MINISTRY OF EDUCATION AND SCIENCE OF RUSSIA
RUSSIAN ACADEMY OF SCIENCES
JOINT INSTITUTE FOR NUCLEAR RESEARCH
SKOBELTSYN INSTITUTE OF NUCLEAR PHYSICS
SAINT-PETERSBURG STATE UNIVERSITY
VORONEZH STATE UNIVERSITY
NOVOVORONEZH NUCLEAR POWER PLANT

LXVIII INTERNATIONAL CONFERENCE

«NUCLEUS 2018»

FUNDAMENTAL PROBLEMS OF NUCLEAR PHYSICS, ATOMIC POWER ENGINEERING AND NUCLEAR TECHNOLOGIES

DEDICATED TO THE CENTENNIAL OF VORONEZH STATE UNIVERSITY AND TO THE 80th ANNIVERSARY OF THE BIRTH OF K. A. GRIDNEV

BOOK OF ABSTRACTS
July 2 – 6, 2018
Voronezh
Russia

Saint-Petersburg

2018

LXVIII INTERNATIONAL CONFERENCE «NUCLEUS 2018». FUNDAMENTAL PROBLEMS OF NUCLEAR PHYSICS, ATOMIC POWER ENGINEERING AND NUCLEAR TECHNOLOGIES (LXVIII MEETING ON NUCLEAR SPECTROSCOPY AND NUCLEAR STRUCTURE).
BOOK OF ABSTRACS.
Editor A.K. Vlasnikov

The scientific program of the conference covers almost all problems in nuclear physics and its applications such as: neutron-rich nuclei, nuclei far from stability valley, giant resonances, many-phonon and many-quasiparticle states in nuclei, high-spin and super-deformed states in nuclei, synthesis of super-heavy elements, reactions with radioactive nuclear beams, heavy ions, nucleons and elementary particles, fusion and fission of nuclei, many-body problem in nuclear physics, microscopic description of collective and single-particle states in nuclei, non-linear nuclear dynamics, meson and quark degrees of freedom in nuclei, mesoatoms, hypernuclei and other nuclear exotic systems, double beta-decay and neutrino mass problem, interaction of nucleus with electrons of atomic shell, verification of theories of elementary particles interaction and conservation laws, physics of nucleus and particles in application to astrophysical objects, theory of direct and statistical nuclear reactions, theory of multiple scattering, theory of reactions with clusters and heavy ions, theory of relativistic nuclear collisions, theory of polarization phenomenon in nuclear reactions, theories of proton, two-protons and cluster radioactivity and fission of nuclei, instruments and methods of nuclear-physical experiment, analysis of measurements, accelerators, radio-ecology, application of nuclear-physical experimental methods to astrophysics, medicine and other fields of research, fundamental problems of nuclear power and nuclear technologies, experience and problems of qualitative training of Russian and foreign specialists in field of nuclear physics, atomic power engineering and nuclear technologies.

Supported by:
Russian Foundation for Basic Research, grant No 18-02-20059 Г;
Joint Institute for Nuclear Research

ISBN 978-5-9651-1156-5

ORGANIZING COMMITTEE

S. Kadmensky	Chairman	VSU	Voronezh
V. Popov	Co-Chairman	VSU	Voronezh
V. Povarov	Co-Chairman	Novovoronezh NPP	Novovoronezh
N. Zelenskaya	Co-Chairman	SINP MSU	Moscow
V. Kukulin	Co-Chairman	SINP MSU	Moscow
A. Vlasnikov	Co-Chairman	SPbSU	St. Petersburg
V. Samarin	Co-Chairman	JINR	Dubna
V. Voronov	Co-Chairman	JINR	Dubna
V. Vakhtel	Vice-Chairman	VSU	Voronezh
L. Titova	Scientific Secretary	VSU	Voronezh

PROGRAM COMMITTEE

Yu. Oganessian	Chairman	JINR	Dubna, Russia
Yu. Penionzhkevich	Vice-Chairman	JINR	Dubna, Russia

V. Baryshevsky (Minsk),	M. Nadirbekov (Tashkent),	H. Shellenberger (Darmstadt),
C. Borcea (Bucharest),	I. Najafov (Baku),	I. Thompson (Guildford),
N. Burtebaev (Almaty),	A. Ogloblin (Moscow),	W. Trzaska (Jyväskylä),
R. Jolos (Dubna),	V. Ostashko (Kiev),	T. Uesaka (Wako),
M. Lewitowicz (Caen),	G. Rogachev (TAMU),	E. Vardaci (Naples),
A. Maj (Kraków),	V. Rubchenya (Petersburg),	J. P. Vary (Ames)

CONTENTS

July 3, Tuesday, 15:30
Section I
Experimental Investigations of Atomic Nucleus Properties

July 3, Tuesday, 15:30
Section II
Experimental Investigations of Nuclear Reactions Mechanisms

July 4, Wednesday, 17:00
Poster Session I
Section I
Experimental Investigations of Atomic Nucleus Properties

Section II
Experimental Investigations of Nuclear Reactions Mechanisms

Section IV
Nuclear Reactions Theory

Section V
Technique and Methods of Experiment and Applications of Nuclear-Physical Methods

MODULATION OF ANGULAR DISTRIBUTIONS OF SCATTERED ALPHA PARTICLES BY MULTICLUSTER NUCLEI

Dyachkov V.V.[1], Dusebayeva K.S.[1], Akhmetzhanova M.M.[2]
[1] *National Nanotechnology Laboratory of Open Type, Almaty, Kazakhstan;*
[2] *Kazakh National University named al-Farabi, Almaty, Kazakhstan*
E-mail: slava_kpss@mail.ru

In [1], for the first time, we explained the phenomenon of a significant excess of cross sections over Rutherford at small angles, which turned out to be a fragment of a simple diffraction pattern with oscillations $\Delta\theta_\alpha$ of a longer period than oscillations on the core-matrix $\Delta\theta_\alpha$ as a whole, that is, $\Delta\theta_\alpha > \Delta\theta_n$. This large period $\Delta\theta_\alpha$ turned out to be the first diffraction ring on intranuclear spatially isolated α-clusters. This explanation is reliable, since the existence of α-particle nuclear matter has been comprehensively investigated by us and, thus, proved earlier [2] on the basis of other experimental data.

In this work, a wide systematic of the modulation parameters of Fraunhofer oscillations on matrix nuclei from lithium to nickel with oscillations from the elastic scattering of incident α particles on intranuclear multicluster with masses from the proton to the α particle is carried out. Cluster widths, equivalent to the stats of multicluster, are taken from our work [3].

$$\sigma_{tot}N_{tot} = \sigma_0 N_0 + \sigma_1 N_1 + \ldots + \sigma_n N_n$$

For the cluster widths of nuclei-matrix are unknown, these parameters were found by describing the experimental angular distributions of the differential cross sections for elastic scattering using the method proposed in [1].

For expansion of the list of the detected multicluster, NNDC databases of experimental angular distributions of the differential cross sections for elastic scattering with doubly magic nuclei with ^{16}O as incident particle were used.

Such incident particles made it possible to find multi-clusters in nuclei with masses from $A = 4$ to $A = 16$.

Thus, the phenomenon of modulation has been extended by us in this work for all the stat widths of all multicluster, which raises new questions to experimental methods increasing the accuracy of measuring the maximums of diffraction oscillations.

1. K.A.Gridnev, V.V.Dyachkov, A.V.Yushkov // Bull. Russ. Acad. Sci. Phys. 2014. V.78. №7. P.640.
2. A.V.Yushkov // Izvestiya AN SSSR. Ser. Fiz. 1975. V.39. Iss.8. P.1548.
3. Yu.A.Zaripova, V.V.Dyachkov, A.V.Yushkov, T.K.Zholdybayev, D.K.Gridnev // International Journal of Modern Physics. E. 2018. V.27. 18500171.

INVESTIGATION OF CLUSTER CONFIGURATIONS OF NUCLEI FROM ^{11}B TO ^{209}Bi ON α-PARTICLES BEAMS

Burtebayev N.[1,2], Dyachkov V.V.[1], Zaripova Yu.A.[1], Yushkov A.V.[1], Zholdybayev T.K.[2], Nassurlla M.[1,2]

[1] *Scientific Research Institute of Experimental and Theoretical Physics, Almaty, Kazakhstan;*
[2] *Institute of Nuclear Physics, Almaty, Kazakhstan*
E-mail: zjkaznu2016@gmail.com

The discovery of two new kinematic methods of detection and investigation of intranuclear multicluster [1] with accurate registration of multicluster kinematics («kintracks») was surprisingly universal, unambiguous and reliable. The only limitations of the method are: 1) the probing particle must be twice magical so that its structure does not appear to be a perturbing factor for the structure of multicluster nuclei; 2) the path of the probing particle in the probed nuclear matter (in the nucleus-matrix) must be comparable or larger than the diameter of the nucleus -matrix, that is, the energy of the probing particle must be appropriately selected.

The experiments were performed on beam of 29 MeV α-particles at ^{11}B, ^{13}C, ^{24}Mg, ^{25}Mg, ^{59}Co, ^{120}Sn, ^{197}Au, and ^{209}Bi nuclei in the angular range from 10° to 89° in laboratory system. The aim of the measurements was to search for light multicluster with mass numbers from 1 to 4: p, d, ^{3}He, α in the indicated nuclei. In this case, we assume a nonzero probability of the existence of such multiclusters inside the volume of the investigated nuclei with the indicated mass numbers, which do not exist in the free state, but in the nucleus volume, in connection with the Heisenberg uncertainty relation, they have a finite probability for existence. To achieve this goal, two tasks were accomplished: 1) find the effect of «dissolution» of multiclusters with increasing mass number; 2) find the effect of «raising» of α-clusters that survived the dissolution process on the surface of the nucleus with increasing mass number.

As a result of systematic experimental studies, both effects have been found - the corresponding cluster widths have a trend toward a decrease in the transition to heavy nuclei. As for such «solid nuts» as nucleons and α-clusters, their survival in a medium with giant nuclear forces tearing loose multicluster into pieces means their high binding energy contributes to their survival. But, nevertheless, alpha-clusters are raised up to the surface by nuclear forces, giving rise to the phenomenon of alpha-radioactivity. The mass spectra of multiclusters are studied. The cluster widths θ_n^2 for them are introduced by us in the $N_0 = N_1 + N_2 + \cdots . + N_n$; $1 = \frac{N_1}{N_0} + \frac{N_2}{N_0} + \cdots + \frac{N_n}{N_0} = \theta_1^2 + \theta_2^2 + \cdots + \theta_{n1}^2$ form. It is shown that cluster widths decrease with increasing mass number. Effective numbers of clusters are found across the whole range of mass numbers. Both the widths and effective numbers confirmed the existence of the above new nuclear effects with exotic nuclei and clusters.

1. V.V.Dyachkov *et al.* // Bull. Rus. Acad. Sci. Phys. 2017. V.81. P.1174.

MODERNIZATION OF THE SCATTERING CAMERA ON THE U-400 BEAM FOR PRECISION MEASUREMENTS OF HEAVY MULTICLUSTERS

Dyachkov V.V.[1], Lukyanov S.M.[2], Sidorov Ya.V.[1]
[1] *Scientific Research Institute of Experimental and Theoretical Physics, Almaty, Republic of Kazakhstan;*
[2] *Joint Institute for Nuclear Research, Dubna, Russia*
E-mail: slava_kpss@mail.ru

In experimental studies of multicluster parameters in nuclei, specific, rather stringent, requirements are imposed on the scattering chamber. First of all, this concerns the total angular resolution of the spectrometer of scattered particles, which consists of two components. The first component is the angular spread of the beam $\Delta\theta_k$, determined by the passive input collimator of the scattering chamber. It is regulated by the diameter of the input cutting diaphragm d_1, the diameter of the output diaphragm d_2 and the distance between them (the base of the input collimator) L. Then the angular resolution of the input collimator will be determined by the formula $\Delta\vartheta_k = 2\text{arctg}\frac{d_1+d_2}{2L}$.

The second component of the total angular resolution of the spectrometer is the geometric system «beam spot on the target (d_m) + input diaphragm of the particle detector (d_d)» and the distance between them (the base of the «target-detector» system) L_{md}. Especially note that it is the beam spot on the target that serves as the "input cutting diaphragm" for the imaginary (virtual) «collimator» of the particle detector. Then the angular resolution of the «target-detector» system will be determined by the formula $\Delta\vartheta_{md} = 2\text{arctg}\frac{d_m+d_d}{2L_{md}}$.

A very important parameter in the attempt to achieve the minimum angular resolution of the spectrometer $\Delta\vartheta_{sp}$ is the distance from the output cutting diaphragm of the input passive collimator to the nuclear target l. Note that this parameter, as a rule, is often overlooked by many researchers. The formula for calculating the beam spot on the target has the form $d_m = d_2 + (d_1 + d_2)\frac{l}{L}$.

With the first measurements of Wulf-Bragg diffraction on quasicrystalline nuclei in the zinc region, we apparently used such a stiff collimation of the beam and the entire geometry of the experiment.

It should be noted that in the planning of experiments with good angular resolution, the use of slotted, square, rectangular and other forms of collimators is absolutely unacceptable. In all these cases, the angular resolution of the spectrometer is completely determined by the diagonal sizes of all these geometric figures.

THE INCLUSIVE CROSS SECTIONS FOR THE FORMATION OF p, d, α FROM THE INTERACTION OF α-PARTICLES OF 29 MeV ENERGY WITH NUCLEI ^{27}Al AND ^{59}Co

Duisebayev B.A.[1], Zholdybayev T.K.[1,3], Sadykov B.M.[1], Nassurlla M.[1,3], Ismailov K.M.[2], Ussabayeva G.Yu.[3], Dyachkov V.V.[3]
[1] *Institute of Nuclear Physics, Almaty, Kazakhstan;*
[2] *Nazarbayev University, Astana, Kazakhstan;*
[3] *Al-Farabi Kazakh National University, Almaty, Kazakhstan*
E-mail: zholdybayev@inp.kz

Obtaining new experimental nuclear data on double differential and integral cross sections of reactions initiated by stable isotopes of helium aimed at replenishing the information base is necessary for the design of the energy reactor safety systems and the development of promising nuclear technologies.

The experimental spectra of nuclear reactions on the ^{27}Al and ^{59}Co nuclei were obtained on an isochronous cyclotron U-150M (Kazakhstan). The energy of the incident ^{4}He ions was 29 MeV. Measurements are made in the angular range of 30° – 135° in the laboratory coordinate system with a step of 15°. As the target, ^{27}Al and ^{59}Co are selected, as structural elements and elements of the target node of the ADS being designed. Enriched foils of these isotopes were prepared, the thickness and uniformity of which was determined by measuring the energy loss of alpha particles from the ^{226}Ra isotope.

To measure the cross sections of the reactions, a standard *dE-E* method was used, where two parameters of the detected particle are recorded: specific ionization and total energy. The energy calibration of the detectors is based on kinematics calculations within the framework of the LISE code. The analysis of the obtained experimental data is carried out within the framework of the PRECO-2006 [1] design code, which is based on modern theoretical models of nuclear decay.

The obtained experimental results fill the missing values of the cross sections of the reactions studied and can be used in the development of new approaches to the theory of nuclear reactions, as well as in the construction of hybrid nuclear power plants, in nuclear medicine.

1. C.Kalbach. PRECO-2006: Exiton model preequilibrium nuclear reaction code with direct reaction. Durham NC 27708-0308. 2007.

STUDY OF THE FACTOR OF LOCAL ACCUMULATION OF DAUGHTER PRODUCTS OF RADON DECAY IN THE BODY BY THE BETA-SPECTROMETRY

Dyachkov V.V., Zaripova Yu.A., Yushkov A.V., Shakirov A.L.,
Bigeldiyeva M.T., Dusebayeva K.S., Abramov K.E.
National Nanotechnology Laboratory of Open Type, Almaty, Kazakhstan
E-mail: slava_kpss@mail.ru

During the life of any animal vegetable or microbial organism is a continuous accumulation of isotopes and radon daughter products (DPR) their decay [1, 2]. According to the ICRP, DPR are oncoradiogenerators of tumor diseases, therefore their identification in the body can be an effective means of early diagnosis of the oncological morbidity of the population.

The purpose of this work was the fundamental research of the mechanisms of formation of nanoscale oncorodiogenic structures in the body and the development on this basis of anirac express devices for their detection.

Experiments have been performed to measure beta spectra in phantom samples of living organisms for a long time accumulating DPR. The Fig. 1 shows the spectrum of one of a series of similar measurements, from which it can be seen that indeed the accumulation effect exists and stands out well enough over the background. To implement the same measurements in the model of the express device, test measurements were carried out using CsI (Tl) photonic amplifiers.

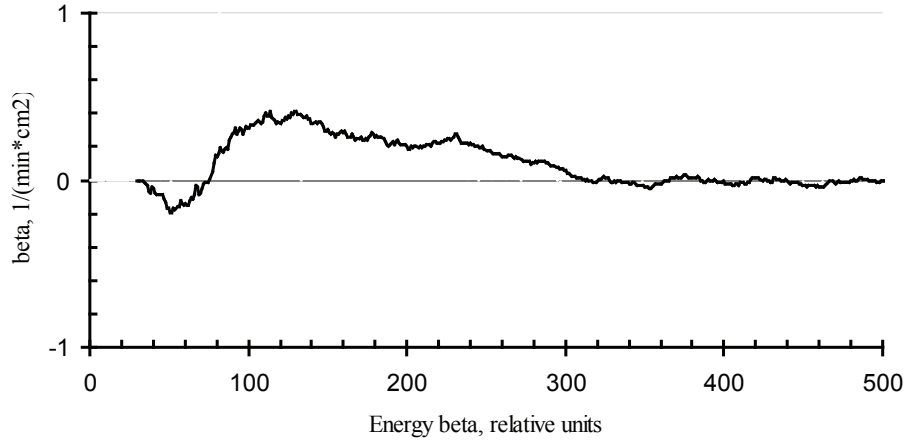

Fig. 1. The beta-radiation spectrum of the accumulated daughter products of the radon decay in the sample.

The work was supported by the state grant financing of basic research (project No. IRN AP05131884, No. IRN AP05133577).

1. Protection against radon-222 at home and at work. ICRP. Publication 65. Ann. 1993. 23(2).
2. V.N.Sevostyanov. The Problem of Radon Safety in Kazakhstan. Almaty: KazgosinTI, 2004. P.212.

AUTHOR INDEX

E

F

G

H

I

M

N

O

P

R

S

T

U

V

W

Y

Z

LXVIII INTERNATIONAL CONFERENCE «NUCLEUS 2018» FUNDAMENTAL PROBLEMS OF NUCLEAR PHYSICS, ATOMIC POWER ENGINEERING AND NUCLEAR TECHNOLOGIES (LXVIII MEETING ON NUCLEAR SPECTROSCOPY AND NUCLEAR STRUCTURE)

BOOK OF ABSTRACTS

July 2 – 6, 2018
Voronezh
Russia

Editor *A.K. Vlasnikov*

Computer make-up by *A.K. Vlasnikov and P.E. Filianin*

Order 607

Publishing VVM
St. Petersburg, Shvetsova, 41