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PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN KOREA

(For the Period January 1971 to December 1971)

Compiled by

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KOREAN NUCLEAR DATA CENTRE

ATOMIC ENERGY RESEARCH INSTITUTE

Seoul, Korea

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Liaison Officer of INDC,
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(1) FAST NEUTRON INDUCES (n, α) AND (n,p) REACTIONS IN GERMANIUM.

M. Cho, M. K. Chung, H. D. Kang and S. W. Cho,
Atomic Energy Research Institute

-- A He^3 detector by utilizing a pair of Si surface barrier detector is under construction for fast neutron spectroscopy. However as the (n, α) and (n,p) cross section of silicon is much higher than in germanium, background counting rate is thought to be high. To overcome this difficulty in Si detector and to testify the applicability of lithium drifted germanium counter as a fast neutron spectrometer, lithium drifted germanium counters of the volumes of 3 cc and 0.6 cc cooled to liquid nitrogen temperature were bombarded with 14 MeV neutrons and the pulse height distributions from the neutron-induced reactions such as (n, α) and (n,p) reactions inside the germanium counters were measured and compared with the data obtained by silicon detector. The characteristics deteriolation of the detector due to lattice defect introduced by fast neutron.

(2) RREVIEW OF THE CURRENT STATUS OF THE U-238, Np-237 AND Th-232 FISSION CROSS SECTIONS

H. I. Bak* and A. Lorenz**
* Seoul National University
**IAEA Nuclear Data Section Vienna, Austria

-- The experimental fission cross-section data of U-238, Np-237 and Th-232, published up to the end of 1970, are reviewed and analyzed

between their respective thresholds and 20.0 MeV. The results of a statistical analysis of the available data performed with a weighted Least-squares Orthogonal Polynomial Fitting computer programme are presented in the form of point-wise cross-section values together with their uncertainties, and in the form of graphs of the fitted curves with an indication of a region of 95% statistical confidence level. An estimate of the fission spectrum weighted average cross-sections and their respective uncertainties is also given.

(3) N-P SCATTERING AT LOW ENERGY.

Seung Tae Kim and Yoon Suk Koh,
Seoul National University

-- The fact that neutron-proton interaction is partially noncentral is well known. Although the tensor potential $V_T(r)S_{12}$ has been introduced, solving the scattering problem with this potential is much complicated. In order to avoid the complexity, we introduce the deformed potential.

$$\left.\begin{aligned} V &= \tfrac{1}{2}\mu w^2(r^2 - a^2) + \tfrac{1}{2}\varepsilon\omega\, w^2(r^2 - a^2)\cos^2\theta \;, && r \leq a \\ &= 0 \;, && r \geq a \end{aligned}\right\} \quad (1)$$

where and W are to be determind from the experimental data.

In formulating $\sigma(\theta)$, we have followed Goldberger and Watson, assuming $|\varepsilon| < 1$. The T-matrix is given by

$$\langle\beta|T|\alpha\rangle = \langle\beta|T_1|\alpha\rangle + (X_{1\beta}^{T-}, V_2 X_\alpha^+)$$

$$\cong \langle\beta|T_1|\alpha\rangle + (X_{1\beta}^{T-}, V_2 X_{1\alpha}^+) \quad \cdots\cdots\cdots \quad (2)$$

The right hand side of (2) can be easily calculated. Using the formula $\sigma(\theta) = A\,|\langle\beta|T|\alpha\rangle|^2$, we can determine the two parameters ε and W from the experimental results at two angles, namely $\theta_1 = 60^\circ$, $\theta_2 = 90^\circ$, when the neutron energy is 14.1 Mev. And we check the theoretical values of cross-section at other angles as well as at other neighboring

energy E = 13.7 Mev with experimental data.

(4) ENERGY DISTRIBUTION OF PHOTOPROTONS FROM $^{93}_{41}Nb(\gamma,p)$ REACTION IRRADIATED WITH 19.0 Mev γ- rays.

B. N. Seong
Seoul National University

-- The energy distribution of photoprotons from Nb irradiated with 19.0 Mev bremsstrahlung produced by betatron have been detected in Ilford C2 nuclear emulsions. The thickness of emulsions were 200 microns. In the energy distribution are appeared many structures which were analogues to those observed in the case of light nuclei. This result indicates that perhaps it will enable to be explained by shell model rather than statistical theory.

(5) PRECISE DETERMINATION OF RELATIVE GAMMA-RAY INTENSITIES IN THE DECAY OF Ag^{110m} AND In^{116m} FOR TOTAL ABSORPTION PEAK DETECTION EFFICIENCY OF Ge(Li) IN THE ENERGY RANGE 80 - 3000 KEV.

M. K. Chung, S. W. Cho,
Atomic Energy Research Institute

-- After the determination of intrinsic volume of Ge(Li) detector (3 cc) by gamma-ray scanning method, the relative detection effciency of gamma-ray total absorption peak was obtained in the energy range 80 - 3000 kev by pairpoint method. Semi-empirical approach to the determination of detection efficiencies was also tried and the results were discussed. The relative intensities of the gamma-rays in the decay of Ag^{110m} and In^{116m} were re-determined according to the efficiency curve which we obtained. Of great usefulness in efficiency calibration would be a radioactive source with many lines with known relative intensities distributed over a wide range.

Ag^{110m} and In^{116m} soon to fullfil these requirements.

(6) THEORY OF SUPERHEAVY NUCLEI IN THE OSCILLATOR MODEL.

Kiuck Lee,
Marquette University

— Recently Marinov and his co-workers[1] reported the discovery of element 112, and subsequent reports by others[2] indicate that the discovery of element 112 as well as the existence of other stable superheavy nuclei may be doubtful. On the other hand, Sobiczewski and his co-workers[3] extended their theorotical study in search for stable superheavy nuclei for mass numbers up to 600. Thus, the search for superheavy nuclei will undoubtedly continue. In view of these developments, theorotical feasibility of stable superheavy nuclei will be discussed with the aid of the harmonic oscillator model, in close analogy with its roles in the development of the theory of nucleus with ordinary mass numbers. For rigorous treatment the three dimensional harmonic oscillator with spheroidal deformation will be employed in estimating the magic numbers beyond Z = 82 and N = 126. Since the coulomb's energy is known to play an important role in nuclei with large Z the effect of the coulomb's energy of deformed nuclei as well as the spin-orbit coupling will be discussed.

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[1] A. Marinov, C. J. Batty, A. I. Kilvington, G. W. A. Newton, V. J. Robinson, and J. D. Hemingway, Nature, 229, 464 (1971).

[2] For example, W. Grimm, G. Hermann, and H. D. Schuessler, Phys. Rev. Lett. 26, 1040 (1971).

[3] A. Sobiczewski, T. Kroqulski, J. Blocki, and Z. Szymanski, Nucl. Phys. A168, 519 (1971).

(7) SINGLE PLAT CRYSTAL GAMMA-RAY SPECTROMETER IN COMBINATION WITH Ge (Li) DETECTOR FOR RADIATIVE CAPTURE STUDIES.

M. K. Chung, S. W. Cho and K. C. Tripathi,
Atomic Energy Research Institute

— To suppress Compton background, a single flat crystal spectrometer in combination with a Ge(Li) detector was constructed and applied to the thermal neutron capture gamma spectroscopy. In this report the operational principle of the spectrometer system and the results of preliminary experiments will be given in detail.

(8) SEMICONDUCTOR DETECTORS AND ITS APPLICATIONS TO NEUTRON MEASUREMENT.

D. H. Suh, E. K. Kim,
Atomic Energy Research Institute

-- The performance of a Si(Li) surface-barrier semiconductor detector and its applications for neutron measurements are described in this report. The detector is constructed from 75 - 120 ohm-cm p type Si with a vacuum evaporated gold film electrode, which showed an energy resolusion about 3% for 5.4 MeV alpha rays. We have measured the spatial distribution of neutrons at the thermal column of TRIGA-II reactor and linearity between counting rates and reactor power, using Li^6 (n, α)T reactions.

(9) STUDY ON THE PERFORMANCE OF THE PLASTIC SCINTILLATORS.

Young-Ho Kang, Sahng-Yun Lee,
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We have studied the performance of the Plastic Scintillators. In this report, by polymerization of various monomer, the Pastic Scintillators were made, and their characteristics are described.

As the monomer, the n-butylmetacrylate, vinyltoluene, and styrene were used. Pterphenyl and 2, 5-diphenyloxazole were used as the primary phosphor, 1, 4-di-(2-5-phenyloxazolyl)-benzene as the secondary phosphor to monomer. Comparing with inorganic scintillator, the Plastic Scintillator, has great difficulty in analyzation of the energy of nuclides, and its background counting rate is nearly proportional to the thickness of the plastic scintillator. The minimum detectable amount for ^{90}Sr of this scintillator was 0.12—0.15 mμCi.

Furthermore, the probe of scintillation dector was also made, and we found that the possiblity of production of plastic scintillation detectors in our Laboratory.

(10) NEUTRON FLUENCE MEASUREMENT WITH URANIUM- OR THORIUM-DOPED FISSION TRACK DETECTOR

Young Soo Yoo,
Atomic Energy Research Institute

-- The fission fragment track detector (FTD) of U- or Th-doped phosphate glass adopting an etching thechnique has been known to be suitable for neutron dosimetry. In this paper, a neutron detector which consists of a phosphate glass doped with a fissile material such as natural uranium (UO_2) or thorium (ThO_2) is described Fission fragment tracks registered in the glass were etched by sodium hydroxide and counted under an optical microscope with a magnification of about 420. The detector was exposed to Pu-Be standard neutron sources and thermal neutrons in graphite pile for the calibration purpose.

The registration efficiency as a function of etching concentration, temperature of etching solution, and etching time was also studied. For each parameter, an optimum time for etching in NaOH of 20 per cent concentration by weight was found to be 20 minutes at 60°C

for U-doped FTD and 10 minutes at the same condition for Th-doped FTD. Let these parameters be the "normal condition."

The sensitivities of U-doped FTD for fast and thermal neutron were found to be respectively, 0.48×10^{-6} ($\pm$ 1.9%) and 2.35×10^{-6} ($\pm$ 1.4%) fission fragment tracks/neutron, and that of Th-doped FTD for fast neutron was 0.32×10^{-6} ($\pm$ 3.2%) tracks/neutron.

(11) THE VARIATIONAL METHOD APPLIED TO THE NEUTRON TRANSPORT EQUATION

Sang Won Kim and Pong Youl Pac,
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Noether's theorem is applied to the one dimensional neutron transport equation. It is obtained the transformation rendering the functional of the one dimensional Boltzmann equation invariant. It is derived the law conserving the product of the directional flux and its adjoint flux. The possible types of the solution of the Boltzmann equation are discussed. The results are compared with the wellknown solution.

(12) MODAL NODAL TRANSPORT ANALYSIS

R. Douglas Johnson
Korea Institute of Science and Technology and Atomic Energy Research Institute

A unified modal-nodal expansion of the angular distribution of neutron flux in one spatial dimension is considered, following the proposal of Harms. Several standard nodal and/or modal methods of analysis are shown to be specializations of this technique. The modal-nodal moment from of the mono-energetic transport equation with isotropic sources and scattering is derived and the infinite medium eigenvalue problem solved.

The technique is shown to yield results which approximate the exact value of the inverse diffusion length in non-multiplying media more accurately than standard methods of equal or somewhat greater computational complexity.

(13) AN ANALYSIS OF SHIELDING DESIGN OF TRIGA MARK - II REACTOR --After Power Upgrading by 2.5 Folds--

Chang Kun Lee,
Atomic Energy Research Institute

Korea's TRIGA Mark-II reactor was primarily designed in 1950's and was constructed in 1962 for 100 kw thermal output, but it was upgraded to 250 kw in July 1969. Nevertheless, the shield remains unchanged, although the radiation level has increased. The result of computation in this paper shows that, with the existing shield, it is safe for the fast neutrons even after the power upgrading by 2.5 times. It is, however, somewhat dangerous for the gamma rays which are comprised of primary and secondary. For the analysis of the reactor shielding design, an attempt is made for the computation toward the horizontal direction. From theoretical point of view, it can be concluded that some layer of additional shield must be reinforced to the existing concrete in order to be radiologically safe in the reactor hall.

(14) SHIELDING EFFECTIVENESS OF MAGNETITE HEAVY CONCRETE ON COBALT-60 GAMMA-RAYS

Yong Kyu Lim
Atomic Energy Research Institute

The gamma-ray shielding effects of magnetite concretes have been

measured using a broad beam Co-60 gamma-ray source. Mathematical formulae for a transmission ratio-to-shield thickness relation were derived from the attenuation curve obtained experimentally and are

$$I_{(x)} = I_{(o)} \exp(-\mu X) \exp(1.03 \times 10^{-1} X - 3.38 \times 10^{-3} X^2 + 5.29 \times 10^{-5} X^3)$$

when X <20 cm,

$$I_{(x)} = I_{(o)} \exp(-\mu X) \exp(4.66 \times 10^{-2} X + 2.12 \times 10^{-1})$$

when X> 20 cm.

Here $I_{(x)}$ is radiation intensity after passing through a thickness X of absorber, $I_{(o)}$ is the initial radiation intensity, μ is the linear attenuation coefficient of magnetite concrete and is given by $(0.0532\ \rho + 0.0083)^{4)}\ cm^{-1}$ in accordance with an earlier study, and X is the thickness of absorber. In addition, a model shield which is a rectangular magnetite concrete box with walls of 8 cm thickness walls and internal demensions of 40 x 40 x 40 cm was constructed and its shielding effect has been measured. The emergent radiation flux appears to be greater with this configuration than with a slab shield of equal thickness.

(15) PREPARATION OF HIGH SPECIFIC ACTIVITY ^{51}Cr

Taeyoung Kim, Young Kuk Kim
Atomic Energy Research Institute

High specific activity ^{51}Cr is mainly prepared by Szilard-Chalmers process from K_2CrO_4 target. Usually the recoil atom, Cr*(III), is coprecipitated with Fe(III) as a scavenger to be separated from K_2CrO_4. A new preparation method has been developed, by adding 0.1N NaOH and C_2H_5OH to the irradiated target solution, to precipitate Cr*(III) without any scavenger such as Fe(III). The new method gives the product of higher specific activity and

better yield than that of other methods, in the shorter processing time.

This method is compared with the conventional method and the French method, and following results are obtained: the new method gives specific activity more than twice that of the conventional method and better yield than the conventional method; the French method and the new method give similar specific activity, but yield of the new method is almost twice that of the French method.

(16) STRONTIUM-90 LEVELS IN MILK

Chan Kirl Park, Kyung Rin Yang
Atomic Energy Research Institute

The levels of strontium-90 in milk produced in Korea were determined during the past six years. Milk samples were collected from dairies and market shops in seoul area. Strontium-90 in milk was separated from calcium using fuming nitric acid and purified radiochemically. After seculear equilibrium was completed, the ratioactivity of yttrium-90 was counted in a low background beta counting system. The determination of stable calcium in milk was also made by volumetric method using 0.1 N potassium permanganate solution. The highest value of 34.9 pCi ^{90}Sr/g-Ca was determined in August, 1966 and the lowest value was 7.5 pCi ^{90}Sr/g-Ca in August, 1967. From the result we can say that levels of strontium-90 are decreasing year after year and are far bellow the maximum permissible level recommended by International Committe on Radiation Protection.

(17) STUDY ON IODINE LABELLING (I) INFLUENCES OF REDUCING AGENT AND IODATE--^{131}I IN SODIUM IODIDE--^{131}I SOLUTION ON LABELLING

Jaerok Kim,
Atomic Energy Research Institute

In Iodine-131 labelling of iodocompounds such as tetrachloro-P-tetraiodo R-fluorescein, sodium orthoiodohippurate and a non-iodocompound, human serum albumin (HSA), the labelling rates and yields are accurately compared with each other. The reaction systems conducted for each compounds were different conditions; sodium iodide-^{131}I containing reducing agent, sodium iodide-^{131}I free from reducing agent, and sodium iodide-^{131}I free from reducing agent but containing considerable amount of iodate-^{131}I etc.

The labelling yields were generally poor; 10% in the case of using sodium iodide-^{131}I containing reduing agent, and 50~60% in the case of using sodium iodide-^{131}I free from reducing agent but containing considerable amount of iodate-^{131}I. However, fair yields were obtained in the case of using sodium iodide-^{131}I free from reducing agent and mostly in the form of iodide-^{131}I. The reaction entities involved in these reactions are also briefly discussed.

(18) KINETIC STUDIES ON THE HALIDE EXCHANGE REACTIONS OF SOME SUBSTITUTED BENZYL CHLORIDES

Ikchoon Lee, Bon-Su Lee and Jae Eui Yie
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Kinetic studies on the halide exchange reactions of some substituted benzyl chlorides have been carried out using radioisotope tracer halide ions.

Results are consistent with our previous conclusion that the rates of halide exchange reactions in acetone with arylmethy halides are dictated by the polarizabilities of both substrate and nucleophile.