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Foreword

This year the Lomonosov Moscow State University hosts the LXXII International conference "NUCLEUS-2022." The first Conference in this series (known to physicists as Meeting at the time) also took place in Moscow in the convention hall of the Moscow University in 1951. It was opened by the President of the Academy of Sciences of the Soviet Union M. V. Keldysh. Academician D. V. Skobeltsyn was the chair of the organizing committee, and corresponding member of the Academy of Sciences B. S. Dzhelepov, representing the Leningrad school of nuclear physicists, was the vice-chair. The proceedings of the Meeting, published in Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya vol. 16, No. 3 (1952), numbered only five articles, all of them from Leningrad.

The next Meeting, also held in the Moscow University in 1952, became more representative due to a larger number of participants from scientific and educational institutions of Moscow, but the list of organizers was kept unchanged. For 44 years, since 1953 the organizing committee of the Meeting was headed by B. S. Dzhelepov, who had established its familiar traditions: publication of the Program and the Book of Abstracts, publication of the proceedings in leading nuclear physics journals, the tradition to call the Meeting annually, and to hold it in Leningrad each five years. These traditions are still kept by our scientific brotherhood.

Starting from the 2nd Meeting the number of participants and their geography began to rapidly enlarge. In addition to Moscow and Leningrad, the Meetings began to be held by scientific centers of soviet republics (now – neighbouring countries), contributing to development of nuclear science across the Soviet Union. The Samarkand Meeting of 1981 became a champion, having attracted about five and a half hundred participants with over six hundred talks.

The range of the topics of the Meeting was expanding. As a result All-Soviet Meetings on Nuclear Spectroscopy and Structure of Atomic Nucleus turned into International Conferences on Nuclear Physics. A number of major discoveries were reported and discussed for the first time there.

The present Book of Abstracts brings to the reader results of modern studies in the field of nuclear physics and their applications, including medical physics.

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DIFFRACTION PROCESSES IN ^{12}C ELASTIC SCATTERING BY MEDIUM NUCLEI

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The study of multicluster structures of a nucleus is an urgent task due to the fact that the influence of cluster states, both excited and ground, rather strongly affects the properties of the nuclei under study. In the framework of the diffraction theory and under the assumption of complete absorption inside the interaction sphere, in this work, the authors obtained expansions of the total amplitudes of the angular distributions of the differential cross sections for elastic scattering of ^{12}C on nuclei up to ^{40}Ca. The study of such diffraction processes using the method [1] makes it possible to reveal the partial scattering amplitudes and their contribution to the total amplitude, which characterize the multicluster structure of the nucleus. For a comprehensive analysis of the multicluster structure of nuclei, the authors of [2] proposed an experimental method for the direct detection of cluster structures in the nucleus. The available world experimental data are described within the framework of the method. This method showed itself well in the study of alpha-cluster 4*n* nuclei. However, for 4*n* ± 1 nuclei, a third component was added to the total amplitude [1]. This modification of the method made it possible to describe a larger range of light atomic nuclei. Until now, only incident alpha particles have been analyzed. In [3], the authors performed an analysis of the angular distributions of the differential cross sections of elastically scattered ^{16}O on 4n nuclei, which fairly well described the experimental data up to ^{40}Ca.

In this work, the authors chose 12-C as the incident particles. As a result, an analysis of the differential cross sections of elastic diffraction scattering of ^{12}C on medium nuclei at energies from tens to hundreds of MeV was performed using a modified method of angular distributions. From a systematic analysis of the previous and results of this work, it was obtained and shown that clusters with characteristic radii of 1 fm and 0.5 fm are mainly detected.

This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09258978).

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STUDY OF SORPTION PROPERTIES OF MODIFIED STRUCTURAL MATERIALS FOR NUCLEAR POWER ON GAMMA-QUANTUM BEAMS OF LINEAR ACCELERATOR

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The energy crisis is currently one of the pressing global problems. And one of the solutions to this problem is the use of a highly efficient resource - nuclear energy. The use and development of this resource is constrained by the safety factor in the operation of nuclear reactors. Today, concrete is widely used as a material for radiation protection: it is cheap, it is easy to form structures of various shapes, and it is a good absorber [1]. Radiation shielding concrete is a composite with special fillers. It is widely used for shielding against gamma rays and neutrons due to its good shielding properties and is the biological barrier of choice in nuclear reactors and other nuclear installations. However, despite this, the process of radiation damage to cement, which is part of concrete, and the effect of different concentrations of chemical elements on its radiation resistance are still insufficiently studied. Therefore, the study of materials used to provide radiation protection is an actual direction.

In this work, studies were carried out on three samples of cement with different contents of B_4C, Fe_3O_4 and $BaSO_4$. To study the coefficients of linear absorption of gamma quanta in the samples under study, an Elekta Axesse electron accelerator with gamma quanta energies of 10 and 15 MeV was used as a source of gamma quanta. The samples were made at Cairo University (Egypt). To obtain the linear attenuation coefficients of the samples, the technique developed earlier by the authors was used [2].

As a result, experimental linear attenuation coefficients for samples with various impurities were obtained, and it was shown that cement with a high $BaSO_4$ content is a good absorber of 10 and 15 MeV gamma quanta. However, such samples must be studied for radiation resistance from neutron radiation.

This research is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09058404).

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ESTIMATES OF THE EXPECTED AVERAGE ANNUAL EFFECTIVE DOSE OF NATURAL RADIATION BACKGROUND OF EMPLOYEES IN THE ADMINISTRATIVE BUILDING, TAKING INTO ACCOUNT THE DISTRIBUTION OF RADON AND ITS DECAY PRODUCTS

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Radium is the most radiotoxic natural radionuclide, since small amounts of it can accumulate in bone tissue, damaging the bone marrow and mutating bone cells [1]. Radon is a decay product of radium and is ubiquitous in the biosphere and present in soils and building materials. Most people are most exposed to radon in residential and industrial buildings. It accounts for about half of the total human exposure dose from natural sources. Radon can damage the DNA of the respiratory epithelium, and radon exposure is suspected to be the cause of lung cancer [2]. Significant health effects have been observed among uranium mine workers exposed to high levels of radon. They found a link between exposure to radon and its decay products and an increased risk of developing lung cancer. Despite this, it remains unclear what impact household exposure to radon has on the development of lung cancer.

The purpose of this work was to estimate the dose load from natural sources of radiation based on monitoring measurements of the topology of the distribution of radon isotopes in a building located near a tectonic fault. The measurement was carried out using a radon radiometer "Ramon-02" in an administrative building located near a tectonic fault from February 2021 to February 2022 in Almaty. The experiments were carried out in rooms with a volume of 128.38 m^3 with a ceiling height of 2.6 m and located in the basement, on the third and fifth floors. During the experiment, the concentration of radon activity averaged 189.59 $Bq \cdot m^{-3}$ for the basement, 23.78 $Bq \cdot m^{-3}$ for the third floor and 35.01 $Bq \cdot m^{-3}$ for the fifth floor. In addition, fluctuations were observed in the range from 59.9 to 568.9 $Bq \cdot m^{-3}$ for the basement, from 12.2 to 33.6 $Bq \cdot m^{-3}$ for the third floor and from 16.2 to 71.8 $Bq \cdot m^{-3}$ for the fifth floor.

Based on the data obtained, the doses from radon and its decay products received by students and faculty members who are in classrooms during the day, month and year were calculated. Calculations showed that the annual effective dose in this administrative building (working time-2000 hours/year) ranged from 0.5 mSv/year (for the fifth floor) to 2.2 mSv/year (for the basement).

This research is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09058404).

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STUDY OF GENETIC EFFECTS IN BIOASSAYS ARISING FROM RADIATION THERAPY USING A LINEAR ACCELERATOR ELEKTA AXESSE

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Currently, gamma radiation is widely used in the treatment of cancer. In particular, in the treatment of oncological diseases, the ELEKTA AXESSE medical linear accelerator is used, which forms beams of gamma rays with energies of 10 MeV and 15 MeV. Gamma radiation of such energies is highly penetrating and thus capable of being absorbed in a sufficiently large volume of biological material. Thus, in this work, the aim is to study the appearance of radiation defects from various doses of irradiation with gamma rays with energies of 10 MeV and 15 MeV. Such a study is of interest in studying the prolonged effect of gamma therapy on body cells.

This paper presents the results on the frequency of mutations induced by beams of gamma rays with energies of 10 and 15 MeV. The relative exposure doses were 2Gy, 5Gy, 10Gy, 15Gy, 20Gy and 30Gy. The electronic accelerator Elekta Axesse of the oncological center "Sunkar" (Almaty) was used as a source of gamma quanta. A study of the genotoxic effects of gamma radiation was carried out using Drosophilamelanogaster. A series of fly larvae after irradiation were placed in test tubes with a medium for crossing irradiated adults. Each tube in the tests was subjected to visual analysis after the complete departure of the generation to identify mutations. Morphoses were chosen as the main criterion for assessing the mutagenic and teratogenic effects of gamma radiation on Drosophila. The formation of morphoses is one of the properties of conditional mutations that are not associated with the primary structure of DNA and occur in regulatory genes responsible for the formation of traits of intraspecific similarity. In this case, the stress factor was gamma radiation, and the appearance of morphoses demonstrated teratogenic effects or disturbances in the genetic development program. In addition to morphoses, cases of sterility or a decrease in the fertility of adults were found, which is evidence of the mutagenic effect of irradiation, since such a phenomenon was not observed in the control. The teratogenic properties of gamma radiation were revealed, expressed in the appearance of morphoses or asymmetric ugly disorders of the soma morphology. The data obtained indicate that gamma quanta have pronounced mutagenic and teratogenic properties, i.e. is genotoxic. As a result of the experiments, the types of induced mutations were determined, and the significance of genetic effects for various energies of gamma rays was assessed.

This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09258978).

STUDYING THE DOSE LOAD ON THE RESPIRATORY SYSTEM FROM HEAVY NATURAL RADIONUCLIDES DURING TOBACCO SMOKING

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According to the ICRP (publications No. 50 and No. 65), radon and its decay products (Rn-DP) contribute more than 50% to the total radiation background. In Kazakhstan, cancer incidence rates remain among the highest among the CIS countries [1-2] and 28831 new cases were detected in 2020 [3]. Currently, it has been proven that the main cause of lung cancer is smoking [4]. However, despite the fact that the first place as a cause of lung cancer is occupied by tobacco smoking, the second place is occupied by the inhalation of radon and Rn-DP. Toxic chemicals in tobacco smoke are one reason why cigarettes cause cancer, but radioactive heavy elements also play a significant role in them. They accumulate in tobacco leaves at the time of their vegetation due to absorption from the soil and air, and the rate of absorption depends on the pH of the soil. The decay product of radon, Pb-210, plays an important role in human radiation exposure, since it has a long residence time in the body [5]. This contributes to an increase in the dose of internal radiation and increases risk of lung cancer. For this reason, conducting studies on the quantitative assessment of the concentration of natural beta-radionuclides in the lungs due to smoking as one of the causes of the carcinogenic effect is an urgent task.

In this work, the authors performed a quantitative assessment of the concentration of natural beta-radionuclides in six samples of the most popular tobacco products in the Kazakhstan. The beta activity concentrations of the samples were measured by beta spectrometry using a scintillation detector. The results of the preliminary analysis of this work show that the lower threshold for the activity of beta-radionuclides in the tobacco of one cigarette is 60 mBq. A person who smokes one pack a day (20 cigarettes) inhales an average of 120 mBq. The annual effective doses were calculated based on the intake of Pb-210, as having the greatest danger among other beta radionuclides, and amounted to 39 μSv/year for a person who smokes one pack per day.

This research is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09058404).

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STUDIES OF RADON CONCENTRATION IN RESIDENTIAL AND PUBLIC BUILDINGS LOCATED IN THE TIEN SHAN FOOTHILLS AND THE NEVA LOWLAND AREAS

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The large territories of the Republic of Kazakhstan and the Russian Federation are characterized by a different radiation environment due to the mining (coal, gas, non-ferrous metals and uranium), the geological conditions, seismic activities and mountainous areas. In this case, the radiation environment is influenced by radioactive gases (radon, thoron), together with their decay products, and radioactive aerosols formed in natural chains of uranium and thorium series. Thus, one of the most important tasks of radioecological research is the analysis of radon concentration in residential and public buildings. Radon enters the building from the ground, through foundations and floors, or directly from building materials. As a result, a rather high radiation background can be registered in the building. Especially if the house has the high concentration of uranium-thorium series radionuclides, or if materials with a high uranium concentration were used in its construction. Also, if there is a positive temperature difference inside and outside the building, a pressure gradient arises and an additional mechanism appears that contributes to the entry of radon. This mechanism is usually much more important than the diffusion transfer of radon [1].

Therefore, it seems to be interesting to study the concentrations of radon and its decay products in residential and administrative buildings, and especially in newenergy-efficient buildings [2]. In present work, the objects of research were buildings located in the foothill regions of the Tien Shan (Almaty region), because tectonic faults and the rocks are additional sources of radon. On the other hand, it would be interesting to compare experimental data on radon concentration obtained in buildings located in mountainous areas with data obtained in buildings built in the Prinevskaya lowland area (with the corresponding geological structure) at the zero mark of the height and depth reference system (region of St. Petersburg).

In this work, data on radon volume activity were obtained and analyzed in the period from February 2021 to February 2022 in housing and public buildings of Almaty and St. Petersburg. As a result, the radon concentration distributions were obtained at all levels of administrative and residential buildings. The dependences of radon volume activity on temperature, humidity and pressure were analyzed. Also, in some local places the high radon volume activity was detected. Such radon «jets» can add an additional radiation load to the total exposure dose for the population from natural radiation sources.

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