PROTON ANGULAR DISTRIBUTIONS IN FULL NUCLEAR DECAYES

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The events of full nuclear decay in π^--^{12}C interactions at 5 GeV/c were researched. In protons distribution the peak is observed in the neighbourhood of θ~57°. Perhaps this peak is connected with a shock wave in the nucleus.

1. Full nuclear decay

The interesting features in the proton angular distributions are observed when studing so-called "full nuclear decay" events in hadron-nuclear reactions. In these events the number of secondary exceeds the half of number protons in a nucleus.

The studying full nuclear decay processes will be found a source of usefull information about properties of a nuclear matter in the state of very high level excitation before decay. In particular, it is reported [1] that in hadron-nuclear interactions the collective excitation of nuclear matter may to create as a shock wave at crossing fast hadron through nucleus. This idea was used for interpretation the full decay of nucleuses by relative particles [2].

The interesting explanation of full nuclear decay phenomen was given in paper [3], where it was suggested collective mechanism of particles radiation (a type of shock wave) at first stage and blast decay of remnant nucleus at second nonequilibrium stage.

The experimental research of this effects are quite poor up to now. Note, probably the only experiment [4] in which the maximum was observed in angular distribution of secondary protons at angle θ~60° in π^--^{12}C interactions at 40 GeV/c. Authors of this paper gives consideration to under observation peak as creation and motion shock wave in the nucleus.

The purpose of this work is investigation of the collective excitations in the events of full nuclear decay in π^--^{12}C interactions at 5 GeV/c. The data was given from one meter bubble chamber in Joint Institute of Nuclear Reseach.

We considerated only pion-carbon reactions in accordance with next requirements (1) - (5):

$$= N_p + (N_{\pi^+} - N_{\pi^-} + 1) \geq 4 \qquad (1)$$

here Q is the total charge of secondary particles; N_p, N_{π^+} and N_{π^-} are numbers of identifyed protons, positive π and negative π mesons;

$$N_p > 3 \qquad (2)$$

The (1) and (2) are criteries full carbon nucleus decay. Due suggested creation in nucleus the high excitions, the more number of π mesons must be created, than in ordinary π^--^{12}C interactions, therefore we use the condition

$$N_{\pi^+} N_{\pi^-} > N_\pi \qquad (3)$$

here N_π~ 1,5, a mean multiplisity of π^+ (π^-) mesons in π^--^{12}C interactions.

$$N_{p^+} > N_{p^-} \qquad (4)$$

here N_{p^+} and N_{p^-} are numbers of protons emitted into forward and backward hemisphere in laboratory system.

As parameter $N_{ps} \sim N_{\pi^+} - N_{\pi^-} + 1$ is proportional to number of fast protons in event, as

$$1 \leq N_{ps} \leq 3 \qquad (5)$$

The protons were registrated in range of moments 0,18 < P_p < 0,7 GeV/c. The positive tracts were taken into account as π^+ mesons.

The 385 events have been choosen under (1) - (5) conditions. The propability of evidence such events (i.e. the ratio of this events to all π^--^{12}C - events) is

$$W^5 = (3,3 \pm 0,2)\%$$

This value equals in frame of statistical mistakes with correspondent value given for π^--^{12}C interactions at 40 GeV/c [4]

$$W^{40} = (4,0 \pm 0,3)\%$$

And so W depends weakly on energy of initial hadron and, probably, is characteristic only nucleus-target.

2. Angular distribution of protons

In figure there are shown distribution on emission angular for protons in laboratory system in full nuclear decay events. We had used results calculations on cascade-evaporation model [5] (CEM) as backround to experimental data.

Comparison of experimental data with the cascade-evaporation model showed [5] that three mechanisms can give the main contribution to the protons production:

a) rescattering on intranuclear nucleons (including processes of elastic and nonelastic rescattering, charge-exchange, pion production etc.);

b) descruction of the excited residual nucleus;

c) absorption of slow π mesons by a correlated pair of intranuclear nucleons.

Contributions of mechanisms a), b) and c) to proton production were disriminated by means of the CEM with allowance for variations of the number of nucleons in the

nucleus due to their knocking-out in the process of the intranuclear cascade. The evaporation stage was calculated by the "destruction" model, based on Fermi's statistical model. 95000 Monte-Carlo generated non-elastic π^-C interactions were used.

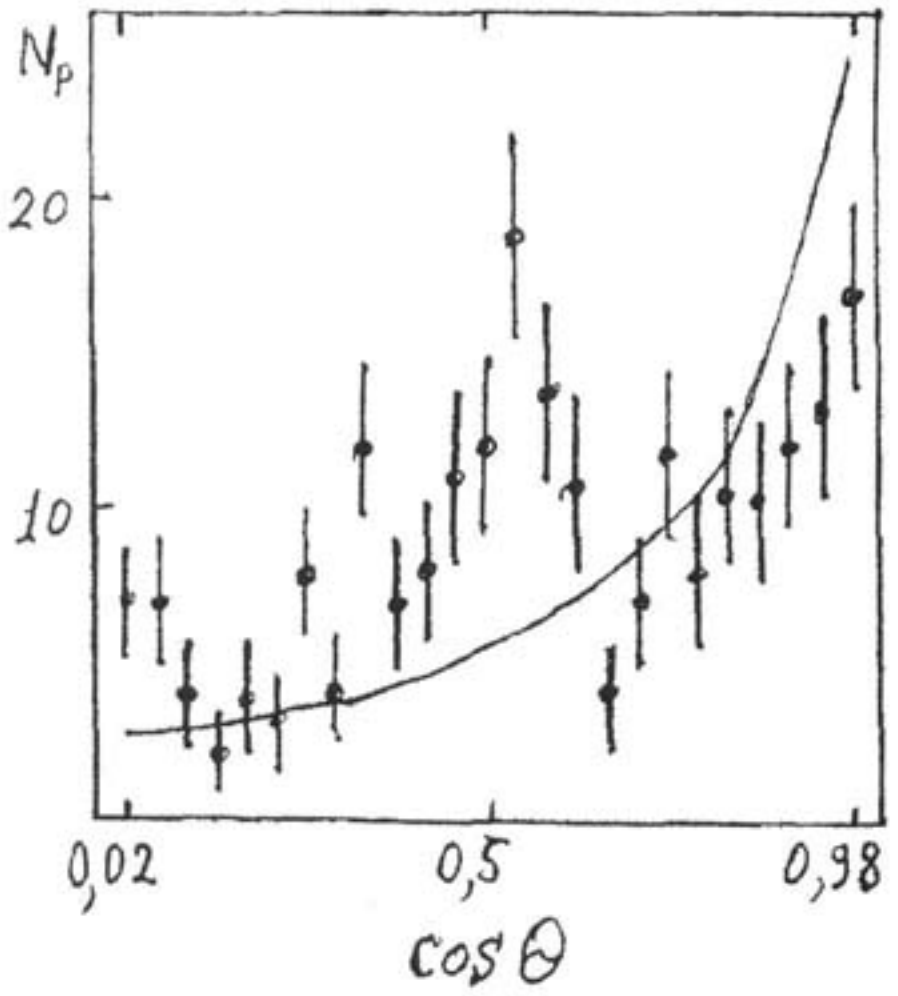

Figure. Distribution of protons on emission angular in full nuclear decay events.

In figure theoretical and experimental distributions were normalized to equal areas. In this distributions we can see the peak above the curve of CEM in range of angle $\theta' = (56,7 \pm 0,8)^\circ$ as in paper [4]. The maximum is observed at close values of angles, that points to weak dependence θ' on energy of initial particle.

It should to note, in the model of shock wave Max's angle, that is a angle between a front of spreading a shock wave and interaction axis, is depended on a rate of wave front V_s and a velosity of initial particle in target V_0 following correlation:

$$\cos(\theta_m) = V_s / V_0 \ ,$$

that is, at more large V_0 an angle θ_m must increase (of course if V_s doesn't depend on V_0 and is constant for given nucleus).

Observing peak in angular distributions of protons in full nuclear decay doesn't describe in framework CEM, that, doesn't reproduce by a), b) and c) mechanisms of CEM (see above).

There are a number of theoretical schemes pretending to prediction peak in the neighbourhood of θ=57°, e.g. appearing and spreading shock wave, or effect of Cerenkov radiation, when a particle moves in matter with velocity more than velocity of light in given medium.

It should be taken that similar irregularity was observed in the angular distribution for reaction pA→pX at 7,5 GeV/c [6]. In authors opinion, this irregularity can been an effect of quasi-free processes.

3. Conclusions

1. The events of full nuclear decay in π^--^{12}C -interactions at 5 GeV/c were researched.
2. In protons distribution the peak is observed in the neighbourhood of θ~57°.
3. It was established that the angle θ doesn't depend of energy of the initial particle.

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TAM PARÇALANAN NÜVƏLƏRDƏ PROTONLARIN BUCAQ ASILILIĞI

5 QeV/c impulsa malik olan tam parçalanan π^--^{12}C qarşılıqlı tə'sirlərdə protonların bucaq asılılığı aşkar edilib və işlənib. θ~57° bucaqda maksimum aşkar olunub. Eksperimental nəticələrin analizi kaskad buxarlanma modelinin köməyilə aparılıb.

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УГЛОВЫЕ РАСПРЕДЕЛЕНИЯ ПРОТОНОВ В СОБЫТИЯХ ПОЛНОГО РАЗВАЛА ЯДЕР

Исследовались угловые распределения протонов в пион-углеродных взаимодействиях с полным развалом ядра углерода при импульсе отрицательного мезона 5 ГэВ/С. При значении угла вылета протонов θ~56° наблюдается максимум в распределении. Анализ экспериментальных данных проводился с помощью каскадно испарительной модели.

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