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PROGRESS REPORT TO NEANDC

FROM SPAIN

September 1975

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Madrid

PREFACE

CONTENTS

1. JUNTA DE ENERGIA NUCLEAR.

1.1. Experimental determination of X_L - ray intensities in Th, U and Pb.

L. González and E. Vañó.

By means of the excitation of thin samples of uranium, thorium and lead with an [241]Am ring-source of 30 mCi, the X_L-ray spectra of these elements have been measured. As spectrometer a 0.37 cm^3 flat Ge(Li) detector was used.

The X_L-ray spectra were obtained by substracting from the excitation spectra the americium source background measured in the same geometrical conditions.

The measured intensities were compared with the theoretical calculations of Scofield and the following intensity relationships obtained:

$L_3M_{4,5}/L_3M_1$ of 18.4, 20.7 and 23.2 for U, Th and Pb respectively; $L_3M_{4,5}/L_3N_{4,5}$ of 4.1 and 3.5 for U and Th; L_2M_4/L_2N_4 of 4.9 and 5.5 for U and Th; L_2M_4/L_2O_4 of 9.6 and 19 for U and Th and $L_2M_4/(L_2N_4 + L_2O_4)$ of 7.0 for Pb.

1.2. Application of the γ -Xray coincidence technique to the measurement of L_2/L_3 vacancy relationships due to internal conversion.

E. Vañó and L. González.

The use of the γ -Xray coincidence technique for the determination of vacancy relationships in certain atomic subshells, due to gamma transitions, is studied..

The method is used to study the [232]Th, by measuring the coincidence spectra of the X_K-and X_L-rays with the transitions of 143, 163, 185 and 205 KeV.

From the measured intensities the L_2/L_3 vacancy relationships were determined by using the theoretical emission rates of Scofield and the fluorescence factors of McGuire.

1.3. Application of the rotational model to the calculation of neutron cross-sections.

J.A. Cabrera Jimenez and R. Martín Garcia.

A nuclear rotational model has been used for the calculation of neutron cross-sections and angular distributions.

An interaction Hamiltonian, with a potential which generalizes the ordinary optical model is used. This Hamiltonian leads in the calculation of the matrix elements between rotational states and deformed nuclei to a set of coupled - equations, which are solved by the ECIS method (Equations Couplées en Iteration Séquentielle) of Raynal. A numerical program was developed which gives the elastic cross sections and their angular distributions for fast neutron reac - tions on deformed nuclei. The program has been used for the study of the particular case of e-e nuclei with a 2^+ first excited state.

1.4. Analysis of a non-local optical model.

R. Martín Garcia and J.A. Cabrera Jimenez.

An analysis has been made of an optical model with non-local potentials, suitable for the study of fast neutron interactions with non-deformed nuclei of - $A \geqslant 50$, in the energy range of $0.1 \text{ MeV} < E < 5 \text{ MeV}$.

A numerical program in FORTRAN V is being developed to solve the Schrödinger equation for each partial wave, in which the potential is an integral operator with complex core and L-S interaction.

1.5. Comparison of the experimental results of the level scheme of ^{22}Na and the theo‾retical predictions of the unified model.

J. Fernandez

The colective model with strong coupling describes well the static and dynamic properties of deformed nuclei, and its great success in the description of the "colective" properties of nuclei with $19 \leqslant A \leqslant 25$ presents a big interest, not only from the experimental point of view but also from the theoretical one. In particular, the nucleus ^{22}Na, which seems to be the most deformed nucleus in this region constitutes a case of upmost interest.

Therefore, and taking into account that ^{22}Na is an auto-conjugated nucleus, an analysis was carried out of this nucleus in which a comparison is made of the experimental values of some levels of ^{22}Na, with the theoretical predictions of the colective model and the isospin selection rules, and a possible interpretation is given for the experimental results in the frame of the shell model theo‾ry.

2. UNIVERSIDAD COMPLUTENSE. MADRID

Facultad de Ciencias.

2.1. Determination of the total cross section of some elements for 0.511 MeV photons

Carlos Willmott.

The atomic total cross rections of carbon, magnesium, aluminium, titanium, iron, copper, molibdenum, cadmium, tungsten, lead and uranium for gamma rays of - 511 KeV incident energy were measured by means of coincidences detection between the photons of the annihilation radiation.

2.2. Liquid scintillator detector behaviour.

M. Ortiz Ramis and J. Campos.

The de-excitation curves of some scintillator materials in solution in the presence of oxygen are been measured for α -and β particles and γ -rays excitation. The experimental results have been compared with theories based in a kinetic treat ment which take into account several hipothesis for the molecules of solute and solvent in those liquids.

3. UNIVERSIDAD AUTONOMA DE MADRID

Departamento de Física Teórica.

3.1. Microscopic description of giant multipole resonances in nuclei.

S. Krewald[*] and J. Sánchez-Dehesa

Giant resonances of a higher multipolarity than the well-known dipole resonance have been detected experimentally in the last two years. Because of this interest, a study was made of the giant resonance region of different nuclei (O, Pb,.) within the framework of the higher RPA theory.

The main characteristics of the treatment are the following:

i) It takes into account the biggest part of the 2p-2h excitations, which come from the coupling of low-lying collective states of the core to the single-particle states in the neighbouring odd nuclei.

ii) The RPA calculations include single-particle orbitals in two major shells above and two bellow the Fermi surface.

iii) It is used the density dependent delta-force proposed by Migdal with parameters fitted in the Pb region to electromagnetics properties.

3.2. Influence of configuration mixture in the Nolen and Schiffer anomaly.

A. Poves and J.M.G. Gómez.

The mass diference between the mirror nuclei ^{41}Sc and ^{41}Ca was calculated by using the shell model in the isospin formalism. The use of the effective inte-

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raction proposed by Zucker for the d - f shell gives place to a mixture of excitations 3p-2h, which represents for the ground state of these nuclei about 28 % of the wave function.

By using the principal components of the wave function the discrepancy in the mass difference between the theoretical and experimental values is reduced in about 20 %.

3.3. **Energetic shift between isobars and possible dependence of the charge on nuclear forces.**

J.M.G. Gómez and J. Sesma.

The energy differences between analogue states in a long series of isobar pairs in the region A = 34-54 are calculated. The calculations are of microscopic type, inside de framework of the shell model, and carried out with several hypothesis for the interactions.

The results, based in charge independent nuclear forces with pure Coulomb interaction, agree very well with the experimental values, except for some states J = 0 T = 1. It is found that if we take into account small corrections, such as the magnetic interactions between nucleons, the agreement is considerably improved. It is discussed also the possible relationship of the small discrepancies between theory and experimental results on the violations of the nuclear forces charge simmetry.

4. INSTITUTO DE FISICA CORPUSCULAL, VALENCIA

4.1. Elastic scattering of 25 MeV alpha particles on several nuclei in the region A =50 - 70.

J. Alabau, E. Casal, A. García, T. Picazo, J.B.A. England[+] , G.J. Pyle[+] and P.M. Rolph[+]

The differential elastic scattering cross-sections for 25 MeV alpha particles have been measured for a total of 18 different nuclei in the region of A=50-70. The corresponding angular distributions were analysed according to the interaction optical model. In particular, the dependence of the values of the respective parameters on the mass number of the target nuclei was studied, as well as the possible characterization of the found results in relationship with the strong absorption radius and the values fo the real potential and its derivative for such distance.

4.2. Inelastic scattering of 25 MeV alpha particles on ^{51}V, ^{52}Cr, ^{53}Cr and ^{54}Fe.

J. Alabau, E. Casal, A. García and J.B.A. England[+].

The analysis of spectra obtained in the interaction of a beam of 25 MeV alpha particles with the nuclei ^{51}V, ^{52}Cr, ^{53}Cr and ^{54}Fe has allowed to identify, together with the maxima of the elastic scattering process, several peaks origina ted by inelastic scattering of the α-particles on the lower excited states of such nuclei. The corresponding angular distributions of the experimental differential cross sections have been analyzed by making use of coupled channel theory.

[+] Physics Department, University of Birmingham.

4.3. Study of the reaction $^9Be(^3He,p)^{11}B$ at 5.0 MeV. Experimental values.

J.L. Ferrero, A. García, J.C. Pacheco, B. Bilwes[++] and R. Bilwes[++].

The angular distributions for the reaction $^9Be(^3He, p)^{10}B$ at 5.0 MeV have been measured for the 10 lower excited states of ^{11}B, by means of photonuclear pla-tes associated to a magnetic single-channel spectrometer and solid state detec tors. The measured angular distributions are compared with those obtained by other authors at neighbouring energies, and a change in the interaction mechanism with the incident particle energy has been shown. In fact, while at lower ener-gies the compound nucleus contribution is the strongest one, this contribution changes with increasing incident energy, so that at higher energies the direct interaction process is dominant (two-nucleons stripping).

4.4. Analysis of the input channel of the $^9Be(^3He, p)^{11}B$ reaction at 5.0 MeV, accor-ding to the optical model.

J.L. Ferrero, A. García, J.C. Pacheco, B. Bilwes[++] and R. Bilwes[++].

The input channel of the $^9Be(^3He, p)^{10}B$ reaction was studied by means of the measurement of the elastic scattering of 5 MeV ^3He particles on ^9Be. The angu-lar distribution was analysed in the framework of the interaction optical model with independent geometries for the real and imaginary parts of the potential. A particular attention was given to the ambiguities which present the real pa-rameters of the model.

The result of this analysis is compared with that obtained for the values of other authors at neighbouring energies.

[++] Laboratoire des Basses Energies. CRN Strasbourg.

5. UNIVERSIDAD DE VALLADOLID

Departamento de Física Fundamental.

5.1. Analysis of the $^{19}F(p, \alpha)^{16}O$ reaction between 1,5 and 3.8 MeV.

C. Casanova and L. Marquez.

The differential cross sections of the $^{19}F(p, \alpha)^{16}O$ reaction were measured at the incident proton energies of $E_p = 1.5$, 2.0, 3.0 and 3.8 MeV. The experimental values have been analyzed by means of the Hauser-Feshbach statistical theory in order to deduce the level density values of the compound nucleus ^{20}Ne.

5.2. Measurement of the multipolar mixture coefficient of the transition $2_2 \rightarrow 2_1$ of ^{62}Ni.

J.L. Casanova, Mª L. Sanchez and J. Casanova.

By means of the $\gamma - \gamma$ angular correlation method, the multipolar mixture ratio E_2/M_1 for the gamma transition between the $2_2 \rightarrow 2_1$ levels of the e-e nucleus ^{62}Ni was measured. The obtained value was

$$\delta_{2_2 \rightarrow 2_1} = -2.7\ ^{+1.8}_{-1.2}$$

The measured value is in good agreement with the prediction of the shell model, supposing a nuclear-nuclear interaction of type MSDI.

6. UNIVERSIDAD DE ZARAGOZA.

Facultad de Ciencias. Departamento de Física Atómica y Nuclear.

6.1. Spin, multipolarities and mixture ratios determination for some excited levels of ^{210}Po.

A. Morales, J. Morales, R. Nuñez-Lagos and M. Pló.

By making use of a ^{226}Ra source of 10 μCi and of angular correlation techniques the values of the spin, gamma transition multipolarities and mixture ratios of some excited levels of ^{214}Po have been determined.