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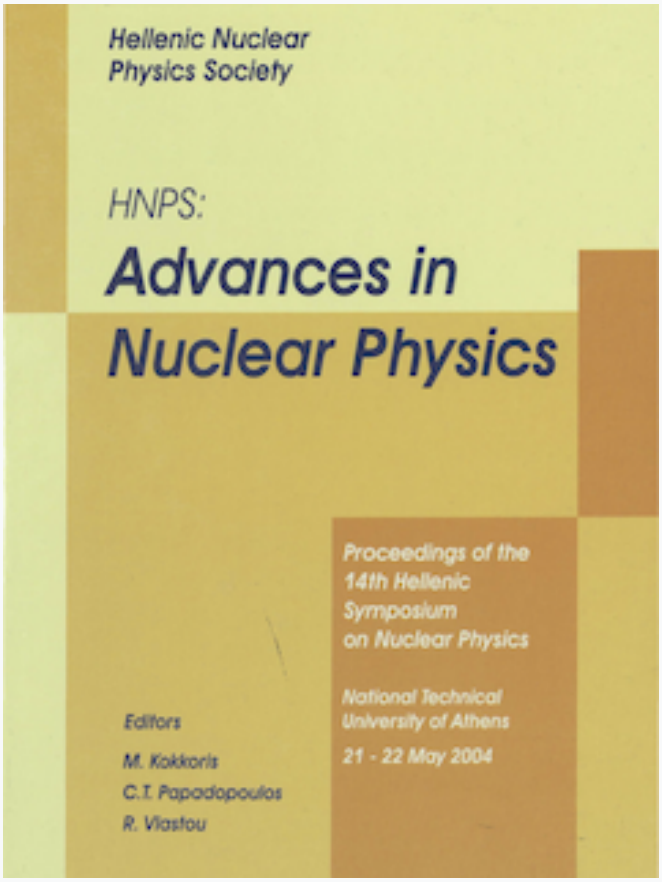

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Evaluation of a Mean Attachment Coefficient For ^{211}Pb on Polydisperse Aerosol

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Abstract

The attachment of small cluster species on to the surface of aerosol particles is a process governing a number of phenomena such as the dose from natural radon progeny and the transfer of condensed vapours to aerosols. The process has also been successfully employed in the epiphaniometer, where the labeling of ambient aerosol with an alpha emitter and the measurement of its activity gives a measure of the aerosol surface area (Gaggeler et. al., 1989). Measurements involve exposure of the sampled aerosol in a chamber where the noble gas ^{219}Rn emanates from a ^{227}Ac source. The decay product with the longest half-life is ^{211}Pb. The aerosol flow is passed through a filter contained close to an alpha activity detector, where the decay of ^{211}Bi (daughter nuclide of ^{211}Pb) is monitored. The attachment of the latter on to the aerosol particles can be related to the aerosol Fuchs surface area. The instrument's raw signal as alpha counts suffers in terms of time resolution due to the overlapping decay of continuously arriving atoms attached on aerosol particles. Previous measurements with the epiphaniometer on monodisperse test aerosol of various types (spherical and non-spherical) showed that the transfer rate of lead atoms to aerosol particles is rather insensitive to particle type and proportional to particle mobility diameter, in agreement with the dependence of the coagulation coefficient on size (Rogak et. al., 1991). However, it has been also proposed (Postendorfer et al., 1978) to assign a mean value for the attachment coefficient regarding radon progeny products indoors. The present work investigates the relationship between a "mean" attachment rate and the mean size of a single mode polydisperse aerosol.

Experiments were performed in the lab, where a setup similar to an epiphaniometer was developed. Polydisperse aerosol was generated by a compressed air atomizer fed with 1% NaCl aqueous solution. Alpha counts from the collected attached fraction were recorded at 2-minute intervals, while the size distribution was recorded by an SMPS at concurrent intervals.

The total number of counts observed from the attached fraction collected and the total number of particles measured by the SMPS can yield a mean value of an attachment coefficient. Results are compared to the experimental findings of Rogak et al., assigning equivalent mean sizes to the aerosol population calculated

from the measured size distribution. It is found that a mean attachment coefficient is meaningful and in agreement with theoretically predicted results when a meaningful mean aerosol size is employed in the calculations. Results were obtained by means of the geometric mean size of the number, surface and Fuchs surface moments of the measured size distributions.

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Determination of Radionuclides in "*Mytilus Galloprovincialis*" by Alpha and Gamma-Spectroscopy

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Abstract

The natural radionuclides ^{238}U ,^{234}Th, ^{40}K and the main man made ^{137}Cs, have been studied in *Mytilus galloprovincialis* (Lamarck, 1819) sampled in Thermaikos gulf – North Aegean Sea, considered as a bioindicator for radiological assessment in the Mediterranean. Besides, the ratio $^{238}U/^{234}U$ has been also examined as for ^{238}U origin justification.

In terms of ^{137}Cs, the activity concentrations in seawater from the studied area have been measured as well, and the concentration factors of ^{137}Cs in the *M. galloprovincialis* are given as a parameter of the organism response to radioactive pollution.

Key words: *M. galloprovincialis*, Bioindicators, Radiological quality, Marine Radioactivity

Design and Development of a Position-Sensitive γ-Camera for SPECT

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A new γ-camera for clinical Single Photon Emission Computerised Tomography (SPECT) applications with high position resolution and sensitivity has been designed and constructed at IASA. The system is based on a pixellated CsI*(Tl)* crystal and a Position-Sensitive Photo-Multiplier Tube (PSPMT R2486, Hamamatsu); it is combined with a conventional PMT for simultaneous or independent acquisition of energy and position information. The position information is obtained with the resistive chain technique, resulting in two charge sensitive anode signals at each x- and y-direction. The camera has a useful field of view of 4.6 cm in diameter and provides around 2 mm of intrinsic spatial resolution. Emphasis during the design has been put on low cost and portability. A new technique, which utilizes digitisation with high speed PCI cards, has been applied for the signal readout. Several image reconstruction techniques based on iterative algorithms, as well as on Artificial Neural Networks (ANN) are discussed.

DECAY PROPERTIES OF HIGH SPIN STATES IN ^{52}Mn AND ^{52}Fe

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During the last few years the study of high spin states in N≈Z nuclei in the $1f_{7/2}$ shell has gained renewed interest due to significant advances in the theoretical and experimental tools. In this work, the electromagnetic decay properties of high spin states in ^{52}Mn have been studied through different experiments with the GASP and EUROBALL arrays combined with the ISIS charged-particle detector and the Neutron-Wall. New high spin states were placed at the ^{52}Mn level scheme by analyzing the coincidence measurements of the above mentioned experiments. Where possible the mean life of the states have been measured by means of the Doppler-shift attenuation method. These results were confronted to the shell model predictions in the full fp shell.

Furthermore, in a recent experiment performed in the On-line mass separator at GSI, the decay properties of the 12^+ yrast trap in ^{52}Fe have been investigated. Two $E4$ gamma branches to the 8^+ states in ^{52}Fe have been observed for the first time and the beta decay into high spin states of ^{52}Mn has been revisited. The experimental findings are compared with the results of shell model calculations in the full fp 45

A Portable Semi – micro XRF Spectrometer for Archaeometrical Studies

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The miniaturization of the X-ray tubes, detectors and data acquisition devices allows nowadays the construction of portable X-Ray Fluorescence (XRF) spectrometers, which can be transported to the museum and/or the archaeological site for *in-situ* measurements. Fulfilling basic requirements posed by archaeologists and conservators for analyzing archaeological material, the use of the XRF technique has considerably increased in the field of archaeometry during the past years. However, a number of archaeometrical questions cannot be answered by conventional milli-beam portable XRF analysis. For example, in some cases it is necessary the exciting X-ray beam to be focused to small details/and or remains on the artifacts, increasing by this way the analytical sensitivity and spatial resolution. In inhomogeneous materials, like the corroded bronzes, the XRF microanalysis can help for a better understanding of the nature and surface distribution of the corrosion products, while providing the possibility for a μ-destructive analysis of the metal core.

Towards this direction a new μ-XRF instrument was designed and constructed in the Laboratory of Material Analysis of the N.C.S.R "Demokritos". It utilizes a novel end window, battery operated, low power X-ray tube (40 kV, 40 μA) with Au as anode material, designed initially for medical purposes, a peltier cooled PIN X-ray detector and associated electronics. The unique design of the probe like X-ray tube anode allows very close coupling of any optical component to the tube anode, as well as to the sample position. Pinhole optics was used to form the micro beam. A series of Monte Carlo calculations, as well as several sets of measurements were performed, in order to determine the optimum geometrical and operational parameters. Preliminary results about the performance of our new μ-XRF spectrometer are compared with those reported in literature for XRF systems that utilize various optical elements (pinholes, poly-capillary lenses) for focusing X-rays, whereas the potential of this μ-XRF spectrometer in the archaeometrical research will be presented and discussed.

Temporal Changes of ^{7}Be And ^{210}Pb Concentrations in Surface Air at Temperate Latitudes (40°N)

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Atmospheric concentrations of ^{7}Be and ^{210}Pb were measured continuously, for a long period of time of almost 15 years (from July 1987 to December 2001) in ground level air at Thessaloniki, Greece (40°38'N, 22°58'E). Monthly, seasonal and annual variations of concentrations of the two radionuclides were examined and discussed with respect to atmospheric processes and meteorological parameters. Mean activity concentrations of ^{7}Be and ^{210}Pb in surface air have been found to be 5.02 ± 2.49 mBq m^{-3} and 664 ± 350 μBq m^{-3}, respectively characterizing the latitude of 40°N. The amplitude of ^{7}Be surface concentration variability related to 11-year solar cycle is about 22% from the mean, suggesting an average increase of about 45% of ^{7}Be concentrations between the maximum and minimum of the solar cycle. The observed monthly average $^{7}Be/^{210}Pb$ activity ratio varies by a factor of about 3 during the year with the highest value observed on May (11.33) and the lowest one on December (4.28). Frequent inversion conditions during autumn period, and the strong vertical removal of air mass within the troposphere during summer months are both phenomena that result in both radionuclides, while stratosphere-troposphere air exchange reflects only to ^{7}Be concentrations in spring period, as a consequence the $^{7}Be/^{210}Pb$ ratio during spring could be an index of stratospheric contribution.

On the behavior of spallation neutrons from extended Pb target plus moderator: A comparison between SSNTDs measurements and theoretical- calculations.

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Abstract

Thick Pb targets with different lengths were irradiated by high energy protons form the Nuclotron accelerators, of the high Energy Laboratory (LHE) JINR, Dubna. The Pb targets were covered by paraffin moderator to shift the neutron spectrum produced by the target to lower energies. The transmutation via (n,γ) reactions is significant at the resonance region of the neutron spectrum. Neutron distributions along the paraffin moderator, surrounding the Pb targets, have been measured by Solid State Nuclear Track detectors (SSNTDs). Slow and fast neutron components were both studied as a function of the proton beam energy and the length of the Pb target. Comparisons of our experimental results were made with calculations based on empirical relations derived from the physics near high energy accelerators.

Distribution and Behavior of Natural Radionuclides in Rocks and Soils of an Insular Area: The Case of the Radioactive Springs in the Island of Ikaria, Aegean Sea

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The island of Ikaria (37° 59' N, 22° 58' E), an area of 267 km^2, is located in the Eastern Aegean Sea, in Greece. In the south littoral zone of the island there are several radioactive fault springs and in the sublittoral zone some springs emerge under the strata through the bottom to the seawater layer above. The concentrations of natural radionuclides in spring waters are in the range of 25±5 Bq l^{-1} - 2467±51 Bq $l^{-1}$for ^{222}Rn, 0.1±0.2 Bq l^{-1}- 5.0±0.4 Bq l^{-1} for ^{226}Ra and 0.1±0.9 Bq l^{-1}- 5.5±0.7 Bq l^{-1} for ^{228}Ra.

The natural radioactive background in terrestrial and marine environment has been studied [1]. Considering the concentrations of natural radionuclides in surface rocks and soils in the island, a wide range is observed although the island covers a small area. By means of these concentrations, areas of high and normal radioactive background are observed. Areas of high radioactive background are located in the vicinity of the springs [1]. Analytically, the concentration rank in rocks and soils is given in Table 1 (probability of the difference between the mean values ≥95). As concluding, the concentrations of natural radionuclides in soils of areas of normal radioactive background follow the respective concentrations in the adjancent rocks. On the contrary, in areas of high radioactive background the concentrations of natural radionuclides in soils do not follow the respective concentrations in the adjancent rocks.

Equilibrium factors for ^{226}Ra/^{238}U range between 0.12 to 4.50 and for ^{228} Th/^{228}Ra range between 0.33 to 2.0. The respective range for ^{228}Ra/ ^{226}Ra is 0.09 – 2.5. So, considering the radioactive equilibrium within each series and in between them disturbances have been observed in the terrestrial abiotic environment. It is obvious that the disturbance of radioactive equilibrium within the uranium-radium series is more significant than the disturbance in thorium series. In the wide Greek territory, significant disturbance of equilib-

Table 1
Relation of concentrations of natural radionuclides in rocks and soils

	Spring areas	**Wide area**
Rocks	$^{40}K >> {}^{238}U > {}^{226}Ra > {}^{228}Ra > {}^{228}Th$	$^{40}K >> {}^{238}U > {}^{228}Ra \geq {}^{226}Ra > {}^{228}Th$
Soils	$^{40}K >> {}^{228}Ra > {}^{228}Th > {}^{226}Ra > {}^{238}U$	$^{40}K >> {}^{238}U > {}^{228}Ra \geq {}^{226}Ra > {}^{228}Th$
Fault materials	$^{40}K >> {}^{238}U > {}^{226}Ra > {}^{228}Ra > {}^{228}Th$	
		Wide Greek environment
Soils		$^{40}K >> {}^{238}U > {}^{228}Ra > {}^{226}Ra > {}^{228}Th$

rium within the uranium series in surface soils has been observed in areas with spas and tectonic faults [2].

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Study on the Radiological Protection Monitoring in the Working Area of an Office Building Under Construction in Athens

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Abstract

The results through an extensive study are presented concerning the radiological protection of the staff and the environmental quality assessment as well, in the area of the headquarters building, of the ETHNIKI ASFALISTIKI company, which is under construction in Athens. In the frame of this study, environmental abiotic material (air, soil, rocks) and building material (cement, scrab etc) were collected from an established sampling network during the work processing. An HpGe gamma radiation monitoring system was used to measure the samples after appropriate physical treatment, in order the proper geometry to be achieved. The concentrations of the long-lived radionuclides both natural (^{238}U, ^{232}Th, ^{40}K, ^{226}Ra) and artificial (^{137}Cs) were determined and evaluated in terms of statistics. The relative data of the routine environmental monitoring of Environmental Radiation Laboratory of "Demokritos" were used to interpret the results of the present study and the radiological risk for the employers was assessed. The results of the present study are reasonable and can be used as a reference guideline for any relative activity. The study will be prolonged and indoor measurements for ^{222}Rn have been scheduled.

Key words: Radiological protection, Radionuclide concentration, Environmental quality

Nafion® Membrane Treatment for Low Level Lead Determination by TXRF

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Abstract

The detection of lead in low level concentrations (a few ppb) can be achieved by the use of special membranes and Total Reflection X-Ray Fluorescence (TXRF) analysis. Membranes were left in various lead solutions for different equilibration times, and various solution volumes. The membranes were produced on quartz reflectors, and they contained various comlpexing reagents in Nafion® matrix. The further treatments of their surface with the use of freeze drying technique increase their surface and the absorbed lead ion capacity (until 100%) as well as the complexation speed. Others methods of treatment with the use of binary layers and simultaneous thinning of the upper layer (membrane) gave similar results. The ion capacity and the equilibration time are of great importance when the higher concentrations of the matrix elements of the solution (calcium, manganese, iron etc.) interference lead detection.

The use of antiprotons for imaging and radiotherapy: A progress report

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The idea that antiprotons could be used for imaging and radiotherapy was put forward by Prof. Kalogeropoulos in the eighties. University of Athens/IASA and JINR/Dubna scientists have used simulation methods, during the last two years, to examine this possibility. The main results of these studies will be reported. It will be shown that the energy deposited by an antiproton, under its Bragg peak, is considerably more than the corresponding one from a proton. The energy spectra of the charged and neutral pions and of the direct gamma rays coming out of the annihilation vertex have also been obtained. It will be shown that there are enough charged particles coming out that the annihilation vertex can be determined with an accuracy of about 1 mm and with good efficiency. Some latest ideas on possible ways of transporting antiprotons from their production site to far away hospitals, where they could be used, will also be described

Topics from the Theoretical Study of Nuclei far from Stability

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Abstract

The physics of nuclei far from stability is currently under intense experimental and theoretical investigation [1]. In this talk, I refer briefly to our two projects that deal with the theoretical study of nuclei far from stability, and present recent selective results. In the first project, we are dealing with statistical global modeling of properties of nuclei (up to now, masses and related quantities and half lives) using neural networks. One of our goals is to provide reliable predictive models that can be used to forecast the values of these properties for nuclei away from stability. Results of our latest mass systematics are presented [2]. The second project deals with the study of the multipole density and current response, from low lying up to Giant Resonance energy regions as they evolve away from stability line. A self-consistent Skyrme Hartree-Fock+continuum RPA model is used. Results are presented from our study of nuclear vorticity in Ni isotopes [3,4].

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*The work discussed here has been carried out in collaboration with S. Athanassopoulos, J. W. Clark, A. Dakos, K. A. Gernoth, P. Papakonstantinou, Y. Yu. Ponomarev and J. Wambach.

Radiation Tail in (e,e'p) Reactions and Corrections to Experimental Data

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Abstract

Medium energy electrons are ultra-relativistic charged particles and thus they strongly radiate in the presence of external fields, a process known as "bremsstrahlung". Standard techniques of correcting inclusive scattering data for radiation effects have been developed, based on QED leading order calculations. But little is done in coincident scattering, based mostly on extensions of single-arm techniques, which are directly applicable only to discrete nuclear states, i.e. for low missing energy and momentum.

We propose a new method, published by J. A. Templon, C. E. Vellidis, R. E. J. Florizone, and A. J. Sarty in Phys. Rev. **C 61** 014607 (2000), for correcting proton knockout data. This amounts to the direct simulation of the radiation tail through event-by-event computation of the A(e,e'p)A–1 cross section, including radiation. The purpose of the method is to analyze and correct the experimental data by direct comparison with the pseudodata. It is based on the previous theoretical work by E. Borie and D. Drechsel, *Radiative corrections in ee'N coincidence experiments*, Nucl. Phys. **A 167**, 369 (1971), where the calculation of the internal radiation tail in the so-called "peaking approximation" is formulated. We extend to the discrete spectrum the formalism derived in that work for scattering in the continuum, and we develop a detailed model for the realistic simulation of the experimental conditions.

We compare the results of application of our method with experimental data of the ^{3}He(e,e'p) reaction, which is closest to the Plane-Wave Impulse Approximation (PWIA) picture and possesses the simplest but still complex spectrum, consisting of a 2-body breakup channel ^{3}He(e,e'p)^{2}H and a 3-body breakup channel ^{3}He(e,e'p)pn. The data are taken from R. E. J. Florizone *et al.*, *The Longitudinal and Transverse Response of the (e,e'p) Reaction in Helium-3 and Helium-4 in the Quasielastic Region*, Phys. Rev. Lett. **83**, 2308 (1999). While the results of the standard procedure of unfolding of the radiation tail proved unstable above a missing energy of 20 MeV, the results of our method, upon including a heuristic factor to account for multiple photon emission, are very satisfactory. This method allows, in particular, for the decomposition of the model cross section used in the simulation into the contributions from the two reaction channels with and without radiation. The results show that no strength from the 3-body breakup channel is detectable above a missing energy of 20 MeV, a region saturated by radiation from the 2-body breakup channel.

In conclusion, the proposed technique for radiative corrections in proton knockout reactions with a complex spectrum is appropriate for the accurate analysis of the spectrum at high missing energy and momentum. This is a difficult region to measure, due to very low cross section, but very important because there the standard Impulse Approximation breaks down by exotic effects, such as relativistic corrections to the bound nucleon wave function as well as off-shell effects from meson exchange currents and isobar contributions.

Characterization and Investigation of Protective Coatings on Steel Samples Prepared by Plasma Detonation Techniques

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Abstract

Plasma–detonation techniques have been used in order to increase the corrosion resistance of austenitic stainless steels. Deposition of Al_2O_3 coatings in combination with high current electron beam treatment and deposition of titanium nitride (TiN) were applied for this purpose. The characterization of the samples was performed using Nuclear Reaction Analysis and Rutherford Backscattering Spectroscopy. The corrosion behavior of the samples was investigated using electrochemical techniques. The obtained results, showed a considerable increase of the corrosion resistance of the coated steel samples. This improvement is connected with the properties of the coatings (e.g. thickness, adhesion). The surface morphology and microstructure of the specimens, before and after the corrosion tests, were investigated by X-ray diffraction and electron microscopy.

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