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GOVERNMENT OF INDIA ATOMIC ENERGY COMMISSION

PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN INDIA - VIII

Compiled by M. Balakrishnan Nuclear Physics Division Indian Nuclear Data Group

BHABHA ATOMIC RESEARCH CENTRE BOMBAY, INDIA

1972

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BHABHA ATOMIC RESEARCH CENTRE BOMBAY, INDIA 1972

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Preface

The eighth progress report on Nuclear Data Activities in India covers the work done during the year 1971. A pert of the work given in this report has been presented at the Nuclear Physics and Solid State Physics Symposium held at Bombay during February 1972.

The total number of CINDA entires sent to the Nuclear Data Section of the International Atomic Energy Agency during the period of the report is 160. The liaison activity with Computer Programme Library (CPL) of European Nuclear Energy Agency was continued.

A major event of the year was the holding of the Fourth International Nuclear Data Committee(INDC) Meeting in Bombay. About twenty participants from outside India, comprising committee members, scientific advisers and observices attended the meeting in addition to the participants from India. A highlight of this meeting was a one day Topical Conference on "Neutron Induced Fission". Work done in India as well a in many other countries abroad on this subject was reported and discussed at the conference. Proceedings of this topical conference have been brought out as INDC Report, INDC-7/U.

The progress report on new facilities for research is as follows:

a) Zero energy fast reactor

A significant development in the fast reactor technology is the zero energy fast reactor, built at BARC. A plutonium fuelled zero energy fast reactor was made critical at the Bhabha Atomic Research Centre, Trombay at 0915 hours, on May 22nd 1972. The reactor has a three litre core and uses about 180 plutonium oxide fuel pins of 1 cm diameter. The critical mass is 21.6 kgs of plutonium. The core is reflected by thick copper and steel on all sides. Primary control is by the insertion / withdrawal of the core vessel into / out of the massive reflector. In addition molybdenum reflector safety and control rods are available.

For quick shutdown in the event of a rapid rise of neutron flux, the core which is held normally by electromagnets drops out of the reflector assembly, simultaneously six molybdenum safety rods are ejected out of the assembly with an initial acceleration of over 15g by means of compressed springs. The neutron instrumentation consists of three neutron pulse channels and five ¹⁰B coated ion chamber-channels with the usual high level and period trip initiating elements.

b) The pulsed fast reactor

The Trombey zero energy fast reactor is a mock up of proposed repetitively pulsed fast reactor (PFR) to be built at the Reactor Research Centre being set up at Kelpakkam, near Medras city; in Temil Nadu. Experiments towards optimising the physics characteristics of the PFR would commence soon after the initial commissioning tests on the zero energy fast reactor are completed.

C) The construction work on the 224 cm. veriable energy cyclotron (VEC) has made all round progress during the year, as per schedule. Casting of steel for the 250 tonne magnet has been completed at the Hervy Engineering Corporation Ranchi and the final mechining is under way. The magnet coil fabrication has started at the Heavy Electricals India Ltd. Bhopal. The fabrication of other components is being done at the Bhabha Atomic Research Centre Bombay. Plans for a 160° analysing magnet and a TDC-16 (Trombay Digital Computer-16) on line computor have been finalized and tendering is in progress. The VEC building is nearing completion and movement of staff to Calcutta has started. The users' committee for physics is formulating plans for utilization of the cyclotron. Users' committees for chemistry and biology have been formed. The cyclotron is expected to go into operation in 1974.

d) At the Penjab University, Chandigarh, the building for the 6 MeV variable Energy Cyclotron is complete. Installation of the cyclotron is in progress.

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A.S. Divatia Convenor Indian Nuclear Data Group

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A. BHABHA ATOMIC RESEARCH CENTRE, TROMBAY, BOMBAY 35

Studies on Analog Statue in Sch by Isospin-Forbidden 1. Resonances in the reaction $\frac{32}{5}(5,7)^{53}$ Cl - M.A. Equaran, M. Ismail, N.L. Regoowansi and H.H. Oza - Nuclear Physics Division - The residual positron activity between bursts of a mechanically chopped beam has been used to measure the yield of the reaction ${}^{32}S(p, \gamma){}^{35}Cl$ systematically in the bombarding energy range $E_p = 3.36$ to 5.41 MeV. Two, T = 3/2states in 33 Cl at $E_p = 3.371 \pm .005$ MeV, $E_x = 5.550 \pm .007$ MeV and at $E_0 = 5.232 \pm .006$ MeV $E_x = 7.402 \pm .003$ MeV have been located and their absolute resonance strengths determined. Each of these resonances was narrower than the estimated 2 keV spread in the proton beam. These two states are interpreted as the analogs of the ground and the second excited state of ³³P with J^{π} , 1/2⁺ and 5/2⁺ respectively. Y -decay of the lower resonance, investigated with a Ge(Li) detector shows

> 33% and < 12% branchings to the first excited state and ground state of 33 Cl respectively. The Ml strength of these transitions are compared with those obtained from beta analog transitions and with the theoretical predictions based on the many-particle shell model calculations.

2. <u>A Study of the Reaction ${}^{64}\text{Ni}(p,p){}^{64}\text{Ni}$ in the Range 3.150 to 4.050 MeV - M.K. Mehta , A.S. Divatia, S.K. Gupta and S.S. Kerekatte - Nuclear Physics Division - Elastic scattering of protons from ${}^{64}\text{Ni}$ targets has been studied with fine resolution (2.5 - 5 keV) in the bombarding energy</u> range from 3.15 to 4.05 MeV. Yields are measured at laboratory angles of 89°, 125°, 140° and 165°. The first three angles correspond to zeroes of Legendre Polynomials of first second and third order. The excitation functions exhibit a large amount of fine structure together with two regions of relatively stronger anomalies. These anomalies are correlated with stronger structure seen in our earlier 64 Ni(p,n) 64 Cu¹) experiment and are identified as levels in the compound nucleus 65 Cu which are isobaric analogues of the loylying levels in 65 Ni.

 S.S. Kerekatte, S.K. Gupta and A.S. Divatia Proc. of Nucl. Phys. and Solid State Phys. Symposium (1970), Madurai, p. 45.

3. Excitation Function for the Gamma-Ray Yields from Alpha Particle Bombardment of ¹⁹F in the Range 3.5 to 4.7 MeV - M. Balakrishnan, M.K. Mehta and A.S. Divatia - Nuclear Physics Division - Gamma rays from alpha particle bombardment of ¹⁹F targets have been detected in 35 c.c. GeLi detector. Gamma rays going to the first and the second excited state at 110 and 197 keV in ¹⁹F have been identified. A gamma ray of 1.277 MeV corresponding to the first excited state in ²²Ne is also observed. Excitation functions for all these gamma rays are measured in the bombarding energy range from 3.5 to 4.7 MeV in 5 keV steps. The structure observed is interpreted in terms of the resonances corresponding to the levels in the compound nucleus ²³Na. The data are correlated with our earlier

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results from a study of ${}^{1}\mathcal{F}(\alpha,n){}^{22}$ Ne reaction¹).

 K.K. Sekharan, M.K. Mehta and A.S. Divatia Proc. Nucl. Phys. & Solid State Phys. Symp. (Calcutta) Vol. II(1965) p. 193.

valculation of the Effect of Fission Fragment 4. Anisotropy on the Measured Prompt Neutron Energy and Angular Distributions - N.N. Ajitanand and S.S. Kapoor - Nuclear Physics Division - The laboratory angular and energy distributions of the prompt neutrons have been calculated for fast neutron induced fission when the fragment angular distribution is forward peaked of the form (1 \div A_2 P_2 (CoS θ). The results of these calculations are presented for various values of the fragment anisotropy for the case of fragment detection in 2 TT geometry. Typically, for 30% fragment anisotropy the average laboratory neutron: energy is increased by about 2% at 0° and decreased by about 1.5% at 90° as compared to the case of isotropic emission of fragments. The correspondeing neutron anisotropy is about 7% and varies linearly with the fragment anisotropy. The measured average number of neutrons should therefore be corrected for the fragment anisotropy effects since very accurate values of $\overline{\mathcal{V}}$ are required for the estimation of breeding ratios in fast breeder reactors.

5. <u>Energy and Angular Distributions of Long Range</u> Charged Particles in Thermal Fission of U²³⁵ - D.N. Nadkarni,

S.K. Kataria, S.S. Kapoor and P.N. Hamarao - Nuclear Physics Division - The energy distributions of the long range charged particles (LRCP) emitted in the thermal fission of U²³⁵ were simultaneously measured with the same semiconductor detector for the cases when the average angle between the direction of LRCP and the fission framgnets were 90°, 46°, 25° and 11°. The data were analysed by the numerical montecarlo method to take into account the effects of the finite size of the source and the various detectors, and the following conclusions are drawn: i) For the total LRCP energy range the assumed Gaussion shape for the angular correlation functions is only valid for the angular region of 50° about the fission axis. For example at the angle of 11°, the measured fractional LRCP yield is (.031+.007) as compared to the value of (0.002 + .001) expected for Gaussion shape (ii) It is found that the width parameter of the angular correlation function is nearly constant in the energy range of 12-20 MeV, while it increases sharply for LRCP energies E > 20 MeV. The angular distribution essentially becomes isotropic for 24.5 \angle E \angle 26.5 MeV and indicates a minimum at 90° for E > 26.5 MeV. These results indicate that a small fraction of LRCP, with a mean energy significantly higher than the average is emitted with a forward peaked angular distribution. It is suggested that this component is the result of evaporation from excited fragments in competition with neutrons.

Studies on Highly Asymmetric Binary Fission ; Fission of Uranium with Reactor Neutrons - V.K. Bhargava, V.K. Rao, S.G. Marathe, S.M. Sahakundu and R.H. Iyer - Radiochemistry Division - Preliminary results have been obtained of a programme of work aimed at defining precisely the nature

of the mass distribution in the highly asymmetric binary fission of heavy elements from a radiochemical investigation of the reactor neutron induced fission of natural uranium. The cumulative fission yields of five nuclides vis. ⁶⁶Ni. ⁶⁷Cu (on the lighter) and ¹⁷²Er, ¹⁷⁵Yb and ¹⁷⁷Lu (on the heavier mass regions) were measured relative to ⁹⁹Mo (taken as 6.2%) using stringent radiochemical separation procedures. The measured yields are $(7.5\pm0.87 \times 10^{-6}\%; -6.2\pm3.07 \times 10^{-6}\%)$ $(-4.7\pm2.5]7x \ 10^{-6}\%; \ (-4.0\pm2.0]7x \ 10^{-6}\%; \ (2.7\pm1.4]7x \ 10^{-6}\% \ for$ 66 Ni, 67 Cu, 172 Er, 175 Yo and 177 Lu respectively. The values reported for ¹⁷⁵Yb and ¹⁷⁷Lu are considered at present as upper limits in view of the extremely low activities observe. and the uncertainties in the impurity contributions.

From a comparison of the present data with those available in the literature (although the reported measurements are limited to A < 161 only), there appears to be a strong tendency for the yields to increase rapidly with increase in the asymmetry of the split as well as excitation energy of the compound nucleus.

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An Alternative Method to Strutinsky Prescrition for 7. Determining Nuclear Ground State Shell correction - V. S. Ramamurthy, S.K. Kataria and S.S. Kapoor - Nuclear Physics Division - The strutineky method of determing the ground state shell correction requires the generation of an average single-particle level sequence which retains the long range behaviour while smearing the local fluctuations of the single particle level sequence. Mathematical prescriptions for the generation of the uniform level scheme have been given by strutinsky and Nilsson and some inadequacies of these prescriptions have been noticed. In this work, we present an alternative method for the determination of the ground state shell correction on the basis of a miscroscopic calculation of the excitation energy dependence of the thermodynamic entropy of a nucleus without reference to any artificially generated average level schemes. The calculation of the ehell correction versus nuclear deformation on the basis of the present method is shown to lead to the familiar doublehumped fission barrier for nuclei in the actinide region.

3. Evidence for the Persistance of Shell Effects on the Saddle Point Deformation of 201 Tl - V. S. Ramamurthy and 81S.S. Kapoor - Nuclear Physics Division - Evidence for the existence of a significant positive shell correction near the highly deformed saddle point of the light fissioning nucleus $201 \atop 81$ Tl is presented on the basis of an analysis of

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the available data on $\frac{1}{2}/\frac{1}{n}$ versus the excitation energy for this nucleus. For the calculation of the neutron emission width $\frac{1}{n}$, the level densities of the residual nucleus were obtained on the basis of a microscopic calculation using a realistic shell model single particle energy level scheme. Bohr-wheeler fransition state theory was applied for the calculation of the fission width $\frac{1}{2}$. A value of +2.4 MeV is obtained for the shell correction at the eaddle point deformation of this nucleus giving rise to a value of 15.4 MeV for the Liquid Drop Model (LDM) fission barrier. This result has important implication on the jetermination of the coefficients of the semiemplrical mass formula of Myer-Swiatecki where the LDM fission barrier of this nucleus is an important input parameter.

9. <u>Further Calculations on the Distribution of Fragment</u> <u>Mass and Charge in Fission</u> - V. R. Ramamurthy - Nuclear Physics Division - Calculated distributions of fragment mass and charge in high energy fission of the light nuclei ¹⁸⁶Os, ²⁰¹Tl, ²¹³Pb and ²¹³At on the basis of the stochastic Theory of fission are analysed. Since in these cases, fragment shell structures do not significantly influence the final mass and charge distributions, the theory can be applied without the use of any free parameters. The results have been compared with the experimental distributions obtained for these nuclei and also with the corresponding distributions calculated on the basis of the Liquid Drop Model. Calculations have also

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been carried out for the case of low energy fission of the Fermium isotopes 254 Fm and 253 Fm. It is shown that for 254 Fm fission is asymmetric, while it is symmetric for 258 Fm fission, as observed experimentally.

Angular Momentum Effects in the Elastic Scattering 10. of ¹⁶O from Calcium Isotopes - A Calculation - M. K. Mehta - Nuclear Physics Division - The dependence of the imaginary part of the optical potential for heavy ions on complex nuclei has been established by the FSU $group^{1}$ on the basis of the maximum angular momentum that can be carried away in the exit channel consisting of an alpha particle plus the residual nucleus. The University of Washington group²) suggested that the direct alpha particle transfer is a more critical channel which affects the angular momentum dependence of the imaginary potential. The 160 scattering from calcium isotopee is examined from this point of view starting with the FSU optical potential. The results indicate that although no drastic effects are expected, the scattering from ⁴⁰Ca will be more sensitive to angular momentum effects than that from ⁴⁴Ca.

 R.A. Chatwin et al Phys. Rev. <u>C1</u>(1970)795
 R.W. Shaw, R. Vandenbosch and M.K. Mehta, Phys. Rev. Letts. <u>25</u>(1970)457.

11. <u>Detailed Analyses of the ⁷Li(p,pt)⁴He Reaction</u>
- A.K. Jain and N. Sarma - Nuclear Physics Division - This

reaction ${}^{7}\text{Li}(p,pt)^{4}$ He has been analysed using completely antisymmetrized cluster model wave functions and distorted wave impulse approximation (DWIA). The inter cluster wave function used has an exponential asymptotic behaviour corresponding to the \sim -t separation energy. The calculations reproduce both the magnitude and shape of the angular correlation data at 156 MeV. It is very encouraging to note that the same formulation fits the data at 55 MeV as well. No free parameters are introduced in these analyses.

12. Model Studies on a Half GEV cyclotron - A. Jain and A.S. Divatia - Nuclear Physics Division - A simple analytical technique for shaping the contours of AVF cyclotron sectors developed earlier⁽¹⁾ has been tested by designing and constructing an electron analogue of a high energy proton cyclotron. Since 255 Kev (1 mec2) electrons have the same mass increase as 470 MeV (2 m_pc^2) protons, an electron cyclotron presents equivalent high energy proton cyclotron orbit stability problems. The spiral sectors designed and constructed for the electron analogue were fixed to the pole pieces of a 30 cm diameter electromagnet. The median plane magnetic field $B(r, \theta)$ of this electron cyclotron magnet was measured using a Hall-probe. The field was emoothened by the method of least squares. The orbit properties under operating conditions were then obtained by a Runge-Kutta numerical integration of twelve simultaneous differential equations of motion in the measured field $B(r, \theta)$ by a digital computer, using the

orbit code ORBIT. The exact orbit properties of this $\frac{1}{2}$ me² cyclotron are compared with those predicted by the design theory.

 A. Jain and A.S. Divatia, Proc. of NP and SSP Symposium, Madural 1970, Vol 2, P.579.

A Fast Neutron Time-of-Flight Spectrometer for use 13. in Neutron Gamma Ray Coincidence Experimente - N.L. Ragoowansi and M.A. Eswaran - Nuclear Physics Division - For use in neutron gamma ray coincidence experiments in nuclear reactions a fast neutron time-of-flight spectrometer arrangement has been set up. . A plastic sciptillator mounted on XP1040 phototube is used for neutron detection and Nal(T1) scintillation counter is used for gamma rays. The main part of the system is a transistorized time-to-amplitude convertor which is built based on the circuitry published in reference (1). This incorporates in addition to the time-to-amplitude convertor, a fast coincidence arrangement which triggers the T.A.C. enabling the timesorter to be operated by only the coincident evente. Using neutron gamma ray coincidences from the reaction 9Be $(\infty.n \gamma)^{12}$ C from Am- \propto -Be source, the performance of the above system has been checked employing various flight paths. The usefulness of this system in general coincidence experiments for recording random and true plus random spectra simultaneously is also studied.

1. R. B. Tomlinson and R.L. Brown, IEEE Trans. on Nuc. Sci, April, 1964 p.28. : 11 :

A New Plastic Track Detector - D.K. Sood - Nuclear 14. Physics Division - Charged particles traversing an insulating medium leave a radiation damage trail which can. often. be selectively attacked by a suitable chemical reagent to produce tracks visible under an optical microscope. Several solid state track detectors such as mica, glasses and plastics have been developed and used extensively. Each detector is characterised by a critical energy loss rate (dE/dx)-orit below which no tracks are registered. Thus most of the detectors proposed so far could record ions heavier than $\boldsymbol{\alpha}$ -particles. We have developed a new plastic (dellubors triacetate) detector capable of registering protons of energy as low as 50 keV. The response of this detector to 400,300, 200, 100 and 50 keV protons; 5.48 MeV, 400 and 200 keV alohus; 3 300 keV N^+ ions and 300 keV Kr^+ ions has been studied. The diameter of the tracks is found to increase with etching time (6N NaOH at 60°C) and with dE/dx of the incident particle. It is shown that the detector possess rather good particle identification characteristics which make it suitable for a wide range of applications in nuclear physics, solid state physics and astrophysics.

15. <u>High Resolution Si (Li) Spectrometer and its</u> <u>Analytical Applications</u> - Madan Lal and S.S. Kapoor - Nuclear Physics Division - A high resolution multichannel x-ray spectrometer employing a cooled 30 mm² x 3 mm Si(Li) detector and a cooled FET preamplifier in the charge sensitive mode, has been set up in this laboratory. The present energy resolution of the system corresponds to about 400 ev and efforts are being made to improve this resolution further. The various factors, crucial to the attainment of high resolution will be discussed. The present energy resolution is good enough to discriminate K x-rays of any two adjoining elements of Z > 20. This set up is now being used for rapid, nondestructive simultaneous analysis of all the elements (z > 20) in any given sample. Several new areas of applications to which this set-up can be put to, are being studied.

Second Order Spherical Aberrations due to a Dipole 16. Magnet - N.C. Bhattacharya, R.C. Sethi, R.K. Bhandari and A.S. Divatia - Nuclear Physics Division - Scherical aberrations due to radial and axial divergences are the most important for a dipole magnet in a beam optical system. They have been calculated including the extended fringing field effect in the most general case i.e. with non-normal entry and exit and non-identical curvatures at the two faces of the magnet. The computation has been done according to Brown's formulation of second order matrices for various elements in a beam transport system. It has been shown that other parameters remaining constant, these aberrations are linear functions of the curvatures at the two faces. Expressions have been derived for the radii of curvature required to eliminate them.

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In the special case of normal entry and exit, identical radii of curvature, relationship between the radii of curvature and the field index n has been presented graphically.

In the case of the analyzing magnet for the 224 cm. Variable Energy Cyclotron, having field index $n = \frac{1}{2}$ and normal entry and exit, the sum of the radial aberrations due to radial and axial divergences is independent of the radii of curvatur and hence it is impossible to eliminate both the aberrations simultaneously.

17. Effect of Magnating Field Errors on Orbit Properties in Cyclic Accelerators - A Jain - Variable Energy Cyclotron Project - An orbit code for finding stability properties of equilibrium orbits in cyclic accelerators has been developed. The twelve first order simultaneous differential equations of motion described by Gordon and Welton⁽¹⁾are numerically integrated simultaneously by a four point Runge-Rutta process in the measured magnetic field $B(r, \theta)$. Three versions of the code are available: The input magnetic field is given i) on vpolar grid, ii) as a table of fourier co-efficients and iii) in an analytical form. The merits of the code and some recent applications have been described. It is theoretically difficult to correlate the errors in the measured field $E(r, \theta)$ with the final orbit properties. The problem has been studied numerically with the orbit code by deliberately introducing a known statistical error in an otherwise smooth field $B(r, \theta)$.

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The effect (on orbit properties) of neglecting higher order torms in the fourier series representation of an azimuthally varying field has also been studied.

1. M. M. Gordon and T.A. Welton, ORNL-2765.

13. <u>Measurement and Evaluation of the Fringing field</u> <u>Effects in A 2 CM. Quadrupole Magnet</u> - R.C. Sethi, A. Jain and A.S. Divatia - Nuclear Physics Division - To evaluate the fringing field effects of the quadrupole magnet for the 224 cm. Variable Energy Cyclotron, a jig has been constructed to map the field of a 2 cm. aperture quadrupole magnet, using a Hall-probe. The magnetic centre of the magnet has been found graphically. The field gradient in the fringing field zone and inside the magnet has been mapped. Non-linearity of the field gradient and deviation from the ideal field gradient have been studied as functions of current and radiue of aperture.

Fringing field effects have been measured in terms of change in length of the quadrupole magnet. The variations of this change in length have been obtained as functions of current and radius of aperture. The exact trajectory of a charged particle through the actual quadrupole field (fringing+main) has been traced numerically and the aberration has been calculated and compared with the hard-edge model approximation. The whole date has been smoothened by the method of least squares. : 15 :

19. <u>Mean Dynamic Stability Studies for the 224 CM</u> <u>Variable Energy Cyclotron</u> - A. Jain and A.S. Divatia - Nuclear Physics Division - Given the input magnetic field $B(r, \theta)$ for a specific particle and energy in a cyclotron, the variation of the betatron frequencies (V_r and V_z) with the radius, the most important drbit stability characteristic, can be computed exactly by orbit integration codes. If the beam is to remain stable, this variation of V_r and V_z should not cross a "resonance" on the $V_r - V_z$ graph throughout the acceleration history of the particle.

The orbit properties for the entire spectrum of particles to be accelerated by the variable energy cyclotron have been computed and mapped. Important conclusions based on these beam dynamic stability studies are discussed. It is found that the present maximum proton energy which is 60 MeV could be raised to only 70-30 MeV, when we strike the $V_X - V_Z = 1$ linear coupled resonance. With the present sector shapes, vertical beam stability also vanishes after this energy. It appears possible to achieve a maximum energy of 130 MeV for protons provided the sectors are redesigned.

20 <u>Radial Motion Studies in the Central Region of the</u> 224 cm Variable Energy Cyclotron - R.K. Bhandari, N. C. Bhattacharya and A.S. Divatia - In order to aphieve good extraction efficiency in a cyclotron, it is necessary to have well centred orbits and high phase space density at the entrance of the deflector. These conditions are met primarily by proper positioning of the ion source and the puller electrode in the central region where the electric field plays a domant role.

Particle orbits and orbit centre points have been calculated to determine the effect of the central region parameters - ion source position, puller electrode position. puller electrode angle, initial radial divergence and the magnetic field on the radial motion of the particles in the median plane, using the program PINWHEEL, obtained from Berkeley and adapted to CDC-3600 computer at TIFR. The necessary electric potential distribution in the central region has been measured by the electrolytic tank method, using a half scale copper model of the central region, incorporating the ion source, the puller electrode and the The potential was obtained on an X-Y grid in the median dee. plane using Type 547 Tektronix oscilloscope. Absolute accuracy in voltage measurement at any point on the water surface is + 5%.

<u>Conversion Electron Studies Following ^{79,31} Br(p,n)</u>
<u>79,31</u> Kr Reactions - Y.K Agarwal^{*}, C.V.K. Baba^{**}, M. G.
Betigeri, S.M. Bharathi^{*}, B. Lal and N.G. Puttaswamy^{***}
Nuclear Physics Division - The low lying states of ^{79,31} Kr

- Permanent address : Tata Institute of Fundamental Research, Colaba, Bombay-5.
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- *** Permanent address : Department of Physics, Bangalore University, Bangalore-1.

isotopez resulting from 79,81 Br(p,n) reactions at E_p= 5 MeV have been investigated using a six-gap β -spectrometer and Ge(Li) detector. Conversion coefficients of transitions involving levels upto 532 keV in 79 Kr and 395 keV in 31 Kr have been measured and the corresponding multipolarities are assigned.

22. Critical Facility of the Pulsed Fast Reactor

- P.K. Iyengar, K. Chandramoleshwar, S.K. Kapil, T. R. Krishnamurthy, V.R. Nargundkar, C.S. Pasupathy, A.K. Ray, S.N. Seshadri, M. Srinivasan and K. Subba Rao - Nuclear Physics Division - The paper briefly describes the salient features of the Critical Facility of the proposed Pulsed Fast Reactor. The critical facility is the first Indian Fast Reactor and is located at Trombay.

The critical assembly has a three litre Fu0₂ core. Melybdenum is used as axial reflector and copper and iron blocks are used as radial reflectors. Free fall of the core in addition to the ejection of molybdenum safety rode forms the main reactor protection feature.

Neutron detectors distributed in andaround the assembly provide the neutron level information for reactor control. Coarse and fine control rods are available for reactivity adjustment. 13 :

23. <u>Kinetics of the Pulsed Fast Reactor Critical</u> <u>Assembly with Temperature Feedback</u> - S. Das and M.Srinivasan - Nuclear Physics Division - The kinetic response of the PvO_2 fuelled pulsed fast reactor critical assembly to ramp reactivity inputs in the range of 10 ¢/sec to 10 \$/sec has been studied in connection with the safety evaluation of the system. The presence of even a small but prompt negative temperature feedback coefficient of reactivity is shown to play a significant role by increasing the time available for the safety system to act. Estimates have also been made of the time spreads in the melting of the various fuel pins of the core in the event of a hypothetical prompt excursion incident.

24. <u>D.C. Channels For Control of Fast Criticality</u> <u>Facility</u> - V.A. Pethe, Rishi Kumar, A.A. Patankar, N. C. Rathod, M.D. Ghodgaonkar and S.A. Gogate - Electronics Division - Three types of direct current channels were develoand and tested in Zerlina. All the channels use silicon devices and use function block type of construction. Two complete channels required only 5¹/₄" x 19" panel space. All the preset controls are inside the function blocks whereas the outgut of the blocks can be monitored from the front panel select switch.

Current amplifiers can sense 10^{-13} amp. Period Meter has a variable response time from 10 sec at 10^{-11} amp. to 0.6 sec. at 10^{-4} amp. The channels (Linear, Log-Safety and Period) were tested in Zerling. The results clearly indicate that overlap between pulse and D.C. channels is more, indicating that these channels respond at low flux levels. Period channels are immune to outside pickups inspite of good response over a very wide dynamic range.

25. <u>Physics Design Aspects of a Pulsed Fast Reactor</u> - V.R. Nargundkar - Nuclear Physics Division - Preliminary physics design aspects of a 30 Kw aircooled, reflector pulsed fast reactor have been considered. Assuming the basic parameters \mathcal{J} , \mathcal{L} , \mathcal{V} and the pulse width θ , peak power Pm, background power Po, maximum prompt reactivity \in mo etc. are calculated. The criteria for stable operation and control of the reactor are analysed.

Heat transfer calculations have been done to estimate cooling requirements and maximum fuel temperature.

The information generated has been found useful in the design of the critical facility of the pulsed fast reactor.

26. <u>Calculation of Keff for Bare Cylinder and Hexagonal</u> <u>Geometries</u> - B.K. Godwal, K. Subbukutty and S.B.D. Iyengar - Nuclear Physics Division - It is known that Keff of a system depends on the geometry. In order to investigate this dependence on geometry, calculations of Keff for bars cylinder and haxagonal geometries have been done by Monte Carlo Method. 27. Exploitation of Information Content in Second Moment of Count Rate During Approach-to-Critical Experiments - M. Srinivasan, K. Subba Rao, T.K. Basu - Nuclear Physics Division- The average count rate of a neutron detector placed in a multiplying assembly has been used traditionally as a measure of the subcritical multiplication of the system. A plot of inverse counts versus fuel loading has indicated the critical dimensions or loading of large heavy water power reactors down to the smallest fast critical assembly. However the basic drawback of the inverse counts method remain namely that the constant of proportionality between ΔK_{eff} and inverse counts is unknown. During the intermediate stages of the approach-to-critical experiment for example, the exact keff of the system is not known.

The feasibility of deriving the absolute degree of subcriticality and other useful reactor parameters by exploiting the information content in the second moment or standard deviation of the count rate of the detectors have been explored.

28. <u>Maximisation of Desired Activity Against Interfering</u> <u>Activities in Threshold Reactions</u> - O. P. Joneja, D. V. S. Ramakrishna and M.P. Navalkar - Nuclear Physics Division - The study of fast neutron flux and spectra in reactors using threshold detectors requires the measurement of reaction rates. The reaction rates are generally obtained by observing the activity of the product nucleus of a threshold reaction. Thus the accuracy of flux measurement demands on the knowledge of the disintegration rate of the desired activity. Apart from the counting statistics and low energy gamma counting in a decay scheme, interference due to impurities in the irradiated sample also presents difficulties. A method based on maximisation of desired activity against interfering activities has been described with special reference to detectors which are commonly employed for fast neutron flux and spectrum measurements.

29. <u>Neutronic Measurements Proposed in Fast Breeder Test</u> <u>Reactor</u> - R. Shankar Singh, - FBTR Design Group, Reactor Research Centre, Kalpakkam, Tamil Nadu - Certain neutronic measurements need to be performed when a reactor is brought to first criticality and before it is taken to full power. These include the neutron spectrum and flux measurements in various regions of the reactor in terms of different reaction rates and spectral indices etc. For Fast Breeder Test Reac: (FBTR)the objectives of such measurements, the types of measurements, the special apparatus required for them, the different kinds of neutron detectors required and the expected results from them, are analysed.

30. <u>Measurement of Fast Fission Ratios in Natural UO₂</u> <u>Clusters</u> - H.K. Jain and V.C. Deniz - Reactor Engineering Division - The fast fission ratios, δ_{23} were measured for 7, 19 and 37 - rod UO₂ clusters with D₂O, air, H₂O and polystyrene moulds as "coolant" in Zerlina reactor. The measurements were made by comparing the fission product gamma ray

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activities of depleted and natural uranium foils irradiated together inside the experimental cluster. The colibration factor P(t) was determined by measuring La¹⁴⁰ 1.60 MeV fission product gamma ray activity.

The details of the experimental technique and the method of analysis, including corrections, are analysed. The experimental results are compared with theoretically calculated values using the computer code EPSICH.

31. Inverse Kinetics Analysis of Power-Time Trace Data of Heavy Water Reactors - M. Srinivasan - Huclear Physics Division - The long half lives of delayed photo neutrons has been a hindrance in reactivity calibration experiments based on stable period measurements, in the case of D_2O moderated reactor systems. With the availability of large fast digital computers it is now possible to dispense with the concept of asymptotic period and inhour relation and deal directly with the basic reactor kinetic equations in the analysis of experimental data. In this approach the experimentally recorded reactor neutron level variations is analysed using a computer program to yield the input reactivity driving function. The advantages of this technique in the context of D₂O reactor system are studied along with · some experimental results

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32. Neutron Scattering Cross Section for Liquid

Methane - K.R. Rao and B.A. Dasannacharya - Muclear Physics Division - The differential scattering cross section for neutron scattering from liquid methane has been measured using 4.1Å neutrons at CIRUS for scattering angles in the range of 15° to 90°. A theoretical model in which simple diffusion and hindered rotation characterised dynamics of molecules in the liquid, gives fairly good agreement with experimental results. However the data had not been corrected for multiple scattering and there were some discrepancies. In this work, the multiple scattering in the liquid corresponding to geometrical conditions of the experiment has been studied. The intensity ratio of secondary to primary scattering is found to vary from about 0.5 to 0.3 for scattering angles 30° to 90° in the inclustic region for a specimen of thickness 0.1 cm. When this correction is taken into account the agreement between experimental data and theoretical results is improved significantly. Gross section corrected for multiple scattering is obtained.

B. TATA INSTITUTE OF FUNDAMENTAL ANDLARCH, BOMBAY-5.

1. <u>Analogue States in 13 C, 13 F and 31 P - M.A. Gunye and C.S. Warke - The analogue states in 13 C, 13 F and 31 P are studied. Results in multishell configuration space are compared with these obtained from shell-moder calculations and with the experimental data.</u>

2. Spins of the Lowlying Levels in 75 Se - 3. Lal and Baldev Sahai - The levels in 75 Se have been investigated by 75 As(pn, 7) 75 Se reaction. The angular distribution of various ground state and cascade gamma-ray transitions from the low lying levels in 75 Se have been measured near their respective thresholds. Using the Hausee-Feshbach formalism of statistical theory of nuclear reactions, the spins of some of the low-lying levels in 75 Se have been determined from the anisotropies observed in the angular distribution of corresponding transitions.

3. <u>Hyperfine Fields of as in Ferromanaetic HOST</u> - R.C. Chopra and P.N. Tandom - Hyperfine field of As in Ni host has been measured using the Perturbed Angular Correlation technique. Radioactive ⁷⁵Se was implanted in Ni using a mass separator. The 121-280 keV gamma-gamma cascade was used in the measurement. The angular correlation of this cascade was measured using a 20 cc Ge(Li) - 2" x 2" Na(21) coincidence system, which gave $A_2 = -0.32 \pm 0.03$ without correcting for geometry. The quantity 'R' was measured with detectors kept at 135°, in a polarising field of 1.2 KG provided by an electromagnet. The results obtained are $R = 0.027 \pm 0.007$, $\omega T = 0.026 \pm 0.007$ and $H_{hyp} = 41 \pm 13$ KG. Measurements on other ferromagnetic hosts are in progress.

4. <u>The 158 keV Level in ${}^{117}Sn = R.C.$ Chopra, R.R.</u> Hogangdi and P.N. Tandon - The half-life of the 158 keV level in ${}^{117}Sn$ has been measured to be $T_{1/2} = 0.32 \pm 0.02$ ns using delayed coincidence technique. The angular correlation of the 560-158 keV gamma rays through this level is measured to be $A_2 = -0.03 \pm 0.03$. Measurements for the magnetic moment of this state are in progress.

5. Decay of Np^{239} To Pu^{239} - K_TP. Jopinathan, A. P. Agnihotry, P.N. Tondon, H.C. Jain and S.B. Patel - The gamma epectrum of Np^{239} has been studied by a 20 cc Ge(Li) detector The Np^{239} was produced by irraditation of natural Uranium in the APSARA reactor at Trombay followed by chemical separation in carrier-free form. The energies (and relative intensities) of the well resolved gamma rays were found to be 61.46 keV (18), 106.14 keV '636), 209.8 keV (29),228.2 keV (100), 277.6 keV (115), 285.5 keV (6.5), 315.9 keV (13), and 334.3 keV (16). Angular correlation measurements using both liquid and solid sources gave results in agreement with each other, The

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weighted mean values were:

Cascade A_2 A_4 106.14 - 228.2 keV $-0.023 \pm 0.005 \pm 0.010 \pm 0.007$ 106.14 - 227.6 keV $-0.0080 \pm 0.0037 \pm 0.0037 \pm 0.0070$ After correcting for the contributions from interfering cascades and assuming that the 106.14 keV transition is pure E1 the analysis of the results gave the E2/M1 mixing ratios of the transitions : $5 \ 223.2 = -0.22 \pm 0.06$ and $5 \ 277.6$ $= \pm 0.21 \pm 0.02$. The half lives of the 391.6 and 285.5 keV levels were measured by means of a time-to-pulse height converter and were found to be 192 ± 8 ns and 1.12 ± 0.06 ng respectively. Further work is in progress.

6. <u>High Resolution Study of Transitions in 144 Pr - K.G.</u> Prasad and A.K. Bandyopadhyay - The gamma-ray and conversion electron intensities in the decay of 144 Ce 144 Pr have been deduced using a high resolution Ge(Li) detector and a double focussing beta-ray spectrometer. The K-conversion coefficient and the L subshell ratios of the 80 keV transity have been determined accurately. The implications of these results on the multipolarity of the 80 keV transition are analysed.

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High Resolution Internal Conversion Measurements 7. in the Decay of Lu^{177m} and Yb¹⁷⁷ - K. P. Copinathan, A. . Agnihotry and S.B. Patel and M.C. Joshi, University of Pombay, Bombay and M. S. Bidarkundi, I.I.T., Powai, Bombay - The internal conversion electron spectra from the decay of Lu^{177m} and Yb¹⁷⁷ have been studied by a double-focusing electron spectrometer at a resolution of 0.1%. The K conversion coefficients and the K and L subshell conversion ratios were determined from the measurements. Transitions of energy 66.1 and 83.8 keV were found to be E1 from the L subshell conversion ratios. The E2 contents of the intraband M1+E2 transitions as determined from the L subshell ratios are : 10.531 keV (10%); 128.6 keV (15%); 153.3 keV (9%); 204.1 keV (11%); 214.5 keV(35%); in the $K = 9/2^+$ (624) band in Hf¹⁷⁷: 112.95keV (90%) in the $K = 7/2^{-1}$ (514) band in Hf¹⁷⁷: 121.63 keV(23%) in the K = $7/2^+$ (404) band in Lu^{177} ; and 138.4 keV (3%) in the K = $9/2^{-}$ (514) state in Lu¹⁷⁷ was found to be weakly excited in the decay of Lu^{177m}. The results are analysed with reference to the rotational model of the nucleur

8. <u>Penetration Effects in Internal Conversion of Tran</u>-<u>sitions in Lu¹⁷⁷ and Hf¹⁷⁷</u> - K.P. Gopinathan and A. P. Agnihotry - Internal conversion coefficients of the hindered E1 transitions in Lu¹⁷⁷ and Hf¹⁷⁷ have been measured with an electron spectrometer at 0.1% resolution and a 20 cc Ge(Li) gamma ray spectrometer. The experimental conversion coefficients are given below. The theoretical values for E1

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E (keV) K	L ₁	L ₁₁	L.
Lu ¹⁷⁷	0.44 <u>+</u> .040	0.102 <u>+</u> .010	0.041 <u>+</u> .004	0.0057 <u>+</u> .0008
150.4	(0.100)	(0.011)	(0.00228)	(0.00245)
Hf ¹⁷⁷		12.4+2.7	1.36 <u>+</u> .45	0.24+.22
55.14		(0.125)	(0.058)	(0.074)
Hf ¹⁷⁷		0.113 <u>+</u> .013	0.035 <u>+</u> .018	0.030 <u>+</u> .16
71.7		(0.071)	(0.026)	(0.031)
Hf ¹⁷⁷	0.052 <u>+</u> .0015	0.0111 <u>+</u> .0004	0.0030 <u>+</u> .0004	0.00257 <u>+</u> .009#
208.32	(0.046)	(0.0063)	(0.0009)	(0.0009)
Hf ¹⁷⁷	0.166 <u>+</u> .016	0.0426 <u>+</u> .006	0.0175 <u>+</u> .007	0.0145 <u>+</u> .008
321.4	(0.0155)	(0.0013)	(0.00024)	(0.00022)

without penetration effects are given in parenthesis.

From the analysis of the results, allowing for any M2 admixture, the penetration nuclear matrix elements are determined and discussed in terms of the structure of the levels involved.

9. Electromagnetic Transitions in 136 W, 136 , 138 Os - B.M. Subba Rao - In view of the current interest in transitional and vibrational nuclei, branching ratios of γ -rays from the 2'+ levels in 186 , 183 Os are measured with a Ge(Li) spectro meter. These are found to be lower than the corresponding Kumar-Baranger theoretical predictions by a factor of about 3 while they are in good agreement with the earlier Davydov-Filippov and Davydov-Rostovski non-axial nuclear models. The ratio of the amplitudes of multiples mixture, (E2/m), of the 630 keV transition is found, from the 630 keV \rightarrow 137 keV directional correlation, to be + 16⁺24 in agreement with both the above nuclear models (| 14.6 |)^{-6.4} and the microscopic theory (+14.7). The two pure E2 transitions of 122.5 keV (186W) and 137.2 keV (¹³⁶Os) have been of continuing interest, for their internal conversion coefficients. Nére, K, L₁, L₂, L₃ M and (N+(O)+P₁) conversion coefficients of these transitions are determined with an iron yoke double focussing β -ray spectrometer and are found to be in good agreement with the improved post-1968 theoretic theoretical calculations.

10. Beta-Gamma Circular Polarization Correlation in $\frac{148}{Pm}$ - H.C. Padhi and S.K. Mitra - The beta-gamma circular polarization correlation of 1020 keV beta and (915 + 1465) keV gamma-rays in the decay of 5.4 days $\frac{148}{Pm}$ was measured. The measured asymmetry parameter A, the Fermi matrix element M_F and the isospin impurity coefficient OC which accounts for the Fermi matrix component in the allowed mixed betadecay are:

$$A = 0.14 \pm 0.03$$
$$M_{\rm F} = (1.46 \pm 0.48)10^{-3}$$
$$= (0.29 \pm 0.09)10^{-3}$$

C. SAHA INSTITUTE OF NUCLEAR PHYSICS, CALCUTFA-9.

1. <u>PAC Studies on the 80 KeV 3⁻ State of ¹⁴⁴Pr - 3.K.</u> Sinha and R. Bhattacharyya - The rotation of the angular correlation pattern of the (53-80) keV cascade of ¹⁴⁴Pr has been detected under an applied magnetic field of 21 K gauss. The amount of rotation is $\omega \Upsilon = 0.08 \pm 0.05$ radian. Further studies are in progress.

2. <u>Complex Angular Momentum Methods For Composite</u> <u>Particle-Nucleus Elastic Scattering</u> - B.K. Satpathy, Sambalpur University, Sambalpur, D.K. Mishra, Ravenshaw College, Cuttact and S.K. Samaddar - Regge-Type representations for the scatteing amplitude, developed earlier are used for the study of elastic scattering of ³He and triton from nuclei. The pole parameters are determined taking optical potential parameters as input. Calculated cross sections are in agreement with experiment. The spin and parity of a few levels of the compound nuclei are predicted.

3. <u>An Exact Description of (p,p) Reaction</u> - S.K. Samadda and Suprokash Mukherjee - The distorted wave Born approximat may be considered as the only practical method for the analysis of direct reactions till to-day. Unfortunately, though it is widely applied, clear understanding of the theory has not yet been possible. Dodd and Greider attempted as formulating as integral equation with the DWBA amplitude as the inhomogeneous term and pointed at certain formal difficulties for its convergence. We have found that their equation is erroneous. Using the projection operator technique of Feehbach, we have written the exact (d,p) reaction amplitude which has certain interesting features about (i) the distortion of the outgoing proton and (ii) the contribution from inside the nucleus. The equation also helps in understanding the DWBA.

Interpretation of ²⁰⁶Pb(t,p)²⁰³Pb Reactions in 4. Terms of Particle-Core States in 203 Pb - K. V. Chalapati Rao -Igo et al. have recently studied energy levels in ²⁰⁸Pb up to an excitation energy of 8.5 MeV though 206 Pb(t,p) reactions. The (t,p) reaction is known to be sensitive to the two-neutron particle correlations in a nuclear state, so most of the levels excited are expected to have 2p-2h structure. We have attempted to understand these levels by coupling the two neutrons outside 208 pb to the vibrations of 206 ph This is an extension of our previous calculations on core. 207 Pb where we studied the positive parity states excited in $206_{Pb}(d,p)^{207}$ Pb reaction by coupling a neutron in the 126-184 shell to the 206 Pb core. The two neutrons are assumed to interact through a surface-delta interaction whose strength is fixed by fitting the energy levels of 210 Pb. The strength of the particle-core interaction is chosen to be the same as

the one used in our calculation: on ²⁰⁷Pb. The results of the calculations are in fairly good agreement with experiment.

5. <u>A Study of the Properties of Ion Beam From Duoplas-</u> <u>matron</u> - D.K. Bose, S.N. Sengupta and B.D. Nagchaudhuri - Extraction of ion beam from a duoplasmatron ion source has been carried out using a modified extraction system. The properties of the extraction system and the results of beam emittance measurements are studied.

6. Nanosecond Pulsing For Electrostatic Accelerator - B. Sethi, V.K. Tikku, H. Singh, S.C. Mukherjee and S. K. Mukherjee - A nanosecond pulsing system for the terminal of a Cockroft Walton accelerator is described. The system consists of an r.f. ion source followed by a gap Einzel lens. Two pairs of deflection plates are mounted in quadrature inside the lens assembly and a phase related r.f. voltage at a frequency of 6.5 Mc/s is applied to the two pairs of plates The team spot moves in an elliptic path and crosses a choppin. aperture once in each cycle. In a bench test the beam bursts of a few nsec are received in a wide-band Faraday cup matched to a 50 SL coaxial cable, and observed on a sampling oscilloscope. The burst duration at the collector is also calculated using simplifying assumptions, and the performance characteristics of the system are studied.

7. <u>L/K Electron Capture Ratio From Gamma-Ray - X-Ray</u> <u>Sum Peak In Ge(Li) Spectra</u> - B.K. Das Mahapatra - A new method has been developed for the determination of L/K electron capture ratio from the spectrum obtained with a Ge(Li) detector. In this method P_K , the probability for a K-electron capture to take place is evaluated from a quantitative analysis of the gamma-ray - X-ray sum peak observed with the detector. With the PK thus evaluated and the known correctione for captures from higher shells, L/K capture ratio is readily determined. The observed L/K capture ratio in the decay of ¹³³ Ba is found to be in good agreement with the recently reported work. Also the total L/K capture ratio in the decay of 12.4 y. ¹⁵² Eu is measured.

8. <u>Half-Life of the 208.1 keV Level in ¹⁹⁹Hg and the</u> <u>Internal Conversion Coefficients of the Transitions in ¹⁹⁹Hg</u> - H. Singh, B. Sethi and V.K. Tikku - The half-life of the 208.1 keV level in ¹⁹⁹Hg has been measured by the delayed coincidence set up. A value of 70 \pm 15 psec is obtained. The 7 -transition rates deduced from our experiments, on comparison with Weisskopf s.p. estimate reveal that the Ml part of the 208.1 keV transition is more retarded (retardation factor, FW = 60) than the 49.9 keV transition (F_W=16). These results, the B(E2) values, and also the comparison of the experimental and model dependent values of magnetic moment for the first excited level in ¹⁹⁹Hg, are seen as an evidence

for the core particle model description for the excited levels in this nucleus.

Decay of ⁴³Sc - H. Singh, V.X. Tikku and B. Sethi 9. - The disintegration characteristics of the 44 h 48 Sc activity have been studied by use of high resolution Ge(14) detector. Irradiation of specpur vanadium metal powder $({}^{51}V$. 99.75%) 14.7 MeV neutrons gives, in addition to the 44 h ⁴⁸Sc activity. a 3 h activity also. The 44 h ⁴⁸Sc activity decays with the emission of 174.9, 985.3, 1038.6, 1212.7 and 1313.3 keV 7 -rays. The 1212.7 keV 7-ray represents the crossover transition between the 3518 and 2295 keV levels in 48₇₁ The 3 h activity appears to belong to an isomer of ⁴⁸Sc. The measurements are also carried out by producing ⁴⁸Sc activity from the irradiation of specpure titanium metal powder with fast neutrons. Based on the singles and coincidence measurements, a decay scheme of ⁴⁸Sc is proposed

10. <u>A New Level in ${}^{67}Zn$ - D. Basu and P. Sen - The decay</u> of 78 h Gallium 67 to Zinc 67 was studied with a high resolution Ge(Li) detector and a 4096 channel analyzer. Besides the gamma rays at (91 + 93), 184, 209, 300, 393, 394,704,795 888 keV energies, a new gamma ray at more gamma rays at 700 and 791 keV are present. A new level has been proposed in the decay scheme. 11. Decay of 97_{Zr} and $97_{Nb} - V.K.$ Tikku, H. Singh and B. Sethi - The decays of the 17 h 97_{Zr} and 72 min 97_{Nb} have been studied using high resolution Ge(Li) detector and 4096 channel analyzer. The 97_{Zr} source was produced by the irradiation of enriched $96_{Zr}(85.25\%)$ at Cirus reactor at a neutron flux of 5 x 1042 n/sq. cm. sec. for 2 days. In addition to the previously reported % -rays of 97_{Nb} and 97_{Mo} , new % -rays at 805.6, 1018.1, 1026.7 and 1361.0 keV energies are observed, and found to decay with the 17 h half-life of 97_{Zr} . Based on these measurements a combined decay scheme of 97_{Zr} and 97_{Nb} is proposed.

12. Decay of ${}^{126}I$ - B.P. Pathak and M.L. Chatterjee - The decay characteristics of 13 d ${}^{126}I$ have been reinvestigated using Ge(Li) and scin-tillation spectrometers. A previously unreported γ -ray of 55 keV has been observed. The existence of low intensity γ -rays of 1377 and 2044 keV has been confirmed by using a 20 cm³ coaxial Ge(Li) detector. An improved decay scheme of 1261 is proposed on the basis of the present study.

D. ALIGARH MUSLIM UNIVERSITY, ALIGARH

1. On The Shell Effects in (n,2n) Reaction Cross Sections at 14.8 MeV - J.P. Gupta, Raj Kumar and R. Prasdad - Presence of shell effects in (n,2n) reactions at 14.8 MeV have been indicated by various workers. Hills and Dilg et al., however, have recently shown the lack of evidence of shell effects by plotting literature values of (n, 2n) reaction cross sections against the asymmetry parameter (n-2)/A. In a programme of cross section measurements, (n,2n) reaction cross sections for some forty four cases have been measured, Measured cross sections are compared with the cross sections calculated from the emperical formula given by Barr et al. The ratio $\int_{axb} / \int cal$, when plotted against the proton number 'Z', indicates the presence of shell effect.

2. Some Calculations on Nuclear Level Spacings - A.K. Chaubey and M.L. Sehgal - We have done some calculations on nuclear level spacings. Lang and Lecoteur have given an expression for spin independent level spacing:- D_0 X const = $(4AW/11)^2 \exp{-(AAW/11)^{\frac{1}{3}}}$. Using our earlier values of D_0 we have calculated the value of 'constant' in several nuclei. It was observed that this constant has got some structure and varies with number of neutrons in the target nucleus, in very interesting way. 3. <u>A Calculation of the Real Part of the Nucleon</u> <u>Optical-Model Potential</u> - Q.N. Usmani and I. Ahmad - Hartree -Fock density distribution has been used to calculate the real part of the nucleon optical-model potential under the formalism of Greenlees et al. Radial distribution of the calculated potential is compared with the phenomenological one, with a view to highlight some interesting points.

4. <u>On Inelastic Scattering of Neutrons by Deuterons</u> - V.K. Sharma, D.S. College - The distorted wave approximation is applied to the problem of neutron-deuteron inelastic scattering. It is assumed that the two body interaction is of central type with Yukawa radial dependence, and the Wheeler's resonating group method is used to derive coupled integro-differential equations.

E. ANDHRA UNIVERSITY, WALTAIR, VISAKHAPATNAM-3(AP)

1. <u>Genma-Gamma Angular Correlation Measurements in</u> $\frac{136}{08}$ - M.L. Narasimha Raju, P. Jagam, B. Vorma Reddy and D.L. Sastry - The (631-137) keV gamma-gamma directional correlation in ¹³⁶Os is measured with a sum peak coincidence scintillation spectrometer using both liquid and solid sources. The present correlation function in liquid source is in good agreement with that reported by King et al. The present measurements indicate that there is no attenuation of the correlation in solid source due to time dependent perturbations.

2. <u>Angular Correlation Studies in Mercury -198</u> - K.Venkata Ramana Rao and V. Lakehminarayana - The angular correlation of the cascade (676-412) keV. in the decay of Gold-198 is studied, using high efficiency sum-peak coincidence arrangement. The resultant correlation pattern is $W(\Theta) = 1 - (0.272 \pm 0.01) P_2 (\cos \Theta)$ (0.143 $\pm 0.006) P_A^2 (\cos \Theta)$

Assuming a $2^+ \rightarrow 2 \rightarrow 0$ spin sequence connecting the cascade, the present correlation coefficients are used to obtain the mixing ratio of the 676 keV transition to be (0.85 \pm 0.06). The results indicate monopole contribution and an admixture of particle and collective excitations in the 676 keV transition in Hg-198. Vibration-like wavefunctions furnished by Govello & Sartoris and Talongo & Alaga for the 2⁺ states are used and the mixing ratios are estimated to be 5.03 and 0.143 respectively. It is concluded that the vibrationlike wavefunctions based on microscopic models are not adequate for describing the second 2⁺ state in Mercury-198.

Experimental P-Wave Neutron Strength Functions and 3. the Optical Model - J Rama Rao, M. Sriramachandra Murty, K. Siddappa and A. Lakshmana Rao - Experimental p-wave neutron strength functions in about 40 nuclei in the mass region 60 \angle A \angle 200 are extracted from average neutron capture cross sections determined at 25 keV. The s-wave capture contributions in these cross sections are evaluated and subtracted out using the s-wave resonance parameters relevant to the keV region recently reported by Musgrove. The p-wave strength functions, so derived, together with those of others, are compared with the optical model predictions of Buck & Perey and Fiedeldey & Frahn. In the 3p resonance region, 80 < A < 120, there is good agreement with Fiedeldey and Frahn's calculations where as in the deformed region, 150 \angle A \angle 190, better agreement is noticed with Buck and Perey's predictions. Possible indication of shell effects are also observed around A \sim 140 and 200.

<u>Modification of the Siegbrain-Slatis Deta Ray Spectro-</u>
 <u>meter for Data Gamma Coincidence Studies</u> - M. Ravindranath,
 Narasimha Rao and K. Venkata Reddy - An Intermediate image

beta ray spectrometer of the Seighalm-Slatie type for measuring beta gamma coincidence is developed. The general are detected by a sodium-iodide crystal-6810A photomultiplier assembly fixed in the fron pole-piece behind the source. The Geiger counter on the beta side has been replaced by a plastic scintilator-6810A photomultiplier detector. The Effect of the magnetic field on the gamma photomultiplier is eliminated using a compensating coil arrangement. The shape of the 960 keV beta transition in the decay of Au-198 has been measured in coincidence with the 412 keV gamma ray.

5. Internal Conversion Measurements of Transitions in 5900- C. Narasimha Rao, K. Venkata Ramaniah and K. Venkata Reddy - The conversion lines in the decay of ⁵⁹Fe have been studied by meane of an intermediate image beta ray spectrometer of the Sieghahn-Slatis type and relative conversion electron intensities of the conversion lines of 141, 191, 334, 1099 and 1299 keV transitions have been determined with a view to, determine the conversion coefficients of the above transitions. The relative photon intensities have been obtained from the gamma spectrum using Ge(Li) detector. The conversion coefficients are calculated relative to the conversion coefficient of the 191 keV transition.

Determination of Conversion Coefficients in ⁷⁵As
 B. Mallikarjuna Rao, K. ^Venkata Ramaniah and K. Venkata
 Reddy - The conversion electron spectrum of ⁷⁵As has been

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reinvestigated by means of an intermediate image beta ray epectrometer. The relative intensities and conversion coefficients for the 121, 136, 198, 264, 279 and 400 keV transitions have been determined. The relative conversion line intensities are normalised with the gamma intensities through the 264 keV transition.

7. <u>Conversion Coefficient Measurements in 160 Dy</u>

- K. Venkata Ramaniah, P. Mallikarjuna Rao and K. Venkata Reddy - The internal conversion coefficients for the 299, 337, 682, 879, 960, 1060 and 1103 keV transitions in ¹⁶⁰Dy have been measured by recording the conversion electron spectrum using a Siegbahn-Slatis beta ray spectrometer. The relative photon intensities of M.A. Ludington et.al. have been employed. The conversion coefficients are calculated relative to the conversion coefficient of 879 keV transition

8. <u>Hadioactive Decay of 76 As</u> - K.L. Narasimham, M.N. Sectaramanath and V. Lakshminarayana - The decay of the radiu active isotope 76 As, produced by the (p,n) reaction on enriched 76 Ge, is studied using a 2.5 c.c. Ge(Li) detector system 41 gamma rays are identified and their energies and relative intensities are determined. The results are in general agreement with those of Tizawa et al. Some gamma rays observed by them are also seen in the present work but did not follow the half-life. Four new gammas of energies 733, 955, 1051 and 1883 keV are observed in the present work.

F. BANARAS HINDU UNIVERSITY, VARANASI-5.

1. <u>Ground State Spin Parity of Odd-Odd Rare-Earth Muoled</u> - D.K. Gupta and P.C. Sood - Nordheim's rules (1950) for assigning spin-parity to the ground states of odd-odd spherical nuclei were extended to the deformed region by Gellagher and Mosskowski (1958). Later detailed empirical studies brought out frequent violations of weak rule of Nordheim, and modification of the same was suggested by Brennan and Bernastein (1960). During recent years substantial new data have become available on odd-odd deformed nuclei. Accordingly we have undertaken a critical examination of the validity of the Gallagher-Moszkowski rules. The study has to be based on the respective odd-mass nuclides. The results of these investigations for nuclei of the rare earth region has been completent.

2. <u>A-Dependence of the Optical Model Potential</u> - D. C. Agrawal and P.C. Sood - The optical model analysis of 11 MeV proton scattering from 20 isotopes in the region 48 Ti to 76 Cby Perey and Perey (Phys. Lett. <u>26B</u>, 123, 1968) was said to have 'revealed a very smooth variation of real well depth as a function of mass number while not following the expected isospin dependence of the potential'. Several contradicting views have since been expressed on the subject. An extensive systematic examination of the optical model potentials defined by analyses of both proton and neutron scattering at various energies and over wider mass range falls to substantiate this A-dependence of the real well depth, whereas the isospin dependence of the potential is still evident with strong local fluctuations, which in piecemeal examination may yield erroreneous conclusions.

3. Decay of Ir^{192} - Rajendra Prasad, S.P. Ram, L. Chaturvedi, S.N. Chaturvedi and A.K. Nigam - Experimental studies on the decay of Ir^{192} are being made using the Ge(Li) gamma ray detector and the sum coincidence technique. The relative intensities of most of the gamma transitions have been determined and compared with the other available results.

4. <u>Higher Order Matrix Elements in Beta Decays</u> - R.P. Singhal - The higher order matrix elements have been deduced for some hindered-allowed beta decays by utilizing all the available experimental data. Exact electron radial functions (with finite size corrections) have been used. It is found that the anomalous shape factor and the non-zero directional correlation can be explained by assuming small values of the matrix elements within the frame work of (V-A) theory. The empirical values of the matrix elements are also compared with other theories. The present work encompasses areas of nuclear models, weak interaction theory, and also the charge independence of nuclear forces.

G. INDIAN INSTITUTE OF TECHNOLOGY, MANPUR

1. Investigation of Nuclear Levels in 28 Si by Means of 27 Al(p, $\frac{7}{2}$) 23 Si Reaction - C. Rangacharyulu, V.C. Jadhao, G.K. Mehta and R.N. Singru - Energy levels of the nucleus 28 Si have been investigated by studying the 27 Al(p, $\frac{7}{2}$) 28 Si reaction with the 2-MeV Van de Graaff accelerator. In particular, the resonance at the proton energy $E_p = 0.992$ MeV leading to the 12.542 MeV level in 28 Si was studied in detail. The gamma decay of this level, when studied with a Ge(Li) detector and coincidence spectrometer, indicates that a level at 10.27 MeV in 28 Si is populated in the decay process. The existence of this level at 10.27 MeV, which was in doubt earlier, seems to be justified by our data.

2. <u>Nuclear Studies of 99 Ph - D.K. Gupta, C. Rangacharyulu,</u> R.Singh and G.N. Mao - The radioactive decay of 16.1 day 99 Rh has been studied using Ge(Li)-Ge(Li) coincidence spectrometer and Na(Tl)-Na(Tl) Sum-coincidence spectrometer. Evidence for the existence of a new gamma ray of energy 910.8 keV is obtained. A level scheme for 99 Rh is established. Four new cascade transitions from the energy levels at 850.7, 1000.2, 1295.2 and 1382.9 KeV are reported. The relative intensities and energies of all the gamma transitions are determined. The halflife of the 89.4 KeV level is measured using the delayed coincidence method. The value obtained is 20.5 \pm 0.1) neec. <u>Nuclear Lifetime Measurements of Some Excited</u>
<u>States in 75-As. 131-Cs. 133-Cs. 170-Yb. 187-Re and 197-Au</u>
D.K. Gupta and G.N. Rao - The halflives of some short
lived nuclear excited states in 75-As, 131-Cs, 133-Cs, 170-Yb,
187-Re and 197-Au are measured using the delayed coincidence
techniques. The present values are compared with the previous
measurements.

4. <u>Lifetime And Magnetic Moment of 68 KeV State In</u> <u>44-Sc</u> - D.K. Gupta, D.N. Sanwal And G.N. Rao - The halflife of the 68 KeV state in 44-Sc is measured using delayed coincidence techniques. The value obtained for the halflife $T_{\pm}^{i} = 155.8$ nsec. The magnetic moment of the 68 KeV state in 44-Sc is also measured using time differential perturbed angular correlation technique in an external magnetic field of 7 KOe. The magnetic moment $\mu = + 0.351$ n.m. The hyperfine field measurement at 44-Sc nuclei in iron matrix is in progress.

5. Search For Super Heavy Elements in Natural Materials - Brij M. Trivedi - Predictions have been made that the elements around Z = 114 should have long lives ($>10^8$ yrs) against spontaneous fission and alpha decay and that they should have survived in earthly materials. Based on these predictions a number of laboratories around the world have tried to look for these elements in rocks, ocean sediments and the old lead eamples. Workers in these labs. have looked for high energy spontaneous and induced fission fragments and high energy neutrons in these samples. So far no clear evidence exists for these elements.

Since the elements around 114 should resemble in their chemical properties with elements around lead (Z = 82)(114 is eka lead), we have tried to separate them from rocks, making use of their volatile property. The samples thus obtained were analysed by alpha particle spectroscopy. So far no anomalous albha activity has been found in these samples.

6. <u>Ge(Li) - Ge(Li) Coincidence Studies in 131 Ce - R.Singh and G.K. Mehta - The level scheme of 131 Ce has been studied by Ge(Li) - Ge(Li) fast - slow coincidence spectrometer. The existen ∞ of 30 gamma rays and the levels at 73.8, 123.5, 133.4, 215.7, 373.0, 585.0, 620.0, 696.3 and 1048.4 keV have been confirmed. No evidences are found for 215.7 - 73.8, 696.3-373.0 and 696.3 - 133.4 transitions reported by earlier workers. The relative intensities of various transitions have been found to agree very well with the results of other authors.</u>

H. INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR-2

1. Equivalence of Two Internucleon Potentials in G_{ink} Calculations - B.K. Srivastava and S.S. Raghavan - It has been shown that, for nuclei in the /S shell, the photodisintegration integrated cross section ($G_{ink} = \int_{c}^{\infty} G(W)$) dW), whose sum rule expression involves the two-body potential directly, fails to distinguish between any two potentials. We explain this inability of G_{ink} calculations to distinguish between two potentials in terms of the well known rangedepth relationship for the nuclear two-body potentials.

2. Effect of Tenerr Forces on (V, P) Photodisintegration of He⁴ - H.L. Yadav, D.Mahanti and B.K. Srivastava - Different radial shape wave functions containing a mixture of ¹S state and the principal⁵ D₁ state, obtained by the variational calculation of the binding energy of the alpha particle using the tensor velocity-dependent potential of Nestor et al., are employed to calculate the photodisintegration cross section of the process He⁴(V_{p} P)H³.

It is seen that the results are in better agreement with the experimental results of Gorbunov et al. as compared to the earlier calculations with central velocity-dependent potentials or tensor potential without hard core or velocitydependent components.

I. INDIAN INSTITUTE OF TECHNOLOGY, NEW DELHI-29

1. <u>On the Transport of One Speed Neutrons</u> - A.K. Ghatak and Shashi Bala - The decay of a monocenergetic burst of neutrons in elabe of various thicknessee has been analytically studied, assuming isotropic as well as highly unisotropic scattering. The calculations corresponding to the fundamental mode have been compared with exact numerical calculations. This comparison shows that if we use Marshak's boundary conditions the results are more accurate than what are obtained by using Mark's boundary conditions. The calculations have been applied to the study of the monoenergetic burst of neutrons in heavy non-moderating assemblies and also to the transport of neutrone of energy corresponding to the first Bragg peak in polycrystalline moderators like beryllium and graphite.

J. PUNJAB UNIVERSITY, CHANDIGARH-14.

1. <u>Magnetic Moment of the 3⁻, 1374 keV Level of ¹⁸²W</u> - A.K. Dhar, Bhupender Singh, Vikram Singh and H.S.Hans - The angular correlation of the 179-152 keV V - V cascade in ¹⁸²W has been measured. The magnetic moment of the 3⁻_p 1374 KeV levels has been determined by observing the rotation of the 179-152 keV V - V angular correlation in an external magnetic field of 15 kilogauss.

2. The Internal HyperFine Fields on Arsenic in Cobalt And Nickel Hosts - A.K. Dhar, Bhupender Singh, Vikram Singh and H.S. Hans - The hyperfine internal magnetic fields on arsenic nuclei in cobalt and nickel hosts have been measured by the integral reversed field method of perturbed angular correlation technique. The $5^+/2$ (121.1-keV) $5^-/2$ (279.6-keV) $3^-/2$ cascade in 75As was used for the directional correlation and rotation measuremente. Using $g = 0.36 \pm 0.04$ and lifetime $\mathcal{T} = [4.67 \pm 0.43)10^{-10}$ sec for the 279.6-keV level of 75As, the hyperfine fields on arsenic in cobalt and nickel at room temperature have been found to be

$$H_{CO}^{AS} = -265 \pm 50 \text{ kilogauss},$$
$$H_{N1}^{AS} = -145 \pm 25 \text{ kilogauss}$$

respectively. The hyperfine fields on arsenic in iron, cobalt and nickel have been found to be proportional to the effective host moments. 3. <u>Directional Correlation And Multipole Mixing of</u> The Gamma Transition in 9^{3} To - S.S. Bhati, A.K. Bharddwaj, Nirmal Singh, P.C. Mingal and P.N. Trehan - Directional correlations have been measured for 740-181, 740-(41)-140, 140-41 and 740-41 keV gamma cascades in 9^{9} T. on the basis of these measurements, a spin assignment of $3/2^{+}$ for 921 keV level has been confirmed. The multipole mixtures of 740,140 and 41 keV gamma rays are found to be E2 + $\langle 1/M1, 95\%$ MI + $(5\pm1\%)$ E2 and predominantly MI + $(0.7\pm0.5)\%$ E2 respectively. The reduced transition probabilities of 41 and 140 keV transitions are deduced. These results when compared with the single particle estimates indicate that 131 (5/2⁺) and 140 (7/2⁺) keV states are predominently single particle intrinsic states.

4. <u>Gamma-Gamma Directional Correlations in 147 Pm - A.K.</u> Bhardwaj, S.S. Bhati, Nirral Singh, P.C. Mangal and P.N. Trean - Gamma-gamma directional correlations of 599-91, 280-412 and 280-322 keV cascades in 147 Pm observed in the decay of 147 Né have been studied by the slow-fast coincidence method. The measured directional correlation functions for these cascades are:

 $1.W(\Theta, 599-91) = 1+(0.022\pm0.19)P_2(\cos\Theta)-(0.012\pm0.033)P_4(\cos\Theta)$ $2.W(\Theta, 280-412) = 1+(0.021\pm0.007)P_2(\cos\Theta)+(0.0013\pm0.005)P_4(\cos\Theta)$ $3.W(\Theta, 280-322) = 1+(0.022\pm0.009)P_2(\cos\Theta)-(0.009\pm0.06)P_4(\cos\Theta)$

The study supports the spin assignments of $5/2^+, 3/2^+$

and $5/2^+$ for 91, 412 and 685 KeV levels respectively. The graphical analysis of these functions yields mixing ratios of 599 and 412 keV gamma rays as $MI+(19\pm6)\%$ E2 and E2+3.8% M3 respectively. The character of 322 keV gamma ray is found to be predominently M1 with < 0.5% E2 admixutre. It is in disagreement with the results of the previous workers. In the light of this study a discussion of the level structure of 147 Pm is attempted.

K. PUNJABI UNIVERSITY, PATIALA, INDIA

Neutron Proton Mass Deformation of the First 2* 1. Excited State of 122 Te - H.S. Sahota - Although vibrational models of the nucleus predict vanishingly small quadrupcle momente for the spherical nuclei yet sizable quadrupole moments have been found to exist¹ for the first excited 2⁺ states of such nuclei in the region 104 < A < 130. Following the treatment of Greiner² we have searched for any difference in the deformations due to the neutron and proton mase distributions for the 564 keV first 2* excited state of ¹²²Te. It has been found that a neutron deformanearly 6 per cent in excess of the proton tion of deformation is consistent with the mixing ratio of the 2* - 2⁺ transition. This is in agreement with the findings of Taylor and Singh³ for the first excited 2⁺ states in 124 Te and ¹²⁶Te.

1. J.de Boer and J. Eichler, Advances in Muclear Faysics (Plenum Press, New York) 1968.

2. W. Greiner, Nucl. Phys. 80, 417 (1966).

3. H.W. Taylor and B. Singh, Gand.J. Phys. 49,881(1971).

L. UNIVERSITY OF DELHI, DELHI - 7

1. <u>Half-Life Measurement of the 1291.6 keV Level</u> in ⁵⁹Co = S.D. Chauhan, R.K. ⁴arg, S.C. Pancholi, S.L. Gupta and N.K. Saha - Half-life of the 1291.6 keV level in ⁵⁹Co has been measured using experimental techniques based in leading-edge timing spectrometry. The decay curve analysed with the moments, slope and Laplace transform methode gave a weighted average value of $T_{\frac{1}{2}} = 0.516 \pm 0.006$ ns. Partial half-lives have been calculated for the 192.3 keV and 1291.6 keV gamma transitions depopulating the 1291.6 keV level and the results are analysed in terms of the core-particle coupling models.

2. Alpha-Gamma Directional Correlation in a Poly crystalline ²⁴¹Am Source - R.K. Garg, S.D. Chauhan, S. L. Gupta and N.K. Saha - Measurements of the \propto - 7 directional correlation for the $\propto_{5486} - 7_{59.4}$ ($5/2^{-5}$ 5/2) cascade have been carried out in a polycrystalline ²⁴¹Am sample using time - differential PAC technique. The value of the attenuation parameter λ_2 and the unperturbed value of the $A_2(0)$ - coefficient, obtained after accounting for finite time resolution and isotropic contribution from the $5/2^{-5}$ $7/2^{-1}5/2 = 5/2^{+}$ triple cascade are: $A_2(0) = -0.37 \pm 0.02$; $\lambda_2 = (1.81 \pm 0.17) \times 10^9$ sec⁻¹. Using the $A_2(0)$ -value, an estimate of the mixing ratio of L = O and L = 2 partial alpha waves in the main ∞ -group is made and the result compared with ∞ -decay-theories. From the exponential trend of the $A_2(t)$ vs. t curve, timedependent buck views of the interaction phenomena, as predicted by the theory of Abragam and Pound for polycrystalline sources, is confirmed.

3. <u>Directional Correlation Studies in 59 Co - M.M. Bajaj,</u> Ashok Kumar, S.K. Soni, S.C. Pancholi, S.L. Gupta and N. K. Sahá - Gamma-gamma directional correlation studies have been made on all the measurable cascades in the decay of 59 Fe to 59 Co using Ge(Li) and NaI(T1) detectors and a multichannel analyser system. The expansion coefficients for various cascades are:

Cascades (keV) **A**4 <u>A</u>2 - 0.070 + 0.005 0.014 + 0.015 142.25-1291.58 0.008 + 0.004 0.004 + 0.008 192.81-1099.27 -0.039 + 0.012 - 0.008 + 0.025334.81-1099.27 The expansion coefficients for the 142.25-(192.23)-1099.27 keV triple cascade have been deduced from the measured data to be $A_2 = -0.0115 \pm 0.0009$ and A4 = 0.A 6.7% correction was applied to the 142.25 - 1291.58 keV cascade on account of the contribution from the 142.25-(192.23)-1099.27 keV triple cascade. The mixing ratio analysis of the correlation functions yields the following values of the mixing parameter for

: 56 :

the 142.25, 192.23, and 334.81 keV radiations: - 0.026 $\leq \delta_{142} \leq 0.027$; $\delta_{192} = 0.22 \pm 0.02$ and $\delta_{335} = 0.13 \pm 0.06$, respectively. The results are analysed in terms of the weak-coupling models.

A New Variational Method For Pulsed Neutron Problem 4. - Feroz Ahmed and Subhaeh Saini - A new variational method has been developed to study the pulsed neutron problem in orystalline moderators, which permits one to take account explicitely of discontinuities in the values of transport cross section of crystalline moderators at Bragg Energies. For reasons of simplicity, the trial function was taken as a linear combination of maxwellian and an exact solution of an eigenvalue equation for some chrosen value of buckling, say β^2 . This gives asymptotic decay constant Λ_o within 2% of the corresponding value obtained by numerically solving the diffusion equation. However, when trial function is a linear combination of maxwellian and exact solutions of the eigenvalue equation for two properly choosen values of buckling, say β_1^2 and β_2^2 , then for any given value of β_1^2 , the asymptotic decay constant λ_o and associated neutron flux ${\mathscr P}_o$ are found very accurately.

This variational method has been extended further by assuming the trial function to be a linear combination of maxwellian and two other functions dependent upon the energy variation of the transport cross sections.

M. UNIVERSITY OF POONA, POONA-7.

1. <u>A Study of the Magnetic Flux of the 5 MeV Betatron</u> to Increase Its Energy to About 10 MeV - M. R. Bhiday, V.N. Bhoraskar - The 5 MeV betatron has the facility to accelerate the electrons in one quarter of the a.c. cycle, as usually the case of a conventional betatron. The increase of current causes the saturation of the central core and hence limits the maximum energy of the electrons to be accelerated.

In order to increase the energy of the electrons from 5 MeV to about 10 MeV, biasing technique is used, which indeed needs the study of the variation of the flux in the median plane with the radius at any particular instant of time.

The median plane of the betatron is divided in concentric planes, and a relative study of the magnetic flux of each concentric plane is done with the central flux. From this, the variation of the flux with the radius is studied, which is used for calculation in the biasing of the betatron for its increase in energy.

2. <u>A Variable Energy Quadrupole Lens Pair Combined</u> With 60° Spectrometer For a Broad Range Spectrometer - M.R. Bhiday, V.N. Bhoraskar - A quadrupole lens pair is designed to accept the particles between 1 MeV to 6 MeV. A complete : 58 :

electrons in the above range. A 60° Magnetic Spectrometer is combined with this doublet and the positions of the quadrupole lenses with respect to the spectrometer are calculated to get the maximum focusing and acceptance of the electrons.

N. UNIVERSITY COLLEGE OF SCIENCE, CALCUTTA-9

1. Internal Bremsstrahlung From ${}^{204}\text{T1}$ - S. Mitra, M. Nath, A.K. De, P.C. Bhattacharya and A.K. Das - The spectral distribution of internal bremsstrahlung (IB) emitted in the β -decay of ${}^{204}\text{T1}$ has been measured from 80-600 keV with a NaI(T1) scintillation spectometer. A modified geometrical arrangement used in the experiment reduces the contribution due to external bremsstrahlung relative to IB to a minimum. The experimental results have been compared with the theoretical calculations from KUB - Lewis & Ford - Nilsson theory. A comparative study of the present results in relation to two other single counter experiments (1,2) reported so far who found a substantial excess number of photons at low energy, has been done.

References:

- 1. R.A. Ricci, Physica 24, 297 (1958)
- 2. K. Narasimhamurty and S. Jhanananda, Proc. Phys. Soc. <u>90</u>, 109 (1966)

O. UNIVERSITY OF ROORKEE, ROORKEE

1. <u>Triple Gamma Angular Correlation Studies of the</u> <u>Radiations from the Decay of Ir^{192} - U.S. Pande and B. P.</u> Singh - Three NaI(T1) detecotrs (Spectrometers) mounted in the plane of the table (two detectors are fixed perpendicular to each other and third detector is movable in opposite quadrant of the two fixed detectors) are used for the coincidence and angular correlation studies for the triple gamma cascade 589 keV - 296 keV - 316 keV in Pt¹⁹² from the decay of Ir^{192} . Angular correlation function W(0) obtained by the method of least square fit and without apply, solid angle correction is

$$W(\Theta) = 1 - (0.110 \pm 0.021) P_2 (Cos \Theta)$$

+(0.052 \pm 0.030) P_4 (Cos Θ)

The multipolarity of 296 keV transition was obtained for the spin sequence of $4 + \frac{589\text{keV}}{\text{Pure E}_2} + 2 + \frac{296 \text{ keV}}{(M_1 + E_2)}$ $2 + \frac{316 \text{ keV}}{E_2}$ O+. The 'S' (the amplitude mixing ratio) of 296 keV gammatransition thus obtained is (-) 10⁺³. The sign δ is independent of phase convention in this measurement.

2. <u>A Separable Potential Model For</u> ¹S. <u>Neutron Proton</u> <u>Interaction</u> - A.P.S. Sirohi and M.K. Srivastava - A number of separable potential models have been proposed for the NN interaction. The off-shell behaviour of these separable potentials is quite different from that of a local potential except in the low energy region. For example, the half-off-shell reaction matrix elements $K(p,k:k^2)$ show an oscillatory behaviour for a local potential while in the case of separable ones they have a smooth monotonic behaviour for $p \ge 4 \text{ fm}^{-1}$. Around $p \sim 3 \text{ fm}^{-1}$, the local potentials give rise to a repulsive hump reflecting the repulsive core at r of order 0.5 fm. Such a hump is absent in the case of the separable potentials used hitherto.

It is shown, that these differences in the off-shell behaviour are not an inherent feature of separable potential models. Even with them it is possible to generate the characteristic oscillatory behaviour of the half-shell reaction matrix elements of local potentials and thereby to make their off-shell behaviour closer to that of the local potentials. Previous reports published by the Indian Nuclear Data Group (INDG) :-

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2.	A.E.E.T.	-227	Nuclear Data mea facilities in Ir	a <mark>sur</mark> Idis	ing L	1965
3.	A.E.S.T.	-228	Progress report data ectivities	on in	nuclear India-II	1965
4.	A.E.E.T.	-227	Progress report data activities	on in	nuclear India-III	1966
5.	B.A.R.C.	-305	Progress report data activities	on in	Nuclear India-IV	1967
6.	B.A.R.C.	-401	Progress report data sctivities	on in	Nuclear India-V	1969
7.	B.A.R.C.	-474	Progress report data activities	on in	Nuclear India-VI	1970
8.	B.A.R.C.	-553	Progress report data activities	on in	Nuclear Indie-VIII	1971



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