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EXPERIMENTAL EVALUATION OF THE NEUTRONS FLUX OF A IRRADIADOR WITH AmBe SOURCES AND ITS POSSIBILITY ~~EXPERIMENTAL EVALUATION OF THE NEUTRONS FLUX OF A IRRADIADOR WITH AmBe SOURCES AND ITS POSSIBILITY~~ OF USE IN MATERIALS ANALYSIS

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This work had as a target to determine the irradiator thermal and over-cadmium (epithermal and fast) neutrons flux , of the Nuclear Experimental Laboratory of the Nuclear Energy Center (CNEN) - IPEN, and the possibility of its use for Neutron Activation Analysis (NAA) by the absolute method. Basically, this Irradiator consists of a cylinder of 1200 mm long and 985 mm diameter (filled with paraffin) with two Am Be sources 592GBq each.
The neutrons flux quantification was performed indirectly by activation technique, i.e., using gold activation foils bare and covered with cadmium, (reaction: $^{197}Au(n,\gamma)^{198}Au$. The neutrons flux was determined for two situations: (a) with polyethylene block 5.0 cm thick and (b) without the polyethylene block. The quantification of the elements present in the irradiated samples was obtained after the experimental determination of the incident neutrons flux in the irradiation position of the sample. Flux values along the irradiator axis were determined, experimentally and by Monte Carlo method. In the irradiator central position, where the materials analysis was done, the flux values obtained, experimentally, were: (a) with polyethylene block, thermal ϕ=(2,11±0,08) 10^4 n cm^{-2} s^{-1} and over-cadmium ϕ=2.34 ±0,09 10^4 n cm $^{-2}$ s $^{-1}$, (b) without polyethylene block, thermal ϕ=(3.75 ±0,14) $10^4 cm^{-2}$ $s^{-1}$and over-cadmium ϕ=(7.63 ±0,28) 10^4n cm^{-2} s^{-1}, and by Monte Carlo method, were: a) with polyethylene block, thermal ϕ=2,19 10^4 n cm^{-2} s^{-1} and over-cadmium ϕ=2,77 10^4 n cm $^{-2}$ s $^{-1}$, (b) without polyethylene block, thermal ϕ=2,81$10^4$ cm^{-2} $s^{-1}$and over-cadmium ϕ=6,08 10^4 n cm^{-2} s^{-1}
The irradiator presents the advantage of supplying a stable neutron flux for a long period, eliminating the need of the use of standard material, so that the process becomes agile, practical and economic. Some materials were analyzed, presenting good agreement with reference values.

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Estudo de equipamento e elaboração de programa computacional para comparação de sinais usado para controle de sistema de medidas usando radiação nuclear

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O controle de qualidade de produtos industriais pode ser feito pela técnica de análise não destrutiva (NDA) utilizando-se radioisótopos. Para realizar uma NDA, métodos que utilizam emissores de radiação gama, beta ou neutrons podem ser aplicados, dependendo do material a ser analisado e do processo industrial. A análise não destrutiva é utilizada no exame de materiais, para verificar a sua adequação aos padrões exigidos pelas normas técnicas ou pelo mercado. A radiação nuclear é coletada pelo detector de radiação, e transformada através de um circuito eletro-eletrônico em tensão elétrica (V), essa é enviada para intertravamento com o software, que compara o valor de tensão elétrica recebido com o valor de referência (Set Point) inserido no programa computacional. O sistema de controle de medidas proposto é feito incidindo-se radiação nuclear no material a ser controlado. O detector de radiação nuclear, faz a leitura da radioatividade emergente ao material, e envia para um circuito eletro-eletrônico, que fará a transformação para uma unidade de tensão elétrica (V), que é a variável manipulada do sistema. A unidade de tensão elétrica (V) é transformada para níveis lógicos (0 ou 1) e enviada para porta paralela do microcomputador, que recebe esse sinal binário através do programa computacional desenvolvido, que verifica se o mesmo está de acordo com os valores de referência pré-estabelecidos e toma a decisão sobre o aproveitamento ou não do produto controlado. Tensões entre 0 e 0,8 Volts são reconhecidas pelo microcomputador como nível lógico 0 e tensões entre 2,5 e 5,5 Volts são reconhecidas como nível lógico 1. Portanto, os componentes do circuito eletro-eletrônico devem ser projetados para enviar para a porta paralela do microcomputador valores de tensão com o qual podem ser reconhecidos como nível lógico 0 ou 1. programa computacional executado na linguagem de programação Turbo Assembly. Quando a porta paralela do microcomputador recebe um sinal que o programa considera o produto reprovado, o mesmo envia uma resposta para porta paralela que gira o motor de passos no sentido anti-horário. Quando o produto é aprovado, o sentido de rotação é invertido (horário). Com esse programa é possível verificar o funcionamento do sistema de medidas proposto.

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Study of the Radiation Response Dependence on the PbI2 Crystal Purity

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Lead iodide (PbI2) is a very promising material with large technological applicability as X-ray and gamma-ray room temperature detectors. PbI2 is a wide bandgap energy (2.3 - 2.6 eV) semiconductor composed of high atomic number elements (ZPb=82, ZI=53), with high resistivity and density of 6.2 g/cm3. The wide bandgap enables low noise operation of the PbI2 detectors at room temperature and above. One of the apparent disadvantages of PbI2 is the low mobility of its charge carriers, 8 cm2/Vs for electrons and 2 cm2/Vs for holes. Therefore, in order to enhance the electrical properties, the trapping time characteristics and the mobilities should be improved. The role of the crystal impurities on the electrical properties of PbI2 is crucial, then improvements on the chemical purification should be achieved. The primary difference between recently developed PbI2 detectors and those earlier fabricated appears to be the degree of crystal purity. Several studies have been carried out about the preparation of the PbI2 semiconductor detector and progresses have been made by the improvement of the techniques of purification, growth and characterization of the crystal. In this work, the commercial PbI2 powders, used as starting materials, were purified by zone refining method and grown by Bridgman method. The efficiency of removing the impurities after 200, 300 and 500 purification passes, was evaluated, by measurements of the impurities concentrations in the PbI2 ingot, using neutron activation analysis. A significant decrease of the impurities concentration was observed in function of the passes number. The purest material of the zone refined ingots was used for crystal growth by Bridgman method. The results show that the dark leakage current, the resistivity and the response of the alpha and gamma radiations were strongly dependent on the purity of the crystal. A significative improvement in the characteristics of the detector-crystal was achieved, when the starting materials became purer. The resistivity and the energy resolution (FWHM) were sensitive parameters to evaluate the detector quality in function of the purity degree.

Nuclear Astrophysics

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Relativistic Equations of State at Finite Temperatures

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We study cold and hot nuclear matter in the framework of the nonlinear Walecka model in the Thomas-Fermi approximation. The hyperons of the barionic octet are included. We start by writing the Walecka lagrangian with nonlinear terms, with the inclusion of the eight lightest barions. Application of the Euler-Lagrange equation yields the equations of motion for the fields. Finite temperature effects are then taken into account by adding the Fermi-Dirac distribution function to the expression of the relevant quantities. Energy density and pressure are then calculated as functions of temperature and barionic density. We make mean field approximation in the static case, in order to solve the coupled nonlinear differential equations for self-consistent values of the mean fields. The TM1 set of parameters is used to obtain the thermodynamical quantitites of interest. We also study the particle populations at different temperatures.
The second part of the work consists of a comparative study of the different results of the extended Walecka model in the context of some different sets of parameters, namely: TM1, GL and NL3. We study the behaviour of the effective mass curves of barions for these three sets of parameters at different temperatures and densities. We perform the calculations through a wide range of barionic densities, which allows us concluding that: (i) GL provides a satisfactory description of the nuclear matter for a wide range of densities, though its effective mass curves are stiffer then those with the other two sets; (ii)TM1 fails to describe the effective mass if hyperons are included, as the barionic density comes to $\sim$ 6.5 times the nuclear matter saturation density; (iii) NL3 also fails at $\sim$ 3.5 times the saturation density. In all cases we consider the hyperon-to-meson couplig constant equal to $\sqrt{\frac{2}{3}}$.

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Study of the reaction ^{25}Mg(^{11}B,^{10}Be)^{26}Al for the determination of the non-resonant part of the capture cross-section ^{25}Mg(p,γ)^{26}Al

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We have performed measurements of an angular distribution of the transfer reaction ^{25}Mg(^{11}B,10Be)26Al and excited states, with the intent of obtaining information of the non-resonant part of the capture cross section ^{25}Mg(p,γ)^{26}Al from the determination of the spectroscopic factor which normalizes the bound state wave function p+^{25}Mg. This reaction is a part of the MgAl cycle that involves a series of proton capture reactions and beta decays in sequence ^{24}Mg(p,γ)^{25}Al(β^+)^{25}Mg(p,γ)^{26}Al(β^+)^{26}Mg(p,γ)^{27}Al(p,α)^{24}Mg.
Such a cycle occurs in second generation stars which contains heavy elements like Oxygen, Neon, Magnesium and others and has a great importance to the comprehension of the ^{26}Al production process, whose decay results in the anomaly in the ^{26}Mg/^{27}Al ratio observed in some meteors. The ^{26}Al nucleus has a half-life of 0.72 x 10^6y in its ground state. The first excited state of ^{26}Al is an isomeric state ($T_{1/2}$ = 6s), which decays to the ^{26}Mg following the MgAl cycle. The ^{26}Al formed in the ground state will escape from the cycle by the reaction ^{26}Al(p,4γ)^{27}Si and does not participate in the production of ^{26}Mg. Capture reactions in stars are peripheral processes, which occur at