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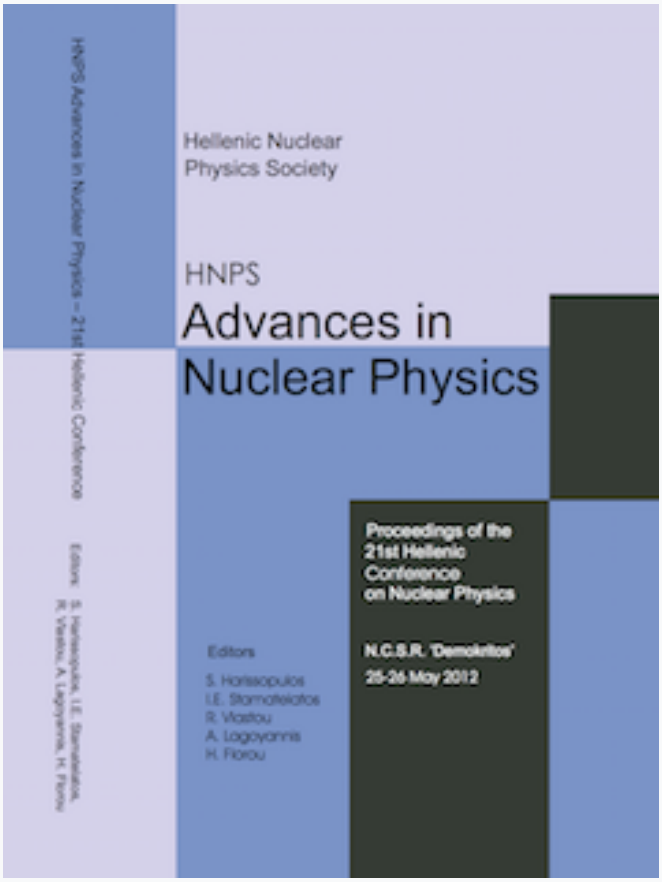

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40 years of “beam on target” at the Tandem accelerator

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Fission induced by light particles at intermediate energies

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The interest of medium energy nuclear data, i.e. in the range of 500-1000MeV, is peaked last years in spallation sources for their applications in accelerator - driven systems (ADS).

Fission studies takes a big part of research on the reaction mechanism at intermediate energies because it can be produced directly by the interaction of projectile – target at large as well as small impact parameters but also as the ending effect of spallation reactions. Most of the data are referred to the fission induced by protons due to the applications in the spallation targets. A lot of results on fission mechanism have been collected from 60s using deuterons and alpha particles as projectiles but at low energies. This presentation deals with fission experimental data at intermediate energies when deuterons are used as projectiles and the systematic collected for actinides and subactinides.

ATLAS New Small Wheel Upgrade: Micromegas

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The luminosity upgrade of the Large Hadron Collider at CERN (sLHC) foresees a luminosity increase by a factor 10 compared to the LHC. To cope with the corresponding increase in background rates, the Muon System of the ATLAS experiment at CERN will likely need major changes in, at least, the highest rapidity region. The MAMMA-ATLAS R&D activity is focused on the development of large-area muon detectors based on the bulk Micromegas technology as candidates for such an upgrade. The detectors will combine trigger and precision tracking in a single device. Their low costs, compared to other detector technologies, and their potential for industrial production make the bulk-Micrormegas excellent candidates for mass-construction of large muon chambers. Beam tests of several size prototype chambers have been performed since 2009, as well as several tests with different types of resistive coating of the readout electrodes, in order to reduce sparking of the chambers. The performance results of these new resistive types of micromegas will be presented.

Studies of the process of N/Z equilibration in peripheral and semiperipheral heavy-ion collisions at 15 MeV/nucleon

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The results of recent experimental studies of peripheral and semi-peripheral collisions of ^{86}Kr (15MeV/nucleon) projectiles on ^{64,58}Ni and ^{124,112}Sn targets will be presented [1]. The motivation of the present work is the possibility to extract information on the properties of the nuclear effective interaction (via comparisons with microscopic transport models) as manifested in the mechanism of nucleon exchange and the process of N/Z equilibration [2,3]. Experimentally, the method of heavy-residue isoscaling [2] was applied to the present data. From a theoretical point-of-view, we have performed preliminary calculations using the code CoMD (Constrained Molecular Dynamics) of A. Bonasera and M. Papa [4]. The code implements an effective interaction with a nuclear-matter compressibility of K=200 (soft EOS) with several forms of the density dependence of the nucleon symmetry potential. CoMD imposes a constraint in the phase space occupation for each nucleon (restoring the Pauli principle at each time step of the collision). Results of the calculations and comparisons with our experimental data will be presented. The importance of such studies to the field of astrophysics (e.g. modeling of core-collapse supernovae and neutron stars) will be pointed out. Finally, the prospects to extend the experimental studies using neutron-rich radioactive beams at existing or planned radioactive beam facilities will be outlined.

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In search of nuclei exhibiting E(5) critical-point symmetry features

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The E(5) critical point symmetry which was introduced in 2000 [1] describes the shape change of a spherical harmonic vibrator to that of a 'γ-soft' rotor. A series of publications have proposed a number of nuclei as possible E(5) candidates [2, 3, 4, 5] but still the experimental confirmation of the E(5) symmetry in nuclear structure remains an open question. Our group in NCSR 'Demokritos' has worked in collaboration with the Universities of Cologne and Jyväskylä among others, in order to pinpoint nuclei which exhibit the E(5) characteristics. To that end, lifetime measurements have been carried out in three of the most promising candidates, namely ^{128}Xe, ^{130}Xe and ^{102}Pd. Our results and conclusions will be presented.

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Invited Talk

Measurements of radioactivity in Athens after the nuclear accident in Japan

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After the nuclear accident in Fukushima Daichi power plant, radioactive pollutants were transferred by air masses to various regions of the Northern hemisphere, including Europe. Very low concentrations of ^{131}I, ^{137}Cs and ^{134}Cs in airborne particulate matter were measured in Athens during the period of March 24 to April 28, 2011. The maximum air concentration of 131I was measured on April 6, 2011 and equaled 490±35 mBq m^{-3}. The maximum concentrations of the two cesium isotopes were measured on the same day and equaled 180±40 mBq m^{-3} for ^{137}Cs and 160±30 mBq m^{-3} for ^{134}Cs. The average activity ratio of ^{131}I/^{137}Cs in air was 3.0±0.5, while the corresponding ratio of ^{137}Cs/^{134}Cs equaled 1.1±0.3. No artificial radionuclides were detected in air after April 28, 2011. Traces of ^{131}I were measured in grass, soil, sheep milk and meat. The total deposition of ^{131}I (dry and wet) was 34±4 Bq m^{-2}, while this of ^{137}Cs was less than 10 Bq m^{-2}. The maximum concentration of ^{131}I in grass was 2.1±0.4 Bg kg^{-1}, while ^{134}Cs was not detected. The maximum concentrations of ^{131}I and ^{137}Cs in sheep milk were 1.7±0.16 Bq kg^{-1} and 0.6±0.12 Bq kg^{-1} respectively. Concentrations of ^{131}I up to 1.3±0.2 Bq kg^{-1} were measured in sheep meat. Traces of ^{131}I were found in a number of soil samples. The radiological impact of the Fukushima nuclear accident in Athens region was practically negligible, especially as compared to that of the Chernobyl nuclear accident and also to that of the natural radioactivity.

Radionuclides from the Fukushima accident in Thessaloniki, Greece and Milano, Italy: Measurements and modelling approaches

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Analysis of ^{131}I, ^{137}Cs and ^{134}Cs in airborne aerosols were carried out in daily samples in Thessaloniki, Greece (40°N) and Milano, Italy (45°N) after the Fukushima accident during March-April, 2011. High volume samplers with glass fiber filters as collection substrates were used for air samplings. Sampling duration of 23 hours and flow rate of about 60 cfm resulted in a total daily air volume throughput on average 2200 m^3. All samples were counted in HPGe detectors. All detectors were calibrated with reference sources and standard geometries with overall uncertainties no more than 3%.

The different maxima found in radionuclide concentrations were related to complicated long-range air mass transport from Japan across the Pacific, the North America and the Atlantic Ocean to Central Europe [1]. The maximum ^{131}I activity concentration observed in Milano, Italy was almost similar with the highest value (497 μBq m^{-3}) observed in Thessaloniki, Greece, and the highest observed value (490μBq m-3) in Athens Greece [2] but was lower than the one observed (810 μBq m^{-3}) in Svalbard [3] and in Lithuania (3700 μBq m^{-3}, [4]). The maximum ^{137}Cs activity concentration at Milano was 63 μBq m^{-3}, while in Thessaloniki, Greece was 145 μBq m^{-3} and in Svalbard was as high as 675 μBq m^{-3}.

The ^{134}Cs/^{137}Cs activity ratio was about 1, related to the burn-up history of the damaged nuclear fuel of the damaged nuclear reactor. The presence of more than one peak of ^{131}I and $^{137,\ 134}$Cs indicates that the radionuclides were continuously transferred from Fukushima, Japan to Europe till the end of April, 2011. The large ^{131}I/^{137}Cs ratio, observed during the first days after the accident, as high as 18, followed by lower values during the next days, as low as 3, reflects not only the initial release ratio but also the different volatility, attachment and removal of the two isotopes during transportation due to their different physiochemical properties.

The NOAA HYSPLIT model was used to assess the transport pattern and to explain the deviation in radionuclide activity concentrations found in Thessaloniki, Greece and Milano, Italy. Thirteen days (312) back-trajectories were calculated for different arrival height and for 12 UTC time. The results showed that the measured activities at both sites of investigation resulted from a complicated air mass transport, arrival time, arrival height, meteorology and downward air mass transport.

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The Application of the ERICA Tool to Radioactivity Measurements for Environmental Impact Assessment: The Case Study of the Fukushima N.P.P. Accident Impact

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The growing international interest in the dose rate and risk assessment of ionizing radiation from anthropogenic sources and NORM industrial activities to non-humans has led to the development of suitable software programs, based on real-time measurements that enable the evaluation of the radiological risk to wildlife.

The ERICA Integrated Approach has been developed under the 6th Framework Program of the EC, for the assessment and management of environmental risks from ionizing radiation. The ERICA Tool, which is the supporting software of the ERICA Integrated Approach, fed by the appropriate radiological data and performing the necessary calculations, is capable to estimate the dose rates and eventually the possible risks and effects to natural organisms. The Tool can also provide the respective levels of the activity concentrations in biota, from the introduced activity concentrations in abiotic components combined to the Tool benchmark radiological data bases.

In this study, the ERICA Tool was applied aiming to simulate the real time measurements of radionuclides (^{137}Cs, ^{134}Cs and ^{131}I) after the Fukushima N. P. P. accident, in terrestrial ecosystem components, either abiotic and biota. For this purpose, samples of soil, grass and tissues of primary mammals (sheeps and goats) were collected, treated and measured by use of a high resolution gamma spectrometry system (HpGe detector of 90% relative efficiency). The results obtained fed the ERICA Tool, in order to estimate the dose rates received by the selected animals and plants.

The estimated dose rates was found to be much lower than the 10 μGy*h^{-1}, which is the reported screening level for measurable effects to non-humans. Nevertheless, the derived radiological risk showed a minor contribution to the natural background radiological impact, indicating no significant changes to the radiological status of "uncertainty to radiation well-being zone", according to the conceptual model of responses of the various levels of life organization to all possible dose rates of ionizing radiation in the environment.

Keywords: Radionuclides, ^{137}Cs, ^{134}Cs, ^{131}I, Radiological risk, ERICA Tool, Impact to non-humans, Terrestrial ecosystem.

Radon in Soil: Experimental measurements and Theoretical calculations

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Radon concentration as function of the soil depth (0- 2.6 m) was measured during the years (2002-2003), (2003-2004), (2010-2011), (2011-2012) in a location of the Aristotle University campus. Radium distribution in soil was found constant. On the contrary, as expected, radon concentration increases with soil depth. However, radon concentration does not follow the well known monotonous increase, which levels off to a saturation value. Radon concentration increases up to a soil depth of about 80 cm, seems to remain constant at depths of 80-130 cm and then increases again. The experimental distribution was reproduced by solving the general transport equation (diffusion and advection). The main finding of the numerical investigation is that the aforementioned, experimentally observed, profile of radon concentration can be explained theoretically by the existence of two soil layers with different diffusion-advection characteristics. Soil sample analysis verified the existence of two different soil layers. Different boundary conditions of the radon concentration at the soil surface were used for the solution of the diffusion-advection equation. It was found that the calculated radon concentration in the soil is, away from the soil surface, the same for the two boundary conditions used. However, from the (frequently used) boundary condition of zero radon concentration at the soil surface, the experimental profile of the radon concentration at the soil surface cannot be deduced. On the contrary, with more appropriate boundary condition the radon concentration at the soil surface could be deduced from the experimental profile. The equivalent diffusion coefficient could be uncovered from the experimental profile, which can then be used to estimate the radon current on the surface of the soil (exhalation rate). The exhalation rate of radon from soil was measured independently in the same location during the years 2010-2011 and 2011-2012. About 40 measurements in each time period were performed. In both time periods the mean radon exhalation rate was about the same (18 Bq m^{-2} h^{-1}) .From the radon distribution in soil, the radon exhalation rate was indirectly deduced, using the diffusion advection equation and it was found in very good agreement compared to the direct exhalation measurements.

Experimental Set Up for the Determination of Natural Radionuclides in Formation Waters Produced in Oil and Gas Exploration Fields

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In this work a new calibration method using extended water samples is presented for natural occurring radionuclide materials (NORM) measurements. The method aims to contribute to a future waste management policy related to the presence of NORM close to offshore industries for oil and gas exploration. The main issue of exploration and production waste stream in the aforementioned fields is the formation waters and their mixture with sea bottom material. Their disposal affects the entire marine ecosystem due to the high concentration of NORM. Also, the quality of formation water is critical since it is used from personnel for the drilling and cleaning purposes. Previous results [1] have shown that, ^{226}Ra concentration ranges from 5 Bq/L to 28 Bq/L and the total activity in formation water is in the range of 16–840 Bq/L (due to enhanced levels of dissolved ^{226}Ra, ^{214}Pb, ^{214}Bi).

The method consists of the photopeak efficiency calibration and the minimum detectable activity calculation using a broad energy HpGe detector. The efficiency is calculated for all gamma ray emitters of NORM (^{40}K, ^{210}Pb, ^{214}Pb, ^{214}Bi, ^{226}Ra, ^{235}U, ^{228}Ac, ^{208}Tl) using the ^{152,153}Eu standard source diluted in aquatic extended sample. The data were reproduced using Monte Carlo simulations. The developed method is characterised by immediate results since no pre-treatment is required, keeping the safety standards minimising the exposure of personnel. Moreover, the small quantity of the sample exhibits low ecological impact in case of disposal of the sample after the measurement.

The control of the marine radioactivity in similar activities that will take place in the Hellenic Seas has large society impact, so monitoring tools have to be applied combining systematic laboratory measurements with continuous monitoring installations (before and after the drilling operations).

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β^--Decay Half-Lives of Nuclei in the Crust of Neutron Stars: The ANN Model*

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Abstract

Lately the crust of neutron stars is under intense investigation [1,2]. Neutron-rich nuclei play a significant role. Assuming nuclear and beta equilibrium (cold catalyzed matter) they determine the crust's composition and properties. Neutron star crust out of equilibrium is considered one of the possible sites where neutron rich nuclei are produced via r-process nucleosynthesis [2,3]. Since experimental information of the properties of neutron-rich nuclei is still limited theoretical models are needed. We focus on their β^--decay half-lives (T_{β^-}). A number of useful approaches to modeling T_{β^-} has been proposed and applied. Among these there is the statistical global model that we have developed for the systematics of β^- lifetimes of the ground state of nuclei that decay exclusively by this mode in the form of a fully connected, multilayer feed-forward Artificial Neural Network (ANN) [4] using data from Nubase2003 [5]. Several tests of its performance have been made as reported in Ref. [4]. We have recently checked its predictive performance for the T_{β^-} of all neutron-rich nuclides that have been experimentally studied after Nubase2003 has been published. The conclusion is that in predictive performance the ANN model can match or even surpass that of established theoretical and phenomenological approaches based on quantum theory and it can therefore provide a valuable complementary tool for explaining β^--decay systematics. In this work we give predictions of the ANN model for the T_{β^-} half-lives of neutron-rich nuclides that are considered to be present in the crust of neutron stars built from cold catalyzed matter [6]. We also present some results from our study of T_{β^-} of nuclei synthesized via the r-process [7]. The latter occurs after the decompression of the neutron star matter from the outer crust that follows its possible ejection. It refers to r-nuclei with A<140 [8]. A comparison is made of the ANN T_{β^-} values with available experimental ones as well as with those of two conventional QRPA based approaches [9]. The study of other properties of neutron-rich nuclides relevant to the physics of neutron stars crust with artificial intelligence techniques is in progress.

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Astrophysical neutrino signals and the role of nuclear structure

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During the last decades, the physics of neutrinos has gained intense interest in nuclear and astro-particle physics as well as in the areas of space sciences like cosmology and astronomy. Specifically, regarding the role of neutrinos in the evolution of massive stars, explosive nucleo-synthesis, etc. [1], recent stellar evolution models describing the explosion mechanism of type II supernovae have provided us with important informa-tion [1]. However, uncertainties on astrophysical interactions of neutrinos with matter are intimately related to our understanding of the neutrino-nucleus cross sections. In addition, neutrino experiments need improvements over systematic errors originating from neutrino-nucleus cross section uncertainties at low and intermediate nuclear excitation energies.

The present work focuses on the role of neutrino-nucleus interactions in analysing the neutrino signals recorded by terrestrial experiments. We also investigate their scattering inside the matter of stars (supernova, etc.) that determine the shape of the neutrino-energy spectra [1]. We pay special attention on the parameterizations of the supernova neutrino energy spectra and the use of the low-energy beta-beam spectra originating from boosted radioactive nuclei, ^{6}He and ^{18}Ne, for their interpretation.

This study may provide useful informations for the neutron spallation sources (SNS) experiments at the Oak Ridge National Laboratory (ORLaND), Tennessee, USA, and at Lund Sweden, as well as for other sources of intermediate energy neutrinos like the beta-beam neutrinos.

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Nuclear physics aspects of the p-process

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The impact of nuclear physics input on the production of heavy elements is one of the most important aspects of nuclear astrophysics. Among the various nucleosynthesis processes the p-process is still not well understood, partly due to uncertainties concerning the p-process site and partly because of uncertainties in nuclear reaction rate data.

In this study we focus on the impact of uncertainties relating to reaction rates on the final abundances. In doing so, an extended reaction network is used to simulate p-process flows. By comparing reaction rate data from two different libraries maximum upper and lower limits on rate values are established and their effect on the final production of p-nuclei is examined.

Neutron Detection via $^{14}N(n,p)^{14}C$ reaction Using the Spherical Proportional Counter

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A large volume (1m3) spherical proportional counter has been developed, for low flux neutron measurements. The detector consists of a large spherical gas volume with a central electrode forming a radial electric field. New gas mixtures, (Ne, C_2H_6, N_2) and (Ar,CH_4,N_2) have been studied for thermal and low energy neutron detection, in comparison with typical ^{3}He counters, providing a new way for the low energy neutron spectroscopy. The neutrons are detected via the $^{14}N(n,p)^{14}C$ reaction. In this presentation we have been studied the optimum gas mixture, gas pressure and also the optimum high voltage supply on the sensor of the detector, to achieve the maximum amplification and better resolution. The thermal neutrons are well detected giving a proton peak well separated from the cosmic ray background.

Research activities of NCSR "Demokritos" for the European Fusion Technology Program

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The realization of fusion for energy production strongly depends on advances in a diversity of science fields and technological sectors. To the one end the development of structural materials withstanding the high temperatures and intense radiation fields of the plasma and also advances in high temperature superconductors for the plasma magnetic confinement are required. To the other end plasma diagnostics and detectors are of paramount importance for plasma engineering and control. Fusion research in Europe is co-ordinated by EFDA, the European Fusion Development Agreement, which is the umbrella organization of all fusion research laboratories in Europe. EFDA is part of the EURATOM program of the European Commission. A consortium of researchers from different Institutes of NCSR "Demokritos" (NCSRD) participates in the EFDA technology activities. The NCSRD consortium is active in two main Fusion technology areas, the one concerns fusion related materials research and development and the other refers to the interactions of plasma produced neutrons with matter and the containment vessel.

The objective of the European Fusion Materials Program, within the framework of EFDA, is to develop materials suitable for the future fusion reactor. In FP7 the goals of the program are more science than technology driven. NCSRD is active in research related to investigation of the physical properties of iron-based steels and the fundamental understanding of their changes under different irradiation conditions. The NCSRD TANDEM and other European ion beams are utilized in order to understand the degradation of materials under irradiation.

In addition, NCSRD group investigates neutron streaming and activation effects in tokamaks and fusion power plants using computational tools.

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Activities of the University of Athens at SUL-X and FLUO beamlines of ANKA Synchrotron facility (KIT, Germany) in Earth & Environmental Sciences

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ANKA is the Synchrotron light source of the Karlsruher Institute of Technology/KIT (Germany), providing light from hard X-rays to the far-infrared for research and technology (http://ankaweb.fzk.de/). The SUL-X beamline combines fluorescence, absorption and diffraction measurements mostly on geological and environmental materials with microfocusing capabilities (μ-XRF/-XAFS/-XRD) whereas the FLUO beamline is dedicated to trace element detection at sub-ppm level and 2D/3D elemental mapping with μm resolution. The previous activities of the NUSTRAP collaboration of UoA (http://magneticmoments.info/nustrap/index.php), at ANKA facility, with regard to Earth & Environmental Sciences, concerned the following topics: 1) Hazardous elements in anthropogenic (e.g. Athens urban particulates, Figure 1, [1]) and natural (i.e. Saharan dust [2]) atmospheric particles, 2) Actinides in mining products (e.g. Al-ores from Greece [3]) and 3) Actinides in sedimentary rocks (e.g. U in limestones of central Greece [4]).

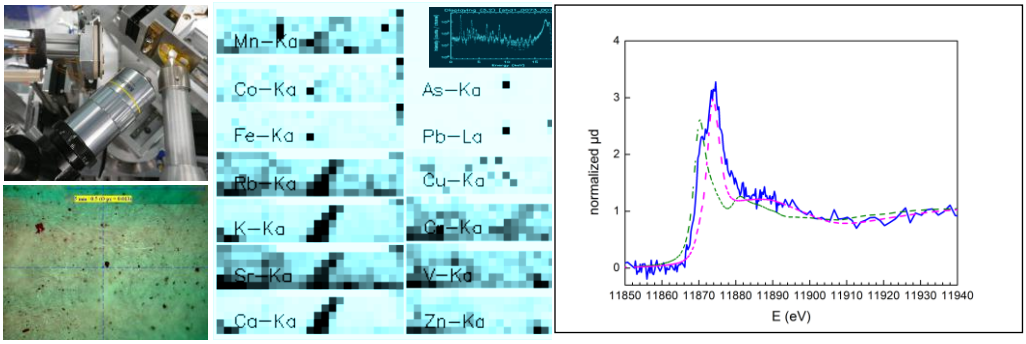

Figure 1: Synchrotron μ-XRF investigation (FLUO beamline) of the respirable fraction ($PM_{2.5}$) of Athens urban particulate matter and As *K*-edge μ-XANES spectra (SUL-X beamline) of an As hot spot. The dash-dotted line is the spectrum of an As(III) reference compound (As_2O_3), the dashed line represents an As(V) reference compound (As_2O_5). Energy has been calibrated to the first derivative of the Au-L_{III} edge (11.919 keV) [1]

Our recent activities at ANKA concern the following topics: 1) Hg and other heavy metals in coastal/lagoon sediments of western Greece, 2) Fe- and As-biominerals from Aegean submarine volcanoes, 3) Hazardous elements in Al-ore (bauxite) and solid wastes (red mud) from Ajka plant (Hungary), and 4) Au and Ag in mining products of Greece.

[1] A. Godelitsas *et al*., NIM **B269**, 3077 (2011)
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Population of isomeric states in neutron-induced reactions on ^{197}Au

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Excitation functions of product yields in neutron-induced reactions on ^{197}Au were recently obtained using the 5.5-MV Tandem Van de Graaff accelerator at the National Centre of Scientific Research "Demokritos" [1]. Cross sections of the ^{197}Au(n,2n)^{196}Au^{g}, the second isomeric state (12^{-}) and the sum of ground (2^{-}) plus the first isomeric state (5^{+}) of ^{196}Au were combined with available database excitation functions and compared with statistical model calculations [1,2]. The inability of the model to describe the high-energy part of the second isomeric excitation function suggested the need for modifications in the effective moment of inertia or the introduction of a rotational gamma band, predicted but not yet observed in ^{196}Au [1,2,3]. In a local statistical model analysis, Avrigeanu *et al*. obtained a consistent description of all available reaction data [4]. However, this was achieved assuming (a) a lower location of the gamma continuum in the residual nuclei compared to the earlier calculations, and (b) one rigid-body value for the moment of inertia for ^{196}Au together with one-half rigid-body value for the nearby ^{194}Ir residual nucleus.

In the present work, we study the possibility for an alternative description promoting the "missing gamma band" scenario. We examine the population of high spin states in the residual nuclei as influenced by (a) the entrance and exit channel neutron penetrabilities and (b) the effect of the nuclear quasi-continuum gamma decay. Gross features in the population of entry states of the evaporation residues were obtained with the statistical model code CASCADE [5]. Furthermore, the effect of the nuclear quasi-continuum in the population of the isomeric states in ^{196}Au was simulated with the statistical code GAMBLE [6]. We discuss the sensitivity of model parameters in the description of the available experimental excitation functions.

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[3] A.J. Kreiner, Z. Phys. A288, 373 (1978).
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Radioactive tracers for long range transport of biomass burning aerosols

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Biomass burning caused by anthropogenic activity such as agriculture practices or naturally occurring forest fires is a frequent phenomenon causing global environmental concern for many reasons. Release of certain radioactive or other hazardous compounds from forest fires occurring over contaminated land is one such issue for concern. The physicochemical processing occurring on smoke particles released in the atmosphere during long range transport is also another topic of interst.

This work presents first results from atmospheric measurements conducted during August 2010 in the Demokritos ERL sampling site for ambient TSP aerosol collected by a High Volume Sampler and anayzed for total β radioactivity and γ spectrometry. Filters were analyzed after a period of 4 days past sampling in order to allow decay of short lived Radon and Thorn daughters. Parallel measurements of aerosol physicochemical properties at the GAW DEM station were also employed.

It was observed that enhanced levels for total beta radioactivity were observed in the period of 12-18 of August compared to the remaining period. An average value of 2.0 ± 0.3 mBq/m^3 was measured over the first period compared to 1.0 ± 0.2 mBq/m^3 found for the rest of the sampling period. The latter is found equivalent to the background levels observed at the site during the summer months. It was also observed that during the enhancement in radioactivity organic and elemental carbon levels were also enhanced above the mean value of long term observations at the site. Especially for organic carbon a higher mean value of 4.4 ± 1.1 μg/m^3 was observed during the "episode" period compared to the rest of the time when 2.4 4 ± 0.7 μg/m^3 was measured.

Air mass back trajectory analysis indicated that the origin of the air mass crossing Athens during the 12-18th of August was the European Russian central plains where extensive forest fires were raging. The enhanced organic carbon values is a strong sugnal for forest fires. The enhanced radioactivity is initially attributed to higher amounts of natural radioactive isotopes like ^{210}Po (Savidou et al., 2006), ^{40} K and ^{7}Be normally found in vegetation and released in the smoke.

Savidou, A., Kehagia, K., Eleftheriadis, K. (2006) Concentration levels of 210Pb and 210Po in dry tobacco leaves in Greece ***J. of Environ. Radioactivity***, 85 (1), pp. 94-102. doi: 10.1016/j.jenvrad.2005.06.004

GAW-DEM (2007).http://gaw.empa.ch/gawsis/reports.asp?StationID=2076202728

Keywords:
natural radioactive isotopes, organic carbon, elemental carbon, biomass burning/forest fires

Sediment measurement of samples from Tigris and Euphrates estuary by means of gamma-ray spectroscopy

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Tigris and Euphrates rivers are the two defining rivers of Mesopotamia. Both emerge in eastern Turkey and cross Syria and Iraq before they unite to Shatt al-Arab River (which is a distance of 200 km before discharging in Persian Gulf). Fifty-two samples of seabed sediment were collected from the estuary of Shatt al-Arab River. The samples were sent to Marine Radioactivity Laboratory of the Hellenic Centre for Marine Research for activity concentration measurements of natural and artificial radioisotopes. The measurements realized by means of a High Purity Germanium detector after a standardized sample pre-treatment technique. The results exhibit relative low concentration of several natural radioisotopes (^{226}Ra, ^{228}Ra, ^{224}Ra and ^{40}K) and very low concentration of ^{137}Cs and ^{235}U. In the case of radium radioisotopes and potassium an inverse relation of the activity with the dry density of sediment was found revealing strong dependency of radioisotopes adsorption with grain characteristics and decreases from fine- to coarse-grained sediment.

Heavy metals and radionuclides in the northern coastal zone of Ikaria island (Greece)

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Within the frame of the present study the possible occurrence of heavy metals and radionuclides in the northern coastal zone of Ikaria island (Karavostamo, Armenistis and Nanouras bays), east Aegean, Greece, was investigated. The samples were collected from three parallel zones including the bottom of the sea in the depth of 2 m. In the last case, various sea shells were also collected. A portable radioactivity detector with NaI(Tl) crystal was used during the land sampling. The initial study of samples concerned particle-size determination using analytical sieves and mineralogical investigation using XRD. The heavy metal and trace element content, in the coastal sea sediments (2 m depth), was determined by means of ICP-MS whereas SEM-EDS was complementary used. The contained radionuclides and the relevant radioactivity were measured using a γ-ray spectrometry set-up equipped with HPGe detector. All samples were found to be relatively coarse (sand up to 100% and pebbles up to 15%) with absence of silt and clay fractions. The XRD patterns showed the presence of typical granite minerals (quartz, feldspars, micas) in the areas of Nanouras and Armenistis located onto the granite of W. Ikaria, while amphiboles and tourmaline were detected in the samples of Karavostamo due to neighboring metamorphic rocks. The geochemical diagrams proved that the immature sea sediments from the granitic areas are enriched in Rb/LREE and depleted in Ni, exhibiting an expected Eu negative anomaly. On the other hand, the Karavostamo immature sediments seem to be weathering products of rather basic rocks. The enrichment (EF) and geoaccumulation (I*geo*) factors indicated relative enrichment in Pb and As most probably due to anthropogenic sources, such as the wooden boats pigments. The carbonate sea shells were found to be affected by Fe but not heavy metals. The natural radioactivity of all samples is attributed mainly to ^{40}K (231 to 1476 Bq/Kg) and in small extent to ^{238}U and ^{232}Th radionuclide series. The contribution of anthropogenic radionuclides is minor, due to small quantities of ^{137}Cs (<5 Bq/Kg). The increased activity of ^{40}K corresponds to abundant K-contained granitic minerals. Natural actinides (U and Th) are due to the existence of primary silicate and phosphate minerals (zircon, xenotime, monazite) and the occurence of secondary phosphates like rabdophane. The natural radioactivity at the northern coast of Ikaria is lower compared to that of the southern coast of the island where the thermal springs are located. The recorded activities are in line with the reported values for other areas of Cyclades and northern Greece covered with granitic rocks.

High uranium concentrations in sedimentary rocks of Epirus (NW Greece)

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Epirus region (NW Greece) is generally composed of Mesozoic (250-65 million years old) sedimentary and ophiolitic rocks derived from the Tethys paleo-Ocean. The sedimentary rocks are mostly limestones and shales while the ophiolitic rocks represent old oceanic crust (a sequence of ultrabasic and basic rocks originating in Earth's mantle). Ophiolites, limestones and shales are fundamentally poor in actinide elements (<0.1, 2.2 and 3.5 ppm respectively) and therefore no elevated actinide concentrations would be expected in Epirus region. However, it is known (internal reports from Greek Atomic Energy Commission and IGME) that in some areas the natural radioactivity is high due to the presence of phosphate-bearing sedimentary rocks (phosphorites). Phosphorites are marine sediments containing an average of 120 ppm U, and may significantly contribute in U geochemical anomalies. Additionally, they are rich in light rare-earth elements/LREE, but not in Th (6.5 ppm) and other HFSE. Uranium in the ocean waters (3.2 ppb) follows anoxic pathways and it is mainly removed from the solution by chemical processes taking place at the interface of organic-rich sediments. It is therefore correlated to organic carbon whereas the diagenetic cycle of the element may include reduction of U^{6+} to U^{4+} related to sulfate bio-reduction. Samples from Epirus region concerning laminated phosphatized limestones (sample: DRYM1), bedded chert-rich limestone (sample: PER1) and tectonized/re-processed phosphatized limestone (sample: PER2), were scanned in the field using a portable radiation detector. Bulk geochemical analyses using ICP-OES/MS showed variable U concentrations with a notable value of 648 ppm in the case of the dark organic-rich part of the sample PER2 (Figure 1).

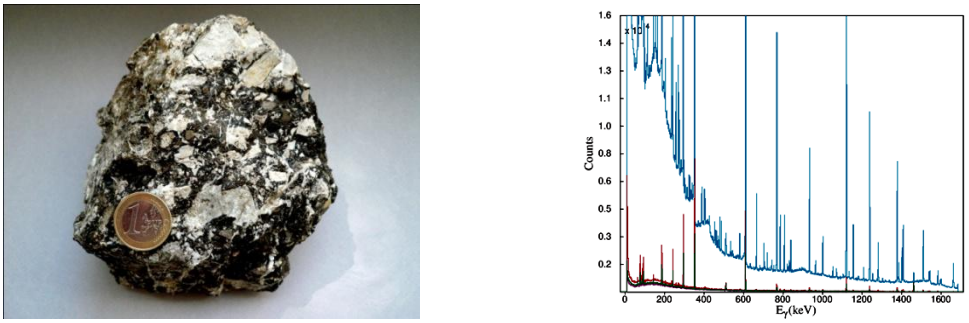

Figure 1: Radioactive rock from Perivleptos, near Ioannina (Epirus, NW Greece); the white carbonate-rich part (sample PER2A) contains 7 ppm U whereas the dark phosphate-/organic-rich part (sample PER2B) contains 648 ppm U yielding the γ-ray spectrum showed at the left (the rest of spectra correspond to other sedimentary rocks of Epirus containing 3-18 ppm U)

Gamma-ray measurements using HPGe showed that the above geological material exhibits high radioactivity mainly due to ^{238}U-series (^{234m}Pa: 8182 Bq/Kg, ^{226}Ra: 6852 Bq/Kg, ^{214}Pb: 7260 Bq/Kg, ^{214}Bi: 6232.18 Bq/Kg). Powder-XRD, SEM-EDS and further chemical analyses indicated abundant apatite and organic matter, besides calcite, which should be associated to the high U content. Relatively high concentrations of Cd, probably related to apatite, were also revealed. On the other hand, the rock is geochemically depleted in LILE (e.g. Cs, Rb, K), as well as in As, Sb and Se in contrast to red soils ("Terra Rossa") of the region. The sample is going to be subjected to further microscopic (TEM) and Synchrotron-based investigation (EXAFS) in order to elucidate the nature of U in the matrix.

Measurements and Monte Carlo simulations of neutron production at a medical accelerator

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Electron accelerators are being routinely used for cancer treatment. Due to high operational energy (up to 25 MeV), a significant number of neutrons is created by (γ,n) reactions when high energy photons interact with the materials of the accelerator head. Neutron leakage radiation reaches the patient, contributing additional unwanted dose to the patient and thus the total neutron fluence must be measured precisely. Neutron activation detectors are one of the best options for the measurement of the leaked neutrons, yet the majority of previous studies are calculating neutron fluencies with Monte Carlo simulations. Usually gold and indium are used as activation detectors in experimental studies.

In this preliminary work, we measured neutron fluencies with neutron activation technique. The LINear ACcelerator (LINAC) under consideration is a 18 MeV Varian Clinac 2100C electron accelerator operating at Papageorgiou Hospital, Thessaloniki, Hellas. We measured the total neutron and photon fluence at the isocenter within a 10x10 cm2 X-ray field by nickel, indium, and natural uranium activation foils. All foils returned comparable results. For instance, the total neutron fluence derived from indium foil is $7x10^6$ $n/cm^2/Gy$. This number is in the range with other studies of similar accelerators.

The results of our Monte Carlo simulations, which replicate the experimental set up, are presented and discussed.

Indicative Radiation Dose Rates in Selected Areas of Elevated Natural radioactivity in Greece

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The natural radiation status has been evaluated in three selected areas, two in the insular and one in the inland Greece of characteristic geological features and the impact of the chronic low level radiation on man and non-humans from various exposure pathways is assessed. The studied areas are described as: a) the island of Milos, located at 36^0 42΄N, 24^0 27΄E, is part of the Hellenic volcanic arc in the southern Aegean Sea, in Greece. This is parallel to the subduction zone of the lithospheric plates of the Eastern Mediterranean. The presence of geothermal vents in the Island results to direct and indirect influence on the abiotic material and organisms at all levels of life organization, as the underground hydrothermal fluids of elevated natural radioactivity emitted through the vents. Therefore, as some volcanic areas (in Greece and worldwide) are characterized by elevated concentrations of natural radionuclides, gamma-radiation measurements of abiotic materials (soil, ore, sediment, spring water, seawater) from the terrestrial and marine environment are of particular radiological interest. b) The island of Ikaria, 37^0 59΄N, 22^0 58΄E, is located in the eastern Aegean Sea. In the littoral zone around the island there are several geothermal springs of elevated natural background radioactivity and in the sub-littoral zone some springs emerge under the strata through the surface of the bottom to the seawater layer above. c) Loutraki, cited at 37^0 36΄N, 26^0 17΄E, is located in Korinthiakos gulf in central Greece. It is the southwestern edge of the Hellenic volcanic arc. Several springs are located in the littoral and sub-littoral zone and in the part of the area considered. The geological origin of the three studied areas, characterized by the presence of geothermal springs and vents seems to have an apparent influence to the concentrations of natural radionuclides in the abiotic components, which present elevated values compared to the mean background of Greec. Therefore, the metallic and/or thermo-metallic springs can be considered the responsible agents of carrying on natural radionuclides in the environmental abiotic components and biota consequently for the studied areas, especially for the island of Ikaria. Nevertheless, the derived dose rates, although higher compared to other Greek areas, are lower than the permissible maxima for human use, whereas for non-humans the estimated dose rates lie between the well-being and the physiological masking zone, according to the conceptual model of the ecosystem damage in terms of the various levels of life organization.

Key words: Natural radioactivity, Geothermal springs, Metallic springs, Volcanic arc, Aegean Sea

3D Modeling of the New Microbeam Setup at INP, NCSR "Demokritos" *

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The newly installed, state-of-the-art microbeam setup has a central role in the future expansion of research activities at the Tandem Accelerator Laboratory of NCSR "Demokritos", especially regarding applications of nuclear physics. The setup will deliver beams of micrometer size through a specially designed set of beamlines and optical components.

The large range of applications requires excellent knowledge of the beam optics, which depends largely on the space configuration and detailed positions of all focusing components. For that purpose, a detailed 3D modeling of the complete beamline has been carried out, using advanced CAD imprinting techniques. Special emphasis was given in the development of a library of modular 3D parts that will enhance the flexibility and reusability of the beam components in various configurations. In addition, the 3D modeling of the microbeam setup will assist in the accurate beam optics modeling by special simulation software in the near future.

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A Nuclear Electromagnetic Moments Database

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The latest upgrade of the Nuclear Electromagnetic Moments Database is described in detail. The database has recently reached a RC3 status after its entire redesign of the server engine. The database has been upgraded to a new operational framework based on MYSQL, PHP and XML online technologies, improving its performance, visual content and serving capabilities. It comprises all data on magnetic dipole and electric quadrupole found in relevant printed nuclear databases as well as a large variety of new information found in literature.

The dynamic content is supported by a blog, which contains all information scanned from e-journals and preprint archives on a weekly basis. The url of the database is http://magneticmoments.info.

N- and O-depth distribution by NRA for the investigation of the corrosion resistance of plasma nitrided and oxidized CoCrMo alloy

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The CoCrMo alloy has been widely used for biomedical applications (orthopaedic prosthesis) because of its corrosion resistance. On the other hand it is found that plasma nitriding at moderate temperature (~400°C) can improve the wear and fatigue resistance of the alloys. Thick nitride layers consisting of a supersaturated nitrogen solution (nitrogen concentration is ~30 at.%) in the matrix can be produced and can also affect the tribological and corrosion properties. Nuclear Reaction Analysis (NRA) in combination with Rutherford Backscattering Spectrometry (E_d: 1.75 MeV) was applied in order to obtain information about the N-and O-depth distribution in the surface of plasma nitrided and oxidized CoCrMo samples. The nitrogen depth distribution was determined using the $^{14}N(d,\alpha)^{12}C$ and the $^{14}N(d,p)^{15}N$ nuclear reactions whereas the oxygen by the $^{16}O(d,p)^{17}O$ (E_d: 1.35 MeV). Investigation of the corrosion behaviour of the samples was performed using electrochemical techniques (potentiodynamic polarization and cyclic voltammetry). The samples were electrochemically treated in simulated body fluid 0.9% NaCl (37 ^{o}C) in order to study their pitting corrosion resistance.

The samples subjected to plasma nitridation and oxidation exhibited the lowest deterioration and better resistance to corrosion compared to the nitrided and the untreated material. This could be attributed to the modified surface region with the high nitrogen content and the presence of oxygen.

Keywords: plasma nitridation; RBS; NRA; corrosion; CoCrMo alloy;

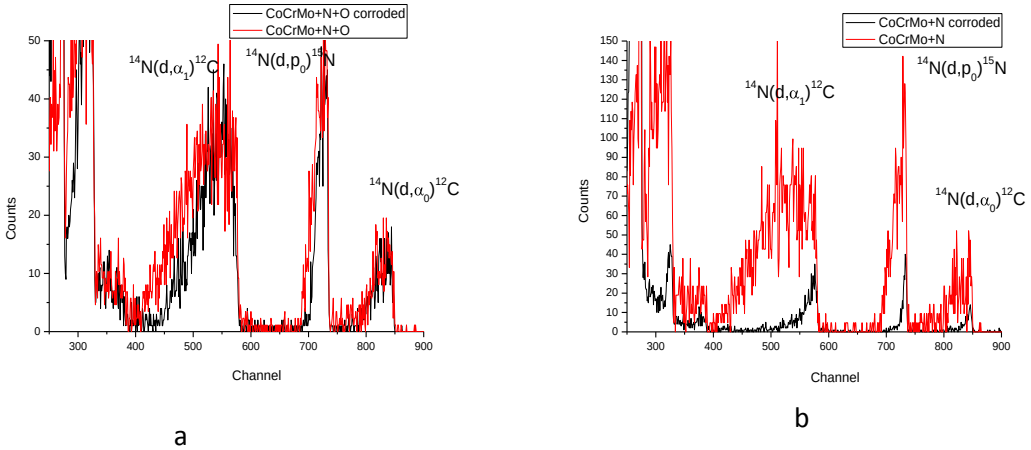

Fig. 1: NRA spectra of the CoCrMo+N+O and CoCrMo+N samples prior and after the corrosion testing in 0.9% NaCl solution.

Proton capture reactions for the p-process nucleosynthesis: the case of the Mo isotopes

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We report on recent (p,γ) reaction cross section measurements in the Mo isotopes at energies relevant to p process by employing the 4π γ-summing method [1]. The aim of these measurements was to derive an extended database of proton-induced capture reaction cross sections to test the predictions of the existing proton-nucleus optical model potentials that are used in abundance calculations of p nuclei.

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Systematic measurements of (α,γ) reaction cross sections for astrophysics applications

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A major nuclear physics uncertainty entering abundances calculations of p-process nucleosynthesis refers to the alpha-particle nucleus optical model potential (α-OMP). Aiming at developing a global microscopic α-OMP we performed a series of (α,γ) reaction cross-section measurements by using the 4π γ-summing technique [1]. The present contribution reports on the results of a number of (α,γ) reactions cross-section measurements in the Ni-Pd region. The data are compared with statistical model predictions

[1] A. Spyrou et al, Phys. Rev. C 76, 015802 (2007).