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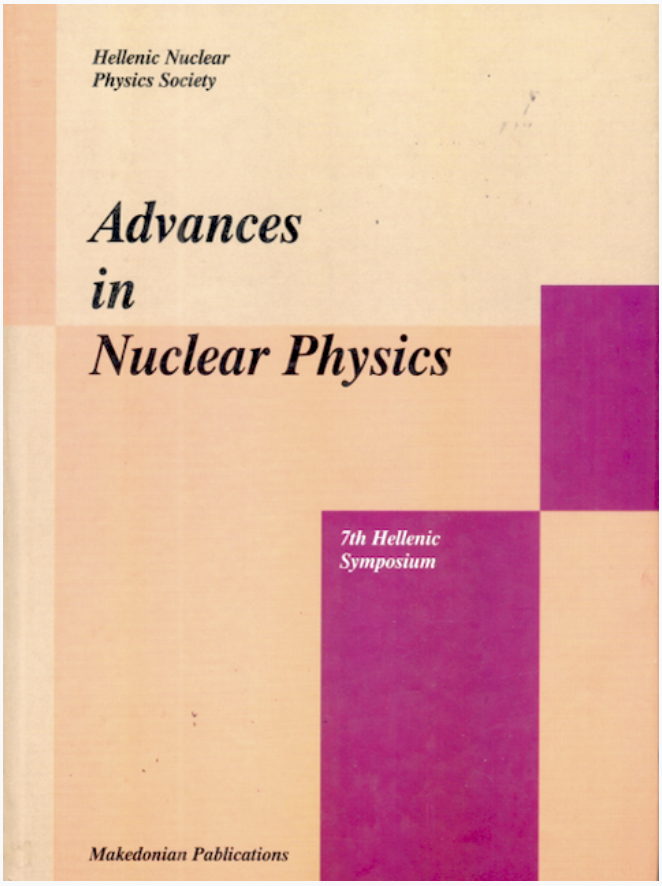

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The End of Nuclear Reactors

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Abstract

We have almost reached the half century of the application of the so called τNuclear energy for peace and it is time to face the presence of the nuclear reactors inside the nuclear cycle not only from the technological, but mainly from the social point of view.

Several nuclear events, characterize the aftermath of this kind of energy production. Of course, among them, the Chernobyl accident, the nuclear waste problems, and the dismantling of all power plants after their age of 30 years are dominating. Some other facts, give several problems which may be arisen by the presence of the nuclear cycle, like the possible radioactive contamination of the Mediterranean sea, the presence of new power plants in our neighbourhood.

But the fact, that depicts the clear end of the nuclear power plants is the very small number of the new reactors built yearly, which is the same as that of the decade of 1950. As a matter of fact, all nuclear reactors outputting their electrical power for 30 years should be closed and dismantled. This means no more electricity output, an enormous expensive and long lasting procedure until the whole unit will be converted to nuclear waste itself.

Atomic Clusters: Present and Future

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Abstract

Atomic clusters are characterized on the one hand by a rather glorious old past while on the other hand they keep a rather ordinary involvement in our every day life. For instance, atomic clusters seem to be just a little younger than Big Bang, and probably other than for their existence our universe may not have been developed the way we know it today. Specifically, the action of gravity, which helped the formation of the usual macroscopic matter, seems not to have started before the already created atoms coagulated first to produce large atomic clusters.

On the other hand our every day experience consists of numerous phenomena in which the presence and the action of clusters is involved. For instance, the smoke of burning cigarettes or candles is nothing else than atomic clusters of carbon, and the cloud formed above a cup of hot coffee is nothing else than molecular clusters of water, grown large enough to be visible by the naked eye.

If, however, clusters are indeed so old and so usual entities, one may wonder about the underlined reasons which caused the recent upheaval in atomic cluster research which has proliferated during the last ten years.

The first reason for that, of special interest to nuclear physicists, concerns our knowledge of the physical reality : it is very though provoking that the atomic clusters of certain simple metals are characterized by properties analogous to those of the atomic nucleus, although the acting forced seem to be of completely different nature. This correspondence in properties poses important new questions which may lead us towards a more unified understanding of matter and nature.

The second reason, and probably the most pertinent to explain the huge investment devoted to that field, is of technological and in final analysis of economic significance. Specifically, it has to do with the realization that the most of chemical, physical and probably biological properties of specific atomic clusters depend on the number of the atoms constituting the cluster, and as a rule these properties are not the same with those of the usual bulk matter.

Consequently, any specific cluster corresponds in fact to a novel material. In that manner, not only the periodic table of chemical elements acquires a third dimension and a few thousand new members, but also an unlimited pool for the synthesis of new materials becomes suddenly available.

It is indicative in that respect that nanostructured copper, composed of atomic clusters with about 3000 Cu atoms per cluster is 500% harder than the usual copper

metal.

In conclusion, it appears that the countries mastering cluster technology will also acquire definite technological and important economic advantages. Japan, USA and certain European countries are already quite advanced. Whether it may or may not be already too late for Greece, this will depend on the intensity of our relevant research and development effort in which, due to the interdisciplinary nature of the field, several different talents and specialties should cooperate and contribute.

The present level of advancement of the relevant research effort as well as the future perspectives will be presented and critically discussed.

High Flux Neutron Production from High Energy Nuclear Reactions

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Abstract

Last years a new type of Power Nuclear Reactor is under development. Their operation principle is based on high neutron multiplication which is obtained by heavy ion reactions at high energies (>1 GeV) on heavy targets. The whole neutron multiplication depends on neutron production in the source, neutron moderation and reactor geometry.

In this work a new type of neutron source is studied. Experiments were performed in the Dubna Synchrophasotron accelerator [LHE] with ^{12}C ions of 1.5, 1.8 and 3.5 GeV/n. Cu and Pb targets were used. Results are given for thermal and fast neutrons produced in the target. Neutron measurements after the moderator were also given. For neutron estimation different experimental methods were used and compared.

The Response of a Passive Neutron Dosemeter Based on CR-39 Nuclear Track Detector in a Real Neutron Field

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Abstract

A passive neutron dosimeter based on a CR - 39 nuclear track detector has been developed. The use of a polyethylene moderator 1 cm thick with ^{6}Li or ^{10}B (n, α) converters extends the energy range of the detecting neutrons from thermal up to 15 MeV. The polyethylene plate acts also as a recoil protons radiator. The detector is not sensitive to γ rays and then the dosimeter is suitable for neutron dosimetry. The dosimeter has been tested in the real field of the subcritical nuclear reactor of the Nuclear Physics Laboratory. The results of the proposed dosimeter have been compared with a rem counter at the same irradiation conditions.

Medical Imaging and Radiotherapy: The Intersection between Nuclear Physics and Contemporary Biomedical Technology

B. Spyropoulos, I. Kandarakis, D. Kavouras

Technological Educational Institution of Athens Medical Instrumentation Technology Department

Abstract

Introduction: A century after the birth of X - rays a very important part of the contemporary Diagnostics is theoretically based on Nuclear Physics and employees the associate technology, thus, progressing the revolution in Medicine introduced by Conrad Roentgen, though the medical application of accelerators and Radioisotopes, the use of CT, SPECT, PET and MRI.

In the present paper the educational and research activities, related to Medical Imaging and Radiotherapy, of the Biomedical Technology Group, of the Medical Instrumentation Technology Department (MITD), of the Technological Educational Institution of Athens will be pointed out.

Education: A major part of the specialty lectures, practicals, final projects and on the job training of the students of the MITD students, is covering the subject - matter of the Technology applied in Radiology, Nuclear Medicine and Radiotherapy, Medical Image and Signal Processing, Dosimetry, Radiation Protection, Safety and Quality Assurance.

There is also a long - term participation and contribution to these fields of studies, in the European Postgraduate Courses in Biomedical Technology and in Medical Physics, based in the University of Patras and the Postgraduate Medical Physics course of the Greek Atomic Energy Commission. Last, but not least, there is student and stuff mobility between European and US University and the MITD.

Research: Following Research and Development activities of the MITD are related someway to Nuclear Physics:

Medical Imaging: Evaluation of the new materials (Y_2O_2:Tb, Y_2O_2Eu, Gd_2O_2S:Tb, La_2O_2S:Tb, ZnSCdS:Ag) for the improvement of phosphor screens. Development of a electro - hydraulic, computer driven, dynamic heart phantom, for quality control applications in MRI, CT and Nuclear Medicine. Software development for tissue and nodule characterization and for the study of anatomical alterations.

Radiotherapy: Development of a system for the estimation of biophysical parameters such as the Extrapolated Response Dose [ERD] , the Tumor Response

Probability [TCP] and the Normal Tissue Complication Probability [NTCP] in Radiotherapy. Monoparametric representation of cell-line Radiosensitivity against Ionizing Radiation of different LET and application schemata. Development of multi - purpose dosimetry techniques and radiation monitoring systems.

Perspectives: Several programs concerning quality assurance, environmental monitoring and radiation effects on materials are in planning or under development.

Collective Reactions in the Continuum

P. Demetriou, A. Marcinkowski and P.E. Hodgson

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Abstract

We show that pre-equlibrium inelastic scattering reactions to the continuum contain substantial collective components in addition to the multistep direct and multistep compound reactions. These collective reactions are investigated for the vibrational nuclei ^{56}Fe, ^{58}Ni, ^{90}Zr, ^{93}Nb, ^{208}Pb and ^{209}Bi, and the strongly-deformed, rotational W nucleus. The collective cross-sections are calculated using the experimental data for low-lying collective excitations supplemented where necessary by the giant multipole resonances evaluated using the energy-weighted sum rule. The M-SC and MSD cross-sections are evaluated by the Feshbach-Kerman-Koonin theory using a consistent set of parameters determined by analyses of *(p, xn)* reactions, that have practically no collective components. The results are compared with high-resolution neutron inelastic scattering data and prove able to account for the absolute magnitude of the cross-sections and also their detailed structure.

A Low Cost Ionizing Radiation Monitoring System

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Technological Educational Institution of Athens, School of Technological Applications, Medical Instrumentation Technology Department.

Abstract

It was aim of this project the development of a low - cost system, managing signals coming - out of several detectors (ionization chambers, NaI - detectors, Geiger - Mueller etc.) mstalled in different areas, monitoring radiation levels.

The output of such detectors is a spike - like waveform, that may be introduced to a schmitt - trigger, producing equal frequency quadratic pulses, that are counted. Alternatively, the output may be introduced to an amplified waveform V(t), corresponding to the monitored rate, will be digitized through a PCL - 812PG A/D I/O card and introduced to a PC (at least 486 DX, 33MHz, 8 MB RAM).

Custom - made (Pascal 7.0) software enables the display of the signal, threshold and alarm settings, as well as , hardware parameter settings (amplification, set - off voltage, sampling rate etc.). The system has been tested experimentally.

Up to 5 detectors may be mounted to the card but the software supports up to 16. Up to 10000 cpm may be registered, because of the limits of the 400Hz antializing filter, the ADC speed and the MUX PCLD - 889 characteristics. The system may be used as a simple low - cost signal monitoring device, enabling the telemetric transmission of the signals, if required.

A System for the Estimation of Important Biophysical Parameters in Radiotherapy

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Abstract

A Radiotherapy Supporting System has been developed, allowing for biological treatment planning considering spatial and temporal dose distribution. Starting point is a scanner - digitized two - dimensional physical treatment plan, of any commercially available System.

A Linear Quadratic Model (LQM) based probabilistic algorithm, including the concept of memory dose, has been programmed in Turbo Pascal 7.0 that leads to the expected results. Three dimensional approximation is possible by using at least three respesentative isodose - plans. Data, for normal tissue tolerance dose levels to therapeutic irradiation and for α / β values, published by B. Emami et al. (Int. J. Rad. Oncol. Biol. Phys. 21 (1991) 123 - 135) and Thames et al. (Radiotherapy and Oncol. 19 (1990) 219 - 235), has been used.

The system provides the means for the estimation of important biophysical parameters such as the Extrapolated Response Dose (ERD), the Tumor Response Probability (TCP), the Normal Tissue Complication Probability (NTCP) etc. The program facilitates also a full - scale case - management (record keeping, fractionation, overlapping of past and present schemata etc.) and enables retrospective data analysis. The system has been tested in the laboratory conditions and a clinical trial is under negotiation.

Systematics of Masses and Half-Lives of Nuclei with Neural Nets

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Abstract

In the last few years a phenomenological approach to nuclear systematics based on multilayer feedforward neural networks has been under development[1,2,3]. Using suitable training sets,back- propagation and other related algorithms[4,5] are applied to teach such networks a given nuclear property. The networks are then asked to predict the property using test nuclei absent from the training set. Training and test sets are provided by the Brookhaven Nuclear Data facility. With proper architecture,coding schemes for input and output data,activation and error functions as well as pruning techniques,a number of networks can be produced that demonstrate high quality of performance in learning. Their predictive power can be competitive with that of traditional theoretical approaches.

In this work,we study the nuclear masses and the half-lives of unstable β-decaying nuclear ground states using the following number of nuclides: 1882 and 1260 as learning sets and 627 and 423 as test sets respectively. Concerning masses, our work is a continuation of the work reported in refs [1,2]. It uses an enriched data basis and tries to achieve the highest possible performance with the smallest number of parameters. So far, our results for the root mean square error are comparable to those of ref. [2] and those derived by the mass fits of Mässon-Jänecke[6] and Möller et al[7]. However, the number of the parameters used in the later fit is significantly smaller. Concerning half-lives,up to now there is no global model based on conventional nuclear theory. There are some models mainly for beta-decay. At present, most of our computer experiments have focused on the study of this decay channel.Our initial learning and test sets include 575 and 191 nuclei respectively. The performance of the models developed in learning is comparable to that of Klapdor et al[8]. The next step is to improve the predictive performance and to study and include the nuclides with other decay channels. The aim of this work is the production of global models

of masses and half-lives of very good quality.

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