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SUMMARY OF THE PROGRESS REPORT

M.D. de Souza Santos

Although there is a fair activity in both theoretical and experimental nuclear physics in several Latin American countries, the Atomic Energy Institute at São Paulo (Brasil) is the only research establishment engaged in experimental neutron physics. It is under the National Nuclear Energy Commission and the University of S. Paulo and has a staff of 350 people, out of which 150 have a University degree. Its nuclear physics division is constituted by 27 people (25 physicists and two technicians).

The activities summarized here cover the period from June 1967 to the present date.

I) SLOW NEUTRON CROSS-SECTIONS

The main facilities available are:

1) a crystal monochromator used in the energy range between 0,0004 to 2 eV (higher orders are eliminated, whenever necessary, with a mechanical velocity selector);
2) a slow neutron time-of-flight spectrometer (slow chopper, BNL type, curved slits; flight path 1,5 to 3,0 meters; TMC 1024 channel time-of-flight analyzer) which covers the energy range between 0,001 eV to 0,1 eV.

I-1) Total cross sections for Pr, Yb, Lu, Er, Ho and Tm were measured and some of the obtained data is already included in DASTAR. New determinations of the total cross-section were made for the above elements in order to have a higher precision. In the case of Lutetium, the old results already reported in CINDA should be substituted by the new values forwarded to NDU since it was found that our sample contained some impurities. The new parameters of the first resonance are

Lu^{176}; $E_o(eV) - 0,145 \pm 0,001$;

$\Gamma(meV)$ 63 ± 2; $2g\Gamma_n^o(meV)$ $0,225 \pm 0,005$

The deduced values for the cross-sections for absorption, scattering and paramagnetic were presented.

I-2) The scattering of slow neutrons by lead (natural) was studied for a monocrystal (220 and 111 parallel to the incoming beam), powder and liquid samples for neutrons of wavelengths between 1 and 10 angströms.

I-3) The total cross-section of UO_2 for neutrons of energies between 0,08 and 0,008 eV with the time-of-flight spectrometer.

The UO_2 sample used was prepared by the nuclear metallurgy division of our Institute. It was obtained from brasilian monasite and comes from the same uranium stock used in the construction of the sub-critical reactor RESUCO. The obtained values showed a good agreement with the BNL values.

I-4) The total cross-section for polycrystalline iron for neutrons in the energy interval between 0,0025 eV and 0,15 eV was measured with the IEA (Atomic Energy Institute) slow neutron time-of-flight spectrometer in order to check its operation conditions. A very good agreement was found between the theoretical cross-section curve and the experimental results. In the theoretical calculation the cross-sections for absorption, coherent and incoherent elastic and inelastic scattering were taken into account.

II) OTHER NUCLEAR PHYSICS ACTIVITIES

II-1) Paramagnetic scattering by rare earth ions.

The theoretical cross-section for paramagnetic scattering calculated for nine rare-earth ions using Trammel's theory and the results of Blume, Freeman and Watson with the Hartree-Fock approximation for the calculation of the orbital and spin contributions.

A comparison with our results obtained experimentally for holmium and thulium showed a good agreement.

II-2) Certain aspects of the calibration and resolution of slow neutron spectrometers.

The method of calibrating and determining the resolution of slow neutron spectrometers by the measurements of Bragg Breaks was discussed and the problem of folding a Gaussian resolution function with a linear function presenting a sharp break was analytically studied.

The effect of a Gaussian resolution in the transmission, inverse transmission and total cross-section is theoretically evaluated for the iron (110) Bragg cut-off, for many resolution widths and several sample thicknesses. It is concluded that the analysis of the measured transmission curve gives the most direct and accurate results. This paper will appear shortly in "Nuclear Instruments and Methods".

II-3) Spectral distribution of the neutrons emerging from one of the IEAR-1 reactor beam tubes.

The spectral distribution of the thermal neutrons was measured with the crystal spectrometer, corrections were made for the reflectivity of the crystal, spectrometer resolution and detector efficiency.

II-4) The slow neutron time-of-flight spectrometer was also used to measure the IEAR-1 neutron spectrum.

II-5) The Atomic Energy Institute nuclear metrology group participated at the international comparison of the activity of Co^{60} solutions organized by the Bureau Internal de Poids et Mésures. The results obtained have shown a high precision (0,07%) and an excellent agreement with the best measurements submitted.

II-6) The use of tracers for the absolute measurement of pure beta emitters was investigated by the nuclear metrology group. Conclusions on the non-linearity of the efficiency function, on the influence of the relative amounts of the tracer and beta emitter and on the actual precision of the method are presented.

II-7) Capture gamma radiation (n,γ) for Al, Fe, Ni and Ti was measured with a Ge-Li detector with an 8-mm compensated layer and 13 KeV resolution. Energy values and transition schemes are presented.

II-8) The Monte Carlo method was used in order to calculate the response function, the photo-fraction value and the efficiency of NaI(Tl) crystals as a function of the gamma-ray energies.

Rayleigh and Compton scattering, photo-electric effect and pair production were considered as primary interactions; as secondary interactions, Bremsstrahlung, annihilation radiation and the energy loss of the electrons in the crystal were taken into account.

III) WORK IN PROGRESS

III-1) Photofission. The behaviour of the photofission cross-section for U and Th is being continued, using monochromatic gamma-rays from (n,γ) processes in several nuclides. The final results will be analyzed within two months and it is hoped that some doubts on the sudden jumps of the fission cross-section near the threshold, observed by Carvalho et al, will be explained.

III-2) A new sector type beta-spectrometer of high resolution (.075% for sources 0,4 cm wide) is being built for (n,e^-) capture processes. The sources will be located at one of the reactor through-tubes, at 380 from the spectrometer; the conversion electrons will be piped in high vacuum and the earth magnetic field will be compensated by magnetic quadrupole lenses.

III-3) Neutron flux measurement with foils (thermal and threshold detectors) is being continued. Special techniques (such as the use of β-γ tracers) are being developed for the accurate measurement of pure beta-emitters with 4π proportional counters.

Solid state (mica and plastics) fission detectors are being used for flux measurement and a comparison with the conventional detectors is being made.

III-4) Slow neutron cross-section measurements with the crystal monochromator are being pursued. A priority will be given to the measurements of our interest which coincide with requests to the INDC.