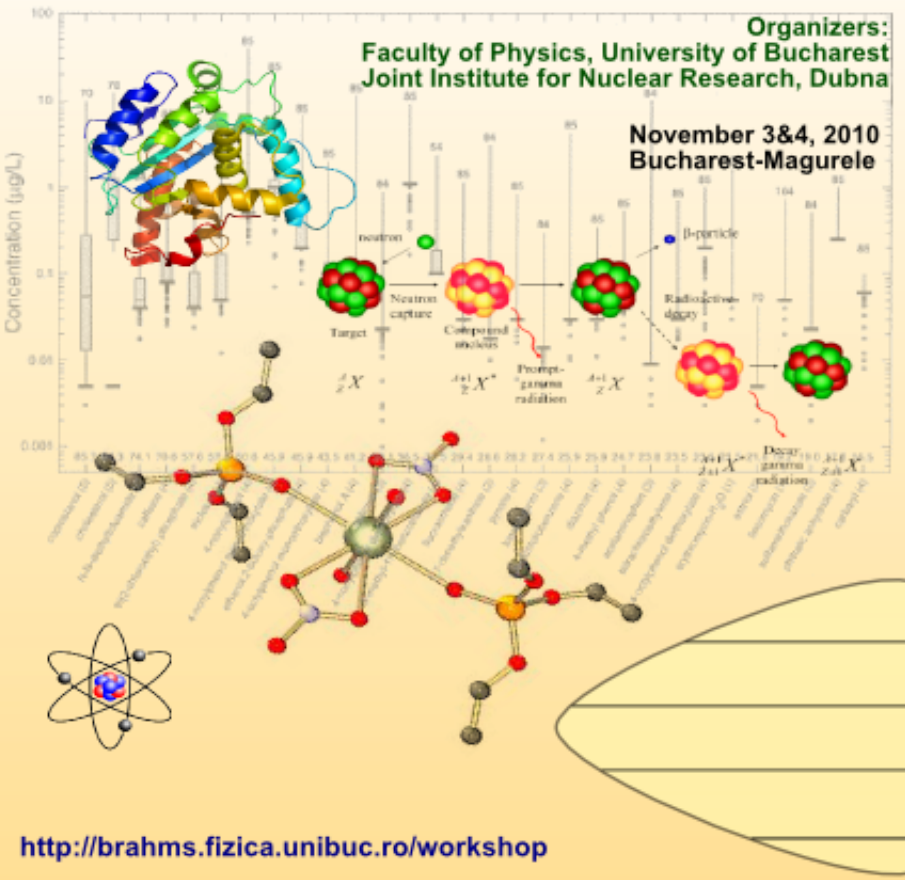
Workshop

Nuclear Analytical Methods and Applications



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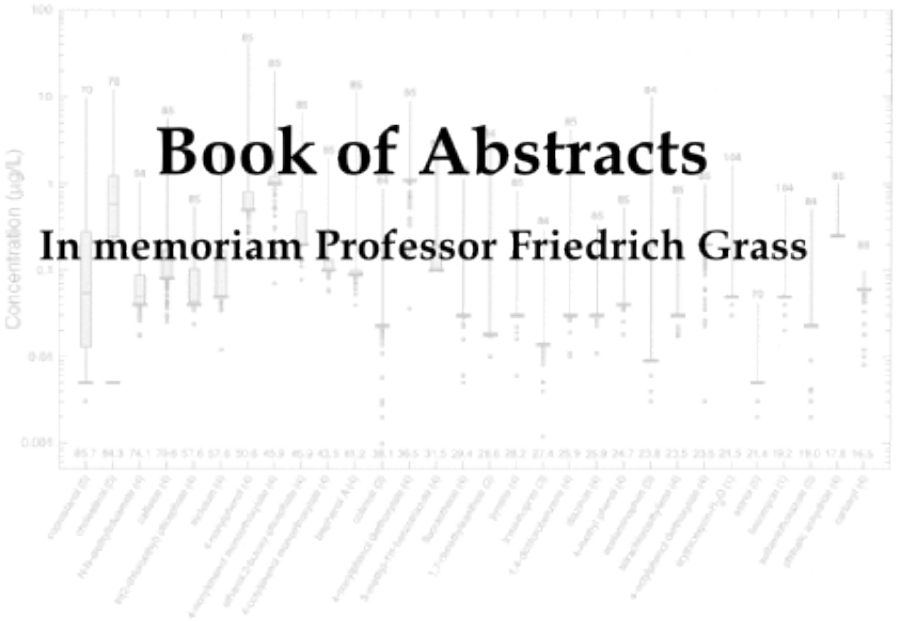
Workshop

Nuclear Analytical Methods and Applications

November 3&4, 2010
Bucharest-Magurele



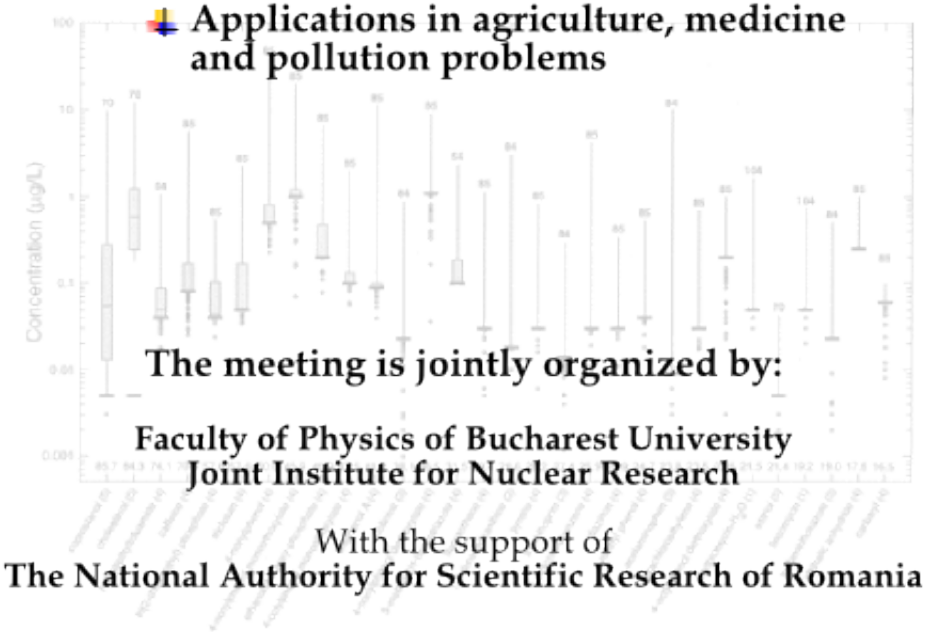
Book of Abstracts

In memoriam Professor Friedrich Grass

Editors:
Cristina Oprea
Alexandru Jipa
Ioan Alexandru Oprea
Petru-Mihai Potlog
Alina-Tania Neagu

Scientific Topics

- **Methodological aspects**
- **Material sciences**
- **Applications in agriculture, medicine and pollution problems**



The meeting is jointly organized by:

Faculty of Physics of Bucharest University
Joint Institute for Nuclear Research

With the support of
The National Authority for Scientific Research of Romania

Scientific Committee

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Prof. Octavian Sima
Dr. Johanes Sterba
Dr. Melissa Denecke
Dr. Cristiana Oprea
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Phd. Petru-Mihai Potlog (ISS)
Phd. Alina-Tania Neagu (ISS)

Agenda

Programme at a Glance

The final schedule of the scientific sessions, lectures and posters

Tuesday, November 2	17.00 - 19.00 20.00 - 22.00	Registration (Hotel IBIS) Welcome party
Wednesday, November 3	08.30 - 08.45 08.45 - 09.30 09.30 - 11.00 11.00 - 11.30 11.30 - 13.00 13.00 - 14.30 14.30 - 16.00 16.00 - 16.30 16.30 - 18.00 18.00 - 19.00 19.30	Registration (A4 Lecture Hall) Opening of the Workshop Morning Session 1 Coffee break Morning Session 2 Lunch Afternoon Session 1 Coffee break Afternoon Session 1 Scientific committee meeting Galla dinner
Thursday, November 4	08.30 - 11.00 11.00 - 11.30 11.30 - 12.00 12.00 - 12.30 12.30 - 13.30 13.30 - 17.30 17.30	Morning Session 3 Coffee break Poster Session Round table Lunch Excursion Closing of the Workshop Departure

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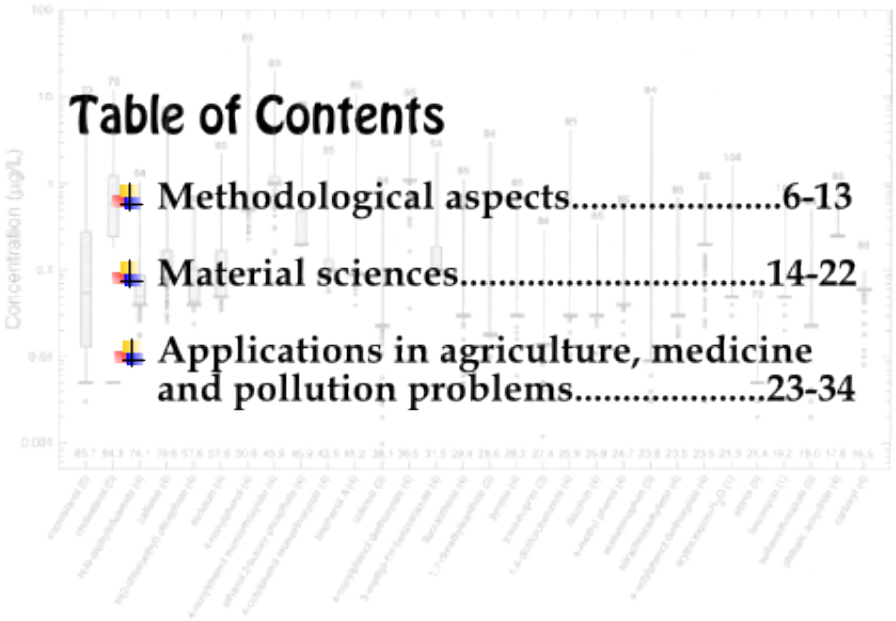

Abstracts Methodological Aspects

ORAL COMMUNICATIONS

Neutron Absorption Activation Analysis

Georg Steinhauser

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Instrumental Neutron Activation Analysis is a sensitive method for the determination of many elements. Unfortunately, some elements cannot be quantified despite their large neutron absorption cross section of one isotope, because the nuclear reaction yields a stable nuclide or a radionuclide which is difficult to measure. In particular this refers to lithium (^{6}Li), boron (^{10}B), cadmium (^{113}Cd), gadolinium (^{155}Gd and ^{157}Gd) and, in the broadest sense, to fissile material (^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu). Here, we propose of a novel nuclear analytical method with which these nuclides can be determined quantitatively. The principle of the method is that the neutron flux depression in a sample is correlated directly to the concentration of the neutron absorbing nuclides in the sample. The fundamental idea of the proposed method – Instrumental Neutron Absorption Activation Analysis (INAAA) – is to add an activatable nuclide (indicator) to the sample prior to activation and to compare the resulting specific activities of the pure indicator and sample+indicator via a

calibration curve. Due to the neutron flux depression in the sample with increasing amount of analyte, the curve represents a reciprocal exponential function, which in fact offers several advantages. INAAA combines some advantageous principles of both Instrumental and Prompt Gamma Neutron Activation Analysis. A preliminary experiment for boron evidences the validity of this approach. The detection limit for boron is in the sub-100 µg range and will be improved for the analytes with even higher cross sections, namely cadmium and gadolinium, by 1-3 orders of magnitude, respectively. The novel method can be applied in various fields such as industry, medicine (Li, Gd), environmental sciences (Cd, B) and it offers an interesting independent analytical approach to the determination of fissile materials including ^{6}LiD-thermonuclear fuel. It is therefore of special interest also for nuclear forensics.

Analytical Techniques in the NIPNE Applied Nuclear Physics Department: Developments, Current and Future Applications

Angela Vasilescu

Horia Hulubei National Institute for Nuclear Physics and Engineering, 077125 Bucharest, Romania, E-mail: angela.vasilescu@gmail.com

Various nuclear techniques are used and developed in the Applied Nuclear Physics Department of the Horia Hulubei National Institute for Nuclear Physics and Engineering (NIPNE). Some of these are accelerator based, using e.g. the NIPNE Tandem van de Graaff accelerator or the local cyclotron (like AMS, PIXE, RBS), and some facilities are developed in our department. We also participate in European projects using

infrastructure on other sites (ANKA/Karlsruhe, BESSY/Berlin, AN2000 at LNL/Legnaro, etc) for applications. Medical and environmental applications, biomaterials and material science, geology and archaeometry are some of the main directions of applied research. The status and description of some of these developments will be given in this presentation (positron spectroscopy, tomography, XRF) and illustrated with examples of studies of geology and metallic artifacts. Some of our interesting results have been obtained by micro-PIXE at LNL and SR-micro-XRF at ANKA and BESSY, non-invasive tools for detailed examination and mapping of inclusions of minor and trace elements in provenance studies in archaeometry. These techniques double the local experiments offering a more global picture of the samples and give deeper insight in our evaluation of the samples analyzed, being capable of detecting and measuring localized smaller quantities of minor and trace elements, profiling and mapping inclusions.

Progress in Modeling Detection Efficiency in Gamma Ray Spectrometry

Octavian Sima

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Present day gamma-ray spectrometry is subjected to demanding requirements with respect to detection limit, uncertainty and throughput of the laboratory. Frequently volume sources are assayed by high efficiency HPGe detectors. In such cases strong self-attenuation and coincidence summing effects affect the efficiency calibration. Experimental calibration is

limited to a small number of measurement configurations. In order to achieve a comprehensive calibration of the spectrometer mathematical methods, especially Monte Carlo simulation, are very useful in complementing experimental calibration. In this work our recent results concerning efficiency calibration using Monte Carlo simulation are presented.

Paleodose Evaluation Using Gamma Ray Spectra Analysis

Rares Suvaila, Octavian Sima

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The present work deals with testing the possibilities of dose debit determination for natural radioactivity contribution to paleodose for Roman period samples collected from the southern Romania area. Soil samples are measured using a close to peak area subtraction in order to evaluate Uranium, Thorium and potassium contributions in terms of gamma ray irradiation. Data analysis is performed using in house software, dedicated to this type of low activity generated spectra.

The results indicate accurate determination of that natural radionuclide contribution, and also a way to calculate Cesium contamination’s contribution, which has been brought to the roman period soil layers by water diffusion over the last years.

On Homogeneity of Volume Sources in Gamma Ray Spectrometry

Elena Stancu, Rares Suvaila, Octavian Sima

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In this work we investigate the possibility to observe non-homogeneity effects, if present, in γ-ray emitting volume sources. To this aim a cylindrical ^{133}Ba source was measured with the cylindrical surface in contact with the detector end cap in several equivalent positions. In the case of a homogeneous source the count rate in the peak corresponding to a specific energy should be statistically the same in any position of the source. If there are departures from homogeneity, they should induce deviations in the count rates that we expect to be different in the case of normal γ-ray peaks than in the case of pure sum peaks. Indeed, in the first case the efficiency is proportional with the solid angle while in the second it is roughly proportional with the square of the solid angle, so the two cases sample the inhomogeneity in a different way, the sum peaks being more sensitive to inhomogeneities. On the other hand, also the uncertainties of the count rates are different, so the statistical significance of the deviations is also different. Therefore it is interesting to test the homogeneity by using the count rate both from normal γ-ray peaks and from pure sum peaks.

New Advances in Methodology of Photon Activation Analysis

Oleg D. Maslov

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The methodology is a doctrine about organization of activity directed on reception of new result. To organize activity means to order it in complete system with the precisely certain characteristics, logic structure and process it of realization. When we speak about the new tendencies in methodology of photon activation analysis, we should take into account all complex of questions arising thus. It concerns and to installation (MT-25 microtron), to expansion of methods of the analysis, that includes a variety of objects for research, purposes and tasks, that determines a choice of that or other method of the analysis. If not to deviate in the party the offered name of paper, we simplify a task and speak about methods and their new advances and further development from the point of view of photon activation analysis only. Photon activation analysis can be realized in instrumental variant, i.e. without decomposition of a sample (use of various energy of photons for an irradiation), and also in chemical variant, with preliminary chemical concentration of elements with subsequent by photon irradiation or in radiochemical variant – concentration of elements researched after the irradiation of the sample. All these opportunities are realized at track analysis of elements testing compelled fission at irradiation by photons.

POSTERS

MT-25 Microtron

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The compact electron accelerator – the MT-25 microtron is the simplest and accessible source of radiation. The accelerated electrons are extracted from the microtron to a stopping target to produce gamma-rays or are directed into a uranium-beryllium converter to produce neutrons. The uranium-beryllium converter is placed into the middle of a graphite cube with a 120 cm side, which is the main neutron moderator.

The MT-25 is used for investigation of (γ, n), (γ, α), (γ, p), (γ, f), (e, γ), (e, f), (n, γ), (n, f) and other nuclear reactions which can be used for a great number of different methods and technique, such as photon activation analysis and thermal or epithermal neutron activation analysis, track analysis, production of radioisotopes and radioactive beams. Track method of activation analysis with chemical separation before the irradiation provides detection limits for ^{232}Th, ^{238}U, ^{237}Np and ^{239}Pu equivalent down to $1\cdot10^{-13}$ g, $5\cdot10^{-14}$ g, $3\cdot10^{-14}$ g and $2\cdot10^{-14}$ g, respectively.

On the Possibility of Use of the Neutron Spectroscopy Methods for Elemental/Isotopic Analysis at IREN

Pavel V. Sedyshev

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Processing of Experimental Spectra Obtained in Neutron Reactions

Ioan Alexandru Oprea, Cristiana Oprea

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Using different nuclear quantitative methods we have obtained experimental spectra of the gamma rays and/or charged particles emitted in the neutron reactions. Depending on the type of experiment it is possible to extract the cross section of the *(n, p)* *(n, γ)* and *(n, α)* reactions. In all cases the spectra were obtained from target with finite thickness and are affected by a large background due in principal to the *(n, γ)* reaction. One of our task is to separate this background with the help of numerical simulation methods. This is very important especially in the quantitative experimental evaluation of the sample content where usually the cross section is large for low energy neutrons and also interference effects should to be quantified and substracted.

Abstracts Material Sciences

ORAL COMMUNICATIONS

NAA in Experimental Archaeology

Johannes H. Sterba

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Natural clay beds are hardly ever usable to make working ceramics. Thus, even today, several processes are necessary to produce the paste that can be formed and fired into ceramic wares. In most cases, the natural clay is cleaned by levigation and tempered with a coarse fraction to reduce shrinkage during drying and firing.

Tempers used are sands, organic material or even ground mis-firings. This addition of material changes the final chemical composition of the finished product. In most cases this change is significant enough to severely disrupt the traditional way of provenancing by chemical fingerprinting techniques. Depending on the method of analysis, several tempers, like quartz or organic material, will result in a dilution of the chemical fingerprint, since the main components are not visible in the analysis. 1988 a statistical filter was proposed by Mommsen et al. that specifically removes this dilution from analytical data obtained by INAA.

Since archaeological artefacts are highly valuable objects of the cultural heritage, large samples can hardly be obtained. Furthermore, for most artefacts neither the original firing temperature nor the tempers used are known or obtainable. Therefore, several pieces of experimental ceramics have been produced form known sources of clay and tempers. They have been fired at different temperatures and sampled with different sampling methods. The data produced from those experimental pieces shows that the statistical filter is a valid method to remove variation in the samples introduced only by the temper. It also shows that different firing temperatures and different sampling methods have almost no significant influence on the final chemical fingerprint.

Application of X-Ray Spectroscopy Methods at ANKA to Issues Concerning Nuclear Waste Disposal

Melissa A. Denecke

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The Institut für Nukleare Entsorgung (INE) at the Karlsruhe Institute of Technology (KIT) operates a beamline dedicated to actinide research at the synchrotron source Ångströmquelle Karlsruhe (ANKA). Experiments on radioactive samples with activities up to 10^6 times the limit of exemption inside a safe and flexible double containment concept are possible. One great advantage of the beamline is its close proximity to INE active laboratories. Samples can be prepared and then characterized and

analyzed before and following synchrotron-based investigations at the INE-Beamline using the state-of-the-art spectroscopic, analytical, microscopic, and structural methods available at INE laboratories. This constellation is unique in Europe.

The INE-Beamline is optimized for X-ray absorption spectroscopy techniques (XANES/EXAFS), but x-ray fluorescence (XRF) analysis, powder diffraction (XRD) and high resolution x-ray emission spectroscopy (HRXES) are also possible, as well as surface sensitive measurements in grazing incidence geometry (e.g., GI-XAFS). Using a focused X-ray beam, spatially resolved studies and investigations of small volumes (µ-XRF, µ-XANES, µ-XRD) can also be performed. In this presentation the INE-Beamline modular design will be shown. Using a number of selected examples related to high level nuclear waste disposal safety, basic measurement principles and variable sample cell design will be presented.

TDPAC Method in Condensed Matter Science

V. B. Brudanin, D. V. Filossofov, O. I. Kochetov, D. V. Karaivanov, N. A. Lebedev, A. F. Novgorodov, V. N. Pavlov, A. V. Salamatin, A. I. Velichkov, L. N. Fomicheva* and A. V. Tsvyaschenko*

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A four-detector perturbed angular γγ correlations spectrometer (fig. 1.) is developed for investigation of hyperfine interactions in condensed matter. The experimental set-up contains cryostat and high-temperature oven and allows measurements in temperature range from 90 to 1300K. An

encased electromagnet makes it possible to generate a magnetic field up to 2T on a sample.

The measurements system also includes a press with a specially design high-pressure chamber allowing on-line PAC measurements in samples under pressure up to 60 GPa. Using the isotope 111Cd we applied a new method to measure on-line perturbed angular γγ correlations under pressure up to 8GPa. The calibration of pressure is taking from independent γγ-PAC measurement on ^{111}Cd in Zn. For example in our γγ-PAC experiments under high pressure it was found that the quadrupole frequency ν_Q measured on the ^{111}Cd located at the Al sites in $YbAl_2$, varies nonlinearly and increases by almost four times with the pressure increase up to 80 kbar. A linear correlation (fig. 2.) between the mean Yb valence, derived from Yb L_3 OFY-XAS and RXES measurements, and the electric field gradient (the quadrupole frequency $\nu_Q = eQV_{zz}/h$) is observed.

Fig.1. The 4 detectors P AC spectrometer and a press with a specially design high pressure chamber.

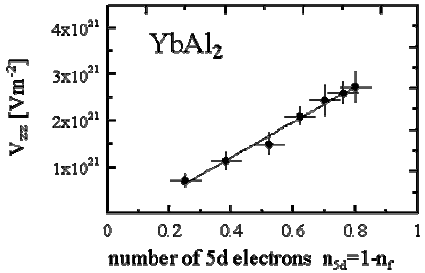

Fig. 2. The electric field gradient V_{ZZ} for ^{111}Cd in $YbAl_2$ versus the number of the band f-electrons having passed into the 5d-band ($1 - n_f = n_{5d}$).

The possibility of

determining the valence of Yb in the Yb compounds with ***sp***-metals from the relation ν_Q (υ(P)) = ν_2 + (ν_3 - ν_2) υ(P) is considered.

Also are shown a few examples to apply the PAC in water solutions – study the fluctuating electric field gradients in ice and the water-methanol solutions. It was represented that the perturbation factors $<A_2G_2>$ (integrated over two mean lives τ_N) don't follow the dependence of macroscopic viscosity η. In that case the fluctuating electric field gradients are the mine factor in perturbation of angular γγ correlations.

Analyzing the Linear Responses of Inorganic Crystals Exposed to High Rose Rate by Lissajous Figures

Song Zhaohui, Li Gang, Guan Xinyin, Zhang Zichuan, Zhang Wenyu

Northwest Institute of Nuclear Technology, Xi'an 710024, China

Inorganic crystals are often used in the field of pulse radiation diagnosis. When the dose rate is too high, the light output of the crystals would be nonlinear. So, it is important to know what the upper limit of a new inorganic crystal before it would be applied to the formal diagnoses.

The linear responses of inorganic crystals exposed to high rose rate were analyzed by Lissajous figures. In the experiments, two pieces of crystal with the same type and sizes were irradiated by the pulsed gamma rays of the equipment "High Light-I". Each piece of crystal was coupled to a photodiode, output currents of which were recorded by a digital oscillograph. One piece of

crystal was fixed far from the target, another one was moved near to the target little by little.

After a pulse irradiation, two waveforms were recorded by the oscillograph simultaneously. Then a Lissajous figure was drawn by two waveforms. From the figures, the light output was linear or not could be judged easily. At the same time, thermoluminescence dosimeters were used to measure the intensities of the incidence gamma rays. According to Lissajous figures and the corresponding dose rate, the linear response upper limits of the crystals were deduced. The results of the experiment show that the light response of CeF_3, LSO and $PbWO_4$ is still linear when the gamma energy flux rate is below 8.0e17MeV/cm^2·s, 1.9e19MeV/cm^2·s and 6.0e19MeV/cm^2·s, respectively.

The PAC Studies of Water Solutions Physicochemical Organization at Temperature below 0^0C

D. V. Filossofov, D. V. Karaivanov, C. Oprea, I. A. Oprea, A. V. Rakhimov and A. I. Velichkov

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^{111}Cd – time-differential PAC measurements have been made using the high specific activity of ^{111}In in the eutectic concentrations of HNO_3 (32.7 w. % HNO_3, T_{eut}= - 43 ^{o}C), $HClO_4$ (40.7 w. % $HClO_4$, T_{eut}= - 60 ^{o}C) NaOH (19,1 w. % NaOH, T_{eut}= - 28.2 ^{o}C), KOH (34.1 w. % KOH, T_{eut}= - 78 ^{o}C) and 0.1M HNO_3 and 0.1M $HClO_4$ - aqueous solutions at the temperature range between 20 ^{o}C and –100 ^{o}C.

The motivation of the present work was to reveal the factors answerable for the dynamic character of the perturbation of the angular correlation in the frozen aqueous solutions even though at the junction of the eutectic temperature. It was supported the similar dynamic character of the time spectra for the considered eutectic solutions at the temperature below T_{eut}. At the same time the obtained results are different for the identical solutions samples with the various means of the preliminary freezing ("slow" and "fast"). The "slow" is the standard way while the "fast" (or "shock") freezing is the method of the sample solution spitting in the vial with the liquid nitrogen. The results of the temperature TDPAC studies for the "slow" and "fast" samples of the eutectic NaOH is shown in Fig.1. Also we observed the

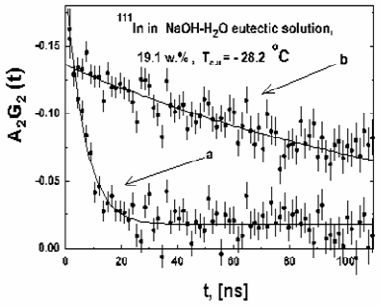

Fig.1. TDPAC spectra of the 171-245 γγ-cascade in ^{111}Cd, measured at the temperature T= -36 °C: a) fast and b) slow freezing. Exponential function was used to fit data.

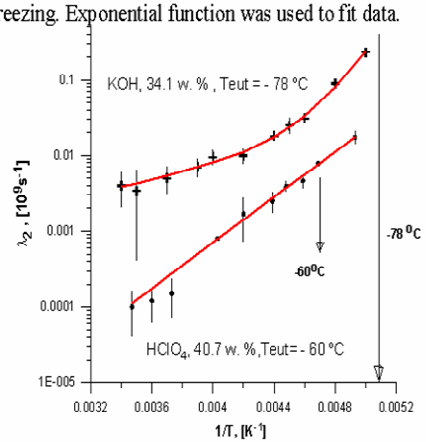

Fig. 2. The relaxation parameter $\lambda_2(T)$ for the eutectic aqueous solutions of KOH and $HClO_4$ versus temperature. We used to fit data one exponent for $HClO_4$ and two exponents for KOH.

same dynamic character of the perturbation of the angular correlation in the liquid aqueous solutions of $HClO_4$ and KOH at temperature below 0^oC (Fig. 2).

The results were analyzed in terms of a diffusion process approach which explains the observed effects due to the ice structure and hydrogen bounding.

POSTER

Vacuum Technology by ICSI Employed at the Reactor IBR-2

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In this paper the development and application of nuclear methods using critical technologies for the analysis of nuclear and magnetic nanostructure of different systems are presented. The work consists of 3 parts:

1. The modernization and use of the thermostat TS-3000K aimed for inelastic and quasi-elastic slow neutron scattering and neutron diffraction experiments in vacuum in condensed matter field, over a very large temperature range (up to 3000 K);
2. The analysis of the nanostructure of Fe-Cu alloy performing measurements in vacuum by RBS and PIXE methods at the EG-5 Van der Graaf electrostatic accelerator of FLNP, JINR;

3. Environmental researches conducted on different ecological objects by NAA and IGAA methods at the microtron MT-25.

The present researches within the frame of the three international priority directions: i) industry of nanomaterials and nanosystems, ii) vacuum technology; iii) rational use of natural resources are accomplished. The results proved that various traditional and new properties of materials which pose a structure at nano level are perspective to investigate by applied nuclear methods.

Abstracts Applications in agriculture, medicine and pollution problems

ORAL COMMUNICATIONS

Radon Implication in Life and Earth Science

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The isotopes of radon ^{222}Rn and ^{220}Rn are the direct descendants of ^{226}Ra and ^{224}Ra radioisotopes. They are involved in many practical studies of medical, geological, climatic and other scientific aspects.

Radon contributes in average with about 50% at the natural irradiation of people in the whole word and it is considered as responsible for a part of lung cancer death, being proved the second main cause for this illness after smoking. In radon risk areas (radon prone areas) this contribution is much higher until 90-95% growing the natural dose exposure of 5-10 times. His contribution to the word mortality was estimated to be of 0.8 – 1.2 %, bigger as other natural causes (fires, transport accidents, floods).

Radon anomalies are connected with some important geological features as presence of uranium and thorium agglomerations, faults or fissures evidence or volcanism manifestations. In many actual researches radon is considered as a possible precursor for earthquakes prediction.

This work presents some methodological aspects of radon measurements (soil and indoor), preliminary indoor radon exposure in Romania, in particular in Stei-Baita area where special aspects were observed. Also connection between radon concentrations and some faults and fissures from Romania are presented. In the last time, a study on the Peceneaga-Camena active fault was started.

Activation Analysis Methods Applied for Traceability of Pollution Trends. Biomonitoring Approach

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Nuclear Analytical techniques could provide the basic tools for certifying environmental natural-matrix and for verifying environmental and radioanalytical test samples for the traceability evaluation. Natural-matrix of environmental samples provides the basis for the assessment of the cleanliness of the natural ecosystems, the air quality and consequently the human health environmental conditions. In the present project, some environmental pollution indicators, such as some known biomonitors, soil and others, all from a natural ecosystem greatly

affected by natural and anthropogenic causes, should to be characterized by several methods and techniques of activation analysis at the microtron MT-25 and XRF analysis. The space and time integrated sampling of surface area over transects will reveal pollution source, the physical and biological status of the region and prevailing atmospheric masses circulation that move the contaminants to/from that region. Different examples of the use of radioanalytical methods to probe key questions about the environmental media evaluation in view of the sources patterns of the main pollutants were already been tested and will be further investigated. Several aspects as radiochemical methods validation, demonstration of traceability for environmental radionuclide measurements, and the basis for measurement comparison over time comparing with data from literature are foreseen.

Researches of Microelemental Contents of Tomatoes Resistant to Root-Knot Nematodes by X-Ray Fluorescence Analysis

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Root-knot nematodes *(Meloidogyne* spp.) are small, worm-like animals which are very common in soil. They have a wide host range, causing problems in many annual and perennial crops. Tomatoes are among the most seriously affected, with the nematodes causing problems in all growing areas. Root-knot nematodes cause an estimated about 20 % loss in economically important vegetable and fruit crops each year. Meloidogyne is

most commonly controlled using resistant varieties and chemical application.

Typically tomatoes have been used as an indicator plant to evaluate nematode galling. However it may take three months to receive results, when struggle with parasitic invasion is already practically impossible. In this connection it is necessary to develop and faster methods of estimation on stability to root-knot nematodes.

It is known, that some microelements are components of the enzymes which are taking part in reactions of formation necrosis at vegetable plants after nematodes invasion. Therefore microelement distribution in tomato bushes resistant to root-knot nematodes and element contents of 40 samples of tomato roots have been researched by X-Ray fluorescence analysis (XRFA). It is established, there is a distinction in the content of elements K, Ca, Fe, Cu, Zn, Rb, Sr in the different variants of samples. Between the content of elements Fe and Sr correlation is found out in plants with various degree of a susceptibility to root-knot nematodes (susceptible, tolerant and steady). The received preliminary results allow making the conclusion about possibility of the express-analysis of a plant physiological condition by XRFA using a portable spectrometer.

PCA Based Neural Network Used in Interpretation of Data Sets Obtained in Multielemental Analytical Measurements

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There are a few methods of factor analysis: the centroid method (used before computer era), alpha factor analysis, principal component analysis, maximum likelihood factor analysis, image factor analysis. One of the most used and effective is the principal component analysis based on the eigenvalue and eigenvector technique. The maximum likelihood factor analysis is based on the minimization of a function representing the “distance” between the observed covariance matrix and predicted values of this matrix.

The listed methods give different results and in order to find a compromise among many criteria, factor analysis extended by neural network models has to be carried out. Factor analysis based neural-network approach was applied to characterize chemical composition of samples measured by several analytical methods. The neural network is a computer procedure which simulates the informational processes from biological systems. The factor analysis problem can be solved using an energy function of a neural network.

For example, the approach developed in this study enabled the separation between various sources of elements deposited in environmental samples.

Microanalysis Investigations of Human Teeth

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The analytical techniques of PIXE, RBS, IPAA and XRF were used for measurement of elemental concentrations in the tooth enamel and knowledge of different phenomena during the time - as short or long-term exposure of the population, or diffusion of heavy metals at the tooth surface. The metal concentrations in dental enamel of urban population were compared and their correlation matrix was examined in order to distinguish between various sources of the tooth enamel.

The results demonstrated that analytical techniques supplemented by multivariate statististical analysis is a useful and practical approach for the investigation of trace heavy metal incorporation and distribution on the surface of teeth as well as in inner layers.

The statistical analyses performed seem to indicate that deciduous teeth might be a suitable indicator of environmental exposure to several trace heavy metals.

Low-Level Tritium Measurements in Environmental Water Samples by Liquid Scintillation Counting

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There are two standard recommendations [1, 2] that specify a method for determining tritium concentration in water by liquid scintillation counting. Basically, the principle is the same with slight differences between the two chemical treatments of water samples. Distillation of water sample and measurement by liquid scintillation counting are common procedures for both recommendations.

The first step in establishing the routine procedure for our laboratory was to settle the appropriate method for determination of counting efficiency. The methods used to determine counting efficiency in the quench presence are as follows: Spectral Quench Parameter of external standard method (SQP(E)) and Internal Standard Method. In our study, a low background liquid scintillation system detector, Quantulus 1220, was used to determine tritium activity concentration in seven heavy water samples with different concentration levels from 99.66 D/H+D% to 1.65 D/D+H%.

A standard calibration curve for the SQP(E) technique has been carried out with ^{3}H low level quenched PACKARD standard set that had an assayed value of 29.240 dpm/std $\pm$ 1.6%. Quench correction for Internal Standard Method has been made for each sample of heavy water with Tritiated Water Internal Standard that had a tritium concentration of 2.51 x 10^{6} dpm/g $\pm$ 3.0%. The specific conditions used in our laboratory were: 20 ml

polyethylene vial, OptiPhase HiSafe 3 scintillation cocktail, 8:12ml ratio water: scintillant, 1000 minutes counting time (50 min/cycle and sample).

Once efficiency settled we focused on the sample preparation. We studied the above mentioned standard methods to determine tritium concentration in different types of water: drinking water, precipitation, surface water and wastewater. All samples were measured according to the two studied standards. Beside the Chemiluminescence phenomenon, there is some interference in the measurement process that leads to different results for the same water sample prepared by the two methods. Even if the differences aren't large, they exceed the uncertainty of the method. We decided that for our laboratory conditions: equipment, practice and materials used routinely for monitoring program, ISO method would be appropriate.

[1] ISO 9698, Water Quality - Determination of tritium activity concentration- Liquid scintillation counting method, first edition 1989.

[2] APHA-AWWA-WEF, Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington DC, 7-39-7-41 19-th edition 1995.

POSTERS

Estimation of Environmental Radionuclide Concentration in Soils, a Comparison of High Resolution Gamma Spectrometry, Alpha Spectrometry and Instrumental Neutron Activation Methods

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A study was made in order to compare and test the performance of several methods for the annual radiation dose determination in luminescence dating. The following techniques were implied: instrumental neutron activation, high resolution gamma spectrometry, and alpha spectrometry. In the case of instrumental neutron activation ^{238}U, ^{232}Th and ^{40}K concentrations were determined using Zirconium standardization method. Detailed analysis was carried out by high resolution gamma spectrometry, the activities of different nuclides (^{234}Th, ^{226}Ra, ^{214}Pb, ^{214}Bi, ^{210}Pb, ^{228}Ac, ^{208}Tl) in the uranium and thorium chains being measured, as well as ^{40}K. The advantage of this method is that radioactive equilibrium or disequilibrium in the uranium series can be checked. In the present work, the direct measurement of ^{226}Ra which can give extra information on the interpretation of the radioactive equilibrium was implied. Since there is a serious spectral interference (up to 43%) on its 186.2

keV gamma line (by ^{235}U at 185.7 keV) the correction procedure was outlined. Radon loss due to sample preparation was also investigated and an average loss of 15% was observed, thus we stress upon the need for storing the samples for three weeks before measurement. Moreover, we undergone polonium, radium and uranium chemical separation, concentrations of ^{210}Po, ^{226} Ra and ^{238} U being also determined through alpha spectrometry. Analyses were carried out on five different soil samples taken from the archaeological site of Lumea Noua, Alba Iulia. The importance of these samples is related to the fact that they surrounded ceramic materials of archaeological interest that was collected for luminescence dating, thus the nuclide concentrations measured in this work and implicitly the dose rates determined can be directly used in the process of obtaining the age of this pottery. The results obtained through gamma spectrometry and neutron activation are consistent within error limits, the advantage of the latter over the first being that is more precise, while the advantage of the first over the latter being the conclusions upon equilibrium that can be drawn.

Neural Network Modeling of Elemental Content in Human Biosubstrata

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Human hair as biomonitor is usually assessed for long-term occupational and environmental exposure. In the present work, neutron activation analysis has been used to evaluate the

elemental content of human hair samples of a group of workers charged in fertilizer industry. In order to find the interrelationships between the elemental concentrations in human biosubstrata a NN (i.e. neural network) exploratory factor analysis was performed. The elemental concentrations data set showed a great variability. To this result can account different factors, as occupation, sex, age, and service stage. The NN multivariate analysis of the optimum data set discriminated between the sex-matched groups of subjects and the exposed and non-exposed subjects.

Elemental Content of Herbal Tea Used in Treatment of Several Diseases

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Recent scientific researches have confirmed the efficacy of many teas and herbal preparations, some of which are remarkable effective. Various plant parts have been a major source of drugs for the treatment of chronic ailments in the ancient traditional Romanian medicine system. In recent years a global trend has been noticed for revival of interest in traditional herbal medicine. Diabetes mellitus, rheumatism, hepatitis or heart diseases are commonly treated with specific medicinal teas. Many plants are considered as a rich source of essential and trace elements and are prescribed because of their good bioavailabilty and least side effects. Previously, we successfully determined the elemental

content of several medicinal herbs commonly used in Romania and the results were reported.

Further, a number of nuclear and atomic methods and related techniques are presently used to determine minor and trace elements in several medicinal tea plants. There will be tried also test measurements at the new neutron facility IREN, which was put in function this year.

XRF of Medicinal Herbs of Bucegi Mountains

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Since time immemorial and in all civilizations of the world different diseases has been treated with plant medicines such as *Achillea millefolium, Chelidonium majus, Cynara scolymus, Hypericum perforatum, Tilia cordata, Matricaria recutita, Mentha, Rosa Canina and Urtíca*, which have different household names in all parts of the word. Although the efficacy of herbs for curative purposes is often accounted for in terms of its organic constituents, it has been established that there exists a relationship between the chelating of metals and some chemotherapeutic agents. The chemical compounds of these herbs are mainly responsible for the curative properties. It is known that there is a significant role of trace elements when treating various diseases. The absorption of their active constituents into the blood can influence the body system and these chemical constituents present in the plant are responsible for their curative aspect. Few studies

have been reported about the elemental composition of medicinal plants in Romania.

The goal of this work is to determine the availability of essential trace elements in commonly used medicinal plants surveyed in Bucegy Mountains and their possible correlation from one medicinal herb to another.

The analytical evaluation of the medicinal plants samples included IPAA at the microtron MT-25 and XRFS measurements.

Monitoring of Atmospheric Pollution in Transylvania Regions. Public Health and Risk Factors

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During this reasearch we proposed to evaluate the risk factors induced by atmospheric pollution to human health in Transylvania regions. Atmospheric pollution with heavy metal particulates (i.e. Cr, Fe, Ni, Cu, Zn, Cd and Pb) of the investigated area was monitored by moss biomonitoring technique. The population health was monitored by elemental content of human teeth. The objectives of this study were accomplished. They were as follows: monitoring of atmospheric pollution using epiphytic mosses; human biomonitoring using teeth; the evaluation of samples by analytical techniques as PIXE, RBS, INAA and AAS; the standard and multivariate statistical analysis of data; the graphical representation of the results obtained, including GIS designing; correlation of the maps of pollution levels with

population health; and the determination of risk factors for environment and humans.

The monitoring strategy used in the present research identify the risk factors of public health responsible for certain pollutant levels, particularly for specific industry emissions.