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GOVERNMENT OF INDIA
ATOMIC ENERGY COMMISSION

PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN INDIA—IV

Compiled by
INDIAN NUCLEAR DATA GROUP
Nuclear Physics Division

BHABHA ATOMIC RESEARCH CENTRE
BOMBAY, INDIA
1967

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PREFACE

The fourth Progress Report on Nuclear Data Activities in India incorporates work done upto June 1967. The response to our request for material has been good; we thank all those who have co-operated, and hope to have their cooperation in the future.

During the last one year the INDG has maintained a steady pace of activity. Regular contributions to the CINDA (Computer Index Neutron Data) have been sent. Literature pertaining to Nuclear Data received from the International Nuclear Data Committee (INDC) of IAEA is being maintained in the Physics Group Library at the Van de Graaff Laboratory at Trombay.

A new journal on Nuclear Data called "Newsletter" is being published by the Neutron Data Compilation Centre of the European Nuclear Energy Agency. This journal is available for reference at the Van de Graaff Laboratory and arrangements have been made to get this journal sent to those specifically interested.

During this year the International Nuclear Data Committee has acquired the status of a permanent committee of the IAEA.

October 1967 Indian Nuclear Data Group

INDIAN NUCLEAR DATA GROUP

Members

M. Balakrishnan	B.A.R.C. (Secretary)
H.G. Devare	T.I.F.R.
A.S. Divatia	B.A.R.C. (Convener)
D.N. Kundu	S.I.N.P.
B.P. Rastogi	B.A.R.C.
M. Srinivasan	B.A.R.C.
G. Venkataraman	B.A.R.C.

B.A.R.C. : Bhabha Atomic Research Centre, Bombay 74

T.I.F.R. : Tata Institute of Fundamental Research Bombay 5

S.I.N.P. : Saha Institute of Nuclear Physics,Calcutta 9

A. BHABHA ATOMIC RESEARCH CENTRE, TROMBAY, BOMBAY-74.

1. Study of the 1.94 MeV State in ^{27}Mg by means of the Reaction $^{26}Mg(d,p)^{27}Mg$ - M.A. Eswaran, N.L. Ragoowansi and K.K. Sekharan - Nuclear Physics Division - Proton-gamma ray angular correlation measurements employing the method of Litherland and Ferguson, have been made in the reaction $^{26}Mg(d,p)^{27}Mg$. Using 1.80 MeV deuteron beam, the protons feeding the 1.94 MeV state were detected at 0° to the beam in a surface barrier detector and angular correlation of de-excitation gamma rays from the state were measured. The combined angular correlation of the two unresolved gamma rays due to the transititions 1.94 $\rightarrow$ 0.98 MeV and 0.98 $\rightarrow$ 0 MeV were analysed by means of a computer programme. The analysis of the results shows that spin choice of 5/2 for the 1.94 MeV state gives the best fit for the observed correlation. The cascade to cross over branching ratio of this state is obtained as 2.0 $\pm$ 0.3.

* Reported in Bull. Am. Phys. Soc. 12, 1 (1967) 72.

2. Proton-Gamma Ray Angular Correlation Measurements in the Reaction $^{24}Mg(d,p_3)^{25}Mg$ - M.A. Eswaran, N.L. Ragoowansi and P.C. Mitra - Nuclear Physics Division - To obtain direct evidence for the spin of the 1.61 MeV state in ^{25}Mg, the level was excited in the reaction $^{24}Mg(d,p)^{25}Mg$ using 2.1 MeV deuteron beam and detecting the outgoing protons feeding the state, at 0° to the beam in an ORTEC surface barrier detector, the angular

correlation of the subsequent 1.61 MeV de-excitation gamma ray was measured. Measurements were analysed by a computer programme based on the Litherland and Ferguson (1) method which is independent of any assumption regarding reaction mechanism. Results can be fitted with a spin choice of 3/2 or 7/2 for the state. Spin value of 7/2 for this 1.61 MeV state agrees with the expectation from other evidences. For this spin value the values of quadrupole to dipole mixing amplitude ratio parameter $|\delta|$, for which the data could be fitted are 0.18 and 2.14. The value of 0.18 for $|\delta|$, is consistent with the known lifetime (2) of the 1.61 MeV level.

(1) A.E. Litherland and A.J. Ferguson.Can.J. Phys.39 (1961) 788.
(2) P.M. Endt and C. van der Leun Nucl. Phys. 34, (1962) 1.

3. Study of Levels in ^{28}Si - S.S. Kerekatte, A.S. Divatia, M.K. Mehta, K.B. Nambiar and K.K. Sekharan - Nuclear Physics Division - Levels in ^{28}Si, lying in the 14 MeV region, were studied by the elastic scattering of alpha particles by ^{24}Mg. The excitation function was measured in 2 to 5 keV steps, over seven resonances corresponding to excited states in ^{28}Si at 13.912, 13.963, 14.160, 14.417, 14.387, 14.448 and 14.627 MeV. From the behaviour of the excitation curve of four selected angles, the levels at 14.417 and 14.387 MeV can be assigned a spin and parity of 4^+. Similarly, the levels at 14.448 and 14.627 MeV can be assigned odd spin and parity.

4. Total and Partial Widths for Levels in ^{17}O* -

A.S. Divatia, K.K. Sekharan and M.K. Mehta - Nuclear Physics Division - Total widths for 16 levels in ^{17}O, in the excitation energy region 7.9 to 10.5 MeV have been obtained from a study of the total cross section for the $^{13}C(\alpha,n)^{16}O$ reaction (1), for the incident alpha energy range 1.95 - 5.57 MeV, using a 4π neutron detector. Partial widths γ_α^2 and γ_n^2 and the corresponding reduced widths Γ_α^2 and Γ_n^2 have been determined for the four levels at E_α = 2.68, 2.81, 3.72 and 4.62 MeV as given in Table I.

* Published in Phys. Rev. 156 (1967) 1187.

Table I The partial widths and reduced widths for levels in ^{17}O

Resonance energy, E_α (MeV)	J^*	l_α	Γ_α(keV)	γ_α(keV)	l_n	Γ_n(keV)	γ_n(keV)	Percentage of Wigner limit θ	θ
2.68	$5/2^+$	3	0.16	2.3	2	3.84	1.6	0.365	0.058
2.81	$5/2^-$	2	0.43	1.3	3	4.57	5.0	0.206	0.182
3.72	5/2	2	0.14	0.11	3	3.86	3.1	0.017	0.113
		3		0.31	2		1.3	0.049	0.047
4.62	9/2	4	0.30	0.82	5	4.70	100	0.130	3.635
		5		4.57	4		12	0.725	0.436

* Values of J were taken from :
B.K. Barnes, T.A. Belote and J.R. Risser. Phys. Rev. 140 (1965) B616.

5. <u>$^{51}V(p,n)^{51}Cr$ Reaction Between 1.56 and 5.53 MeV</u> - K.K. Sekharan, M.K. Mehta and A.S. Divatia - Nuclear Physics Division - The relative yield of neutrons for the $^{51}V(p,n)^{51}Cr$ reaction has been measured with fine resolution for the incident energy range 1.56 to 5.53 MeV using a 4 π neutron counter. The excitation function shows large number of peaks super imposed on a rapidly rising background. The data has been analysed according to the statistical fluctuation theory using the formula

$$C(\epsilon) = \frac{\Delta E}{E_2 - E_1} \sum_{E_1}^{E_2} \left(\frac{\sigma(E_i)}{\langle \sigma(E_i) \rangle} - 1 \right) \left(\frac{\sigma(E_i + E)}{\langle \sigma(E_i + E) \rangle} - 1 \right)$$

for various values of the averaging interval δ. The average width Γ = 3.5 keV was obtained using the equation $C(\epsilon) = C(0) \frac{\Gamma^2}{\Gamma^2 + \epsilon^2}$ for levels in ^{52}Cr nucleus in the excitation energy range 12 to 16 MeV.

6. <u>Analysis of Elastic Scattering of Alpha Particles on ^{6}Li</u> - M. Balakrishnan, K.B. Nambiar, A.S. Divatia and M.K. Mehta - Nuclear Physics Division - A general programme for the analysis of elastic scattering of α- particles involving arbitrary channel spin was written and debugging completed. This deals with the general R-matrix formalism of Wigner. A shape fitting of the elastic scattered alpha particles is being done to determine the spins of the levels in the compound nucleus ^{10}B.

7. Statistical Analysis of the Reaction $^{51}V(p,p)^{51}V$ -

C.M. Lamba, N. Sarma and N.S. Thampi - Nuclear Physics Division - and D.K. Sood and V.K. Deshpande - Indian Institute of Technology, Kanpur - Excitation functions of the reaction $^{51}V(p,p)^{51}V$ were measured at laboratory angles 100°, 120°, 140° and 160° in the proton energy range 4.00 to 5.515 MeV in energy steps of 5 keV with an overall resolution $\sim$ 1 keV. Rapid fluctuations observed in all excitation functions were analysed on the basis of the theory of Ericson and Brink and Stephen. The method of Allardyce et al., and the moving average method have been incorporated to deal with 'modulation' effects. The correlation and cross section probability distribution analysis were used to extract the values of Γ, N and Y_{D^v} The variable energy resolution method of Corti et al, to determine Γ is discussed.

8. Branching Ratio in the Electron Capture Transitions of ^{65}Zn - H.K. Sahoo and U.C. Gupta - Electronics Division -

Branching ratio in the electron capture transitions of ^{65}Zn has been measured using a coincidence set up developed in this laboratory in conjunction with a gamma ray spectrometer. The set up employs a high pressure 4π proportional counter for the detection of X-rays and Auger electrons. Gamma rays are detected in a NaI(Tl) crystal placed outside the proportional counter.

The coincidence measurement gave the total electron capture rate while the gamma spectrometer gave the gamma emission rate. The branching ratio was calculated from these two measurement and was found to be (0.53 ± 0.03). This value is in good agreement with the values obtained by other methods (1,2).

(1) G.I. Gleason, Phys. Rev. 113 (1959) 287.

(2) J.G.V. Taylor and J.S. Merritt, Phys. Canada 19 NO.3, (1963) 17.

9. Propagation of Thermal Neutron Waves in Graphite -

K. Chandramoleshwar, M.P. Navalkar, M.R. Phiske - Nuclear Physics Division - The introduction of sinusoidal variation in thermal neutron intensity at the boundary of a rectangular symmetric moderator, results in time behaviour of neutron flux which is also sinusoidal. A thermal neutron detector placed at different distances along an axis perpendicular to the source boundary records amplitude attenuation and phase lag. The magnitude of these quantities gives a measure of the diffusion constant Do.

The above principle was employed to determine the value of diffusion constant Do for graphie stack 7' x 5' x 5' with a channel of 4" x 4" was set up for thepurpose. 4 MeV neutrons were obtained from a pressurised horizontally mounted Van de Graaff Accelerator using, (d,d) reaction. The modulation was

achieved by superimposing a sinusoidal voltage on steady d.c at the ion source anode. The deuteron beam thus modulated resulted in modulated neutron intensity. The depth of modulation was 50% and the frequency was 400 cps. A thermalising tank containing steel graphite and water was used to obtain thermal neutron from fast source. An enriched ^{10}B crystal (NE 401) mounted on 6292 photomultiplier tube was employed as detector. A 400 channel time analyser was used. Necessary corrections were effected for epithermal background. A monitor was employed for normalization. Two graphs were plotted, one depicting the logarithms of amplitude and the other the phase angle as a function of distance respectively. The respective slopes corrected for finite geometry, yield the value of Do.

A value of 2.67×10^5 cm^2/sec has been obtained for graphite (ρ = 1.6 gm/ec.).

10. <u>Neutron Pulse Propagation Studies in Graphite</u> - K. Chandramoleshwar, M.P. Navalkar, M.R. Phiske - Nuclear Physics Division - A burst of neutrons introduced at one of the boundaries of a rectangular moderator diffuses in the medium in the familiar way. However, detector placed along a direction perpendicular to the source surface records a growth and decay that resembles a pulse. It has been shown within diffusion approximation that the pulse maximum shifts at a velocity which is proportional to the square root of diffusion constant Do. The pulse width and the rate of shift of pulse-maximum could also be related to Do. This

principle was employed to determine the value of Do for graphite.

A 7' x 5' x 5' graphite stack with a 4" x 4" channel was the first medium investigated. 4 MeV neutron was obtained from pressurised horizontally mounted P,N 400 Van de Graaff Accelerator employing (d,d) reaction. A pulser unit which delivers pulse of 1 millisecond width and 100 pulses per second repetition rate was used to pulse the deuteron beam and hence the neutron intensity. A thermalising devise was used to show down the source neutrons. An enriched ^{10}B crystal (type NE 401) mounted on 6292 photomultiplier tube was used as detector. The target pulse was differentiated and used for triggering a 40 channel time analyser with a channel width of 50 microseconds. A monitor was employed for normalisation. The data obtained was fourier analysed. A fortran program was written up to enable the solution of the integrals on CDC - 3600.

Preliminary results analysed so far yield a value of 2.34×10^5 cm^2psec for graphite (ρ = 1.6 gms/c.c.).

11. <u>Magnetic Structure of $(Mn,Co)_4C$</u> - N.S. Satya Murthy, C.S. Somanathan, R.J. Begum, M.R.L.N. Murthy and B.S.Srinivasan - Nuclear Physics Division - Polarised neutrons can be used to great advantage in the elucidation of magnetic structure even if only powder samples are available. This has been demonstrated clearly in the determination of the structure of $(Mn,Co)_4C$ which is found to be a Cubic ferrimagnet with a Neel temperature of 537°C. The magnetic structure consists of a manganese atom at the corner of the cubic with a magnetic moment of 4.0 μB and the face centres occupied statistically by the other

Mn atom and two Co atoms. The face Mn atom with a moment of 3.0 μ_B is aligned antiparallel to the corner Mn atom while the Co atoms have a moment of 0.8 μ_B each and are parallel to the corner Mn atom. This leads to a net feric moment of 2.6 μ_B per unit cell. The carbon atom at the body centre plays an important role in the structure.

12. Magnetic Structure of Mixed Ferrites - N.S. Satya Murthy, R.J. Begum, C.S. Somanathan, M.G. Natera*, S.I. Youssef**, B.S. Srinivasan and M.R.L. N. Murthy - Nuclear Physics Division - The mixed ferrites having spinel structure are of great technological importance and the understanding of their physical and magnetic properties dependes on a complete knowledge of the cation valencies and distribution, their magnetic moments, magnetic structures and Neel temperatures. A new method using polarised neutrons has been developed to elucidate these structures. Ambiguities in the cation distributions among the tetrahedral and octahedral sites have been resolved by a judicious combination of unpolarised and polarised neutron data. A number of mixed ferrites having different compositions in the magnesium-manganese and zinc-nickel systems have been investigated.

* Guest Scientist from the Philippine Atomic Research Centre, Quezon City, The Philippines.

** Guest Scientist from the U.A.R. Atomic Energy Establishment, Cairo, U.A.R.

13. Exchange Integrals in Chromium Halides - L.Madhav Rao,

N.S. Satya Murthy, P.K. Iyengar and G. Venkataraman - Nuclear Physics Division - Energy distribution of neutrons scattered from chromium tribromide and chromium trifluoride in their paramegnetic phase have been measured using the time of flight technique. Chromium tribromide is an ionic ferromagnet with a Curie temperature of 37°K and chromium trifluoride is an ionic antiferromagnet with a Neli temperature of 80°K. At large momentum transfer the second moment of the energy distribution is directly related to the exchange integral J, according to de Gennes.

Measurements have been made at suitable momentum transfer values and exchange integrals are extracted from these measurements.

14. Computer Programme for Analysis of Magnetic Structures - R.J. Begum, N.S. Satya Murthy and M.C. Natera* - Nuclear Physics Division - The Oak Ridge least squares programme for the refinement of crystallographic parameters has been modified to handle nuclear and magnetic intensities simultaneously in the case of unpolarised neutron diffraction data. The two major modifications are the incorporation of two new subroutines - one for the calculation of the important magnetic parameter q^2 and the other for calculating the magnetic structure factor and its derivatives.

For the analysis of polarised neutron data a second least squares programme has been written. Efforts are being made to

amalgamate the two least squares programmes so that a single programme will handle unpolarised neutron data with and without an applied magnetic field and data with neutron spin parallel and antiparallel to the net magnetisation of the sample in order to arrive at more accurate and consistent values of different parameters.

A 3-D Fourier programme which can be used for unpaired electron spin density determination using the experimentally observed magnetic intensitites as well as theoretically calculated values has been developed. The Patterson function can also be obtained from the same programme.

* Guest Scientist from the Philippine Atomic Research Centre, Quezon City, The Philippines.

15. Criteria for use of Polarised Neutrons in the Determination of Magnetic Structures - M.G. Natera*, N.S. Satya Murthy and R.J. Begum - Nuclear Physics Division - A method of analysing polarised neutron powder diffraction patterns has been developed. The ratio of the sum of the difference of intensities of reflections with neutron spin-up and neutron spin-down gives directly the sign and magnitude of the magnetic structure factors. The method is applied to the analysis of polarised neutron data on magnetite and mixed ferrites having spinel structures. The sensitivity of the method depends on the relative signs and magnitudes of the nuclear and magnetic structure factors as also on the polarising and

flipping efficiencies and the degree of depolarisation in the sample.

* Guest Scientist, from the Philippine Atomic Research Centre, Quezon City, The Philippines.

16. Neutron Diffraction Study of the Space Group and Structure of Maganese Leonite - S. Srikanta, A. Sequeira, and R. Chidambaram - Nuclear Physics Division - A total of 542 neutron reflections - three-dimensional upto $(\sin\theta)/\lambda \sim 0.40$ and in three zones, h01, hk0 and 0kl, upto $(\sin\theta)/\lambda \sim 0.70$ have been used to refine the structure of $K_2Mn(SO_4)_2 \cdot 4H_2O$ in the space group C2/m to an R-factor of 0.092. One of the two non-equivalent sulfate groups appears to be disordered. All the hydrogen atoms of the water molecules are involved in normal O-H---O hydrogen bonds. The water molecule $H_2O_w(1)$ has a tetrahedral coordination; one of its lone pair orbitals is directed toward a potassium ion and the other toward a manganese ion. For the other two water molecules, $H_2O_w(2)$ and $H_2O_w(3)$, the bisectors of their lone-pair orbitals are directed toward manganese ions. In addition, O_w (2) has two potassium-ion neighbours at 3.09. A nearly normal to the plane of the water molecule leading to an approximately trigonal bipyramidal coordination for $H_2O_w(2)$. Refinements of the structure in the alternative space groups C2 and Cm have provided no justification for choosing either of them in preference to C2/m.

17. <u>A Neutron Diffraction of the Crystal Structure of Barium Chlorate Monohydrate</u> - S.K. Sikka, S.N. Momin, H. Rajagopal and R. Chidambaram - Nuclear Physics Division - A single-crystal neutron diffraction study has been made to determine the shape and coordination of the water molecule in $Ba(ClO_3)_2 \cdot H_2O$. The intensities of 557 neutron reflections-partial three-dimensional data with $\sin\theta/\lambda = 0.80$ have been measured and the structure has been refined to an R-factor of 0.081. Although the earlier x-ray structure is basically correct, there are significant differences in the two sets of structural parameters. The structure contains O_w-H---O_2 hydrogen bonds of length 2.891 ± 0.014 A, in which the O_w-H distance is 0.958 ± 0.011 A (corrected for thermal motion) and the angle O_w-H----O_2 is 163.6 ± 0.9°. The H-O-H angle is 110.7 ± 1.4°. The orientations of the interproton vectors found in the present study agree with those determined by the proton magnetic resonance method to within 2.5°.

18. <u>Dynamics of Liquid CD_4 from Cold Neutron Scattering</u> - G. Venkataraman*, B.A. Dasannacharya and K.R. Rao - Nuclear Physics Division - Expressions are derived for the scattering of slow neutron from a monomolecular system under the assumption of no vibrational scattering and weak anisotropic forces. In applying the theory to liquid CD_4, two models (A and B) are considered, assuming a simple diffusive centre of mass motion for single particle motions and with a structure-depending

damping for collective motions. The rotations are assumed free in model A and hindered in model B. Use has been made of the optical data to describe the rotational motions. Both models make essentially the same predictions for the quasi-elastic widths. The spectra predicted by the two models are very nearly the same for liquid CD_4 unlike in the case of liquid CH_4 where hindering of the rotation influences the spectrum considerably. This is a consequence of the fact that rotational effects appear mainly via incoherent scattering which is small in CD_4.

* Now at the University of Michigan, Ann Arbor, Michigan.

19. Neutron Scattering from Liquid Gallium - K.R. Rao, G. Venkataraman, B.A. Dasannacharya and V.C. Sahni - Nuclear Physics Division - The neutron diffraction and inelastic stattering studies of liquid gallium have been made at 45°C. The structure factor derived is used in deriving the resistivity of the liquid using the pseudopotential as given by Animalu. The inelastic scattering data is being analysed.

20. Kohn Anomalies in Zinc - P.K. Iyengar, Y.H. Gameel*, K.R. Rao, G. Venkataraman** - Nuclear Physics Division - Dispersion relation in zinc was investigated to search for Khon anomalies. In particular the LA branch along the 0001 direction and TA branch along the $01\bar{1}0$ direction have been studied. Anomalies observed in these two branches are consistent

with the free electron model.

* Guest Scientist from Atomic Energy Establishment, Cairo.
** Now at the University of Michigan, Ann Arbor, Michigan.

21. A Neutron Diffraction Study on the Crystal Structure of Triglycine Sulphate - V.S. Yadav, R. Balsubramaniam and V.M. Padmanabhan - Nuclear Physics Division - In continuation of our work on ferroelectric crystals a single crystal neutron diffraction investigation of triglycine sulphate (TGS) has been made in which the intensities of 300 reflections in all the three prism zones were measured. The data is being analysed to locate the hydrogen atoms and the nature of hydrogen bonding in the crystal.

22. Fission of ^{223}Ra by Reactor Neutrons* - H.C. Jain, M.V. Ramaniah, C.L. Rao and Satya Prakash - Radiochemistry Division - Fission of ^{226}Ra by charged particles (1,2) and by neutrons of different energies (3) has been studied and these studies suggest a transition from predominantly asymmetric fission as the fissioning nucleus changes from thorium to radium. In view of this suggested trend, a study of mass distribution in the fission of actinides has been undertaken in this laboratory (4,5) and in this connection it was considered desirable to study the fission behaviour of a lighter isotope of radium with reactor neutrons. ^{223}Ra was chosen due to its availability as a daughter product of ^{227}Ac. The present work

was undertaken with a view to establish, if possible, fission of ^{223}Ra with reactor neutrons and study the mass distribution if large enough activities were obtained. The only attempt reported in literature to observe the fission of ^{223}Ra with thermal neutrons was that of PETERSON and GHIORSO, (6) an upper limit of 100 barn was reported by them for the fission cross-section. No definite evidence of fission was obtained. A calculation based on the empirical formula a VANDENBOSCH and SEABORG (7) indicates that the fission cross-section for ^{223}Ra with reactor neutrons could be of the order of one barn. This note describes the experiments and an approximate estimate made for neutron fission cross-section of this isotope. An upper limit on the value of the fission cross-section of ^{223}Ra with pile neutrons as well as epicadmium neutrons has been placed at 700 mb.

* J. inorg. nucl. Chem., 29 (1967) 267.

23. Prediction of Neutron Cross-Sections in the Energy Range 1.0 to 10.0 MeV* - S.B. Garg and B.P. Rastogi - Reactor Engineering Division - Total shape elastic and reaction cross-sections have been computed for Nb, Pb, ^{235}U and ^{239}Pu on the basis of optical model in the energy range 1.0 to 10.0 MeV. The reaction cross-section has been plit up into compound elastic and in elastic components using the Hauser-Freshbach theory. Angular distributions of elastically and inelastically scattered neutrons have also been predicted.

* To be presented at the Symposium on Fast Reactor Physics and Related Safty being held at Karlsruhe.

24. Generation of Cross-Sections for Fast Reactor Analysis - V.K. Shukla and S.B. Garg - Reactor Engineering Division - For fast reactor analysis a 26 group cross-section set has been generated covering the energy region thermal to 10 MeV for materials H, Be, C, O, Na, Cr, Fe, Ni, Mo, Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{239}P and ^{240}P. Self shielding effects have been accounted for by calculating resonance integrals using 'narrow resonance' and 'narrow resonance infinitely heavy absorber' approximations. In elastic group transfer matrices have also been calculated for these materials.

25. Five Port Switching Magnet[1)] - T.P. David, N. Sarma, M. Bhatia and P.R. Sunder Rao - Nuclear Physics Division - The magnet yoke and pole pieces have been fabricated from Tata 'A' grade steel and assembled. A magnet mount has been designed and fabricated with provision for levelling and for movement of the magnet by $\pm$ 1.5 cms in the direction perpendicular to the beam axis. The magnet coil has been fabricated from electrical grade aluminium tubing of 12.7 mm square section. Insulation between the turns has been provided by winding PVC insulation tape over the tube throughout its length. The coil was made in units of double layers of 11 turns each and taped. These units are assembled on the pole pieces and welded end-to-end to maintain continuity of current as well as the flow of cooling water. A high current variable DC supply has been built for feeding the main coils. This supply is stabilized by a bank of series controlled transistors. The

stabilization unit has been built by the Technical Physics Division.

It is proposed to provide each exit port with a pair of adjustable insulated pick up slits. The amplified signals picked up by these slits would control a low current power supply feeding an auxiliary coil wound with 2000 turns of enamelled wire. Apart from giving an additional stabilization this arrangement will also provide a small range of energy scanning without manually adjusting the switching magnet current.

The magnet coils and all the power supplies have have been already built and assembled. The system is undergoing current and field stability tests.

The five port vacuum chamber and other connecting tubes, all of aluminium, have been fabricated and are being vacuum tested. The insulated adjustable control slits are under fabrication.

B. TATA INSTITUTE OF FUNDAMENTAL RESEARCH

1. Gamma rays from the reaction $^{55}Mn(p,n\gamma)^{55}Fe$ - K.V.K. Iyengar, B. Lal and S.K. Gupta - The 510 and 680 keV levels in ^{55}Fe reported by Kim do not seem to be generated in the $^{55}Mn(p,n)^{55}Fe$ reaction to an intensity higher than 8% and 4% respectively of the 413 keV level as determined by observing the direct gamma radiations with a lithium drifted germanium detector, with incident protons of energy 1.80 - 3.50 MeV. The measured angular distributions of the 935 and 1322 keV gamma rays at E_p = 2.40 and 3.50 MeV and that of the 1413 keV gamma rays at E_p = 3.50 MeV are in reasonable agreement with those calculated from statistical model. The reaction proceeds through the compound nucleus and the random phase approximation appears to be valid for the compound nucleus ^{56}Fe at these excitation energies.

2. Magnetic moment of the 114 keV state in ^{149}Pm - P.N. Tandon and H.G. Devare - The magnetic moment of the 114 keV state in ^{149}Pm has been measured from the rotation of the angular correlation pattern in an external field. The gamma cascades used were 424 - 114 keV and 542 - 114 keV. Differential correlation was done to find out the attenuation coefficient G2. The value of 'g' factor obtained is 1.04 ± 0.14 after correcting for G2 and the paramagnetic correction β. This corresponds to a value μ = 2.60 ± 0.35 for the spin 5/2 of this state.

3. Measurement of the 'g' factors of two levels of ^{131}I - P.N. Tandon and H.G. Devare - The 'g' factors of the 150 keV first excited state and a state at 1797 keV of ^{131}I have been measured from the rotation of the angular correlation pattern in an external magnetic

field. The integral method was used and coincidence counting rates at 135° were recorded for two directions of the field. The gamma-ray cascades involved are 452-150 keV in the case of the 150 keV state and 102-200 keV for the 1797 state.

The results are

$G_2 = 0.097 \pm 0.012$ for a magnetic field of 13.2 kg

and $g = 1.11 \pm 0.20$ for the 150 keV state

$G_2 = 0.073 \pm 0.016$ for a magnetic field of 12.8 kg and

$g = 0.16 \pm 0.05$ for the 1797 keV state.

In the latter measurement the attenuation coefficient due to time-dependent perturbations was seen to be $G_2 = 0.9 \pm 0.1$ by studying the anisotropy as a function of time by delayed coincidence technique.

4. <u>On the spin of ^{228}Ac from beta decay experiments</u> - S.K. Bhattacherjee, S.K. Mitra, H.C. Jain, H.C. Padhi, K.S. Bhatki and D.C. Ephraim - The spin of the odd nucleus ^{228}Ac($T\frac{1}{2}$ = 6.13 hrs) has been determined to be I = 3 from the beta-circularly polarized gamma correlation studies on two prominent beta-gamma cascades: (i) 1.19 MeV beta-group - (966 and 908) keV gamma rays and (ii) 1.76 MeV beta group - 338 keV gamma-ray. The matrix element ratio, X for the 1.76 MeV beta transition has been determined to be $X = 0.40 \pm 0.10$.

5. <u>Fermi matrix elements in allowed beta transitions in ^{56}Co, ^{58}Co and ^{134}Cs</u> - S.K. Bhattacherjee, S.K. Mitra and H.C. Padhi - The angular-correlation asymmetry parameter for circularly polarised γ-rays following allowed β decay has been measured for three nuclei - ^{56}Co, ^{58}Co and ^{134}Cs. The polarimeter employed the usual forward

Compton scattering of γ -rays. The measured asymmetry parameter A and the Fermi matrix element M_F, in these decays are as follows:

	A	$M_F \cdot 10^3$
^{56}Co	0.014 ± 0.022	0.5 ± 0.1
^{58}Co	- 0.16 ± 0.04	0.3 ± 2.0
^{134}Cs	- 0.072 ± 0.018	0.6 ± 0.1

The present available data on measurements of the Fermi matrix element M_F in different regions of the periodic table are reviewed in the light of isospin impurities of nuclear wave-functions.

6. <u>Beta-gamma correlation measurements on ^{192}Ir</u> -

S.K. Bhattacherjee*, S.K. Mitra, H.C. Jain, and H.C. Padhi -

The beta gamma directional correlation in the 536 keV beta group and the 605 keV 612 keV gamma rays in the decay of 72d ^{192}Ir has been measured at several beta ray energies. The measured correlation coefficient, $\epsilon(W)$, is found to rise from - 0.074 ± 0.015 at 185 keV to - 0.098 ± 0.010 at 255 keV and then starts falling; near the end-point energy the anisotropy is found to be very small. The large β - γ anisotropy observed conclusively establishes that the parity of ^{192}Ir is negative. Attempts have been made to extract information about the relevant matrix element ratios governing the 536 keV β transition. The beta-gamma directional correlation in the outer β group of 669 keV and 469 keV γ-ray ($4^- \xrightarrow{\beta} 4^+ \xrightarrow{\gamma} 2^+$) has also been measured; it shows nearly isotropic correlation in the beta energy region 400 to 650 keV. The beta gamma circular polarization correlation in the above cascade has also been measured. It is concluded that while large cancellation among the vector type matrix elements is responsible

for the observed energy dependence of the beta gamma anisotropy in the 536 keV beta group, the outer group of 669 keV apparently satisfies the quasi-allowed approximation. The nature of the 785 keV (4^+), 921 (3^+) states in ^{192}Pt is discussed in the light of these findings.

* Present Address: Department of Physics, California Institute of Technology, Pasadena, California.

7. Magnetic moment of the 1290 keV ($3/2^-$) in ^{59}Co - Y.K. Agarwal, C.V.K. Baba* and S.K. Bhattacherjee - The life time and the magnetic dipole moment of the 1290 keV ($3/2^-$) state in ^{59}Co have been measured to be $T_{\frac{1}{2}} = (0.59 \pm 0.02)$ nsec. and $\mu = 1.90 \pm 0.35$ n.m. The electromagnetic properties of the 1100 keV and the 1290 keV states have been explained by assigning a mixture of P $3/2^-$ and $\left\{ f_{7/2},\ 2^+;\ 3/2^- \right\}$ configurations to the 1100 keV and 1290 keV states.

* Member, Bhabha Atomic Research Centre.

8. Measurements of the g-factors of 2^+ states in even nuclei utilizing hyperfine fields in iron lattice (I), 316 keV state in ^{192}Pt and 328 and 622 keV states in ^{194}Pt - Y.K. Agarwal, C.V.K. Baba** and S.K. Bhattacherjee - The g-factors of the first excited 2^+ state in ^{192}Pt and the first and second excited 2^+ states in ^{194}Pt have been measured by integral gamma-gamma angular correlation method utilizing the hyperfine magnetic fields at Pt nuclei in the dilute Ir-Fe alloys. The following values have been obtained.

316 keV state in ^{192}Pt, $g = 0.33 \pm 0.05$*
328 keV state in ^{194}Pt, $g = 0.24 \pm 0.03$
622 keV state in ^{194}Pt, $g = 0.15 \pm 0.05$

* A Schwarzchild Phys. Rev. 141 (1966) 1206

** Member, Bhabha Atomic Research Centre, Trombay.

9. Spectral shapes and a Beta-Gamma Directional correlation in the Beta Decay of ^{172}Tm ($I^{\pi} = 2^{-}$) - P.G. Hansen, H.L. Nielsen and K. Wilsky, Research Establishment Risco, Roskilde, Denmark; Y.K. Agarwal, C.V.K. Baba, and S.K. Bhattacherjee - The isotope ^{172}Tm populates the 0^{+}, 2^{+} and 4^{+} states of the ^{172}Yb ground-state rotational band directly in beta decay. The shapes and intensities of the three beta groups have been measured by means of a six-gap magnetic spectrometer operated in coincidence with a NaI(Tl) crystal. The experimental shape-factor plots are taken relative to the ^{90}Y shape factor measured in the same circumstances, and it is concluded that on this basis the shapes of all three ^{172}Tm beta groups agree with theoretical shape for a first-forbidden unique transition. The directional correlation for the 2^{-} $(\beta)2^{+}$ $(\gamma)0^{+}$ cascade has been measured at six energies from 1010 to 1550 keV and these results too are consistent with the assumption that the $2^{-} \rightarrow 2^{+}$ beta transition is purely of tensor rank 2. The data for the $2^{-} \longrightarrow 2^{+}$ transition are analysed on the basis of the modified B_{ij} approximation, which defines parameters X and Y corresponding to the relative contributions of tensor ranks 0 and 1 respectively. The shape measurement provides the limit $X^2 + Y^2 \leq 0.10$, whereas the angular-correlation measurement gives $Y = 1.64X + (0.02 \pm 0.03)$. The reduced transition probabilities $(\underline{f}_1\underline{t})^{-1}$ can therefore be compared with the theoretical intensity rules for $\lambda = 2$, which predict the ratios 0.70 : 1 : 0.05 for the branches to the 0^{+}, 2^{+} and 4^{+} states. The experimental result is $(0.63 \pm 0.19) : 1 : (0.046 \pm 0.007)$.

10. Level of ^{149}Pm from the Decay of $^{149}Nd^{*}$ - K.P. Gopinathan** and R.M. Singru^{+} - The decay of ^{149}Nd has been investigated by means of a double-focussing beta-ray spectrometer, a Ge(Li) gamma transitions in ^{149}Pm on the basis of internal-conversion measurements: 114 keV(M1+E2),

156 keV (E1), 189 keV (M1+E2), 211 keV(M1 + 20% E2), 240 keV (M2), 268 keV (M1 + 30% E2), 270 keV (E1), and 327 keV (E1). The gamma spectra studied in a well-type 3-in X3-in. NaI(Tl) crystal as well as a Ge(Li) detector showed high-energy transitions upto 1540 keV. Gamma-gamma coincidence measurements and delayed-gating technique established energy levels in ^{149}Pm at 114, 189, 211, 240, 270, 397, 538, 654, 767 and 966 keV. Other possible high energy levels weakly populated from the decay of ^{149}Nd are discussed. A combined analysis of the earlier gamma-gamma directional correlation measurements and the present internal-conversion measurements lead to the following spin and parity assignments to the low-lying energy levels of ^{149}Pm : 114 keV ($5/2^+$), 211 keV (5/2), 240 keV ($11/2^-$), 270 keV ($7/2^-$), and 538 keV ($5/2^-$).

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** Present address: Brookhaven National Laboratory, Upton, New York.

\+ Present address: Indian Institute of Technology, Kanpur, India.

11. A Current integrator for use in nuclear reaction Studies - S.K. Gupta - A simple transistorized current integrator circuit, linear in the current range 1 nA - 10 μA, has been designed. It is having a leakage of about 5 x 10^{-12} amp. with the reproducibility of the calibration to ± 0.3%. The circuit employs a direct coupled amplifier, a schmitt trigger, a gated free-running multivibrator and a charge pump. The inclusion of the multivibrator gives continuous operation under

occasional overload surges of the input current. The performance of the circuit can be further improved by using temperature compensated zener diodes for power supplies.

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

1. Decay of ^{98}Y to the 3.22 and 3.52 MeV levels of ^{88}Sr - S. Shastry and R. Bhattacharyya - Decay of ^{88}Y has been studied in a 10 cm in diam and 10 cm thick NaI(Tl) phosphor. As the mass difference of ^{88}Y and ^{88}Sr is 3.62 MeV, it is energetically possible that 3.22 and 3.52 MeV states of ^{88}Sr may be excited by the decay of ^{88}Y. These levels 3.22 MeV and 3.52 MeV of ^{88}Sr have been identified in the capture decay of ^{88}Y. The 3.22 MeV level decays by a direct transition ($I_{\gamma\ell} = 0.03$) to the ground state and also through a 1.36 ($I_{\gamma\ell} = 3$) - 1.86 MeV cascade. The 3.52 MeV level decays directly to the ground state ($I_{\gamma\ell} = .01$).

2. Gamma-gamma angular correlation in ^{125}Sn - A.K. Nigam and R. Bhattacharyya - Gamma-gamma angular correlation between five cascades 0.81 - 1.07 MeV, 0.91 - 1.07 MeV, 0.34 - 1.07 MeV, 0.47 - 1.41 MeV and 1.16 - 1.07 MeV has been measured with the help of sum coincidence technique. Spin assignments to the 2.23, 1.98, 1.88, 1.41 and 1.07 MeV levels of ^{125}Sb are found to be 11/2, 11/2, 13/2, 11/2 and 7/2 respectively.

3. Studies in ^{187}W - A.K. Nigam and R. Bhattacharyya - The levels of ^{187}Re decaying from $^{187}W(T_{\frac{1}{2}} = 24$ hrs) were studied using the total absorption gamma spectroscopy, various γ-γ coincidence and γ-γ angular correlation techniques. A search for the existence of 760 and 911 Kev levels was made using the total absorption gamma spectrometer. The γ-γ directional angular correlation experiments on the 72 - 134 keV and 552 - 134 keV cascades were also performed.

4. <u>The Gyromagnetic ratio of the 379 keV level of ^{169}Tm</u> -

A.K. Nigam and R. Bhattacharyya - The g-factor value of $g = 0.274 \pm 0.021$ of 379 keV level ($T_{\frac{1}{2}} = 50 \times 10^{-9}$ sec) of ^{169}Tm has been measured by observing the perturbed angular correlation in the applied magnetic field with the help of Differential - Delay - Reverse - Field Method. Further experiments are in progress in this line.

5. <u>The Gyromagnetic ratio of the 122 keV level of ^{152}Sm</u> -

A.K. Nigam and R. Bhattacharyya - The g-factor of 122 keV level ($T_{\frac{1}{2}} = 1.4$ ns) of ^{152}Sm has been measured with the help of Integral Reverse Field Method utilizing the perturbed angular correlation technique.

6. <u>The g-factor measurement of 480 keV level of ^{181}Ta</u> -

A.K. Nigam and R. Bhattacharyya - The differential - Delay - Reverse Field method DDRF has been used to measure the gyromagnetic ratio of the 480 keV level of ^{181}Ta. The results are in fairly good agreement with values obtained by other workers.

7. <u>On the Electric Dipole and Octupole transition in ^{88}Sr*</u> -

S. Shastry and A.K. Saha - Exact zero-range force calculation have been performed to explain the collective nature of the 2.76 MeV 3^- state of ^{88}Sr. The results show that the E1 transition is in good agreement with experiments while E3 transition falls short by a factor of 10.

*Nucl. Phys. <u>85</u> (1966) 393

8. On the collective octupole state in ^{88}Sr* - S. Shastry and A.K. Saha - A finite-range force calculation has been performed to explain the collective character of the 2.76 MeV 3^- octupole state of ^{88}Sr. The ratio of experimental to theoretical transition probability as 1.96.

*Nucl. Phys. A97 (1967)

9. Collection nature of the 1.29 MeV 2^+ state of ^{116}Sn - S. Sen

Exact zero-range force calculation have been performed to explain the collective nature of the 1.29 MeV 2^+ state of ^{116}Sn nucleus containing 50 protons and 66 neutrons. Considering only one hole - one particle neutron excitation, quite satisfactory agreement with experimental results was obtained. The results obtained with δ -force strengths = 22 MeV are given below along with the experimental values for ready comparison.

State (J^π)		Calculated	Experimental
First	2^+	1.29	1.29
Second	2^+	2.68	2.12
	4^+	3.10	3.06

Transition probabilities	Calculated values	Experimental
T(E2) from first 2^+ to ground state	0.25×10^{12} sec^{-1}	0.56×10^{12} sec^{-1} 1.4×10^{12} sec^{-1}
$\frac{\text{T(M1) from second } 2^+ \text{ to first } 2^+}{\text{T(E2) from second } 2^+ \text{ to ground state}}$	1.8	0.8 1

D. NUCLEAR PHYSICS LABORATORY, BOSE INSTITUTE, CALCUTTA 9

1. Emperical Estimation of Coherent Scattering Cross Section of Gamma Rays - A. Nath and A.M. Ghose - An empirical formula has been obtained by an analysis of the available cross section data especially by studying the dependence of the cross sections or the atomic number of the scatterer (z), energy of the photon (E) and on the transfer of momentum (q) during the scattering process. The basic difference of the formula reported earlier with the final expression is the inclusion of a specifically energy dependent term which is important only for E > 0.4 MeV and increases monotonically with E and q. The formula is given by the following expression

$$\sigma_R(\theta) = \frac{1}{2}(1+\cos^2\theta)\ \phi(E,q)\ (Z/82)^{n(q)} f_\gamma(q) \tag{1}$$

where $\sigma_R(\theta)$ denotes the Rayleigh scattering cross section in barns per unit solid angle at the scattering angle θ;

$$\phi(E,q) = (13.5E - 4.4)^{-0.35q} \quad \text{for } E \geq 0.4 \text{ MeV}$$
$$= 1 \quad \text{for } E \leq 0.4 \text{ MeV}$$

$n(q) = 2.90 + 0.089 + 1.27q^2 - 0.36q^3 - 0.90 \exp(-500q^2)$; and

$$f_\gamma(q) = (0.14 + 2.65q)^{-3.20} \quad \text{for } 0 \leq q \leq 0.1\ mc$$
$$= (3.15q)^{-2.50} \quad \text{for } 0.1mc \leq q \leq 2.5mc$$

In the above E is expressed in MeV and q in mc unit.

The empirical formula as given by the above expression has been compared with the experimental data for Pb, and Cu scatterers in the energy range 0.279-1.33 MeV. In the case of Pb, the experimental data agree quite well with the values predicted by the formula over the entire range of q for which the formula is valid; the difference between

the two results being within ± 10% in most cases. In the case of Sn, although there is general agreement of the experimental data with the formula within the range of experimental uncertainty, there is a systematic trend of the cross section data in the range q = 0.5 mc to about q = 1 mc to be higher than the values given by the formula. This trend is however, not unexpected because for this range of q, the hard noncoherent fraction of the scattered radiation poses a serious problem to the experimental measurement of the coherent scattering cross sections from low Z elements like Sn.

The formula has also been compared with the accurate theoretical data of the Birmingham group for the K-shell of Hg at 1.28 and 2.56 mc^2 photon energies. The agreement between the two results is very good. This shows that the coherent scattering cross section calculated from eqn. (1) is quite accurate and may be reliably utilised in the estimation of the coherent scattering cross sections in a large number of experimental situations where accurate theoretical data do not exist. The form factor results of Nelms and Oppenhum agree well with the results of eqn. (1) for q upto 0.2 mc unit.

2. Measurement of (n,2n) Cross Sections of fast Neutrons -

Arun Chatterjee, A. Nath and A.M. Ghose - (n,2n) cross sections of several nuclei have been measured absolutely by measuring the absolute value of the fast neutron flux by a heavily biased plastic scintillator and the absolute value of the positron activity using an absolutely calibrated high resolution coincidence spectrometer.

The measurement of the fast neutron flux has been carried out by a new procedure developed in our laboratory.

The samples have been irradiated using the Bose Institute neutron

spectrometer keeping the deuteron energy confined to 130 kev. The irradiations were carried out in the forward direction and the incident neutron energy was thus 14.8 ± 0.1 MeV.

Absolute calibration of the positron coincidence spectrometer has been carried out with the help of secondary standard sources of the same dimensions as the samples. The secondary sources have been calibrated by using reference sources available through the courtesy of N.B.S., U.S.A.

Table I shows the experimental (n,2n) cross sections obtained in the present work. The estimated error in our measurements is of the order of ± 10%.

TABLE I

(n,2n) Cross Sections of Nuclei for 14.8 MeV neutrons

Nuclei	Cross Section (in mb)
^{19}F	46.3 ± 4.6
^{63}Cu	509 ± 51
^{64}Zn	165 ± 16
^{69}Ga	950 ± 95
^{107}Ag	530 ± 30

3. (n,p) Cross Section variation of 14.8 MeV for a few nuclei at E_n = 14.1 ± 0.1 to E_n = 14.8 + 0.1 MeV - B. Mitra - Attempts to add proton shell effect to other structural effects in statistical model calculations of (n,p) cross sections have been attempted by several workers (Chatterjee, Nucl. Phys. 60, 1964, 273). The computed cross section values have been presented for comparison side by side with

experimental values which are obtained by averaging of scattered experimental data. In this connection to find out how far it is justified to have "averaged" cross sections for such comparison, we performed experiments, even in a "poor resolution" way. We have measured (n,p) cross sections of ^{37}Cl, ^{65}Cu, and ^{75}As, at $E_n = 14.1 \pm 10.1$ MeV and at $E_n = 14.8 \pm 0.1$ MeV respectively. Even in this poor resolution experiment of $\Delta E \simeq 100$ keV, there are considerable fluctuation of $\sigma_{n,p}$ values for a mean E_n fluctuation of 0.7 MeV, which is shown in the table I. The values obtained are relative to ^{63}Cu, the excitation function of which has been carefully measured by Csikai (Doctoral thesis, 1966). We have used Csikai's experimental curve, having extrapolated it upto 14.8 MeV. The result for ^{75}As is rather startling, since it represents a factor of 2 change in this energy interval. Values of ^{37}Cl also represent a trend which does not explain a very low value of cross section, $\simeq$ 5mb. at a higher energy of 17 MeV. A scope for renewed excitation function measurement exists in the energy range 13-17 MeV for ^{37}Cl as well as ^{75}As.

TABLE I

Nucleus	En MeV	np in mb (author)	n,p mb (literature)
^{37}Cl	14.1 ± 0.1	21 ± 3	18 ± 8 at 13.9 ± .2 Cohen and white.
	14.8 ± 0.1	25 ± 3	31 ± 7 at 15.1 ± 25 Mani et al.
^{65}Cu	14.1 ± 0.1	19 ± 2	26 ± 7 Borman
	14.8 ± 0.1	26 ± 3	22 ± 7 at 15.7 ± .45 Borman
^{75}As	14.1 ± 0.1	15 ± 4	20.7 ± 1.5 Prestwood and Bayhurst
	14.8 ± 0.1	33 ± 3	15.9 ± 36 at E_n = 14.93 ± .36 Do.

E. LABORATORIES FOR NUCLEAR RESEARCH ANDHRA UNIVERSITY, WALTAIR

1. Determination of end-point energies of Beta Transitions with Siegbrahn-Slatis Spectrometer - T. Nagarajan, M. Ravindranath, K. Venkata Reddy and Swami Jnanananda - A Siegbahnslatis Intermediate-image focussing spectrometer is optimised for shape measurements of beta spectra. The use of a plastic scintillator as the beta detector allows through pulse-height analysis an effective discrimination against scattered electrons and other backgrounds. A particular well-shape geometry is adopted for the detector, which renders the crystal back scattering effectively zero down to 50 keV. The Fermi-analyais is carried out using exact Fermi functions derived from Bhalla and Rose tables. The end-point energies of the principal beta transitions of Co-60, Au-198 and In-114 are found to be 310 $\pm$ 3, 961 $\pm$ 2 and 1990 $\pm$ 2 keV respectively. The end-point energy of P-32 beta transition after linearising the F-K plot is found to be 1710 $\pm$ 2 keV. The maximum energy of Pr-114 ground state transition is found to be 2999 $\pm$ 5 keV. The spectral shape shows definite deviation from statistical shape. The Fermi analysis of the beta spectrum of Mo-99 shows that there exists no beta feed to the ground state of Tc-99. The end-point energy of the highest beta-cpmponent feeding the 142 keV level is found to be 1232 $\pm$ 3 keV.

2. $4^- \rightarrow 3^+$ And $4^- \rightarrow 4^+$ Beta Transitions in Ir-192 - K. Appalacharyulu, D.L. Sastry and Swami Jnanananda - Beta-gamma directional correlation measurements, both differential and integrals were made on 535 (β) (605 + 612) keV (γ) and 669 (β) - 469 keV (γ) cascades in the decay of Ir-192. In the case of the first cascade the angular correlation is found to exhibit an unusual behaviour with energy. The angular correlation function ϵ (W) exhibits a maximum in the distribution. An attempt is made to evaluate the matrix element parameters responsible

for this type of behaviour. In the case of the second cascade the behaviour of $\epsilon(W)$ is found to be in accordance with the 'ξ' approximation.

3. <u>Beta-gamma Angular Correlation Measurements in the decay of Sm-153</u> - K.S. Row, D.L. Sastry and Swami Jnanananda - The energy dependence of the beta-gamma angular correlation of the $(3/2^-) \rightarrow \beta(3/2^+) \rightarrow \gamma(5/2^+)$ cascade in the decay of Sm-153 was measured in the beta energy range 210-630 keV with a fast-slow scintillation assembly. The integral correlation experiment was also conducted and the results showed that A_2 was -0.04 ± 0.001 and A_4 was -0.001 ± 0.012. The results of the differential correlation experiment were in accordance with the quasi- allowed approximation applicable to some non-unique first forbidden beta transitions.

4. <u>Beta-gamma Angular Correlation Measurements in the decay of Ce-143</u> - M.L. Narasimha Raju, D.L. Sastry and E. Kondaiah - The energy dependence of the 1100 keV beta-293 keV gamma directional correlation is studied with a conventional slow-fast scintillation spectrometer. The present measurements are in favour of a spin assignment $3/2^+$ to the 351 keV level in Pr-143. The validity of quasi-allowed approximation in this 1100 keV beta-293 keV gamma-transition is also discussed.

5. <u>Lifetimes of the 57 And 351 keV Levels in Pr-143</u> - V.V. Ramamurty, M.T. Rama Rao and V. Lakshminarayana - Measurements

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of lifetimes of the 57 and 351 keV states in Pr-143, formed in the decay of Ce-143, are carried out by the delayed coincidence method using time to pulse height converter and a hundred channel analyser. The following results are obtained:

$T_{1/2}$ of the 57 keV level : (4.05 ± 0.12) ns.

$T_{1/2}$ of the 351 keV level: (69 ± 14) ps.

The transition probabilities corresponding to these half lives are estimated and compared with the single particle estimates. The theoretical values are also obtained using Pure De-Shalit type of wave-functions and the wave functions of Chowdhury and Kujawski, in the case of the 57 keV level. The present experimental values of T(E2) and T(M1) are in good agreement with the later theoretical values. Assuming the ground state wave function of Chowdhury and Kujawski and expressing the 351 keV state as a superposition of the $7/2^+$ phonon and 5/2+ phonon parts, the present experimental value is employed to obtain their relative amplitudes as (0.70 ± 0.18) and (0.30 ± 0.08) respectively.

6. <u>Mean-Life of the 538 keV State of Rh-103</u> - M.T. Rama Rao, V.V. Ramamurty and V. Lakshminarayana - The mean-life of the 538 keV state of Rh-103 is measured, for the first time, to be (56 ± 18) ps, with a delayed coincidence spectrometer employing a time-to-amplitude converter and using the centroid shift technique. The theoretical values of the transition probabilities are estimated assuming the configurations of the 40 and 93 keV levels to be $(g_9/2)^5$ 7/2

and $(g_9/2)^5_{9/2}$ and the 538 keV as a superposition of these configurations and phonons and compared with the experimental values. Alternatively, the wave function of the 538 keV state is assumed to be

$$|5/2\rangle_{538} = A\,(g_{9/2})^7_{5/2} + \sqrt{1-A^2}\left[(g_{9/2})^7_{7/2} + \text{Phonon}\right]$$

and the 40 keV state is assumed to be $(g_{9/2})^7_{7/2}$.

The present experimental value yielded the values of A and $\sqrt{1-A^2}$ to be

	A		$\sqrt{1-A^2}$
Set I	(0.81 ± 0.26)	and	(0.59 ± 0.19)
Set II	(-0.76 ± 0.25)	and	(0.65 ± 0.21)

7. <u>Angular Correlation Studies in ^{99}Tc</u> - P Jagam and V.Lakshinarayana - Angular correlations of the cascades 740-180 keV and 740-(40)-140 keV are studied using a sum peak coincidence arrangement. The zero bias sum peak coincidence spectra are recorded for angles 90°, 135° and 180° between the detectors. The variations of the intensities of the peak at 920 keV yielded directly the correlation patterns of these two cascades together. The observed combined correlation pattern could be fitted in an equation $W(\theta) = 1-(0.031 \pm 0.006)\,P_2\,(\cos\theta) + (0.009 \pm 0.006)\,P_4(\cos\theta)$. Assuming equal amounts of admixture of the two cascades and the spins of the ground, 140 and 180 keV states to be $9/2^+$, $7/2^+$ and $5/2^+$ respectively, the correlation coefficients are estimated for different spin values for the 920 keV state. A value of $\frac{1}{2}+$ yielded a good agreement between the theoretical and the present experimental values. This study is also used in an alternative analysis to predict the multipole character of the 40 keV unobserved radiation

in the latter cascade and the value of the quadrupole content is found to be less than 15% for this transition.

8. Studies on Core-Particle Interaction in some odd A Nuclei with ground State Spin $\frac{1}{2}$.- M.N. Seetharamanath and V.Lakshminarayana - An investigation is made into the core-particle interaction in some odd A spherical nuclei with ground state spin $\frac{1}{2}$. A scalar interaction of the form $H_{int} = \sum_K C_k (T_c^k . T_p^k)$ is assumed between the core and the particle where T_c and T_p are tensor operators operating on the core and the particle degree of freedom respectively. The relative contributions of the different terms are determined. For odd nuclei with ground state spin $\frac{1}{2}$ the terms K = 0 and K = 1 are significant. A systematic study is carried out on nuclei Si-29, P-31, Fe-57, Se-77, Rh-103, Ag-107, Ag-109, Cd-111, Te-125, Hg-197, Tl-197, Hg-199, Tl-199, Tl-201, Tl-203 and Tl-205 using the energies of the levels corresponding to the spin $(3/2)^+$ and $(5/2)^+$ and the energies of the 2+ states of the neighbouring even-even nuclei. The analysis revealed that the monopole (K = 1) interaction strength is a constant whereas the product of the monopole matrix elements varies. On the other hand the dipole interaction strength varies and the product of the dipole matrix elements is a constant.

9. Precompound and Compound Particles of Decay in (n,p) Reactions - E. Kondaiah and K. Parthasaradhi - A few (n,p) reaction spectra have been analysed using the expressions given by Griffin(1) based on 'excit-on' model. Evidence in favour of precompound particles of decay leading to low excitation of residual nuclei and emitted at forward angles, is obtained.

(1) Phys. Rev. Lett. 17, 9(1966) 478

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

1.	A.E.E.T/NP/10	Progress report on nuclear data activities in India-I	1964
2.	A.E.E.T-227	Nuclear data measuring facilities in India	1965
3.	A.E.E.T.-228	Progress report on nuclear data activities in India-II	1965
4.	A.E.E.T.-267	Progress report on nuclear data activities in India-III	1966