FRAGMENTATION OF LIGHT RELATIVISTIC NUCLEI IN NUCLEAR TRACK EMULSION

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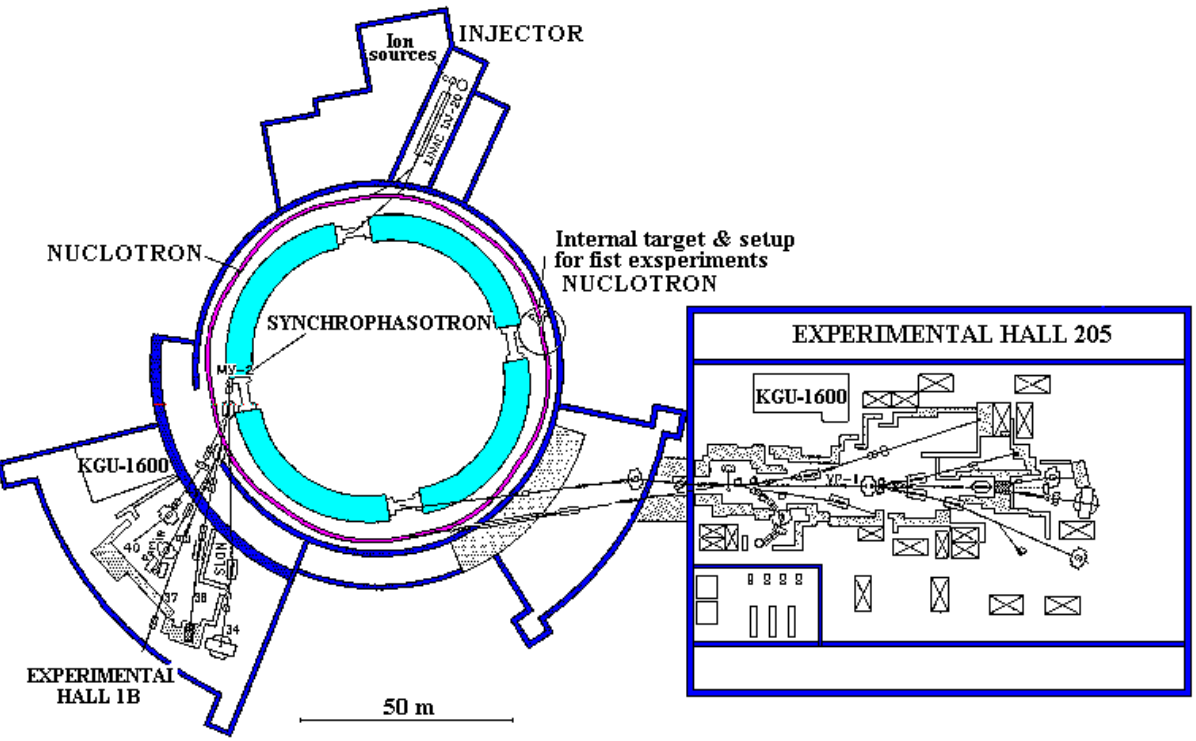
Introduction

Nuclear beams of energy higher than 1 A GeV are recognized as a modern tool used for the study of the structure of atomic nuclei (a recent review *). Among the variety of nuclear interactions the peripheral dissociation beams a uniquely complete information about the excited states above particle decay thresholds. The peripheral dissociation is revealed as a narrow jet of relativistic fragments the summary charge of which is close to the charge of the primary nucleus. In spite of the relativistic velocity of motion the internal velocities in the jet are non-relativistic.

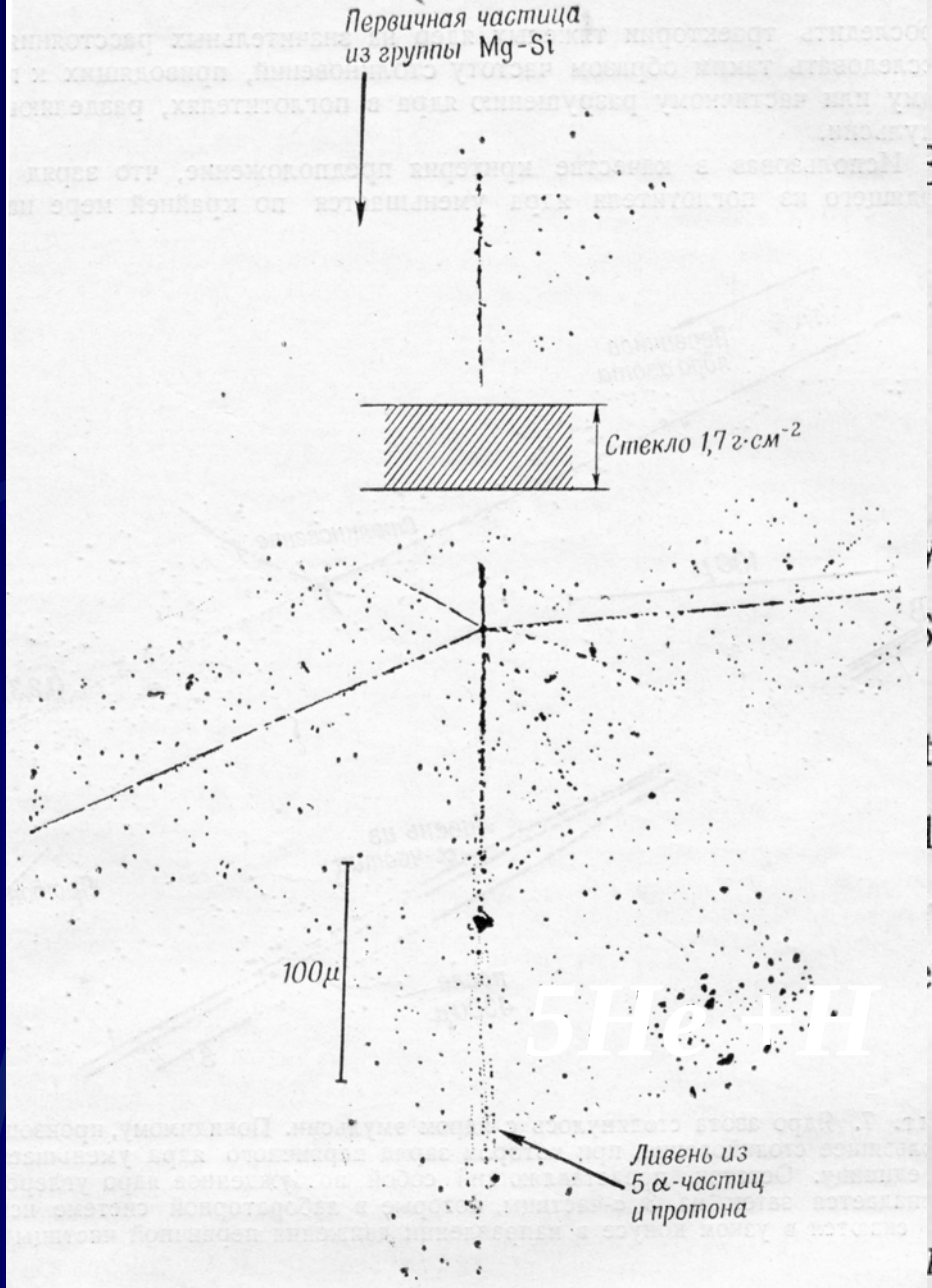
***T. Aumann, Eur. Phys. J. A, 26, 441(2005).**

BEryllium (Boron) Clustering QUEst in RELativistic Multifragmentation

The fragmentation of a large variety of light nuclei was investigated using the emulsions exposed to few A GeV nuclear beams at JINR Nuclotron.



http://nucloserv.jinr.ru



Фиг. 6. Ядро из группы Mg — Si столкнулось с ядром эмульсии. Предполагают, что узкий ливень, состоящий из протона и 5 α-частиц, возник в результате испарения первичного ядра, возбужденного столкновением. Остальные частицы, испущенные в звезде, являются, повидимому, осколками ядра мишени.

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PHYSICS

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tors

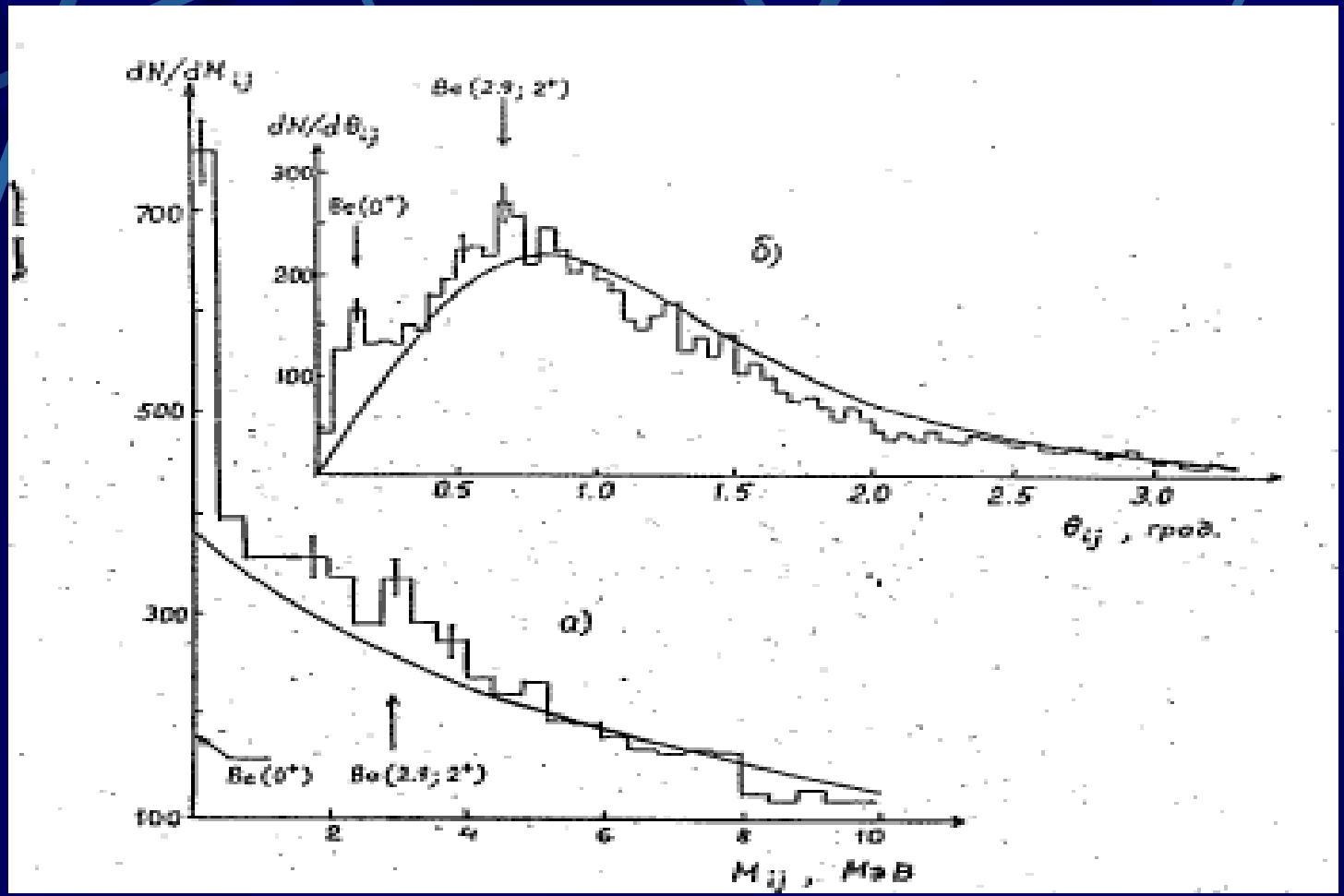
G. Puppi
N. Dallaporta
her E. P. George
H. Elliot

M, 1952

Mg-Si
Few A GeV
29 km

The $^{12}C \rightarrow 3\alpha$ and $^{16}O \rightarrow 4\alpha$ fragmentation at the energy of 3.65 A GeV was studied at JINR Synchrophasotron* .

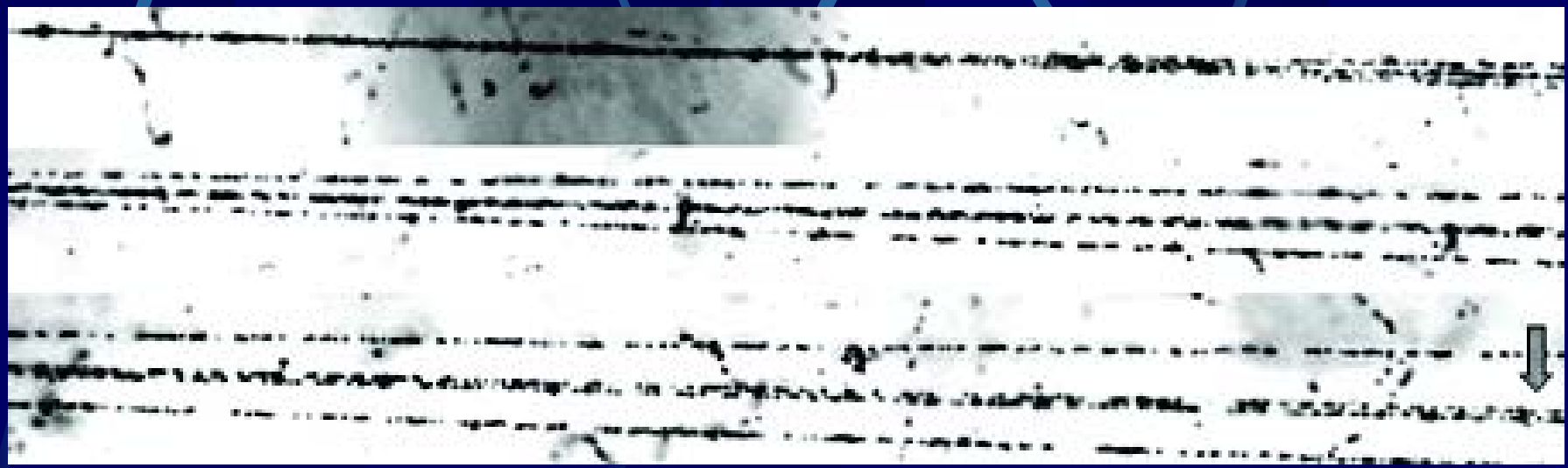
$^{12}C \rightarrow 3\alpha$, 3.65 A GeV



*V.V. Belaga et al., Phys. At. Nucl., vol. 58 1905 (1995)

The $^{16}O \rightarrow 4\alpha$ fragmentation were investigated using a large amount of information (641 events). An analysis of the angular correlations gave evidence that the angular momentum was transferred to the systems of fragments and that the cascade decays via ^{8}Be and ^{12}C nuclei were nonessential*.

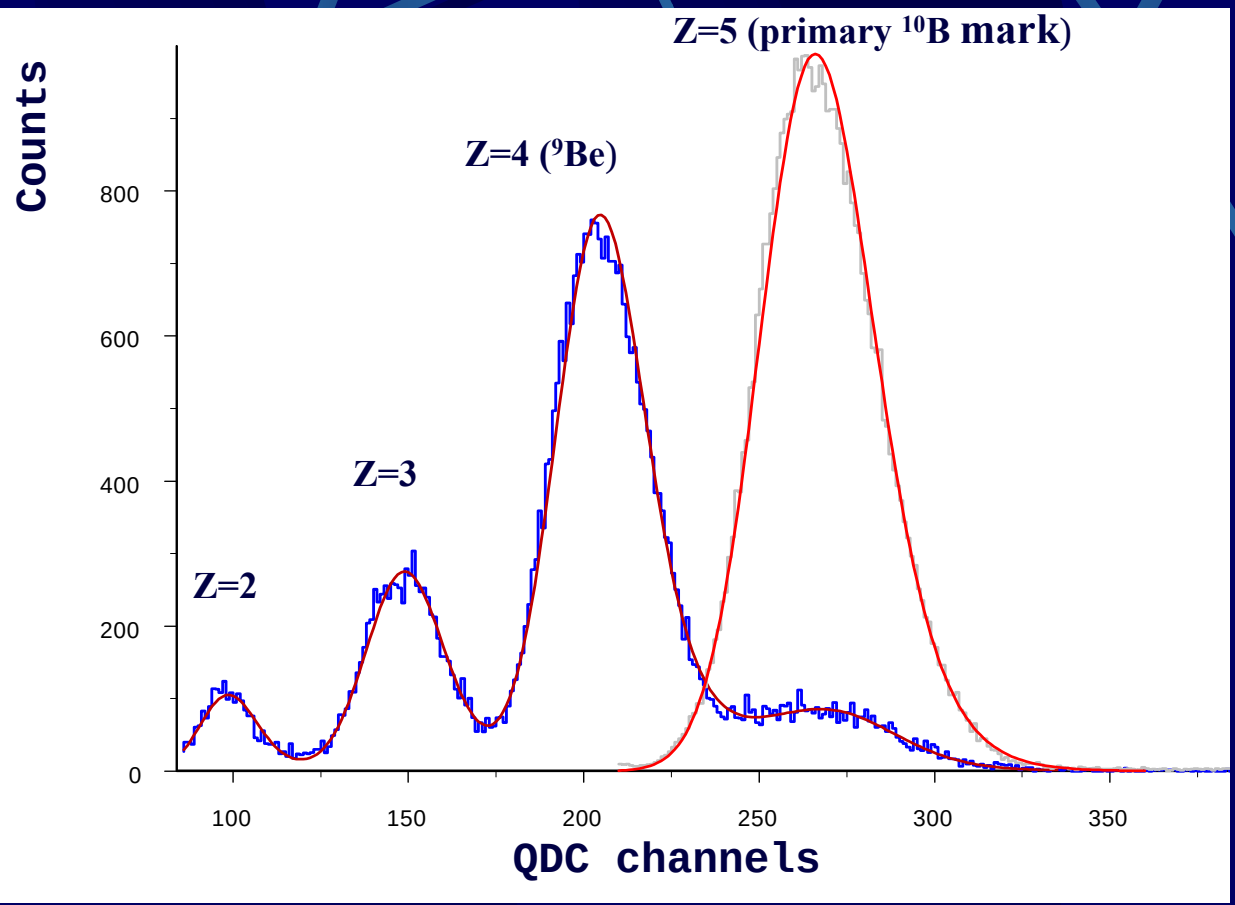
$^{16}O \rightarrow 4\alpha$, 3.65 A GeV (PAVICOM image)



*F.A. Avetyan et al., Phys. At. Nucl., vol. 59 №1 (102-108) 1996

Fragmentation of relativistic ^{9}Be nuclei at 1.2 A GeV

The beam of relativistic ^{9}Be nuclei was obtained in the ^{10}B→^{9}Be fragmentation reaction with polyethylene target (JINR Nuclotron).

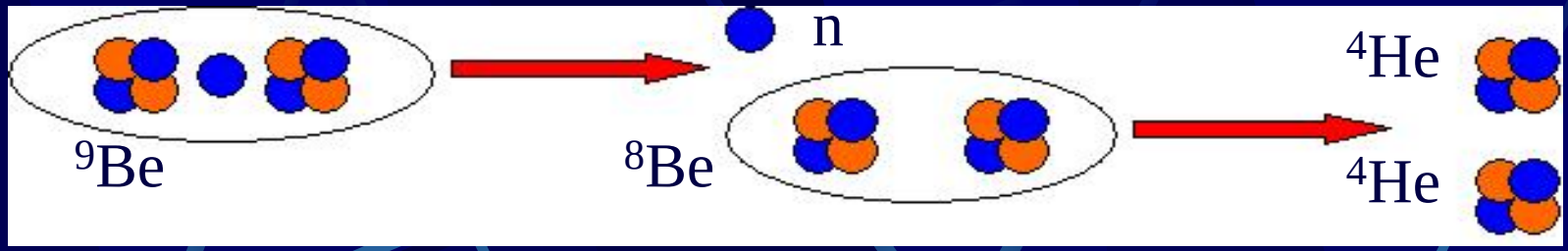


^{9}Be fraction in the beam: 67 ± 2 %*

Found: 362 events of ^{9}Be →2He fragmentation

Angular measurements accuracy not worse then 4.5×10^{-3} rad.

*P. A. Rukoyatkin et al., Czech. J. Phys. 56, 379 (2006).

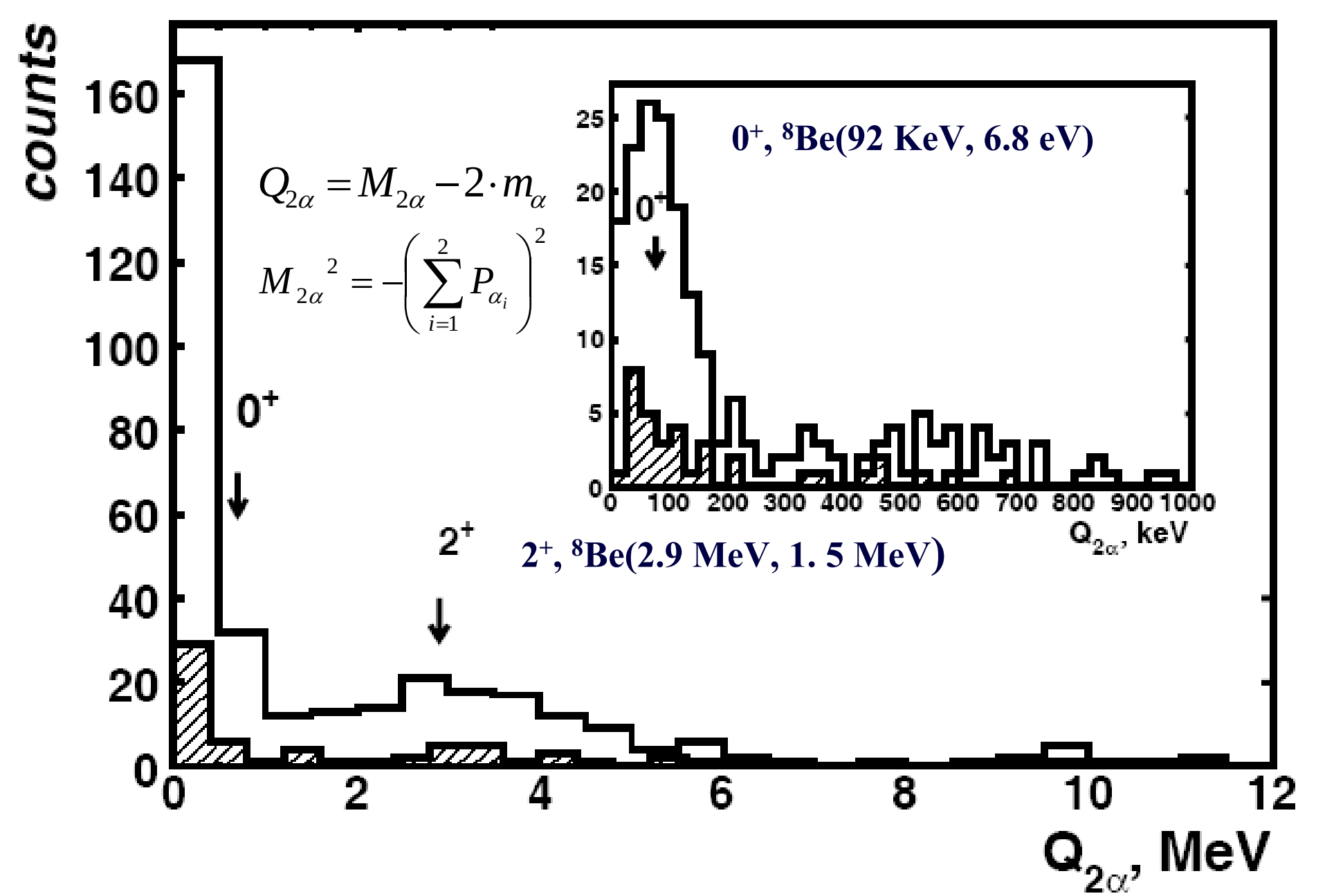


144 “white” stars

*.avi *.mov

27 stars with target proton recoil (g-particle)

39 stars with heavy fragment of target nucleus (b-particle)

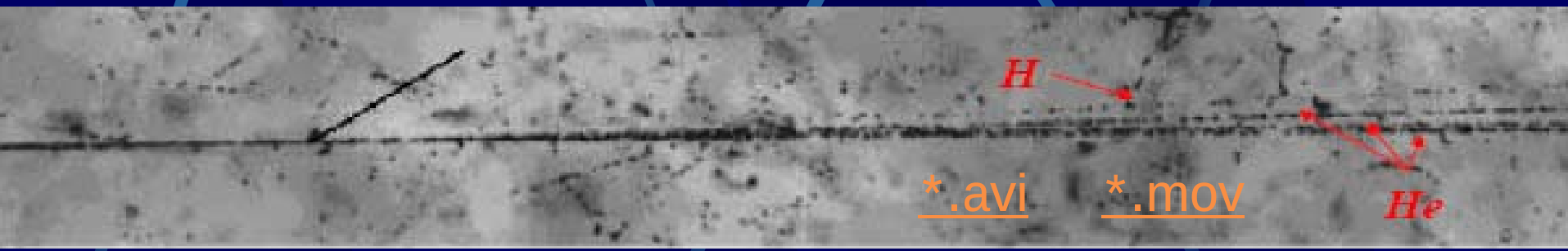


D. A. Artemenkov, arXiv:nucl-ex/0605018 (2006).

Fragmentation of relativistic ^{14}N nuclei at 2.1 A GeV

A stack of layers of BR-2 emulsion of a relativistic sensitivity was exposed to a beam of ^{14}N nuclei accelerated to an energy of 2.1 A GeV at the Nuclotron (JINR).

^{14}N→3He+H, 2.1 A GeV



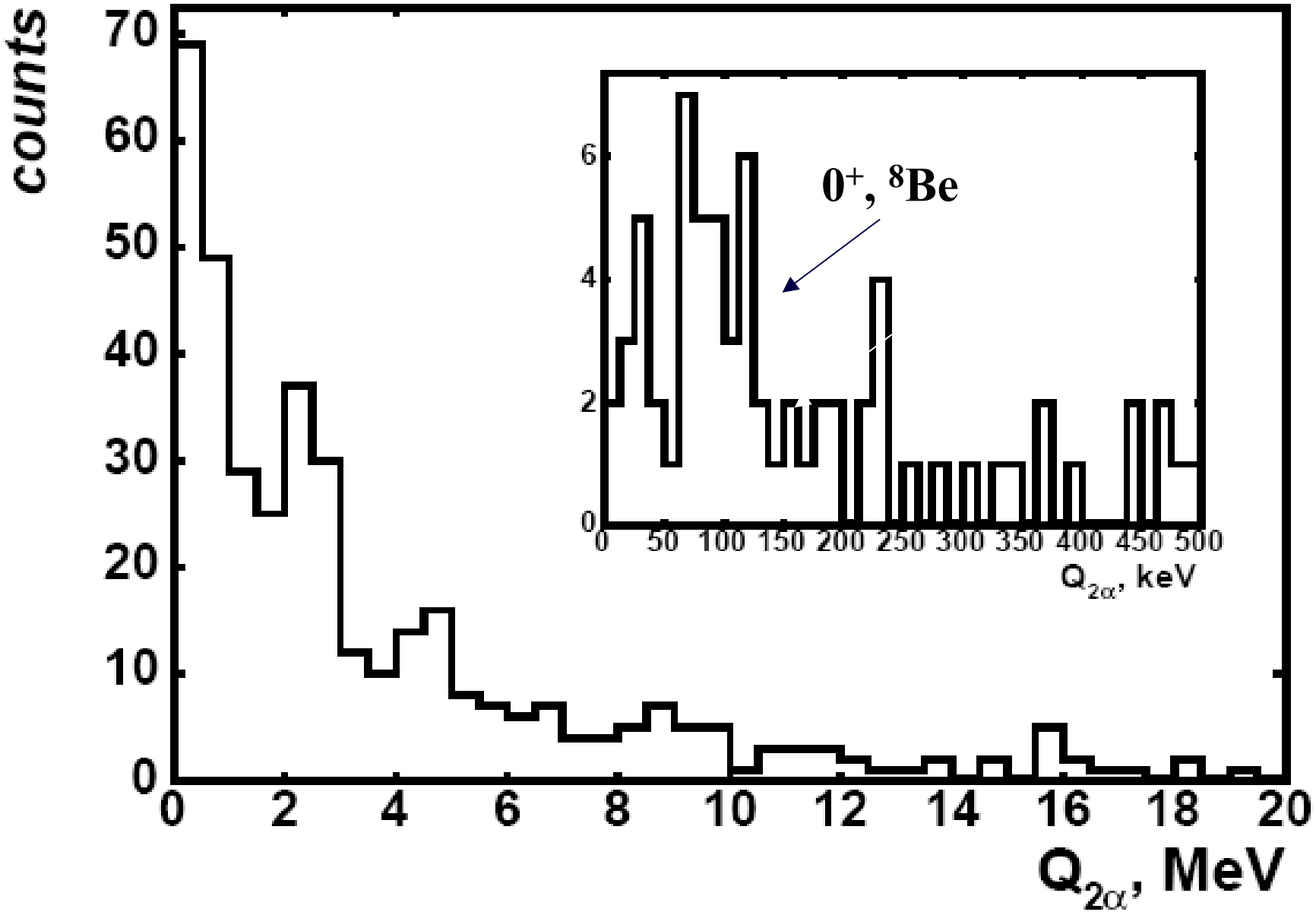
*.avi *.mov

found: 950 events of ^{14}N fragmentation.

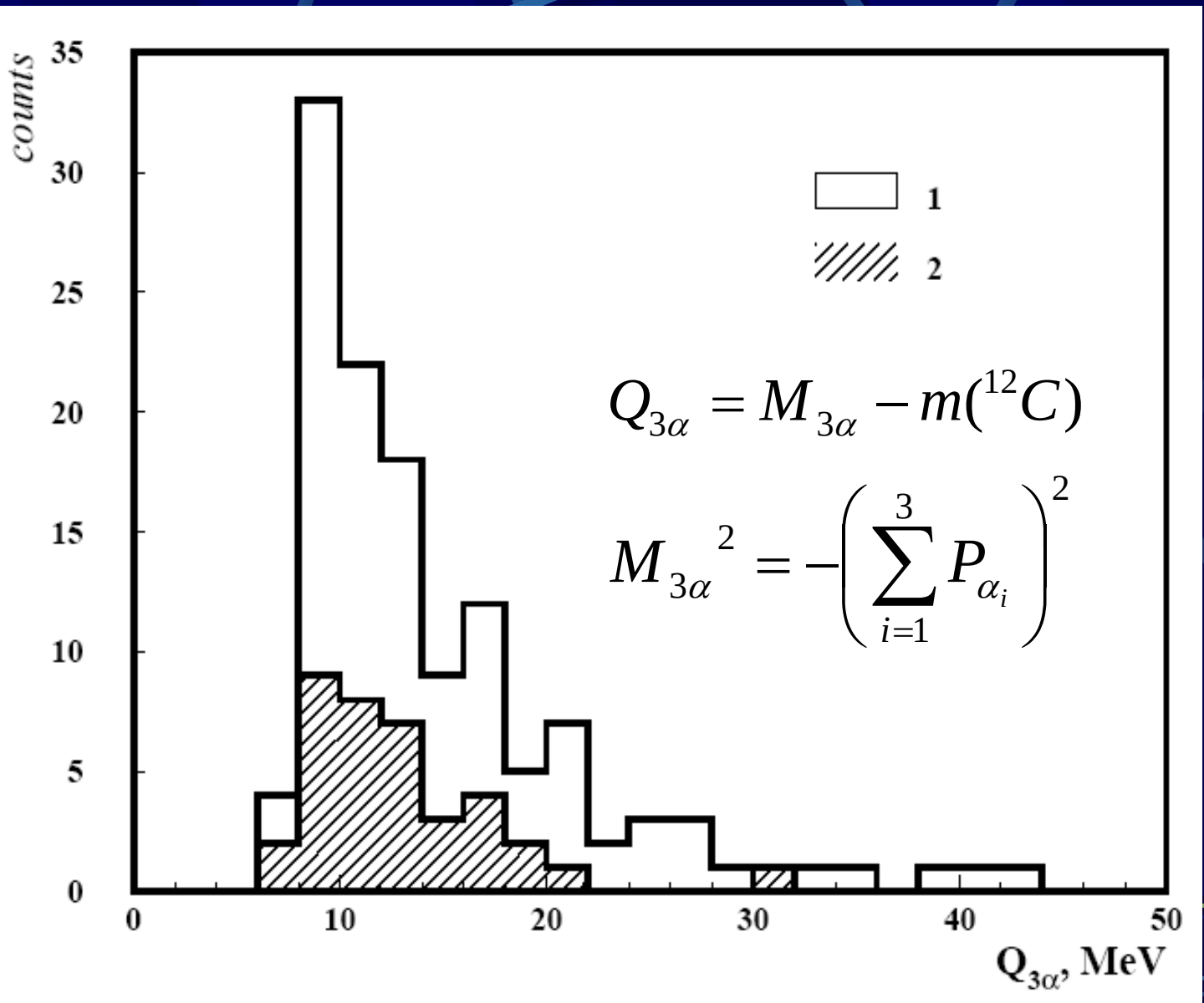
Angular measurements for 132 events of ^{14}N→3α+H were carried out.

T. V. Shchedrina, et al., arXiv:nucl-ex/0605022 (2006).

Excitation energy $Q_{2\alpha}$ for the channel $^{14}N \rightarrow 3\alpha + X$



Excitation energy $Q_{3\alpha}$ for the channel $^{14}N \rightarrow 3\alpha + X$



1: all events of $^{14}N \rightarrow 3\alpha + X$

2: "white" stars only

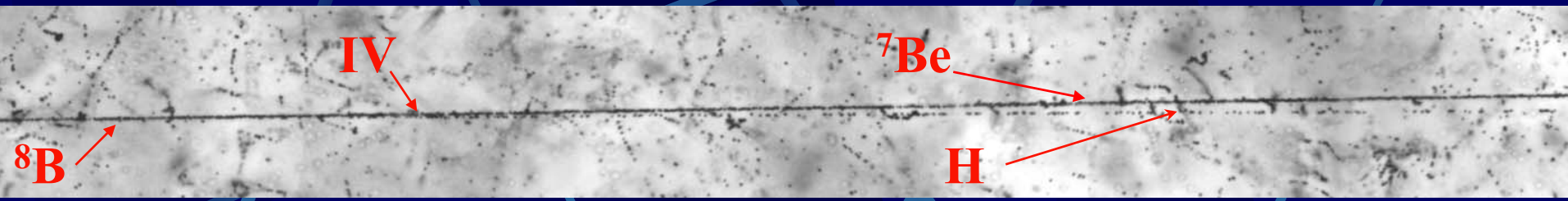
Fragmentation of relativistic ^{7}Be at 1.2 A GeV

TABLE III: ^{7}Be fragmentation channel (number of events)

Channel	2He	2He	He+2H	He+2H	4H	4H	Li+H	Li+H	Sum
	$n_b=0$	$n_b>0$	$n_b=0$	$n_b>0$	$n_b=0$	$n_b>0$	$n_b=0$	$n_b>0$	
^{3}He+^{4}He	30	11							41
^{3}He+^{3}He	11	7							18
^{4}He+2p			13	9					22
^{4}He+d+p			10	5					15
^{3}He+2p			9	9					18
^{3}He+d+p			8	10					18
^{3}He+2d			1						1
^{3}He+t+p			1						1
3p+d					2				2
2p+2d					1				1
^{6}Li+p							9	3	12
Sum	41	18	42	33	2	1	9	3	149

N. G.Peresadko, et al., arXiv:nucl-ex/0605014 (2006).

Fragmentation of relativistic ^{8}B at 1.2 A GeV



The charge topology distribution for the peripheral type interactions.

Q	B	Be	Li	He	H	N_{tf}	N_{ws}
5	-	-	-	1	3	61	14
5	-	-	-	2	1	44	12
5	-	-	1	-	2	8	-
5	-	-	1	1	-	1	-
5	-	1	-	-	1	17	24
5	1	-	-	-	-	17	1
5	-	-	-	-	5	21	4

R. Stanoeva, et al., arXiv:nucl-ex/0605013 (2006).

Summary

- The degree of the dissociation of the relativistic nuclei in peripheral interactions can reach a total destruction into nucleons and singly and doubly charged fragments. In spite of the relativistic velocity of motion of the system of fragments as a whole, the relative motion of fragments is non-relativistic one.

- In peripheral interactions ^{9}Be nuclei are dissociated practically totally through the 0^{+} and 2^{+} states of the ^{8}Be nucleus.

- The energy scale of the 3α system production in ^{14}N peripheral fragmentation has been estimated. According to the available statistics 80% of interactions are concentrated at 10-14 MeV. The fraction of the $^{14}N \rightarrow 3\alpha + H$ channel involving the production of an intermediate ^{8}Be nucleus is about 25%.

• **Topology of charged fragments produced in peripheral dissociation of radioactive ^{8}B, ^{7}Be nuclei is discussed.**

•**Studies of the fragmentation of the light nuclei can serve as «building blocks» of a pattern of the phase transition of heavy nuclei to the lightest cluster systems.**

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