NUCLEAR STRUCTURE

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This research program is focused on the determination of nuclear parameters, in order to get a better understanding of the structure intrinsic to the nucleus, as well as the development of nuclear instrumentation. Moreover, some applications of nuclear techniques have been developed, mainly in the health area. In the pure physics field, the studies are performed in the transitional deformation region between 100<A<200. Regarding applied physics, the Absolute Neutron Activation Analysis technique has been used to perform quali-quantitative analyses in biological materials. In addition, a facility has been developed to perform neutron dosimetry and irradiation, and also new facilities have been projected for data acquisition system. These activities involve collaborations with Research Institutes from São Paulo University (LAL, Microsul and LANFI), Santo Amaro University (UNISA), Sincroton Laboratory (LNLS), the Center of Applied Studies for Nuclear Development (CEADEN/Cuba), Promon Engenharia and the Centro Regional de Ciências Nucleares (CRCN/PE). Nuclear Structure Studies: In the field of pure physics the studies are focused on β and γ decay of quasi-spherical nuclei. The nuclear parameters that can be established are: energy, intensity and multiple mixing ratio of ? transitions and spin, parity, log *ft*, branching ratio and half-life of excited levels. These measurements are performed at the Nuclear Structure Laboratory (LEN) and photonuclear reactions cross section measurements, using thermal neutron capture gamma rays, are performed at the IEA-R1 research reactor. Besides, measurements of directional angular correlation were performed in collaboration with the Linear Accelerator Laboratory (LAL) from IFUSP, using a multi-detector system. For this purpose the angular correlation function was established for n-independent pairs of HPGe detectors. Applied Nuclear Physics: In the field of applied physics we show that the Absolute Neutron Activation Analysis technique can be used to perform clinical analyses of urine and some body organs of small size animals, with many advantages towards the traditional methods. For this purpose, the Cadmium Ratio technique was used for the measurement of thermal and epithermal flux distribution and the concentrations of elements in the biological samples were obtained using facilities and software developed by the group. In comparison to the conventional techniques this nuclear methodology presents some advantages: it is an alternative method for the diagnostic of anomalies in organs; its uses smaller quantities of the samples (few μl for liquid samples and <5mg for solid samples); it also allows the simultaneous evaluation of several elements' concentrations in the biological samples at once, something not always possible in the conventional clinical analysis; it eliminates the need to use standard material, thus making the analyzing process agile, practical and also economic in researches that involve clinical evaluation of small animals. Yet related to this activity two projects were concluded: "Uranium incorporation in the poultry bones in function of administration at chow doped with phitase and Uranium" and "Nuclear methodology to performed clinical analyses" and another has just begun: "Nuclear methodology standardization for Iron concentration determination in human whole blood samples".

Nuclear Instrumentation: In order to perform low-dose/low-flux neutron irradiation, an irradiator has been assembled at IPEN facilities. It consists of two 600GBq ^{241}AmBe sources installed inside a 1200mm-long, 985mm-diameter Al cylinder filled with paraffin; an additional 80mm diameter Al tube, passing through the longitudinal direction of this cylinder, was installed to allow the samples to be placed in several different positions. The two sources can, also, be placed in two different configurations, one enhancing the thermal flux and the other enhancing the fast one. Monte Carlo simulations were performed, using the MCNP-4C code, to estimate the neutron flux for both configurations. A neutron flux of $4.4x10^4 cm^{-2}s^{-1}$ (50% thermal) and $2.8x10^5 cm^{-2}s^{-1}$ (41% fast) was found for both the thermal and fast configurations, respectively. In collaboration with the CRCN/PE neutron techniques based on Solid State Nuclear Tracks and Thermoluminescent detectors have been applied to the auspicious of measuring neutron doses in different conditions as inside cavities of neutron irradiators. Finally, in collaboration with the technical staff of CRPq, a data acquisition interface has been elaborated, allowing the accumulation of up to five coincidence spectra simultaneously, improving considerably the precision of the final results of angular correlation analyses, as well as optimizing the acquisition procedure.

NEUTRON DIFFRACTOMETRY AT IPEN

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A new IPEN-CNEN/SP neutron powder diffractometer was constructed and installed at the 4.2 MW thermal IEA-R1m research reactor. It is an extensive upgrading of the old IPEN-CNEN/SP multipurpose neutron diffractometer. The old diffractometer was a single-detector instrument with a boron trifluoride (BF3) detector and a flat copper mosaic single crystal monochromator. The main modification introduced in the old instrument is the installation of a position sensitive detector (PSD). A rotating oscillating collimator, placed at the entrance to the detector shielding, eliminates parasitic scattering from furnace or cryorefrigerator heat shields in the vicinity of the sample, while only reducing the scattered intensity by ca. 10%. The collimator also makes the PSD less sensitive to ambient background leaking in through the shielding entrance. Placed at a distance of 1600 mm from sample, the PSD spans an angular range of 20º of a diffraction pattern, resulting in a quite good resolution for the instrument. An extended powder diffraction pattern can be obtained by moving the detector and collecting the data in 20º segments. In order to increase the neutron beam flux at the sample position, a focusing perfect Si single crystal monochromator will be installed in the instrument. With a take-off angle of 84°, the monochromator can be positioned to produce 4 different wavelengths, namely 1.111, 1.399, 1.667 and 2.191 Å. A beam shutter will protect operator during sample manipulation or installation of any device in the monochromatic beam. In comparison to the former instrument, the new diffractometer will have better resolution and will be ca. 600 times faster in data acquisition. Research lines (in progress): the Rietveld method applied to the determination of crystalline and magnetic phases of multiphase systems, development of the neutron multiple diffraction as a method of structural analysis and study of the mosaicity of single crystals.