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GOVERNMENT OF INDIA
ATOMIC ENERGY COMMISSION

PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN INDIA – VI

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

BHABHA ATOMIC RESEARCH CENTRE
BOMBAY, INDIA
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INDIAN NUCLEAR DATA GROUP

Members

1.	M. Balakrishnan (Secretary)	Nuclear Physics Division, BARC
2.	H.G. Devare	Tata Institute of Fundamental Research
3.	V.C. Deniz	Reactor Engineering Division, BARC
4.	A.S. Divatia (Convener)	Nuclear Physics Division, BARC
5.	S.S. Kapoor	Nuclear Physics Division, BARC
6.	D.N. Kundu	Saha Institute of Nuclear Physics
7.	B.P. Rastogi	Reactor Engineering Division, BARC
8.	N.S. Satyamurthy	Nuclear Physics Division, BARC
9.	S.B. Garg (Co-opted)	Reactor Engineering Division, BARC
10.	M.C. Joshi (")	Tata Institute of Fundamental Research
11.	S.K. Mitra (")	Tata Institute of Fundamental Research
12.	M.P. Navalkar (")	Nuclear Physics Division, BARC
13.	P.K. Patwardhan (")	Electronics Division, BARC

PREFACE

The sixth progress report on Nuclear Data Activities in India incorporates work done during the year 1969. A part of the work outlined in this report has been presented at the Nuclear Physics & Solid State Physics Symposium held at Roorkee during December 1969.

Submission of CINDA entries to the International Atomic Energy Agency has been continued. The backlog of entries to be submitted from the previous years is over. The total number of entries sent during the period of the report is 36. The entries for DASTAR (DAta STorage And Retrieval) are being requested by the International Nuclear Data Committee (INDC) directly from the authors and our efforts have been to speed up the sending of this data by the authors. In all, three reports, have been submitted to the INDC during the year. A list of the reports prepared by the Indian Nuclear Data Group (INDG) upto the present is given on the last page.

New facilities for nuclear physics research are as follows:

a) The Punjab University at Chandigarh has started assembling the components of the 6 MeV Variable Energy Cyclotron received from the University of Rochester as a gift. A separate building for this cyclotron has been sanctioned by the Punjab University and the building design is ready.

b) At the Indian Institute of Technology, Kanpur, a 2 MeV HVEC Van de Graaff accelerator is being installed, in a separate building which is ready.

c) The work on the 224 cm Variable Energy Cyclotron to be installed by the Bhabha Atomic Research Centre, at Calcutta has entered the execution stage. The foundation for the building at Calcutta has been laid. Major contracts have been awarded and procurement of materials is in progress.

d) A nano-second pulsed ion-source is being installed in the TIFR 1 MeV Cookcroft-Walton accelerator.

A sub-committee has worked out the details of organising a Nuclear Data Library on magnetic tape at Trombay.

A.S. Divatia

(A.S. Divatia)
Convener
Indian Nuclear Data Group

A. BHABHA ATOMIC RESEARCH CENTRE, BOMBAY-85

1. **14 MeV neutron fission cross sections of Th^{232}, U^{233}, U^{235}, Np^{237}, Pu^{239} and Am^{241} using solid state track detectors** - R.H. Iyer and R. Sampathkumar - As part of a systematic program of neutron fission cross section measurements, the 14 MeV neutron induced fission of Th^{232}, U^{233}, U^{235}, U^{238}, Np^{237}, Pu^{239} and Am^{241} was studied. Total fission cross section relative to U^{238} (taken as 1.2 barns) were determined by means of a simple technique involving detection and counting of fission fragment tracks in Lexan polycarbonate plastic. The results which compare very well with those obtained using other elaborate and involved techniques are given below:

Target	Total fission cross section barns*	
Th^{232}	0.34 ± 0.03	(3)
U^{233}	2.40 ± 0.40	(3)
U^{235}	2.20 ± 0.20	(3)
U^{238}	1.20	
Np^{237}	2.98 ± 0.30	(3)
Pu^{239}	2.65 ± 0.30	(3)
Am^{241}	2.70 ± 0.47	(4)

2. **Total Cross-Section Measurement in the $^{37}Cl(p,n)^{37}Ar$ Reaction** - S. K. Gupta, S.S. Kerekatte and A. S. Divatia - The cross section of the $^{37}Cl(p,n)^{37}Ar$ reaction has been measured in 2 keV steps at proton energies ranging from 1.64 MeV to 2.50 MeV. Using the measured properties of the levels

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* Number in parenthesis represents number of determinations.

of ^{38}Cl obtained from the $^{37}Cl(d,p)^{38}Cl$ reaction[1] the level positions and the energy integrated total cross-sections of the expected anlog resonances in the ^{38}Ar nucleus have been calculated and compared with the present data.

1) Rapoport & Buechner, Nucl.Phys.83 (1966) 80

3. Measurement of the Total $^{48}Ca(p,n)^{48}Sc$ Reaction Cross Section Around the Isobaric Analog State at E_p= 1.976 MeV - K.K. Sekharan and M.K. Mehta - The total (p,n) cross section for the $^{48}Ca(p,n)^{48}Sc$ reaction has been determined in the bombarding energy range 1.90 to 2.05 MeV in 0.6 keV steps around the isobaric analog resonance in ^{49}Sc corresponding to the ^{49}Ca ground state. The total widths and partial proton and neutron widths have been obtained.

4. Proton Transfer Reaction on ^{66}Zn - M.G. Betigeri - The reaction $^{66}Zn(^{3}He,d)^{67}Ga$ has been studied at an incident energy of 18 MeV and the reaction products are analysed with a wide-band magnetic spectrograph.* The excitation energies of levels in ^{67}Ga are determined to an accuracy of 15 keV. Analysis of angular distributions yields the orbital angular momenta of the stripped proton in transition to levels in ^{67}Ga and the corresponding spectroscopic factors. The results indicate a pure $|(2P_{3/2})^2>_c$ proton configuration for ^{66}Zn.

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* Data obtained from Max Planck Institut fur Kernphysik, Heidelberg.

5. Distortion and Antisymmetrisation Effects in $^{6}Li(p,pd)^{4}He$ Reaction - A. K. Jain, N. Sarma and B.Banerjee* - The reaction $^{6}Li(p,pd)^{4}He$ has been analysed using the Distorted Wave Impulse Approximation (DWIA). A fully antisymmetrised ^{6}Li cluster model wave function has been used which has the correct asymptotic behaviour for the relative d - α wave function. The effects of distortions and antisymmetrisation are investigated. Satisfactory agreement with 155 MeV data is obtained.

6.. Determination of Width and Resonance Energy of the 7.01 MeV level in ^{10}B and Comparison of the Experimentally Observed Spin with Intermediate Coupling Calculations - M. Balakrishnan, M.K. Mehta and A.S. Divatia - The resonance energy and the width of the broad resonance around 7 MeV excitation energy in ^{10}B have been determined as 7010 $\pm$ 9 keV and 140 $\pm$ 20 keV (lab) respectively using the $^{6}Li(\alpha,\alpha)^{6}Li$ reaction. Various trial combinations of the resonance energy, level width and channel radius were used to arrive at the results. The experimentally determined J^{π} values of 2^{+}-(1) for this level is discussed with reference to the intermediate coupling calculations.

1. M. Balkrishnan, M.K. Mehta and A.S. Divatia, Proc. Nucl. Phys. and Solid State Phys. Symp.Bombay 1968, Vol II, P.44.

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* Tata Institute of Fundamental Research, Bombay-5.

7. Correlated Emission of K X-Rays From ^{252}Cf Fragment Pairs - D.M. Nadkarni, V.S. Ramamurthy and S. S. Kapoor - The observed yield of the K x-rays in fission has so far been interpreted in terms of the internal conversion probabilities during the γ-de-excitations in the individual fragment nuclei. In this connection it is important to know whether the emission of K x-rays from the pair fragments could be correlated due to certain common factors existing at the scission point. We have carried out these investigations by simultaneously detecting light and heavy fragment x-rays with two NaI(Tl) detectors in coincidence with fission fragments in the spontaneous fission of ^{252}Cf. The observed triple coincidence data were suitably corrected for any background triple coincidence arising from true fragment-gamma-gamma or fragment-gamma-K-x-ray coincidences. The observed results on the correlation coefficient are being studied.

8. Fragment Angular Distributions in the Framework of the Double Humped Fission Barrier - V. S. Ramamurthy, S.K. Kataria and S.S. Kapoor - Our recent understanding of the presence of shell structure in highly deformed nuclear configurations leading to a "Double humped" fission barrier has necessitated a re-interpretation of the experimental data on fragment angular distributions. From an analysis of the measurements in near threshold fission of various nuclei, Strutinsky and Bjornholm have concluded that the fragment angular distributions are decided by the properties of the nucleus on the top of the

second barrier. It is shown in the present work that this assumption is not consistent with the available results on the angular distributions in medium and high energy fission, in particular with the measured variation of the effective moment of inertia of the transition state nucleus as a function of the fissionability parameter. Possible reasons for this inconsistency are discussed suggesting the modifications required to explain both near threshold and medium energy data on fragment angular distributions.

9. Systematics of the Second Minimum for the Fissioning Nuclei - D.K. Sood and N. Sarma - The high resolution fission cross section data on the nuclei ^{233}U, ^{235}U, ^{239}Pu, ^{240}Pu, ^{241}Pu and ^{242}Am have been analysed to determine the average spacing of the class II levels using an improved method of correlation analysis. The spacing has also been derived from results on subthreshold fission experiments. The energy difference between the two minima of the deformation curve has been obtained, as a function of the neutron number and is largest for N = 147 in agreement with the calculations of Strutinsky.

10. Liquid Argon Ionization Chamber - R.Y. Deshpande and R. Ramanna - An ionization chamber using liquid argon has been operated. Argon gas is liquefied in a J-type cryostat with liquid nitrogen as the cooling medium. It is found that the chamber behaves as a counter even at relatively low fields of

the order 10^3V/cm. The counting property is very sensitive to the impurities, particularly oxygen, present in the liquid. This is presumably due to electron-attachment and non-recombination as in a gas chamber. Several physical properties of liquid argon such as the resistivity, dielectric constant, and electron mobility have also been determined. Preliminary data about these is presented.

11. A Counter Telescope for use in the study of neutron Induced Reactions - M. G. Betigeri, C.M. Lamba, D. K. Sood, N. S. Thampi and N. Sarma - A counter telescope using surface barrier silicon ΔE - E detectors has been set up. Particle discrimination is achieved by obtaining a product pulse of E and ΔE pulses which is independent of energy of the incident particle. The proton and deuteron groups from the reactions $^{19}F(p,p)$ and $^{19}F(n,d)$ are well separated. The deuteron group has been separately gated to study the reaction $^{19}F(n,d)^{18}O$. The angular distribution for the ground state transition has been studied and indicates an $\ell = 0$ transfer. The value of the absolute cross section at 0° and the spectroscopic factor for this transition agree with an earlier study of this reaction.

12. On the Constants of Charged Particle Identifier - S.K. Gupta - Two methods to calculate the constants F and E_o for the charged particle identifiers using the relationship,

product $P = \Delta E(E + F \cdot \Delta E + E_o)$ have been described. Such constants have been calculated for silicon detectors. The extensions to other detectors have been pointed out. The limitations of the methods in practical cases have been discussed. A method to set the constants in the actual multiplier circuits has been suggested.

13. International Intercomparison of Thermal Neutron Flux Density Standards Using 4π β-γ Coincidence Technique - M.G. Shahani and D. Sharma - Thermal neutron flux density standard established at B.A.R.C. using six Am-Be (α,n) sources imbedded in graphite moderator has been directly compared with the standards maintained at N B S, USA; IMM, Russia and ETL, Japan. In order to minimize the effects of epithermal flux, the quantity compared was Westcott flux density below cadmium cut off energy. Pairs of thin circular gold foils sandwitched between aluminium and cadmium covers irradiated in the standards to be compared were exchanged for the purpose. The comparison was carried out as a part of the programme organised by the Bureau International Des Poids et Mesures, France, in which eleven countries participated.

4π β-γ coincidence technique was employed to determine the counting efficiencies for the foils. Corrections due to decay scheme, self shielding and flux depression have been evaluated.

14. Technique of Absolute Standardization of Cobalt-60 Used at BARC for International Intercomparison - P. K. Srivastava and G.D. Khera - The technique of absolute standardization of Cobalt-60 is of great importance for the precision measurements of radio-activity because, due to its nearly ideal decay scheme, this radionuclide is amenable to standardization to the highest presently achievable accuracy. International intercomparison of this technique was, therefore, organized by the Bureau International des Poids et Measures, France. Twenty - five national and international laboratories of the world, including Bhabha Atomic Research Centre, participated in this intercomparison.

This work describes the technique employed at BARC for the absolute standardization of CO-60, giving brief description of source handling, $4\pi\ \beta-\gamma$ coincidence counting and data processing including assignment and evaluation of errors. The results of measurement of 25 participating laboratories are also given.

The technique used in this work offers high accuracy, precision and reliability and, with minor modifications, is widely applicable to many radionuclides of interest. The results show that this technique yields a precision of about 0.1 per cent.

15. Charge Form Factor for ^{6}Li Nucleus - A.K. Jain and N. Sarma - The intercluster wavefunction of ^{6}Li was modified

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13. International Intercomparison of Thermal Neutron Flux Density Standards Using $4\pi\ \beta$-γ Coincidence Technique - M.G. Shahani and D. Sharma - Thermal neutron flux density standard established at B.A.R.C. using six Am-Be (α,n) sources imbedded in graphite moderator has been directly compared with the standards maintained at N B S, USA; IMM, Russia and ETL, Japan. In order to minimize the effects of epithermal flux, the quantity compared was Westcott flux density below cadmium cut off energy. Pairs of thin circular gold foils sandwitched between aluminium and cadmium covers irradiated in the standards to be compared were exchanged for the purpose. The comparison was carried out as a part of the programme organised by the Bureau International Des Poids et Mesures, France, in which eleven countries participated.

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The technique used in this work offers high accuracy, precision and reliability and, with minor modifications, is widely applicable to many radionuclides of interest. The results sh that this technique yields a precision of about 0.1 per cent.

15. Charge Form Factor for ^{6}Li Nucleus - A.K. Jain and N. Sarma - The intercluster wavefunction of ^{6}Li was modified

in an earlier work to predict the cross section of the reaction $^{6}Li(p,pd)^{4}He$ correctly. This wave function is now used to calculate the charge density and charge form factor for ^{6}Li nucleus. All the exchange terms in the matrix element have been computed. Agreement with experiment appears to be satisfactory.

16. Differential Equation for Logarithmic Derivative and its Applications - S. K. Gupta - Using a simple transformation the radial Schrodinger equation has been transformed into a first order differential equation of the Riccati type. This equation offers possibilities of simplifying calculations. It has been used to derive recursion relations for different l values and to calculate an asymptotic solution for the Coulomb potential. The equation can also be applied to calculate the transmission coefficients and the elastic scattering cross-section using the optical potential.

Neutron Crystallography

17. Structures of Hydrogen-bonded Ferroelectric Crystals - V.M. Padmanabhan, V.S. Yadava and K.K. Wadhavan - Continuing studies on crystals having N-H...X type of bonding, hydrogen bonded ferroelectric crystals and unusual type of coordinated complex crystals, the following structures were solved : triglycine sulphate, sodium thiosulphate pentahydrate, potassium mercuric tribromide monohydrate and ciscobalt dioxide bis ethylene diamine nitrate.

The crystal structures of ammonium sulphamate, ammonium tartrate, ammonium bisulphate and diglycine nitrate are under various stages of refinement.

18. Structure of Hydrated Crystals - R. Chidambaram, A. Sequeira and S.K. Sikka - In the programme of studying the hydrogen bonding effects on the structure of water molecules in hydrated crystals, the crystal structure of $K_2C_2O_7 \cdot H_2O$ has been refined using the 3-dimensional neutron intensity data. The data were processed by the various computer programmes developed in this laboratory.

Investigation on $K_2CuCl_4 \cdot 2H_2O$ was carried out as a part of India-Plilippines-IAEA Project and part of work was done in the Philippine Atomic Research Center, Quezon City, Philippines.

19. Structure of Paraelectric RbH_2PO_4 - R. Chidambaram and A. Sequeira - Aim of this investigation is to study the structure and atomic motions both above and below ferroelectric transition point of this crystal. Further work is in progress.

20. Structure of Amino Acids - R. Chidambaram, A. Sequeira and S.K. Sikka - We have embarked on a systematic study of 20 amino acids that are the basic building blocks for proteins. (The x-ray structure studies done so far are faced with the well known difficulty of x-ray diffraction technique for locating the hydrogen atoms). To this end, neutron diffraction

work on single crystals of Glutamic acid hydrochloride (using the diffractometer 3D-FAD) and on a single crystal of asparagine monohydrate (using diffractometer 'DCD') is in progress.

21. Application of the Symbolic Addition Procedure in Neutron Diffraction for Non-Centrosymmetric Crystals - R. Chidambaram and S.K. Sikka - The symbolic addition procedure was shown earlier to determine in centrosymmetric crystals the signs of about 95% of the neutron structure factors when the contribution of the negatively scattering atoms to the total neutron scattering is less than 25%. Now, this procedure has been shown to be applicable for non-centrosymmetric crystals.

The procedure was applied to determine with reasonable accuracy the phases of Bragg reflections for resorcinol and methyl GAG.2HCl. H_2O.

It has also been shown from probability considerations that symbolic addition procedure will apply for crystals containing up to 100 atoms per unit cell.

22. The N-H——O Hydrogen bond Interaction Between peptide Groups: Modified Lippincott-Schroeder Potential function - R. Chidambaram - The parameters of non-multifurcated N-H——O hydrogen bonds from crystal studies so far by neutron diffraction have been calculated and analysed.

23. Instrumentation - R. Chidambaram, A. Sequeira, S.K. Sikka and S.A. Momin - A paper tape controlled automatic diffractometer 3D-FAD has been designed and commissioned at the Cirus reactor, for recording 3-dimensional neutron diffraction data for the study of crystal structures.

Neutron Diffraction Study of Magnetic Materials

24. Magnetic Ordering and Cation Distribution in Spinel Compounds - N.S. Satya Murthy, R.J. Begum, M.R.L.N. Murthy, B.S. Srinivasan, M.G. Natera, S.I. Youssef, L. Madhav Rao and S.K. Paranjape - Apparent inconsistencies in earlier work have prompted a systematic investigation of single and mixed ferrites and other spinel compounds. A method of using polarised neutrons with polycrystalline samples has been developed to enhance the data available for the solution of various parameters. The samples studied are $MnFe_2O_4$, $MgFe_2O_4$, $CoFe_2O_4$, Co_2TiO_4 and Zn-Ni and Mg-Mn mixed ferrites. Some of the important results are $MnFe_2O_4$ is 92.6% normal, $MgFe_2O_4$ is 86.5% inverted and $CoFe_2O_4$ is 88.2% inverted. The diffraction pattern at 4.2°K of the complete inverted spinel Co_2TiO_4 indicated a complicated magnetic structure Mg-Mn ferrites have the Neel type of ferrimagnetism, while the existence of YK angles in the mixed Zn-Ni ferrites has been established.

25. Magnetic Structure of Heusler Alloys - N. S. Saty Murthy, M.G. Natera, M.R.L.N. Murthy and R.J. Begum - Five Heusler alloys Pd_2MnSn, Pd_2MnGe, Cu_2MnIn, FeMnAl and CoMnSb have been studied

with a view to throw some light on the mechanism of magnetic ordering in this matrix. These alloys are all ferromagnetic with transition temperatures of 190°K, 260°K, 575°K, 170°K and 460°K respectively. The Mn atoms in each alloy show a moment value close to 4.0 μ_B at liquid nitrogen temperature.

26. Magnetic Structure of FeMnGe - N.S. Satya Murthy, M.R.L.N. Murthy, M.G. Natera and R.J. Begum - FeMnGe has a hexagonal, filled NiAs structure with the cell constants a_o = 4.15 Å and 5.19 Å. The 2(a) and 2(d) sites are preferentially occupied by Mn and Fe atoms. 76% of Mn goes to the 2(a) sites while 80% of Fe goes to the 2(d) sites. The alloy shows two magnetic transitions. Below 340°K, the 2(d) site moments only are ferromagnetically aligned, but below 245°K the 2(a) site moments also become ordered with neighbouring moments being antiparallel to each other.

27. Paramagnetic Neutron Scattering - N.S. Satya Murthy, L. Madhav Rao, S.I. Youssef and M.G. Natera - The method of moments has been employed to extract the exchange integrals operating in a number of ionic compounds like $TlMnF_3$, $ZnFe_2O_4$, $MnAl_2O_4$. J for $TlMnF_3$ has been found to be 3°K which compares well with the GF, BPW and DS predictions. Taking into account the small inversion of 9% in $MnAl_2O_4$, the following values were obtained for the exchange integrals.

$$J_{AA} = - 0.21°K$$

$$J_{AB} = - 16°K$$

Dynamics of Solids and liquids:

28. Librational Modes of Water Molecules in Single Crystals of $K_2C_2O_4 \cdot H_2O$. H_2O and $Ba(ClO_3)_2 \cdot H_2O$ - C.L. Thaper, B. A. Dasannacharya, A. Sequeira and P.K. Iyengar - Polarisation dependence of neutron incoherent scattering cross section can to some extent be used to assign librational frequencies of the motion of water molecules and to differentiate under suitable conditions between two closely spaced librational peaks which are unresolved in experiments with powder samples. For $\vec{Q}$ parallel and perpendicular and at intermediate angles to H-H vector, the libration spectra at 120°K were obtained and rocking frequencies assigned unambiguously.

29. Dispersion Relations for Phononsin CaF_2 and SrF_2 - P.K. Iyengar, P.R. Vijayaraghavan and S.N. Siva - Measurements on CaF_2 have been made on a multiarm spectrometer in constant Q mode of operation along [100] , [110] and [111] directions and to this date 7 branches have been completed - the accoustic branches and the lower most transverse optic branch along the [100] direction. Measured value of q = 0 transverse optic mode is 7.75×10^{12} cps with an estimated error of 1.5%. Measurements of SrF_2 having similar structure are in progress.

30. Study of Reorientations in Ammonium Salts - H.J. Kim,P.S. Goyal, G. Venkataraman, B.A. Dasannacharya and C.L. Thaper - The scattering of neutrons by a number of ammonium salts such as $(NH_4)_2SO_4$, NH_4 Br, NH_4I and $(NH_4)_2SnBr_6$ has been studied. The scattering is quasielastic and the spectrum has large wings.

This is a consequence of the reorientation of the ammonium ions. This feature persists at all scattering angles at room temperature and at several temperatures from -50°C to 140°C. In Skold's theory $S(Q,\omega)$ is a sum of pure elastic and quasi-elastic term. The quasi-elastic term is a Lorentzian, the widths and intensity of which depends on a characteristic time τ representing mean time between two reorientations. Assuming τ to vary as $\tau = \tau_0 e^{V/KT}$ and using the value of τ_0 and V from NMR measurements validity of Skold's model has been established and also demonstrated the direct comparison between NMR and neutron results.

31. Theoretical Study - V.C. Sahani and G. Venkataraman -

1. Group Theoretical methods have been used in Born-von-Karman theory to cover the case of external modes in complex crystals as a further extension to Chen and Dvorank's work. As an illustration case of $CaWO_4$ (space group C_{4h}^6) has been investigated.

2. A method of constructing irreducible multiplier representations (appropriate to a given factor system) from a knowledge of IMR's of a normal space group (of prime index) of it was developed. The necessary proof and illustration of the method are given.

3. In some crystals a model, in which each constituent atom of a tightly bound group is assumed to carry a certain charge is found to predict many properties fairly well. It

is shown that it is possible to extend the method of Kellerman to study the macroscopic field effects that the model leads to.

4. If the different modes corresponding to a given q are labelled by IMRSs of the point group $G_0(q)$ underlying the group of wave-vectors $G(q)$ and there is an IMRS that occurs only once in the labelling then it is possible to obtain the eigenvectors of the modes corresponding to IMRS by purely symmetry arguments. Thus for such modes the structure factor can be calculated by symmetry arguments alone. A computer programme has been written to calculate the structure factor.

32. Status of Nuclear Data Work in Reactor Engineering Division - S. B. Garg - Work was done on all the three branches, namely - evaluation, compilation and derivation of nuclear cross-sections.

Evaluation:- Elastic and inelastic cross-sections were calculated for Cr, Fe and Ni in the energy range 1.0 - 10.0 MeV using the local optical model potentials which were obtained by fitting the measured elastic scattering cross-sections and their angular distributions.

Compilation:-KEDAK evaluated cross section library was stored on magnetic tapes to carry out the reactor design studies. This library consists of 41 materials including the isotopes.

Raw data scattered over 8 magnetic tapes was scanned and efforts were made to rearrange the data for each material separately. A computer code was written to accomplish this job.

Derivation:- A 26 group cross-section set was generated from the basic energy point cross-section data to study the large fast power reactors. This set consists of 15 materials and covers the energy range .025 eV - 10.0 MeV. The derived group cross-sections were modified in view of the new alpha values of plutonium-239.

B. TATA INSTITUTE OF FUNDAMENTAL RESEARCH, BOMBAY-5

1. Angular Distribution of Gamma-Rays From $^{59}Co(p,n\gamma)^{59}Ni$ and $^{51}V(p,n\gamma)^{51}Cr$ Reactions - B. Lal and Baldev Sahai - The angular distribution of several gamma rays generated in the reactions $^{59}Co(p,n\gamma)^{59}Ni$ and $^{51}V(p,n\gamma)^{51}Cr$ has been studied with a 2 cc. Ge(Li) detector. The incident proton energies were chosen to be just above the threshold for the excitation of low lying states in Ni^{59} and ^{51}Cr. Hauser-Feshbach-Satchler statistical model is being applied to infer the electromagnetic decay properties of these low lying states.

2. Angular Correlation Analysis of the (π^-,nn) Reaction - B. K. Jain and B. Banerjee - Angular correlation distribution of the reaction (π^-, nn) on ^{6}Li and ^{12}C nuclei has been analysed in the quasi-deuteron model absorption for the pion. For the bound nucleons single particle wave functions have been used. The scattering of the outgoing neutron with the residual nucleus has also been included. Results are in good agreement with the experiments.

3. Distortion and Antisymmetrisation Effects in $^{6}Li(p,pd)^{4}He$ Reaction - A.K. Jain, N. Sarma and B. Banerjee - The reaction $^{6}Li(p,pd)^{4}He$ has been analysed using the Distorted Wave Impulse Approximation (DWIA). A fully antisymmetrised ^{6}Li cluster

model wave function has been used which has the correct asymptotic behaviour for the relative d - α wave function. The effects of distortions and antisymmetrisation are investigated. Satisfactory agreement with 155 MeV data is obtained.

4. Quantitative Estimate of Precompound and Compound Particles of Decay in Nuclear Reactions - M.L. Jhingan and E.Kondiah - Griffin's "exciton" model of a nuclear reaction is used to calculate the ratio of the pre-compound to compound emission probabilities in medium energy nuclear reactions. The experimental ratios are obtained by fitting the theoretical distributions of the emitted particles to the observed reaction spectra reported in literature.

5. High Resolution Studies of $^{228}Ac \rightarrow ^{228}Th$ Decay - R.C. Chopra, Bidarkundi*, S.H. Devare and H.G. Devare - The gamma spectrum of the 6.1 hr. activity of ^{228}Ac is studied with a 20 c.c. Ge(Li) detector at $\lesssim$ 3 keV resolution. The K conversion lines of 209.1, 270.1,327.9, 338.2, 910.1 and 968.1 KeV gamma rays and L shell conversion of 127.9 and 153.5 KeV gamma rays have been studied with a double focusing beta ray spectrometer. The relative intensities of the conversion lines combined with the relative intensities of the gamma transitions give the internal conversion coefficients. These are used to

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* Guest worker from I.I.T., Powai.

deduce the multipolarity of the transitions. In particular, the possible M2 admixtures in some of the E1 transitions have been estimated.

6. Perturbed Angular Correlation and Paramagnetic Correction in $^{143}Ce \longrightarrow {}^{143}Pr$ Decay - R.C. Chopra, S.H. Devare and H. G. Devare - The angular correlation of the 293-57 keV gamma ray cascade in the $^{143}Ce \longrightarrow {}^{143}Pr$ decay is studied in an external magnetic field of 6 k gauss. for both the field directions. The source was used in two different chemical forms. With $CeCl_3$ in a dilute liquid form the rotation of the angular correlation pattern due to the effective magnetic field was 21° while with the activity as CeO_2 powder, a rotation of 16° was observed. This directly proves that the paramagnetic correction factor β is different in the two cases and hence the resulting ionic states of Pr are different. This enables unambiguous determination of the Larmor frequency and hence the g factor of the 57 keV state irrespective of any perturbations of the angular correlation.

7. Lifetime and Magnetic Moment of 93 KeV state in ^{103}Rh - S. K. Bhattacherjee and H.C. Jain - The half life of the 93 KeV state in ^{103}Rh populated in the β -decay of ^{103}Ru has been measured both by $\gamma - \gamma$ and β -conversion electron delayed coincidince methods. In the first case a Pb-loaded plastic scintillator has been used to detect the low energy γ -ray. In the second case, a single gap β -ray spectrometer has been

used to select the K-conversion electron of the 53 keV transition. The results of both the experiments give a half life of 1.13 ± 0.03 ns.

Directional correlation measurements have been made on the composite (557 - 53) keV and (444 - 53) keV γ-γ cascades. Further the magnetic moment of the 93 keV level has been measured by perturbed angular correlation method. A preliminary result of (1.20 ± 0.25) has been obtained for the g factor of the 93 keV state.

8. Decay of Lu^{177m} - A.P. Agnihotry, K.P. Gopinathan and M.C. Joshi - The decay of Lu^{177m}(155 d) to excited states of Hf^{177} has been studied with 20 c.c. Ge(Li) detector having a resolution of $\sim$ 2.5 keV at 300 keV. Due to the higher efficiency of the Ge(Li) detector improved relative intensities of gamma rays were obtained. Coincidence measurements were done with the Ge(Li) detector and NaI(Tl) detector. The E2/M1 mixing ratios and branching ratios have been calculated and compared with the pure rotational model.

9. Internal Conversion Measurements in the Decay of $Yb^{169} \longrightarrow Tm^{169}$ - A.P. Agnihotry, K.P. Gopinathan and M. C. Joshi - Internal conversion electrons from the decay of $Yb^{169} \longrightarrow Tm^{169}$ have been measured with a double-focusing electron spectrometer with better than 0.1% resolution. The gamma spectrum has been studied with a 20 c.c. Ge(Li) detector

having a resolution ~ 2.5 keV at 300 keV. The L subshell internal conversion ratios of the hindered 63.12-, 177.18-, and 197.97 keV transitions were found to be : $L_I/L_{II}/L_{III}$ = 200.1 / 73.0 / 100, 873 / 172 / 100, 1583 / 254 / 100 respectively. Possible Nuclear structure effects in the L sub-shell conversion coefficients of these transitions are analysed.

10. Levels of Sb^{123} from the Decay of Sn^{123} (41 min) - K. G. Prasad, A.P. Agnihotry and M.C. Joshi - The decay of 41-min. activity of Sn^{123} was studied with high resolution Ge(Li) gamma-ray detector. The γ rays of energies 160-, 380-, 540- and 550 keV with relative intensities 100, ≈ 0.004, ≈ 0.003 and ≈ 0.003 respectively, were observed. The β-γ coincidence measurements are also made to determine α_K -the K-shell internal conversion coefficient of 160 keV transition. The results are explained by constructing the levels at 712-, 540-, and 160 keV in Sb^{123}. Nature of these levels is deduced.

11. The Calculation of Nuclear Compressibility - V. R. Pandharipande - The compressibility of finite nuclei is calculated by constrained Thomas-Fermi method. It is found to be much lower than the infinite nuclear-matter compressibility and its variation with A is well explained by the nuclear liquid-drop model.

12. Fabrication of a high Resolution Lithium-Drifted Germanium Detector - M.D. Deshpande and S.K. Mitra - A planar type lithium-drifted germanium detector of active volume 0.4 cm^3 and intrinsic thickness 2.5 mm has been fabricated in our laboratory. Single crystal, p-type germanium doped with gallium with a resistivity in the 5-15 ohm-cm range was used as the basic material. Lithium-diffused germanium diode was obtained by evaporation and subsequent diffusion of lithium on to one face of the crystal in a vacuum evaporator unit. Lithium-ion drift was carried out in an atmosphere of dry nitrogen at temperatures and bias levels ranging upto 50°C and 300 volts respectively. The diode was tested finally at 77°K in a cryostat with a vacuum maintained by a molecular sieve cryosorption pump. The diode has been found to give a resolution of 2.6 keV (FWHM) at 198 keV gamma-ray energy increasing to 6.2 keV at 1.35 MeV.

13. Some Data for a six Gap Beta Ray Spectrometer - S. K. Amburdekar, S.M. Bharathi and C.V.K. Baba - Data regarding the construction and performance of an enlarged version of the original Copenhagen model of a six gap beta ray spectrometer are given. The spectrometer was constructed with the view to study low energy conversion electron spectra arising from thermal neutron induced reactions. An electron energy range from about 5 keV upto about 5 MeV can be covered.

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

1. Excitation Energy of Fermi Gas Systems - Swapna Chatterjee and Aparesh Chatterjee - Studies of fast neutron reactions reflect the nuclear structure effects in the reaction cross-sections[1]. In a reaction process, the nuclear system is often described as an ensemble of free fermions with an excitation energy U_o measured from the Fermi surface ϵ_o. In a real nuclear system, ϵ_o is shifted to ϵ due to nuclear interactions, and the excitation energy U is measured from the modified Fermi surface ϵ. Thus in general, $U \neq U_o$. When the theory of statistical nuclear reactions are applied to estimate the reaction cross-section σ, the observed U has to be shifted by properly taking care of nuclear interactions to match U_o.

In a form of renormalized interacting gas model developed by us[2], the surface ϵ is correlated with ϵ_o by considering the long range and short range parts of the residual interactions of the extracore nucleons in an open shell system. The long range part tends to unbound the system by the magnitude of the Rosenzweig shift[3]. The short range and collective interactions (pairing and deformation effects) tend to bind the system; these are estimated from the BCS formalism of Belyaev[4].

When properly correlated to its non-interacting form, the nuclear interaction energies will be released and will contribute

to U.

Fast (n,2n) cross-sections are calculated and compared[5] with experiments from the above viewpoint and are found to agree well in the trend and magnitudes.

The cross-section depends equally sensitively on the single particle density function g. This g can be similarly correlated to its non-interacting form g_0 again using the nuclear interactions properly[6].

1. A. Chatterjee, Nucl.Phys. 60(1964)273; Phys.Rev.134B (1964)374; S. Chatterjee and A. Chatterjee, Nucl. Phys. A125(1969)593; P. Stronal et al., Nucl. Phys. 30(1962)49; M. Bormann, Nucl. Phys. 65(1965) 257; J. Csikai and G. Peto, Phys. Lett. 20(1966)52; P.Hille, Nucl. Phys.A107 (1968)49; F. Manero, JEN internal report (unpublished); Private comm.; Antwarp Neutron Conf.(1965) paper no.120.
2. A. Chatterjee, unpublished (1966-69);A Chatterjee, S. Chatterjee, S.K. Ghosh and R. Sarkar, to be published in parts.
3. N. Rosenzweig, Phys.Rev.108(1957)817;private comm.
4. S.T. Belyaev, Dan.Mat. Fys. 31(1959), No.11.
5. S. Chatterjee, to be published in Nucl.Phys. (1970)
6. S.K. Ghosh, S. Chatterjee and A. Chatterjee, to be published

2. Evaluation of the a-parameter from the Renormalised Fermi Gas Model-Sudip Kumar Ghosh, Swapna Chatterjee and Aparesh Chatterjee - The single particle level density at the Fermi surface of a nucleus and the associated level density parameter (the a-parameter) are being studied in terms of nuclear structure effects. Previous works[1] on the level density parameter have shown that these parameters strongly reflect the nuclear structure effects, and they have been rather empirically treated.

We attempt to treat the a-parameter in the framework of a renormalised interacting Fermi gas model[2] (RGM). In the RGM, the free gas Fermi surface shifts as a result of single particle interactions (evaluated through the Rosenzweig combinatorial correction[3]) and the pairing interactions; the deformation effects, the odd-even mass effects and the coulomb energy contribution in a deformed nucleus are also included as and when necessary. These corrections are evaluated from the BCS formalism of Belyaev[4] and the collective potential energy surface (PES) concept of Mosel and Greiner[5].

An expression for the single particle has been derived[6] from a standard phase analysis. Information of nuclear structure has been introduced from the RGM and the phenomenological coulomb correction has been treated from the PES. The calculated values for the a-parameter agree fairly well with those obtained experimentally and reproduces the empirical conjectures[1]. This set of a-parameters will be used to analyse

the structure effects in neutron induced reactions.

1. T.D. Newton, Can. J.Phys. 34(1956)804; A.G.W. Cameron, Can.J. Phys. 36(1958)1040; E. Erba et al., Nuovo Cim. 22(1961)1237; U. Facchini and E. Saetta-Menichella, Energia Nuclare 15(1968)54; A.V. Malishev, Soviet Phys. JETP 18(1964)221

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5. U. Mosel and W. Greiner, private comm., Z. Physik 217(1968)256.

6. S.K. Ghosh, S. Chatterjee and A. Chatterjee, to be published.

3. Nuclear Structure Effects in (n,2n),(n,p) and (n,α) Reactions - Swapna Chatterjee, Sudip Kumar Ghosh and Aparesh Chatterjee - The two basic parameters needed for evaluating the statistical nuclear reaction cross-sections are the excitation energy U and the level density parameter; the excitation energy U is measured from the nuclear Fermi surface ϵ and the level density parameter a is needed to generate the total level density ρ at an excitation U. The RGM is able to treat both these quantities satisfactorily[1].

An attempt is being made to use the microscopic self-consistent RGM formulation in fast neutron reactions and to reanalise and improve the previous viewpoint[2]. The specific channels in which these improved treatment will be used are (n,2n), (n,p) and (n,α) reactions.

1. See the two previous reports
2. A chatterjee, Phys.Rev.134B(1964)374; Nucl.Phys.60(1964) 273; Proc. Antwarp Neutron Conf. (1965), paper No.113.

4. Optical Potentials for ^{3}He and Triton - S. Mukherjee, R.K. Satpathy and S.K. Samaddar - The optical potentials for ^{3}He and triton are calculated in terms of the optical potentials of its constituents by extending the formalism of Mukherjee for the case of deuteron in a straight-forward manner. Comparison with experimental results for elastic scattering cross-sections of ^{3}He from various targets indicates that a good fit to the experimental results cannot be obtained if the well depth of the imaginary part of the nucleon optical well is not allowed to vary with energy.

5. Lifetime of the Excited States in ^{51}V and ^{90}Y - H. Singh and B. Sethi - The life-times of the excited states in ^{51}V and ^{90}Y have been measured by the delayed coincidence technique using a time to amplitude converter. The radioactive sources of the 5.8 min ^{51}Ti and the 3.1 hour ^{90m}Y were produced by ^{51}V(n,p) ^{51}Ti, ^{93}Nb(n,α) ^{90m}Y and ^{90}Zr(n,p)^{90m}Y reactions at

the structure effects in neutron induced reactions.

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14 MeV neutron energy. The results obtained are as follows:

Nucleus	Level	Half-life (nsec)
^{51}V	320	0.190 ± 0.030
	930	0.070 ± 0.025
^{90}Y	202	0.180 ± 0.030

The relative intensities of the γ-rays in ^{51}V and ^{90}Y have been measured with the help of a Ge(Li) detector, and on the basis of these results, the partial half-lives for γ-emission have been determined and compared with Weisskopf estimates.

6. The Decay of 6-MIN ^{152}Pm - K.S.N. Murty, B.P. Pathak and S.K. Mukherjee - The decay of 6-min ^{152}Pm, produced by the (n,p) reaction on ^{152}Sm has been studied using scintillation and Ge(Li) detectors. Besides the gamma rays of 122 and 245 keV reported earlier, new gamma rays of 811, 1113, 1408 and 1511 keV have been observed to decay with 6-min half-life. The observed beta and gamma transitions have been incorporated into a decay scheme.

7. The Decay of ^{91m} & ^{g}Mo to the Levels in ^{91}Nb - N.C. Das, B.P. Pathak and S.K. Mukherjee - The decay characteristics of metastable (66 sec) and ground (15.6 min) states of ^{91}Mo have been studied using Ge(li) and scintillation spectrometers. The gamma rays of 586, 786, 1034, 1406 and 1576 keV energies have been found to decay with 15.6 min half-life. The 66 sec metastable state of ^{91}Mo has been found to decay with the

emission of beta-groups with end-point energies 2.1, 2.7 and 4.0 MeV and gamma rays with energies 654(IT), 1172, 1196, 1537 and 1626 keV. A decay scheme for ^{91m} & ^{g}Mo is suggested.

8. Level Scheme of ^{152}Gd - B. K. Dasmahapatra - 23 gamma rays are fitted in a new decay scheme of ^{152}Gd from a study of high resolution (2,6 keV) Ge(Li) gamma spectra of the 12.4 y ^{152}Eu activity. Three new levels : 2^+, 1109.1 keV, 3^+, 1434.2 keV and 4^+, 1281.8 keV are located in ^{152}Gd. Unlike previous informations, it is shown that ^{152}Gd may have properties consistent with large nuclear deformation.

9. Decay of ^{71m}Zn - H. Sing, B. Sethi and V.K. Tikku - The decay of the 3.9 hour ^{71m}Zn has been investigated with the help of a Ge(Li) detector and scintillation counters. The ^{71m}Zn source is produced by ^{71}Ga(n,p) ^{71m}Zn reaction with 14 MeV neutrons using enriched ^{71}Ga target, The relative intensities of the gamma-rays arising in the decay have been accurately measured and the branching ratios for the beta- and gamma-rays have been deduced.

10. Decay of ^{74}Ga and Energy Levels of ^{74}Ge - H. Singh and B. Sethi - The decay of the 7.9 min ^{74}Ga to the levels of ^{74}Ge has been studied with the help of a Ge(Li) detector and scintillation counters. The ^{74}Ga activity has been produced

by $^{74}Ge(n,p)\ ^{74}Ga$ reaction with 14 MeV neutrons. New gamma-rays have been found in the energy interval 0.6 - 2.2 MeV. A decay scheme of ^{74}Ga is proposed on the basis of accurate energy and intenstiy measurements of gamma- and beta-rays, and coincidence studies.

11. Decay of 15-Min Ga^{65} to Zn^{65} - D. Basu - Fifteen minutes Ga^{65} was produced from the $Zn^{64}(p,\gamma)Ga^{65}$ reaction. The decay of this isotope was studied using a Ge(Li) detector. Several γ-rays have been detected, and a consistent level scheme is proposed.

12. Energy Distributions in Prompt Fission Fragments - Ratna Sarkar and Aparesh Chatterjee - Total energy release in prompt fission phenomena and the distribution of this energy as the excitation and kinetic energies of a conjugate fragment is predicted from the potential energy surface (PES) concept[1] and the renormalised Fermi gas model[2] (RGM). In the PES concept, the total nuclear energy $E_A(P)$ at ground state deformation is expressed in Belyaev's BCS formalism. This energy is expanded in a power series[1] to obtain energy $E_A(\alpha)$ at an arbitrary deformation α. If α is the saddle-point deformation parameter, the total energy release in fission for binary divisions is

$$E = \sum_{F=L,H} E_F(0_F) - E_F(P_F) + \frac{Z_L Z_{He}^2}{R_0 F}\left[1 - \left(\frac{5}{4\pi}\right)\frac{\frac{1}{2}RR_{0L}\,o_L}{R_0 F} + \frac{3}{5}\left(\frac{5}{4\pi}\right)\frac{\frac{1}{2}R_0 L_0 L}{R_0 F}\right]$$

where the square bracketted terms represent the

interaction[3] between the light (L) and heavy (H) fragment of a conjugate pair. The o 's are estimated by minimizing the energy with respect to o.

The nuclear structure-sensitive part of the PES is treated by the RGM. The shell effects, pairing effects and dedormation effects appear as suitable energy corrections f, π and δ . The total RGM correction is f $-\pi-\delta$. It is assumed that the total RGM corrections of the fragments over those of the fissioning nucleus must appear as a part of the excitation energy U^{RGM}. The rest of the excitation energy is estimated from the change of the deformation-dependent part of the PES U^{PES}. The total excitation energy is thus $U^{RGM} + U^{PES}$. The total kinetic energy T is then $E_R - U$.

These predictions are tested for the spontaneous fission of ^{252}Cf, thermal neutron induced fission of ^{233}U, ^{235}U, ^{239}Pu and fast neutron fission of ^{238}U. In each case, good agreement was found between the experimental and predicted values[2].

1. U. Mosel and W. Greiner, Private comm.; Z. Physik 217(1968)256.

2. R. Sarkar and A. Chatterjee, Phys. Lett.30B(1969)313; Phys. Rev. (to be published)

13. Prompt Gamma Decay of Fission Fragments - Ratna Sarkar and Aparesh Chatterjee - Our previous RGM-PES approach[1] was found to give fairly good description[2] of the fission energy

kinetics in case of spontaneous fission of ^{252}Cf, slow neutron fission of several nuclei, and fast neutron fission of ^{238}U, without using a mass formula to evaluate the fission energy release E_R. The partition of energy E_R into the prompt fragment excitation UF and fragment kinetic energy T_F were also satisfactorily treated. A realistic structure-sensitive variation of the symmetric and asymmetric collective stiffness coefficients C_o and C_2 (or C', for notations, see ref.[2]) may be considered by assuming that they are functions of extracore nucleons n in a nucleus $A_F(n/A_F = \delta\epsilon/\epsilon_o)$. The occupation dependence of the coefficients are

$$C_{oF} \simeq C_{oo}\,(1 - \delta\epsilon_F/\epsilon_o), C'_F \simeq C'_o\,(1 - \delta\epsilon_F/\epsilon_o) \quad (1)$$

where C_{oo} and C'_o are the stiffness coefficients of a free gas. In this work, C_{oo} = 320 MeV and C'_o = 160 MeV have been assumed.

The entire fragment de-excitation process is assumed to be:

$$A_F \xrightarrow[\nu_F]{n} A_{F'}{}^{*} \xrightarrow[sF']{\gamma} A_{F'} \quad (2)$$

where ν_F and $s_{F'}$ are the number of neutrons and gamma rays respectively from the fragments F and F'. A cascade de-excitation process is assumed to be favoured both for theoretical[2] and experimental[3-5] reasons.

Since the RGM can evaluate the single particle density g (or its related level density parameter a of the nuclear

system in the form

$$g_{F'} = g_0 \, (1 + \delta\epsilon_{F'}/\epsilon_0) \qquad (3)$$

we assume that the cascade process is allowed only through a set of equidistantly spaced levels (of spacing $d_{F'} = 2/g_{F'}$) of the same kind of parity. We thus obtain the result

$$E_\gamma^{max} = U_{F'} = 2(s_{F'} - 1)/ g_{F'} \qquad (4)$$

where E_γ^{max} is the maximum gamma energy[5] (about 3-4 MeV).

Fairly good fits of the prompt gamma energies and gamma ray yields have been found using the above ideas[6] for the thermal neutron fission of ^{235}U and spontaneous fission of ^{252}Cf.

1. A. Chatterjee, unpublished; A. Chatterjee, S. Chatterjee, S.K. Ghosh and R. Sarkar, to be published in parts
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5. E.C. Malenschein et al., Proc. 2nd Intern. Conf. on Peaceful Uses of Atomic Energy (United Nations, Geneva) 1955, 15, paper No.P/670
6. R. Sarkar and A. Chatterjee, to be published.

14. Independent Mass Yields of the Fission Fragments - Ratna Sarkar and Aparesh Chatterjee - In the case of binary fission, the life time of the fissioning nucleus is assumed to be so large that a statistical equilibrium is set between the fissioning nucleus and the preformed fragments and hence the entire fission phenomenon may be described in terms of the phase space available to the process[1]. The relative decay probability in a given fragment pair (1,2) is then given by the relative transparency factor T_{12} times the level densities of the fragments:

$$Y_{12} \propto P_{12} = T_{12} \exp 2(a_1U_1)^{\frac{1}{2}} \exp 2(a_2U_2)^{\frac{1}{2}}$$

where Y_{12} is the yield and P_{12} is the decay probability.

It is possible to calculate the excitation energies U_1 and U_2 from the RGM-PES approach[2]. It is further possible to compute the statistical level density parameters a_1 and a_2 from the RGM directly[2] as

$$a_i = \pi^2 A/4\, \epsilon_i = (\pi^2 A/4\, \epsilon_o)(1 + \delta \epsilon_i/\epsilon_o)$$

where ϵ_i is the RGM correction of the i-th nucleus.

The complicated problem of evaluating the relative transparency factor T_{12} is handled by using a simple form of ion-optical potential due to Thomas[3]. Using the WKB approximation, the transparency T_{12} for a parabolic barrier of height B is of the form

$$T_{12} = 1/(1 - \exp(2\pi/\hbar\omega)(B-T)) \text{ with } \hbar\omega = (\hbar/\mu)(d^2V/dr^2)^{\frac{1}{2}}$$

evaluated at a point where V(r) is a maximum for $\ell = 0$.

The independent mass yields Y_{12}, and Y_1 and Y_2, ($Y_1 = Y_{12}^{\frac{1}{2}}$), are calculated for the fission of ^{238}U with neutrons of energy E_n = 2.8 MeV. The agreement between the theoretical[4] and experimental[5] values is satisfactory. The agreement at E_n = 14 MeV is also impressive[4,5].

1. T. Ericson, Advan. Phys. 9 (1960)425
2. R. Sarkar and A. Chatterjee, Phys.Lett.30B(1969)313
3. T.D. Thomas, Phys. Rev. 116(1959) 703
4. R. Sarkar, to be published
5. S. Katcoff, Nucleonics 16(1958),p.78

15. Fission Energy Kinetics, Fragment Deformations, The Fission Barrier and Mass Yields - Ratna Sarkar and Aparesh Chatterjee - Encouraged by the partial success of a unified microscopic RGM-PES approach[1] of treating the energy kinetics in fission phenimena, a detailed program has been undertaken to calculate the above quantities for a large number of fissile nuclei (A = 185 to 260). We hope to treat (i) the scission point deformations of the fragments, (ii) evaluate the scission point barrier heights, and (iii) predict the independent mass yields from the same basic self-consistent approach without the use of a mass formula.

Only a limited part of the program has so far been carried out[2] with fair success.

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$$a_i = \pi^2 A/4\, \epsilon_i = (\pi^2 A/4\, \epsilon_0)(1 + \delta \epsilon_i / \epsilon_0)$$

where ϵ_i is the RGM correction of the i-th nucleus.

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Only a limited part of the program has so far been carried out[2] with fair success.

1. R. Sarkar and A. Chatterjee, see the previous three reports
2. R. Sarkar and A. Chatterjee, to be published

16. The Stability of Actinide Elements and Superheavy Nuclei - Sudip Kumar Ghosh and Aparesh Chatterjee - A great deal of recent work has studied the question of stability of actinide elements and superheavy elements in the framework of the liquid deop model and collective behaviour of the nucleons. An attempt is being made to look into the stability problem form the interacting renormalized Fermi gas model (RGM) viewpoint. The RGM treats the long-range and short-range parts of the residual nuclear interactions properly[1].

The RGM is also able to treat the single particle level density g of the nuclear system by reconsidering the same basic interactions in a deformed potential and additing up the phenomenological coulomb interaction effects. We expect these two features of the RGM to define at least a partial criterion of stability.

The main difficulty of treating the superheavy nuclei is that the shell model interactions in these regions are obscurely known. A correct guess of the shell structures are needed to obtain the RGM structural corrections $\delta\epsilon$ and the RGM single-particle density g . These are being looked into[2] .

1. See previous reports
2. S.K. Ghosh and A. Chatterjee, unpublished

17. Predictions of Deformations and Quadrupole Moments - Swapna Chatterjee and Aparesh Chatterjee - Simple calculations[1] on these properties of nuclei showed the need of considerable

improvement in our treatment of the RGM. We shall recalculate them with our modified RGM.

1. S. Chatterjee, unpublished.

D. LABORATORIES FOR NUCLEAR RESEARCH, ANDHRA UNIVERSITY, WALTAIR

1. Isomeric Ratio Analysis of (n,2n) Reaction on Some Rare-Earth Nuclides - P. Rama Prasad, J. Rama Rao and E.Kondaiah - Isomeric cross section ratios for (n,2n) reactions on Nd-142, Sm-143 and Eu-153 were measured at E_n = 14.2 ± 0.2 with a well-type NaI(Tl) Scintillation Spectrometer. The experimentally determined values are compared with those calculated theoretically using the Huisenga and Vandenbosch formalism, to find the value of the spin cut-off factor The corresponding nuclear moments of Inertia are also deduced.

2. Precompound Particles in $^{115}In(p,n)^{115}Sn$ Reaction; and (p,n) Reactions in General - K. Parthasaradhi, C.R.Chandran, V. Seshagiri Rao and S. Ramamurthy - An examination of $^{115}In(p,n)^{115}Sn$ reaction data at four bombarding energies reveals features found previously in $^{80}Se(p,n)^{80}Br$, $^{94}Zr(p,n)^{94}Nb$, $^{116}Sn(p,n)^{116}Sb$, $^{117}Sn(p,n)^{117}Sb$, $^{118}Sn(p,n)^{118}Sb$ and $^{122}Sn(p,n)^{122}Sb$ reactions,-viz., the existence of pre-compound particles at all bombarding energies and the increasing bombarding energies. General conclusions concerning (p,n) reactions are drawn.

3. K-X Ray and Gamma-Ray Directional Correlation in the Decay of Rehenium - 186 - K.V. Ramana Rao, P. Jagam, D.L. Sastry. - In view of the recent work of Perpelkin on Mn-54 in wh ch he reported a definite angular correlation between the K-Xray following the K-capture and the succeeding gamma ray, we conducted measurements carefully employing a high efficiencey Sum-peak Coincidence Spectrometer Set-up on the angular correlation between the K-X ray following the K-capture and the succeeding gamma ray in the decay of Rhenium -186.

4. Nuclear Matrix Elements Governing the 450 KeV First Forbidden Beta Transition - M. L. Narasimha Raju, V. Seshagiri Rao and D.L. Sastry - The energy dependence of the angular correlation of the 450 KeV beta - 176 keV gamma cascade in Sb-125 measured with a fast-slow scintillation spectrometer. A maximum beta-gamma anisotropy of about 25% is found. The present values of angular correlation are combined with the allowed shape of the 450 keV beta transition in order to obtain the first forbidden matrix elements governing the 450 keV beta transition. The exact theoretical expressions that include the finite size effects and Bhalla and Rose tables are used in the analysis. The analysis is carried out on the CDC 3600 electronic computer.

5. The Structure of the 80- And 364-keV States in Xenon-131 - V.V. Rama Murty, M.T. Rama Rao, G. Satyanarayana and V. Lakshminarayana - Delayed coincidence measurements on the 80 and 364 keV levels in Xenon-131 are performed. The measurements yielded values of (380 ± 20) psec. and (360 ± 40)psec. respectively for the half lives of the two levels. The single particle estimates of the transition probabilities are compared with those calculated on the basis of the experimental values of half lives. These values indicate that the 80 keV and the 364 keV levels should arise out of some collective mechanism of excitation. The results are discussed in the light of the recent phenomenological nuclear models of de-Shalit and Kisslinger and Sorensen. While the Kisslinger and Sorensen wave-functions seem to describe the ground and the 80 keV levels adequately well, evidence for dominant contributions from the $d3/2^+$ phonon and $s1/2^+$ phonon parts in the 364 keV level is observed. The unified nuclear model with a restricted configuration space consisting of s1/2 and d3/2 orbitals alone available for the odd neutron occupancy seems to be applicable to this nucleus.

6. The Structure of the 57 and 351 keV Levels in ^{143}Pr - V.V. Rama Murty, M.T. Rama Rao, S. Khayyoom and V. Lakshminarayana - The half-lives of the 57 and 351 keV levels

in ^{143}Pr are measured to be (4.05±0.12) ns and (68±8) ps, respectively, by the delayed coincidence technique, using a time-to-amplitude converter. From a comparison of the observed transition probabilities with the single particle estimates, it is inferred that the levels could be attributed to a collective mechanism of excitation. The core exciatation model, extended with admixture in the wave functions, as well as the pairing and long range force model, are found to be inadequate to explain the observed results. Wave functions have been provided by Choudhury and Kujswaki as well as Heyde and Brussaard, on the basis of the unified nuclear model in its intermediate coupling approach, with $1g_{7/2}$ and $2d_{5/2}$ orbitals available to the odd proton. While the former rule out an experimentally established $3/2^+$ state around 351 keV, and indicate a $7/2^+$ spin to this level, the wave functions provided by the latter for a $3/2^+$ level below 500 keV provide results which agree approximately with the present experimental estimates. A better agreement appears possible with the inclusion of $2d_{3/2}$ and $3s_{1/2}$ orbitals also in the intermediate coupling model calculations.

7. Beta Groups of ^{99}Mo - T. Nagarajan, M. Ravindranath and K.V. Reddy - An analysis of beta spectrum of ^{99}Mo taking into account the correct shape of the outer beta group revealed beta groups with endpoints: 1215±1 (84%), 840±5 (2%),

450±10 (4%) keV. The shape co-efficient of outer group is : a = -0.013±.007. On the basis of shell model matrix elements, the CVC prediction for Λ gave a positive value for a, whatever be the value of Λ_0. Treating both Λ and Λ_0 as free parameters, a fit with experimental shape gave : $3.4 \leq \Lambda \leq 5$ and $2.3 \leq \Lambda_0 \leq 3.7$. The shape of the inner group (840 keV) was found to be that of 1st forbidden non-unique type consistant with shell-model prediction, even though the 514 keV ($3/2^-$) level fed by this beta group is considered as arising from the weak coupling of $p^{1/2}$ proton-hole to the 2^+ first excited state of the core (^{98}Mo). But the large log ft value of this transition may perhaps be explained by giving "microscopic" picture to the core.

E. ALIGARH MUSLIM UNIVERSITY, ALIGARH

1. Measured (n,p) Reaction Cross Sections and Their Predicted Values at 14.8 MeV - R. Prasad and D.C. Sarkar - (n,p) reaction cross sections for some fortyfive cases in the range $167 \geqslant A \geq 6$ are measured by the activation technique at 14.8 $\pm$ 0.5 MeV neutron energy. Measured cross sections are compared with the cross sections semi-empirically predicted by Gardner and Cevkovskii. Experimental cross sections are also compared with cross section values obtained theoretically using a shell dependent level density.

2. Statistical Theory Calculations of Neutron Capture Cross Sections at 200 KeV - A. K. Chaubey, M.S. Rajput and M.L. Sehgal - Neutron capture cross sections have been calculated using statistical theory of nuclear reactions at 200 KeV. By comparing these calculated cross sections with the earlier measured values of capture cross sections at 200 keV, values of parameter $\xi = (D/2\pi\sqrt{\gamma})$ were calculated. These values of were compared with the values of ξ obtained from low energy resonance parameters. In general there is good agreement in these two values of ξ which confirms the validity of statistical theory at this energy.

3. On Spectral Density Method in the Perturbed Angular Correlation - K. Rama Reddy - For a linear response detecting

system the time and frequency spectra of the perturbed angular correlations are calculated. Calculations are based on the techniques of random signal analysis. The frequency spectra, thus calculated, contain resonances whose positions are determined by the hyperfine interactions. The line width of a resonance is just the natural line-width of the decaying nuclear state. Numerical results are discussed for various stationary and non-stationary perturbing interactions.

F. Department of Physics, Bangalore University, Bangalore-1.

1. Spectroscopic Factors for Pickup Reactions* - N. G. Puttaswamy - Nuclear reactions involving the transfer of one nucleon are being studied in large numbers. For nuclei in the s-d shell, spectroscopic factors for stripping reactions have been predicted by Glaudemans et al[1] who have performed a shell-model calculation assuming an inert ^{28}Si core and permitting all configurations within the s(1/2) and d(3/2) shells. Since pickup reactions yield very similar information, the same wave functions have been used to predict spectroscopic factors for ptoron and neutron pickup reactions on all stable nuclei with $29 \leq A \leq 40$[2]. In particular, the results on the neutron pickup from ^{37}Cl and ^{39}K is dealt with in reference to recent data from (d,t) reactions.

* Work supported by financial grant from the University Grants Commission.

1) P.W.M. Glaudemans, G. Wiechers, and P.J. Brussard, Nucl. Phys. 56, 548 (1964)

2) The author is thankful to the Computer Staff at H.M.T. Ltd. for their help and cooperation.

G. BANARAS HINDU UNIVERSITY, VARANASI-5

1. Suitable Optical Model Parameters for Evaluation of Neutron Cross Sections Below 2 MeV - H.C. Sharma and N. Nath - The effect of varying individual parameters of the optical model potential on the angular distribution of elastically scattered neutrons has been investigated for a number of nuclei. The aim is to find the permissible range of these parameters such that both the differential elastic as well as inelastic cross sections can be reliably estimated well within the usual experimental errors. Further, the compound elastic cross sections from different nuclei have been estimated to look for the extent of shell effects. An attempt has also been made to study possible effect of compound nucleus level-width fluctuations on these cross sections by appropriately varying the imaginary potential depth parameter.

2. On the connection between the RMS Charge Radii for Tri-Nucleons - V.S. Mathur and A.V. Lagu - The connection between the r.m.s. charge radii of ^{3}H and ^{3}He and the bremsstrahlung weighted cross section of photodisintegration of these nuclei, which one expects on the basis of the sum-rules of Levenger and Bethe, can be seen more clearly on taking account of the charge distributions of the nucleons. It is seen that this connection gives an independent check on the value of the slope of the neutron charge form-factor GE_n (0).

This is rather interesting because the information on this quantity, as derived from the electron-trinucleon scattering data, is not quite unambiguous being dependent among other things on the assumed wavefunction of the trinucleons.

H. BOSE INSTITUTE, CALCUTTA-9.

1. Electronic Charge Distribution in Heavy Atoms from Non-Resonant Coherent Scattering Cross-Sections* - S.C. Roy and A.M. Ghose - An attempt has been made to determine the electronic charge distribution of heavy and intermediate mass atoms from the experimentally determined values of the non-resonant coherent scattering cross-sections $\sigma_R(\theta)$ of gamma rays for these elements. In the non-relativistic case and for a spherically symmetric atom the atomic form factor $F(z,q)$ is related to the electronic charge density distribution $P(r)$ by $P(r) = \frac{1}{2\pi^2 r \hbar^2} \int_0^\infty F(z,q) \sin\frac{qr}{\hbar} \cdot q \cdot dq$ where q is the change of momentum of the photon.

The experimental $\sigma_R(\theta)$ has been analysed to estimate the relativistic effects and the compensating effective non-relativistic cross-section has been used to determine $F(z,q)$. Numerical integration was carried out using Simpson's $\frac{1}{3}$ rd rule for q ranging between 0 to 2.5 mc units. The $P(r)$ was calculated upto L-shell of electrons which was then compared with the values obtained from Hartree-Fock approximations. Although K-shell radii are obtained satisfactorily by this method, anomalous peaks in charge distribution have been found between K- and L-shells. Possible causes for discrepancy are being studied.

* Work performed under the sponsorship of the U.S. National Bureau of Standards.

2. Measurement of Coherent Scattering Cross Sections at Very Low Momentum Transfers* - A. Nath - Coherent scattering cross sections of gamma rays at very low momentum transfers ($q = 0.009$ to 0.118 mc) have been measured for C, Cu, Al, Fe, Sn and Pb scatterers using ^{141}Ce 0.145 MeV photons. The experimental results show reasonable agreement with Hartree-Fock form factor calculations as well as with the empirical formula of Nath and Ghose. Violent disagreements with theoretical results as well as unexpected structure effects reported by Hauser et al have not been confirmed.

* This work was performed under the Sponsorship of U. S. National Bureau of Standards.

3. Absolute (n,2n) Cross Sections of Nuclei Near 14 MeV - Absolute values of (n,2n) cross sections of ^{19}F, ^{50}Cr, ^{63}Cu, ^{64}Zn, ^{69}Ga, ^{79}Br, ^{91}Mo, ^{107}Ag, ^{113}In(112 m), ^{113}In(112 g), ^{121}Sb and ^{141}Pr have been measured near 14 MeV ($E_n = 14.2$ and 14.8 MeV). Absolute neutron flux has been measured by a biased plastic scintillator using response function determined by the method developed by Chatterjee and Ghose. Positron activity has been measured by a calibrated coincidence spectrometer.

I. INDIAN STATISTICAL INSTITUTE, CALCUTTA-35

1. Nucleon-Deuteron Scattering - G. Ramachandran - The importance of the D-state and its relative phase with respect to the leading S-state of deuteron in the context of nucleon-deuteron scattering is discussed. The impulse approximation is used and the validity of the model at low energies is also analysed in the light of experimental data at these energies.

J. INDIAN INSTITUTE OF TECHNOLOGY, KANPUR (U.P.)

1. Shell Model Calculation of π^- -Absorption Rate in Complex Nuclei - R.S. Kaushal - The process of two-nucleon emission (which predominantly occure) following the π^- -capture in complex nuclei is studied. We calculate the pion absorption rate in a complex nucleus like ^{12}C and study the contributions due to excited states in the residual nucleus. The results are found to be in satisfactory agreement with experiments only if the absorption due to 1^+ excited level of ^{10}B is taken into account. The branching ratio R(=W(pn → nn) /W(pp → pn)) is also satisfactory. It is further noticed that the inclusion of final state interactions do not cancel each other and provide a substantial contribution making the results somewhat unsatisfactory.

2. Absorption of Free Pions Followed by Single-Nucleon Emission - R.S. Kaushal and Y.R. Waghmare - Using the Hartree-Fock model for the complex nucleus we study the single-nucleon emission process following the absorption of positive pions. Differential cross sections for single-nucleon emission from a given shell in cases of ^{12}C and ^{16}O nuclei are calculated. For ^{12}C, the results are compared with available experimental data at 68 MeV pion energy and the agreement is found to be satisfactory. The effect of a distorted outgoing proton wave has been pointed out.

3. Statistical Resonance of Plutonium-239 - A. Sengupta and G. Srikantiah - Recent data show that neutron resonances of Plutonium-239 have been resolved upto an energy of about 300 eV(1). However, neutron cross sections of fissile nuclei over the entire energy region are needed for nuclear reactor calculations. Statistical methods have been applied previously to obtain average cross sections over the energy range of unresolved resonances (2). In this work the theory and a critical examination of such statistical methods is given and these methods are then applied to obtain the resonance parameters of plutonium-239 in the unresolved region. The results have been compared with the available integral experimental data. Though the agreement is not good there is evidence to show that the experimental data can be bracketed in between theoretically derived curves based on different statistical distributions (3). This indicates a plausible energy dependence of the number of degrees of freedom (which physically correspond to the number of open channels for the particular reaction).

1) J.J. Schmidt, Kernforchungszentrum Karlsruhe, Report KFK-120, 1962

2) G. Srikantiah, Brookhaven National Laboratory, Report BNL 7363, 1963

3) A Sengupta, Dept. of Mechanical Engineering, IIT, Kanpur, M. Tech. Thesis, 1969

4. Liquid Drop Model Calculation of the Total Prompt Gamma Energy, The Total Kinetic Energy and the Scission Point Deformations of Different Fission Fragment-Pairs From the prompt Neutron Numbers - Shankar Mukherji and K.B. Lal - Assuming that the scission point configuration may be well approximated by two collinear tangent prolate spheroids, the extent of deformation of each of the complementary fragments has been calculated by equating the deformation energy of each fragment as given by the Bohr-Wheeler expression to the energy required to evaporate the experimentally observed number of prompt neutrons. Using the deformation parameters thus calculated, the total prompt gamma energy and the total kinetic energy for any fragment-pair has been calculated by equating them to the coulomb and the quadrupolar interaction energies between the complementary fragments at the scission point, respectively. Prompt gamma energies of individual fragments have also been predicted. These calculations have been performed for about thirty fragment pairs from each of the fissile nuclei : U-233(n,f), U-235(n,f), Pu-239(n,f) and Cf-252*(spont). The calculated values are in excellent agreement with the corresponding experimental values in literature.

K. INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR-2

1. Binding Energy of Alpha Particle with a Tensor Velocity-Dependent Potential - D. Mahanti, H.L. Yadav and B K. Srivastava - We make a variational calculation of the binding energy of the alpha particle with the tensor velocity-dependent potential of Nestor et al. The trial wave function is a mixture of S-state and the principal D-state, the radial dependence of both these states being Gaussian. We calculate the Coulomb energy of interaction of protons in the alpha particle by using perturbation theory. Our calculation gives values of binding energy and r.m.s. radius of the alpha particle in reasonable agreement with experiments.

L. MADRAS UNIVERSITY, MADRAS-25

1. Nuclear Distortion Effects of the Emitted Pion in Photo-Pion Reactions - V. Devanathan - The surface production mechanism first suggested by Butler for photoproduction of pions from nuclei is a phenomenological model and is introduced to explain the gross features in the absence of any detailed knowledge regarding the effects of (i) two-nucleon correlations in nuclei and (ii) the final state interaction of the emitted pion with nuclei. A detailed study of these two effects have been made.

M. PUNJAB UNIVERSITY, CHANDIGARH-14.

1. The Decay of ^{124}Sb - S. P. Sud, K. K. Suri and P.N. Trehan - The decay of ^{124}Sb has been investigated employing scintillation spectrometer in fast-slow, sum- and sum-peak coincidence modes. From γ -γ coincidence studies new levels at 2040 and 2775 keV proposed by Stelson (1) and Zirnheld and Henck (2) are confirmed. Levels at 1901 and 2865 keV in the level scheme adopted by Lederer et al (3) are not supported by the present investigations. Weak gamma transitions from 2693 and 2293 keV levels are confirmed. The directional correlation of γ-γ cascades; 2090-603, 1690-603, 1368-1326, 1386-722, 968-1326, 968-722, 645-603, 1368-603 and 722-608 keV have been measured. The results of the directional correlation measurements permit spin assignments 2^+, 4^+, 2^+, 4^+, 3^- and 3^- to the 603, 1248, 1325, 1960, 2293 and 2693 keV levels of ^{124}Te. In case of the 2040 keV level the possible spin assignments are limited to 2^+, 3^+. The experimental level scheme of ^{124}Te is found to be in broad agreement with the predictions of the vibrational model.

2. The Decay of ^{134}Cs and ^{192}Ir - S.P. Sud, K.K. Suri, P.C. Mangal and P.N. Trehan - The gamma ray spectra observed in the decay of ^{134}Cs and ^{192}Ir have been investigated using scintillation spectrometers in fast-slow, sum-and sum-peak

coincidence modes. In the case of ^{134}Cs a weak gamma ray of 1580 keV reported by Nagpal and could not be observed in the present studies. The gamma-gamma coincidence studies support the existence of a weak level at 1773 keV in ^{134}Ba. The directional correlation measurement of the 1038-605 keV cascade assigns a spin 3^+ to the 1643 keV level in ^{134}Ba. In the case of ^{192}Ir, the 4π sum-peak coincidence spectra with integral biases set at 200 and 400 keV support the existence of a 769 keV gamma ray from the 1380 keV level in ^{192}Pt. A cross-over transition from the same level has been found to be absent. The sum-coincidence spectra with the gates set at 1380, 1200 and 921 keV support the existence of gamma rays of energies 785, 769 and 460 keV. These weak gamma rays could not be observed in a recent study by Palaska et al. using a Ge(Li) detector.

3. Gamma-Gamma Directional Correlations in ^{110}Cd - S.P. Sud, P.C. Mangal and P.N. Trehan - The directional correlations of eight gamma-gamma cascades in ^{110}Cd following the decay of ^{110m}Ag have been measured. The cascades investigated are: 764-1505, 1505-658, 1565-658, 706-1565, 1384-884, 884-658, 937-884 and 446-(937)-884 keV, of which the cascades 1565-658, 706-1565 and 446-(937)-884 keV have been attempted for the first time. The results of the directional correlations of the 1565-658 and 706-1565 keV cascades permit a unique spin assignment of 4^+ to the 2220 keV level. The

following characteristics for the gamma radiations are obtained: γ 1505: $(9.0 \pm 1.8)\%$ E2 and $(91.0 \pm 1.8)\%$ M1 ; γ 1565: $\sim 100\%$ E2; γ 706: $(91.0 \pm {}^{7.0}_{9.5})\%$ E2 and $(9.0 \pm {}^{7.0}_{9.5})\%$ M1; γ 1384: $(9.5 \pm 1.0)\%$ E2 and $(90.5 \pm 1.0)\%$ M1; γ 884; 100% E2; γ 937: $\sim 100\%$ E2 and γ 446: $(81.2 \pm {}^{5.8}_{8.7})\%$ E2 and $(18.8 \pm {}^{5.8}_{8.7})\%$ M1.

N. SHIVAJI UNIVERSITY, KOLHAPUR-4.

1. Resoname Magic Cores Model For B^{10} - K.L. Narayana.- The total wave function on the basis of this model is written as a linear combination $\psi = \psi_{SC} + \beta \psi_{MC}$ where ψ_{SC} and ψ_{MC} stand for possible single core and multiple core structures. The multiple core structure which arises for the Boron-10 nucleus is a double core formed by the two α-particles separated by a distance 3.23 fm. We have in addition a proton and a neutron moving about these two α-particles. This resonates with a single core structure of Be^8 plus the two nucleons. The $\alpha - \alpha$ interaction of a gaussian shape involving both the attractive and repulsive parts is used. (Physical Review, I38, 637B, (1965)). The results indicate that a 40% dual core component requires the n-p interaction of strength about 50 MeV, to furnish the experimental ground state energy of B^{10}. A consistent interpretation of the ground state energy of $_{\Lambda}B^{10}$ hypernucleus is also considered on the basis of this model.

O. UNIVERSITY OF ROORKEE, ROORKEE.

1. On the Higher Order Effects in Some Allowed Beta Transitions from the Decay of Cs^{134} and Sb^{125} - H.S. Dahiya and B.P. Singh - Beta-Gamma angular correlation studies are done for the allowed transitions from the decay of Cs^{134} and Sb^{125}. For these studies plastic scintillation spectrometer for β particles and NaI(Tl) scintillation spectrometer for γ -rays alongwith slow-fast coincidence set is used. In Cs^{134} decay the following β groups and γ transitions are studied (a) β group of 410 keV in the energy range of 300-400 keV with gamma radiation of 1040 keV using integral spectrum above 900 keV (b) β group of 662 keV in the energy range 500-600 keV with gamma radiat.ons of 796 keV in 4 volts channel width (1 Volt $\approx$ 15 keV). In Sb^{125} the following studies are done (a) β group of 130 keV in the energy range of 80-100 keV with 600 keV gamma radiation in 4 Volts channel width (1 volt $\sim$ 15 keV) (b) β group having energy range of 120-150 keV with gamma radiation in 4 Volts channel width selecting gamma radiation in 400-460 keV.

2. Nuclear Transitions in Cs^{133} from the Decay of Ba^{133} - U.S. Pande and B.P. Singh - In order to study the multipolarity of 79.60 keV transition from the 161 keV level in Cs^{133} from the decay of Ba^{133} and also the spin of 161 keV

excited level the gamma-gamma-gamma angular correlation study is done having 276 keV-79.6-81 keV cascade. For this study three NaI(Tl) spectrometers are used. Two detectors detecting 276 keV and 79.6 keV gamma rays are fixed, one in the plane of the table and other perpendicular to the plane of the table respectively, selecting the gamma rays integral spectrum above 200 keV and photopeaks in 2 volts channel(2 Volts = 20 keV) respectively. The third detector detecting the 81 keV gamma rays photopeak in 2 volts channel (2 Volts = 20 keV) is movable in the plane of the table. The source was kept at 4.5 cm from the detectors. The angular correlation function was obtained by keeping the detector detecting 81 keV gamma rays at various angles. The function thus obtained is (without applying solid angle correction),
$W(\theta) = 1+(0.104\pm0.022)P_2(\cos\theta)+(0.003\pm0.026)P_4(\cos\theta)$.

All other possibilities are ruled out except spin sequence 7/2, 5/2, 5/2 and 1/2 for ground state, 81 keV, 161 keV and 439 keV level respectively, taking mixtures in 81 keV and 79 keV gamma rays and 276 keV to be pure. The multipolarities for 79.6 keV transition, thus obtained is compared in the light of other data.

3. Triple Gamma Cascade Studies in W^{182} From the Decay of Ta^{182} - U.S. Pande and B.P. Singh - The gamma-gamma-gamma (triple gamma cascade) angular correlation studies have been done in W^{182} from the decay of Ta^{182}. The studies have been

done using three scintillators NaI(Tl) detectors. Two of the detectors are mounted on the table, one of them is fixed and the other one is movable in the plane of the table. The fixed detector detects the first and the movable detector third radiation of the gamma cascade. The third detector is kept perpendicular to the table which is also fixed and makes an angle of 90° with both the detectors and detects the 2nd gamma ray (middle of the cascade). The angular correlation studies were done by changing the angle of movable detector with respect to fixed detectors. The correlation function for the cascade (without applying solid angle correction)are as follows. For 68 KeV-1122 keV-100 keV cascade $W(\theta) = 1+(0.1565\pm0.0141)P_2(\text{Cos }\theta)+(0.0118\pm0.0179)P_4(\text{Cos }\theta)$ and for 151 keV-1122 keV-100 keV cascade $W(\theta) = 1-(0.1181\pm0.0674)P_2(\text{Cos }\theta)+(0.1137\pm0.0824)P_4(\text{Cos }\theta)$.

Previous reports published by the Indian Nuclear Data Group (INDG) :-

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4.	A.E.E.T.-267	Progress report on nuclear data activities in India-III	1966
5.	B.A.R.C.-305	Progress report on Nuclear data activities in India-IV	1967
6.	B.A.R.C.-401	Progress report on Nuclear data activities in India-V	1969