a considerable contribution of alpha structures to



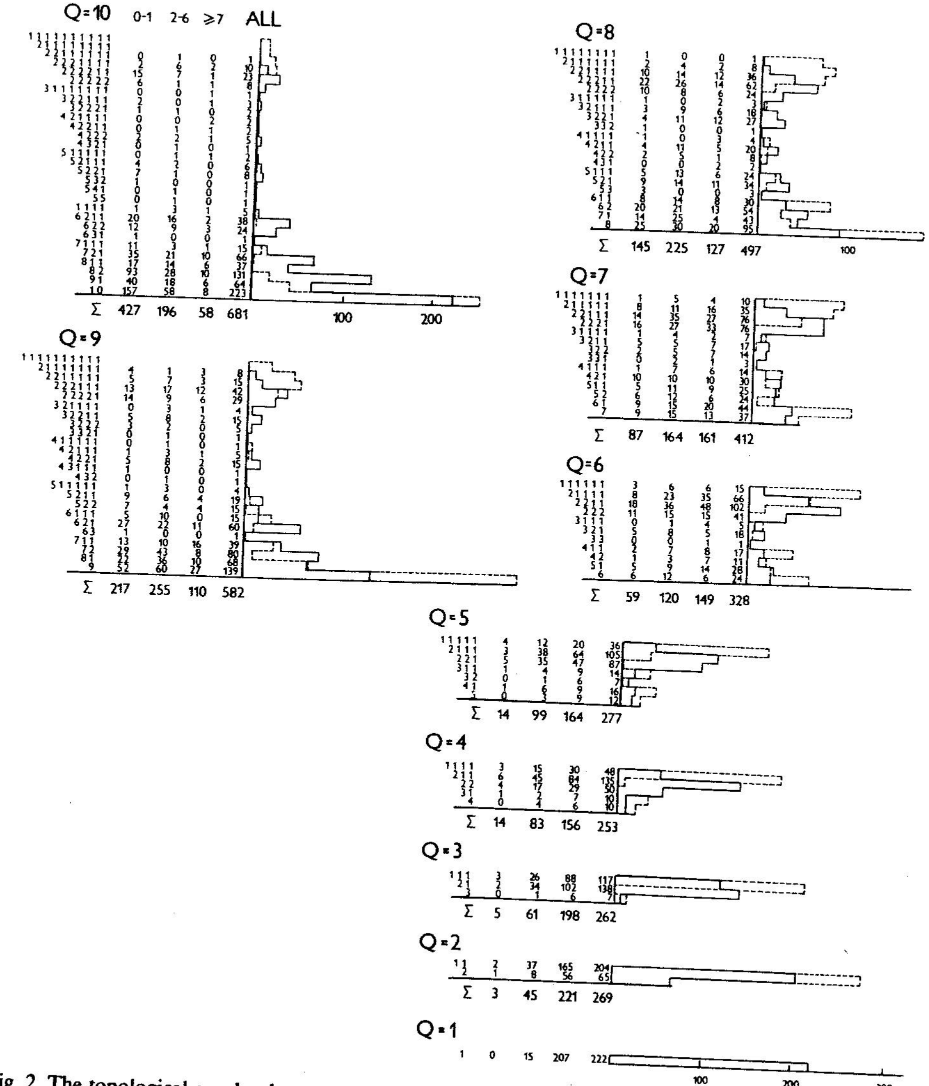


Fig. 2. The topological graphs characterized the charge content of fragments from events with different $Q$ at three intervals of $h$-particle multiplicity ($N_h$). The results of the cascade-evaporation model calculation are shown by the dashed line.

the excited spectator part of the nucleus. 4. The ratio of the yields of two-charged fragments to one-charged ones decreases appreciably with increasing overlap degree of the colliding nuclei (decrease of $Q$), see Fig. 3, i. e. at a large desintegration of the nucleus its alpha clusters are destroyed.

Similar conclusions have been drawn in [2], where the analysis of the topological graphs for charged fragments of the carbon projectile at 4.5 A GeV/c has been carried out.

### III. DISCUSSION

The results of the cascade model calculations [4] are shown in Fig. 2 (dashed line). An appreciable disagreement with experiment is observed. The yield of the channels with two-charged fragments is underestimated or is completely absent.

The production of different topology events can be explained by two-body decays with the emission of one- and two-charged particles (Fig. 4). We notice a monotonous decrease of the number of experimentally observed events in each direction up to the TD events, where this monotony is destroyed. Such a picture may point to the difference between the mechanisms responsible for the two types of reactions. The TD events are probably connected with a large excitation energy of the non-overlapping part of the nucleus. Let us compare the multiplicity characteristics of the particles from the overalapping zone ($S$ and $g$ particles) and the target nucleus fragments ($b$ particles) for the two types of nucleus projectile disintegration with given $Q$ in order to test the former assumption.

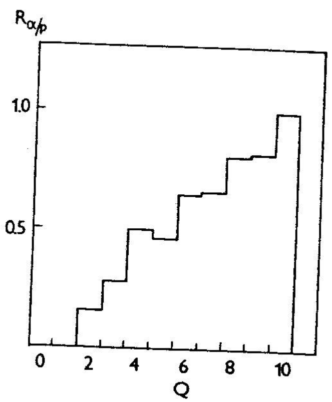


Fig. 3. The ratio of two-charged fragments yield to one-charged particles as afunction of $Q$.

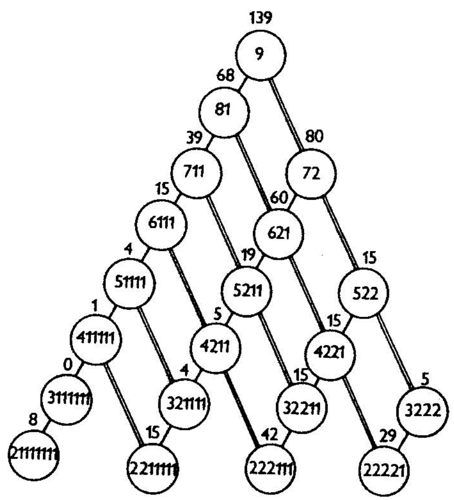


Fig. 4. The grapf of two-body decay with the emission of one- or two-charged particles from the spectator part of the incident nucleus.

The average multiplicities $\langle n_s \rangle$ and values of $\Delta n_g$, $\Delta n_b$ are shown in Fig. 5 as a function of $Q$ for events with $Z_f \geq 3$ and TD events. For TD events the average multiplicities of $s$ particles are larger than for $Z_f \geq 3$ events (roughly by unity), and



an unimported excess of $n_g$, $n_b$ is observed. This fact can indicate a large temperature in the overlapping zone which can lead to a larger excitation of the projectile spectator part.

In literature the question is discussed concerning the mechanisms responsible for

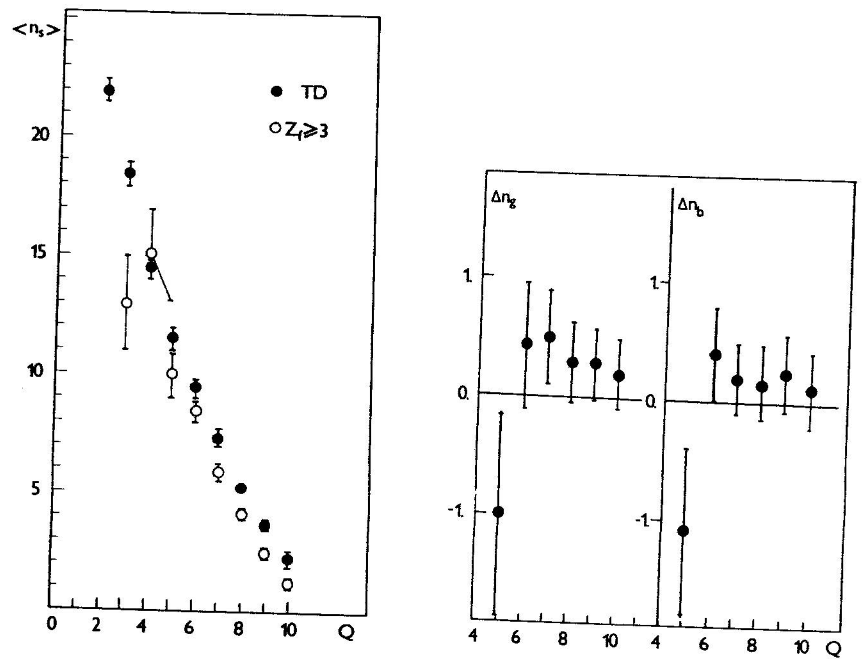


Fig. 5. The mean multiplicity of $s$-particles for the events with $Z_f \geq 3$ and TD events as a function of $Q(a)$. The multiplicity differences $\Delta n_g$ and $\Delta n_b$ for events with $Z_f \geq 3$ and TD events (b).

nuclear multifragmentation processes, but calculations of the mass fragment yields are carried out for heavy nuclei in inclusive experiments. If we present our data in the same form, a qualitative character of the mass distribution is close to that found in [5, 6].

Figure 6 shows graphs for the accompanying particles of many-charged fragments at a given $Z_f$. The heightened yield of channels with the emission of two-charged particles is the most striking at this figure. Such graphs may be useful for experiments carried out by other methods, for example, by means of solid state detectors, scintillation counters and so on, where the relativistic fragment charge is determined according to its ionization capacity proportional to $Z_f^2$. The charge content of the accompanying particles will make it possible to check the precision of such measurements.

Concluding we can note that the study of the topological content of relativistic

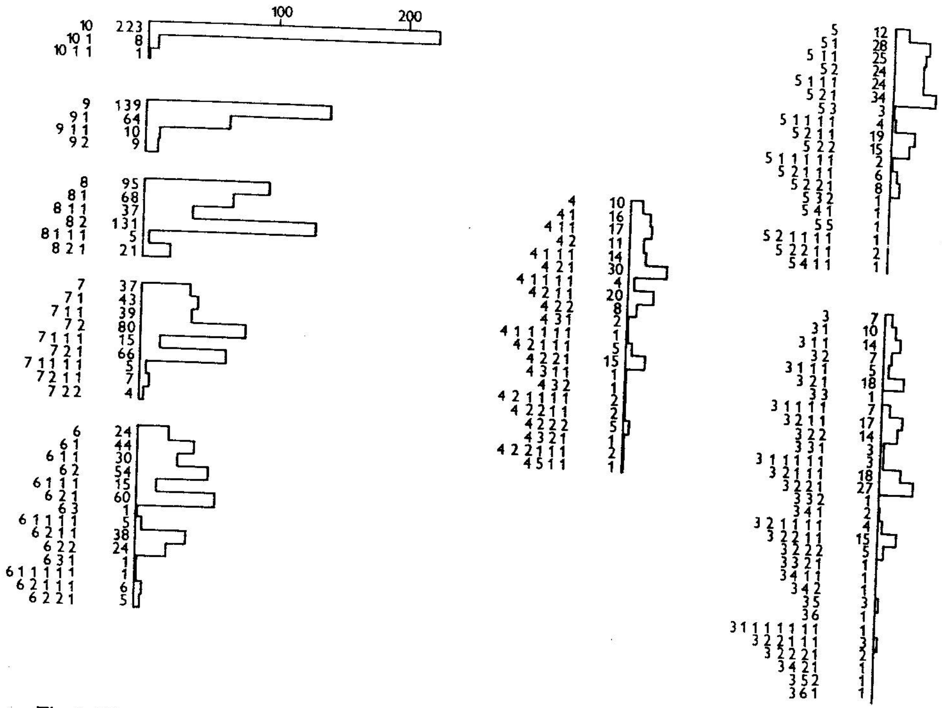


Fig. 6. The topological graphs for particles accompanying multiplecharged fragments of neon-22.

nuclei fragments has shown the existence of two types of disintegration of the projectile non-overlapping part, which is evidently due to the different degree of its excitation. The role of the alpha cluster structure in the content of the nucleus spectator part is considerable and depends on the excitation energy.

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