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Compiled by F. Gama CARVALHO

Laboratório de Física e Engenharia Nucleares

Sacavém - PORTUGAL

L - CATEGORY DOCUMENT

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Laboratório de Física e Engenharia Nucleares
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I - DEPARTMENT OF PHYSICS

FACULTY OF SCIENCES, UNIV. OF LISBON, LISBON-2

1. NUCLEAR SPECTROSCOPY GROUP

(Project IAC - LF1 - II; Director: Prof. F. BRAGANÇA GIL)

1.1. EXPERIMENTAL NUCLEAR SPECTROSCOPY

1.1.1 - MEASUREMENT OF ATOMIC FLUORESCENCE YIELDS BY COINCIDENCE METHODS
(Amélia Maio, A. Barroso, J. Pires Ribeiro, F. Bragança Gil and J. Gomes Ferreira)

Measurements of the L_{II} and L_{III} atomic yields of bismut following the decay of ^{226}Ra by means of coincidence experiments between $XK\alpha_1 - XL$ and $XK\alpha_2 - XL$, using $\text{Ge}(\text{Li})$ and $\text{Si}(\text{Li})$ detectors are in progress.

1.1.2 - MEASUREMENT OF THE HALF LIFE OF NUCLEAR EXCITED STATES

(M. Conceição Abreu, J. Pires Ribeiro, J. C. Soares and F. Bragança Gil)

Measurement of the half life of the $9/2^-$ and $9/2^+$ excited states of ^{177}Hf is in progress using a double lens magnetic spectrometer (Gerholm type). The aim is to check an experimental method for correction of half-life measurements.

Also the mean life of the $3/2^+$ excited state of $^{119}\text{Sn}^m$ has been measured by $X-\gamma$ and e^+e^- delayed coincidences. Previous measurements using either Mössbauer effect or $X-\gamma$ (25.3 keV- 23.8 keV)

coincidences are not in good agreement. It is hoped that e^-e^- and X- γ (66 keV) coincidence experiments will throw some light on the discrepancies.

1.1.3 - ANGULAR CORRELATIONS

(F. Bragança Gil and M.J. Temes D'Oliveira)

The present available theoretical and experimental values for the A_{22} coefficients of the X-ray angular correlation function (K-L X-ray cascades) are compared in order to discuss the calculated values for M2/E1 mixing ratios. The experimental values were obtained from previous angular correlation experiments and the calculated ones from previous fluorescence yield determinations. A paper has been published on this subject^[1].

Reference:

- [1] Bragança Gil, F. and Temes D'Oliveira, M.J., Portugal. Phys., 8, 199-216 (1973)

1.2. INSTRUMENTATION

1.2.1 - DETECTORS

The absolute efficiency of a Si(Li) detector has been measured using a variable energy X-ray source with fixed geometry. The experimental points were fitted with a semi-empirical curve by computational methods. Identical procedure is in course for a Ge(Li) detector.

(M. Conceição Abreu, Amélia Maio and M.J. Temes D'Oliveira)

1.2.2 - MINICOMPUTER SYSTEM FOR NUCLEAR SPECTROSCOPY

A minicomputer system has been installed working both as amplitude analyser and nuclear spectra processing system. The central unit is a 16 K-8 bit minicomputer (MULTI-8 INTERTECHNIQUE). The peripheral environment consists in: (1) a 100 MHz ADC (CT 102

INTERTECHNIQUE) with zero and gain stabilization (UT 103 INTERTECHNIQUE); (2) an oscilloscope display unit (PLURIMAT 20); (3) a Teletype ASR 33, and fast paper tape reader and punch as input and output units.

Software has been provided by Intertechnique and consists mainly in spectroscopy data acquisition and processing programs (4 to 8 K core memory) and Assembler and BASIC facilities.

The system is expandable up to 32 K core memory (8192 channels; 8×10^6 counts/channel).

(Gaspar P.Ferreira)

1.3. THEORETICAL NUCLEAR PHYSICS

1.3.1 - FINITE RANGE EFFECTS IN NUCLEAR TRANSFER REACTIONS

(A.C.Eiró, F.D.Santos)

The finite range parameter for the (d,p) reaction has been calculated using the phenomenological wave functions of McGee, Hamada and Johnston and Reid. Values of β between 1.30 and 1.34 fm⁻¹ were obtained.

Calculation of the effect of the D state admixture in the two and three-body wave functions in the (³H,d) and (³He,d) reactions are in progress.

2. INTERACTIONS BETWEEN THE NUCLEUS AND THE ATOMIC ELECTRONS

(Project IAC - LF1 - II; Director: Prof.J.G.FERREIRA)

2.1. MEASUREMENTS OF L_I AND L_{II} ATOMIC YIELDS BY THE ANALYSIS (CURVED CRYSTAL SPECTROMETRY) OF LX-RAYS FOLLOWING NUCLEAR DESINTEGRATION

(L.Salgueiro, M.T.Ramos, F.Parente and J.G.Ferreira)

Measurements of L_I and L_{II} atomic yields are in course by means

of a curved crystal spectrometer and using radioactive sources. To increase the intensity obtained a Soller colimator was adapted to the spectrometer and experiments are now in progress in order to get the LX-ray spectrum following the decay of ^{198}Au .

2.2. L_I ATOMIC FLUORESCENCE YIELDS (SEMICONDUCTOR X-RAY SPECTROMETRY)
(M.I.Marques and J.G.Ferreira)

A Si(Li) X-ray spectrometer has been mounted and measurements of relative efficiencies and calibration are in progress.

The K and L X-ray spectra following the internal conversion of γ radiation in some nuclei will be analysed in order to measure the L_I atomic fluorescence yields.

II - LABORATORIO DE FISICA E ENGENHARIA NUCLEARES
(NUCLEAR RESEARCH CENTER), SCAVEM

1. NEUTRON PHYSICS

1.1. THERMAL NEUTRON DIFFUSION PARAMETERS
(E.Martinho and M.M.Costa Paiva)

1.1.1 - Measurements of diffusion and extrapolation lengths of thermal neutrons in 12 organic substances at room temperature using a static method have been completed and reported [1].

1.1.2 - Work in progress concerns the diffusion of thermal neutrons in cadmium-poisoned aqueous solutions.

Reference:

[1] Martinho, E. and Costa Paiva, M.M., Atomkernenergie, 21, 93 (1973)

1.2. σ TOTAL OF POLYCRYSTALLINE GRAPHITE
(V.Esteves and M.Sequeira)

A series of measurements of the total cross-section of nuclear grade graphite between 1 meV and 200 meV has been performed at the LMW swimming-pool reactor. The measurements were conducted using the pulsed neutron beam of the time-of-flight diffractometer installed there. Preliminary results show the contribution of small angle scattering in the sample in the cutoff region. To correct for this effect a new series of measurements is in preparation.

2. THEORETICAL NUCLEAR PHYSICS

2.1. VECTOR AND TENSOR ANALYSING POWER OF (d,p) REACTIONS AND DEUTERON D-STATE EFFECTS

(R.C.Johnson^{*}, F.D.Santos, R.C.Brown⁺, A.A.Debenham⁺, G.W.Greenlees⁺, J.A.R.Griffith⁺, O.Karban⁺, D.C.Kocher⁺ and S.Roman⁺)

The vector and tensor analysing power was measured for (d,p) reactions on ^9Be , ^{12}C , ^{16}O , ^{19}F , ^{25}Mg , ^{28}Si and ^{40}Ca for laboratory reaction angles from 0° to 50° at 12.3 MeV deuteron energy^[1]. Fifteen transitions were studied including orbital angular momentum transfer $l_n = 0, 1, 2, 3$. The experimental results were analysed in terms of distorted-wave theory including deuteron D-state effects. The calculations show that the deuteron D-state cannot be ignored in the description of the tensor analysing power. The j-dependence of D-state effects is discussed.

Reference:

[1] Johnson, R.C. et al., Nucl. Phys., A208, 221 (1973)

2.2. FINITE RANGE APPROXIMATIONS IN DIRECT TRANSFER REACTIONS (F.D. Santos)

Finite range effects in direct transfer reactions are discussed using an irreducible tensor expansion of the translation operator^[1]. An expansion of the transition amplitude appropriate to heavy ion transfer is obtained. The form factor of each term is given analitically for bound state wave functions expressed as a sum of Hankel functions. A strongly inhibitory selection rule for the orbital angular momentum transfer in the reaction due to recoil is presented and discussed.

References:

[1] Santos, F.D., Nucl. Phys., A212, 341 (1973)

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+ Univ. of Birmigham, U.K.

2.3. HEAVY ION TRANSFER REACTION FORM FACTORS

(L.A.Cunha and F.D.Santos)

Heavy ion transfer reaction form factors were calculated analytically by fitting the bound state wave functions in the projectile and residual nucleus generated in a Wood-Saxon well with a sum of Hankel functions^[1]. Good fits were obtained using a least squares computer procedure. Distorted wave calculations using this method for calculating the reaction form factors are in progress.

Reference:

- [1] Cunha, L.A. and Santos, F.D., Proceedings of the International Conference on Nuclear Physics, 1973, ed. by J. de Boer and H.J. Mang (North Holl. 1973) p.426.

3. EXPERIMENTAL NUCLEAR PHYSICS

3.1. LOW LYING LEVELS OF ^{29}Si

(M.S.Vouga and M.F. da Silva)

A detailed analysis of the $^{28}\text{Si}(d,p)^{29}\text{Si}$ angular correlation measurements previously reported has been carried out.

A value of δ_{20} significantly different from zero has been obtained which is in some disagreement with the literature.

In order to check this result the experiment was repeated using a different experimental setup involving a PDP-15 computer for on-line data acquisition.

The results of this experiment confirm the anomalous δ_{20} and further work is being pursued to clarify the possible enhancement of the M3 component relative to the expected pure E2.

3.2. RESONANCES IN THE $^{27}\text{Al} (p, \gamma) ^{28}\text{Si}$ REACTION

(J.M. Cunha, P.M. Corrêa and C.M. da Silva)

The analysis of the data previously reported has been completed. The γ -decay of the three doublet resonances at $E_p = 1363$; 1662 and 1962 keV has been resolved. The upper member of the $E_p = 1662$ keV doublet was found to decay only via the particle channels, whereas the lower member is deexcited predominantly by γ -ray emission; the two members of either the $E_p = 1363$ keV and the $E_p = 1962$ keV doublets show similar γ -decays, with major differences in the weak branches ($\leq 10\%$). Total widths of all resonances have been measured. The measured width for the lower member of the $E_p = 1662$ keV doublet ($\Gamma = 1830 \pm 160$ eV), together with the work by Tveter^[1], allowed a J^π assignment of 2^+ . Two new bound levels in ^{28}Si have been seen, at $E_x = 9798 \pm 3$ and 10517 ± 3 keV.

Reference:

[1] Tveter, A., Nucl. Phys., A185, 433 (1972)

3.3. DETAILED SHAPE OF RESONANCE YIELD CURVES

(P.M. Corrêa, J.M. Cunha and J.M. Pulido)

A Monte Carlo code has been written and is successfully being used to study the detailed shape of resonance yield curves considering the discrete character of the energy loss of projectiles in the target. The aim is to extend the work done by several authors^[1,2] to a wider range of resonance widths (Γ) and beam energy spreads (σ). It seems that the effects detected in the half maximum position and interquartile range of thick target yield curves still persist when the Lewis peak disappears due to an increase of Γ and or σ .

References:

[1] Donhowe, J.M. et al., Nucl. Phys., A102, 383 (1967);

[2] Mourad, W.G. et al., Nucl. Phys., A102, 406 (1967).

4. INSTRUMENTATION

RPI REACTOR

A replacement core for the swimming-pool RPI reactor has been ordered. The new fuel elements are MTR type with 18 parallel plates and 90% enriched uranium. With the core it is planned to replace the present control rods and their drives by in-line drives with out-of-water magnets. The old B_4C shim rods will be replaced by In-Cd-Ag rods. The new core will probably begin operation in late Spring 1974.