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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

Progress Report

Nuclear Data Programme in Hungary

1980

Compiled by

Gy. Kluge

June 1980

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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PROGRESS REPORT

Nuclear Data Programme

in

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June 1980

P R O G R E S S R E P O R T

H U N G A R Y

1980.

Compiled by

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CENTRAL RESEARCH INSTITUTE FOR PHYSICS
OF THE HUNGARIAN ACADEMY OF SCIENCES

BUDAPEST

Fragmented $g_{9/2}$ isobaric analogue resonance in the ^{52}Cr /p, γ/ ^{53}Mn reaction

I. Fodor, J. Sziklai, P. Kleinwächter[+], F. Herrmann[+], and H. Schobbert[+]

Resonances consistent with fragmented $g_{9/2}$ analogue resonance have been found in ^{53}Mn corresponding to the E_x=3.715 MeV level in the ^{53}Cr parent nucleus. The resonance was located through the $^{52}Cr/p, \gamma/^{53}Mn$ reaction. Total γ spectra were measured with a Ge/Li/ detector in 2 keV steps in the expected proton energy range. The $g_{9/2}$ IAR was found in nine components at E_p=4114, 4134, 4140, 4157, 4165, 4167, 4182, 4188 and 4197 keV. The angular distribution of γ rays was measured on the five strongest resonances which were suggested as having spin J=9/2 based on the γ excitation functions and branching ratios. The absolute gamma transition strength distribution was fitted with a strength function. The region of the IAR E_a, the spreading width Γ_s, and the analogue-hallway coupling matrix element were deduced from the fit. The Γ_{γ_0} transition strength for the IAR was determined as $\overline{\Gamma_{\gamma_0}}$=21 keV.

I. Fodor, J. Sziklai, P. Kleinwächter, F. Herrmann, H. Schobbert: $g_{9/2}$ isobaric analogue resonance in the $^{52}Cr/p, \gamma/^{53}Mn$ reaction, J. Phys. G: Nucl. Phys., 5 /1979/

I. Fodor, J. Sziklai: Analog doorway and its effect in the different channels, Phys. Rev. C21 /1980/ 787

[+]Zentralinstitut für Kernforschung, Rossendorf, GDR

Two step processes in two-nucleon transfer reactions

G. Pálla, G. Lindström[+] and V. Riech[+]

The /p,t/ reaction on the even-even Sm isotopes has been investigated at a proton energy of 25.5 MeV. The simple assumption of a direct one-step two-nucleon transfer fails in explaining the observed transitions to the collective low lying states, which have anomalously shaped angular distributions. The /p,t/ reaction has been calculated with the inclusion of higher order transitions that go through intermediate collective states. The indirect transitions including inelastic excitations in both of the target and final nucleus are found to be almost as large as the direct ones for the 2^+ quadrupole and 3^- octopole states. A satisfactory agreement in magnitude and shape has been found for the angular distributions in the whole nuclear range where a transition in character from vibrational to permanently deformed can be observed.

G. Pálla, G. Lindström and V. Riech: Higher order processes in two-nucleon transfer reactions, KFKI-1979-31

[+]Universität Hamburg, I. Institut f. Experimentalphysik, Hamburg, FRG

Coupled-channel effects in helion scattering

G. Pálla and C. Pegel[+]

The cross sections of helion scattering leading to the ground state and the first four-six excited states of the even-even stable samarium isotopes were analysed at an incident energy of 40.9 MeV in terms of the strong coupling approximation assuming the $^{144, 148}$Sm, ^{150}Sm and $^{152, 154}$Sm nuclei to be harmonic vibrators, asymmetric rotator and symmetric rotators respectively. A systematic study was carried out to deduce a single common optical model potential for this nuclear range. A description of the elastic and inelastic scattering cross section is given in the framework of the coupled channels theory and the collective model; the importance of multistep processes in inelastic scattering is emphasized.

The existence of a single common optical model potential that is able to represent the measured scattering data demonstrates that in a nuclear region which is collective in nature the coupling of elastic and collective-inelastic channels is the most important effect on the optical-model potential, i.e. in the dissimilarity of the individual one-channel potentials the effect of collective characteristics of nuclear states is manifested indirectly.

G. Pálla and C. Pegel: Inelastic scattering of helions from even-even stable samarium isotopes at 40.9 MeV, Nucl. Phys. A321 /1979/ 317

[+]Universität Hamburg, I. Institut f. Experimentalphysik, Hamburg, FRG

Lattice location of Co implanted in silicon

E. Kótai[+], T. Lohner, A. Manuaba, G. Mezey, R. Coussement[*], I. Dézsi, G. Langouche[*], D.L. Nagy, M. de Potter[*]

The Mössbauer spectra of implanted Co in Si and Ge showed two resonance absorption lines. The interpretations of this result are contradictory because it could be explained by the existence of Co atoms in one or in two different lattice sites. Recent Mössbauer measurements made in high magnetic field revealed that Co atoms can be found only at one lattice site of low symmetry.

Channeling and backscattering experiments were made on Co implanted in Si at 70 keV with a dose of 1.10^{14} atom/cm^2 in order to obtain further information on the lattice location of Co. The comparison of the results obtained by the two methods will be presented.

G. Langouche, I. Dézsi, M. Van Rossum, J. Debruyn and R. Coussement: On the existence of a quadrupole interaction at ^{57}Fe implanted in Si and Se, Phys. Status Solidi, B89, K17 /1978/

I. Dézsi, R. Coussement, G. Langouche, B. Molnár, D.L. Nagy and M. de Potter: On the localization of Co Atoms in Silicon, Journal de Physique, C1, suppl. no. 1. 41 /1980/ C1-425

[+]Industrial Research Institute for Electronics, Budapest, Hungary

[*]Instituut voor Kern- en Stralingsfysika University of Leuven, Leuven, Belgium

Operation and development of the 5 MeV electrostatic accelerator

E. Klopfer, P. Kostka, J. Roósz

At the single-ended 5 MeV Van de Graaff ion accelerator operation for the experiments was continued also over the years 1977-79. The accelerator was running yearly for 3500 - 4500 hours for experiments in basic and applied nuclear physics. The capability of the machine was extended by the application of a new switching magnet, allowing a switching of the ion beam over six target places. A new quadrupole lens and beam steerers serve for better focusing of the beam. Target area was enlarged by two rooms. In addition to the acceleration of protons, deuterons and helium ions now nitrogen may be used too. The installation of turbo molecular pumps makes it possible, to have a better and cleaner vacuum within the whole system.

Nuclear fission studies

J. Kecskeméti, A. Lajtai, P.P. Dyachenko* and
V.M. Piksaikin*

The measurement of the energy spectrum of neutrons from the reaction $^{235}U/n_{th},f/$ in the 0.01 - 2 MeV energy region have been carried out using the TOF method with a gas scintillation chamber and a glass scintillation detector of ^{6}Li content as fragment and neutron detectors, respectively.

The spectra of neutrons are measured relative to that of the spontaneously fissioning ^{252}Cf. To get a more complete information the experiments have been extended to the direct determination of the background from scattered neutrons. The background from delayed γ-rays has been determined with a glass scintillation detector of ^{7}Li content.

A. Lajtai, J. Kecskeméti, Gy. Kluge, G. Petravich, P.P. Dyachenko and V.M. Piksaikin: The prompt neutron spectrum from thermal neutron-induced fission of ^{235}U for the energy range 30 keV to 1 MeV, INDC /HUN/-14/1 /1978/

V.N. Kononov, E.D. Poletaev, M.V. Bohovko, L.E. Kazakov, V.M. Tihonov, P.P. Dyachenko, L.S. Kutsaeva, A. Lajtai, J. Kecskeméti: The neutron detection efficiency of the 0.95 cm thick NE-912 lithium glass, KFKI-1979-72

*Physics and Energy Institute, Obninsk, USSR

Transport in cylindrical plasma, bifurcation in the heat transport

G. Páris and G. Németh

A typical plasma transport equation with an anomalous diffusion coefficient $D \sim 1/n$ has been analitically investigated. We have got self similar solutions of the diffusion equation and stationary solution for the source being a linear function of the density n/r/. In the stationary solution a bifurcation has been found: at the same plasma radius for different n/o/ two stationary temperature distributions exist, a Gaussian and a hallow one.

Plasma X-ray diagnostics

G. Hordósy and G. Hrehuss

A gas proportional-scintillation /GPS/ spectrometer has been developed specifically for plasma diagnostical purposes. The aim was to construct a fast spectrometer for soft X-rays down to quantum energies as low as 200 eV with an energy resolution comparable to that of semiconductor counters. The X-ray emission of hot plasmas of e.g. the more recent tokamak devices is known to have an exponential spectral distribution from $h\nu \approx 1500$ eV upwards with few characteristic lines of the heavier impurity ions superimposed. At lower quantum energies, however, strong deviation from the exponential distribution has been expected, representing as high as 30 - 50 % of the total input power.

The GPS spectrometer was constructed in such a way that it displays the /incorrected/ soft X-ray spectra of a single tokamak discharge separated in succeding time intervalls of about 100 ms. In this way also the time evolution of the spectra during each single pulse can be measured. The correction of the spectra for the transmission of the absorbents etc. was performed off-line.

The most important parameters of the spectrometer are as follows. Line width /FWHM/ 90 eV at $h\nu$ =280 eV, minimum detectable quantum energy $h\nu$ /min/ $\approx$ 150 eV, maximum permissible counting rate 7×10^4 cps.

Positron annihilation study of quartz

A. Andreeff[++], Á. Balogh, G. Boden[+], G. Brauer[+]

The crystallinity of different quartz samples were studied by using positron annihilation lifetime and Doppler broadening measurement. The natural Brasilien quartz single crystal, its crystallinity is 1, and the amorphous silica glass produced from silicon-tetrachloride, its crystallinity is 0, were used as reference points to the determination of the crystallinity of the various quartz samples which were fused from natural Brasilian quartz by a detonating as fire. Both methods have given the same result, demonstrating that the positron annihilation measurements can be successfully used as a non-destructive method to detect the crystallinity of silica glasses

G. Brauer, G. Boden, Á. Balogh, A. Andreef: Crystallinity of pure silica glass studied by pozitron annihilation, Appl. Phys. 16, 231 /1978/

[+] Zentralinstitut für Kernforschung, Rossendorf, GDR
[++]Technische Universität, Dresden, GDR

Mössbauer study of silica supported catalysts

I. Dézsi, M. Eszterle*, L. Guczi and D.L. Nagy

Previous studies on impregnated and reduced silica supported PtFe catalysts have been continued and extended to the RuFe/SiO_2 system including the study of the calcined state.

It has been established that during the preparation line the pH of the impregnating solution plays an important role. High dispersity can only be obtained if the pH value during the impregnation is kept at low /$\sim$ 1/ values. Although the dispersity is decreasing during calcination the higher dispersity in the impregnated stage results in a higher dispersity in the calcined stage, too.

On studying the metal-metal interaction in PtFe catalysts it has been found that below 40 at. % Fe concentration high dispersity superparamagnetic PtFe alloy is formed on the surface of the support the cubic structure of which is highly distorted. At Fe concentrations higher then 40 at. % the excess iron can not be reduced. In contrast to Pt, Ru is hindering the reduction of iron in the concentration range 40 - 70 Fe at. %. This explanation of this phenomenon needs further investigations.

I. Dézsi, D.L. Nagy, M. Eszterle, L. Guczi: Characterization of silica supported PtFe catalysts by Mössbauer spectroscopy, React. Kinet. Catal. Lett. 8, 301 /1978/
I. Dézsi, D.L. Nagy, M. Eszterle and L. Guczi: Mössbauer study of silica supported catalysts, J. Physique 40, C2-76 /1979/

*Institute of Isotopes of the Hungarian Academy of Sciences

Mössbauer study of frozen aqueous solutions

D.L. Nagy, J. Balogh, I. Dézsi, H. Spiering[+], G. Ritter[++], H. Vogel[++]

Mössbauer spectra of superquenched frozen aqueous solution of 0.2 mol % $^{57}Fe/ClO_4/_2$ /17% glycerol added/ were measured at 4.2 K in longitudinal and transverse external magnetic fields up to 50 kG. The glassy environment of the $Fe/H_2O/_6^{2+}$ ions results in considerable broadening of the resonance lines in contrast with the $Fe/H_2O/_6^{2+}$ complex in crystalline hydrates. The main features of all spectra can be qualitatively well reproduced supposing a D_3 symmetry at the Fe nuclei. For the calculation performed in the $^5T_{2g}$ subspace of the ^5D groundstate of the high spin Fe^{2+} ion the same covalency /α^2=0.92/ and the same hyperfine coupling constant /H_L=530 kG, H_c=-275 kG/ were used as those extracted from the Mössbauer spectra of the crystalline hydrates. This means that the water octahedra are mainly trigonally distorted which is also expected as a consequence of the Jahn-Teller effect. The trigonal splitting of the $^5T_{2g}$ levels is about 800 cm^{-1}; the glassy environment, however, leads to a distribution of this splitting, the width being about 200 cm^{-1}. The orbital ground state is a singlet hence $V_{zz} < 0$.

D.L. Nagy, J. Balogh, I. Dézsi, H. Spiering, G. Ritter, H. Vogel: Ligand Field Calculation for the Complex $Fe/H_2O/_6^{2+}$ in Frozen Aqueous Solution of $Fe/ClO_4/_2$.
J. de Physique C1 Suppl. No. 1. 41/1980/ C1-283

[+] Johannes-Gutenberg-Universität, Mainz, FRG
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Positron annihilation and Mössbauer studies of binary alloys

Khalid Al Ani[+], Á. Balogh, J. Balogh, I. Dézsi, Zs. Kajcsos, B. Molnár and D.L. Nagy

Measurements have been made on In-Pb alloys. The aim was to study the defect structure and to determine the vacancy formation energy in the different samples. Room temperature angular correlation curves and the determination of the vacancy formation energy on $In_{80}Pb_{20}$ alloy was completed. The value is 0.55 $\pm$ 0.05 eV, which is very near to the values of In and Pb, known from the literature. Similar studies on the Cu-Ni and Fe-B systems are in progress. In the case of the In-Pb and of the Cu-Ni system a correlation of the isomer shift of ^{57}Co impurities and the conduction electron contribution of angular correlation curve of annihilation gammas was found.

I. Dézsi, Á. Balogh, J. Balogh, Zs. Kajcsos, D.L. Nagy and É. Zsoldos: Positron and Mössbauer studies on Cu_xZn_{1-x} alloys, J. Phys. F: Metal Phys. 9, 999 /1979/

[+]On leave from the Nuclear Research Institute, Baghdad, Iraq

DIFFUSION MEASUREMENTS OF IMPLANTED Sb /AND Ga/ INTO Si, USING SiO_2 /AND Si_3N_4/ ENCAPSULATION

E. Kótai[+], T. Nagy, O. Meyer[++], J. Gyulai, P. Révész, G. Mezey, T. Lohner, A. Manuaba

Backscattering- and Hall measurements have been applied to study:

- Snow-plow effect on Sb implanted layers
- Drive-in behavior Sb-implanted layers in Si and SiO_2 layers
- Enhanced solubility of Sb implanted and oxidised layers
- Diffusion properties of substitutional and non-substitutional parts of Sb implanted atoms after snow-plow.

P. Révész, Gy. Farkas, G. Mezey, J. Gyulai; Epitaxial regrowth of evaporated amorphous silicon by a pulsed laser beam Appl. Phys.tett.33 /1978/ 431

G. Mezey, E. Kótai, T.Tohner, T. Nagy, J. Gyulai, A. Manuaba,

Improved Depth Resolution of Channeling Measurements in Rutherford Backscattering by a Detector Tilt; Nucl.Instr. and Meth. 149 /1978/ 235-237

M. Somogyi, M. Farkas, G. Mezey, J. Gyulai: Investigation of surface layers produced by chemical treatment of GaP; Thin Solid Films, 60 /1979/ 377

G. Mezey, J. Gyulai, E. Kótai, T.Lohner, E. Evans: A comparison of techniques for depth proling oxigen in silicon, Nucl.Instr.Meth.167 /1979/ 279

+ Industrial Research Institute for Electronics,Budapest,Hungary
++ Kernforschungszentrum, Karlsruhe, BRD

Quasi-free interaction of intermediate energy protons

J. Erő, Z. Fodor, P. Koncz, Z. Seres, B.A. Khomenko+, N.N.Khovanskij+, Z.V. Krumstein+, Yu.P. Merekov+, V.I. Petrukhin+, L. Végh+ M. Csatlós+

The quasi-free interaction of 670 MeV protons with correlated nucleon pairs within the nuclei was investigated at the proton synchrocyclotron of the Joint Institute for Nuclear Research /Dubna, USSR/ in cooperation with the Laboratory of Nuclear Problems. There was completed the analysis of experimental data of /p,nd/ and /p,pd/ reactions on ^{6}Li and ^{7}Li target nuclei.

Evidence has been found in the ^{7}Li /p,nd/ ^{5}Li /ground state and first excited state/ reaction for the quasi-elastic exchange scattering of protons on two correlated neutrons. Transitions to highly excited or completely disintegrated states of the residual nucleus have also been observed. Their cross sections and energy distributions are similar to those observed in the reaction ^{6}Li /p,nd/ ^{4}Li which have quasi-free character and are associated with large missing energies corresponding to the break-up of the alpha-core.

It has been shown that in the ^{6}Li /p,pd/ ^{4}He reaction at intermediate energies the dominating mechanism is the auasi-free scattering of protons on quasi-deuterons. In the case when two p-shell nucleons are involved in the interaction, the momentum distribution of the recoil alpha particle measured at large angle scattering geometry is wider than predicted by the theory using realistic intercluster wave functions with correct exponential asymptotics. Three-body calculations, however, give momentum

+ Joint Institute of Nuclear Research, Dubna, USSR

distribution in excellent agreement with experiment indicating that /p,pd/ reactions may provide detailed informations on the two-nucleon wave functions in nuclei. Interactions followed by disintegration of the residual nucleus has also quasi-free scattering character and can be interpreted as scattering on the deuteron component of the alpha-core.

D. Albrecht, J. Erő, Z. Fodor, I. Hernyes, Hong Sung Mu, B.A. Khomenko, N.N. Khovanskij, Z.V. Krumstein, Yu.P. Merekov, V.I. Petrukhin and Z. Seres

Investigation of the /p,nd/ reaction on ^{6}Li and ^{7}Li at 670 MeV.
Preprint JINR, D1-11843 /1978/ Nucl.Phys. A 322 /1979/ 512

D. Albrecht, M. Csatlós, J. Erő, Z. Fodor, I. Hernyes, Hong Sung Mu, B.A. Khomenko, N.N. Khovanskij, P. Koncz, Z.V. Krumstein, Yu.P. Merekov, V.I. Petrukhin, Z. Seres and L. Végh

Large-angle quasi-free scattering in ^{6}Li /p,pd/ ^{4}He at 670 MeV.
Preprint JINR, E1-12727 /1979/; Nucl.Phys. A 338 /1980/ 477

L. Végh

On the elastic pd and quasi free A /p,Nd/ B scattering at intermediate energies.
Preprint JINR, E2-12369 /1979/; J.Phys. G:Nucl.Phys. 5 /1979/ L 121

L. Végh and J. Erő

The $d\sigma$/p,p'd/ / $d\sigma$/p,nd/ ratio for ^{7}Li at T_p=670 MeV
Calculated in a simple model
Preprint JINR, E2=12675 /1979/ J.Phys.G: Nucl.Phys. 5 /1979/ L 227

Mössbauer and positon annihilation studies of amorphous metals

Khalid Al Ani[+], J. Balogh, Á. Cziráky[++], I. Dézsi, B. Fogarassy, L. Gránásy, T. Kemény, D.L. Nagy, A.S. Schaafsma[+++], M. Tegze, I. Vincze, F. van der Woude[+++]

For the investigation of the kinetics of the first step in the crystallization process of Fe-B system, $Fe_{83}B_{17}$ samples were heat treated in a calorimeter at different temperatures. The amount of α-Fe precipitates in the partly crystalline alloys were determined by Mössbauer spectroscopy.
We began to study the effect of the transition metal and metalloid substitution on the short range order in the Fe-B system. A systematic study of Fe-Ni-B alloys showed that below a critical Ni content the hyperfine field distributions are practically identical, but a significant narrowing occurs at high Ni content. This type of behaviour contradicts to the predictions of all kind of dense random packed structure models and gives a further justification of the prominent role of short range order in the structure of amorphous alloys. Identification of the crystalline products at different concentrations is in progress. Investigations on Fe-B-C system were begun. The first results show that there is no significant change in the hyperfine field distribution of the $Fe_{84}B_6C_{10}$ alloy compared to $Fe_{84}B_{16}$ sample. Crystalline product is Fe_3 /B,C/ with cementite structure even at 2 at.% carbon content.

No marked difference between the amorphous and the crystallized Fe-B samples has been found by positron annihilation measurements performed at room temperature.

+ Nuclear Research Institute, Baghdad, Iraq
++ Roland Eötvös University of Science, Budapest, Hungary
+++ Solid State Physics Laboratory, Materials Science Center, University of Groningen, The Netherlands

J. Balogh, I. Vincze: Temperature dependence of the hyperfine field distribution in an amorphous ferromagnet.
Solid State Commun. 25, 695 /1978/

J. Balogh, I. Dézsi, B. Fogarassy, L. Gránásy, D.L. Nagy, I. Vincze: Influence of Atomic Substitution on Short Range Order in Amorphous $Fe_{84}B_{16-x}C_x$ Alloys.
J.de Physique, 41 /1980/ C1-253

I. Vincze, F. van der Woude , J. Balogh:
Short Range Order in Transition Metal-Metalloid Glasses.
J.de Physique 41 /1980/ C1-257

M. Tegze, J. Balogh, T. Kemény, A.S. Schaafsma , I. Vincze, F.van der Woude ; Comparision of the Short Range Order of Amorphous and Crystalline /Fe,Ni/B Alloys. J.de Physique 41 /1980/ C1-255

Empirical continuation of the differential cross section

I. Borbély

J. Phys. G: Nucl. Phys., 5 /1979/ 937-959

The theoretical basis as well as the practical methods of empirical continuation of the differential cross section into the nonphysical region of the cos Ø variable are discussed. The equivalence of the different methods is proved. A physical applicability condition is given and the published applications are reviewed. In many cases the correctly applied procedure turns out to provide nonsignificant or even incorrect structure information which points to the necessity for careful and statistically complete analysis of the experimental data with a physical understanding of the process analysed.

THREE-BODY MOLECULAR DESCRIPTION OF ^{9}Be /I/. Born-Oppenheimer approximation

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Joint Institute for Nuclear Research, Dubna, USSR

Nuclear Physics A 326 /1979/ 182-192

A three-cluster model composed of two α-particles and a neutron is used to describe the low-lying spectrum of ^{9}Be. The resulting three-body problem is solved by the Born-Oppenheimer method for different two-body n-α and α-α potentials. Molecular energy curves are obtained that explain the binding mechanisms leading to both the ground state and first excited state of ^{9}Be.

+ Supported by the US Department of Energy.

++ On leave from JINR /Dubna, USSR/ and CRIP /Budapest, Hungary/.

THREE-BODY MOLECULAR DESCRIPTION OF ^{9}Be.

II. Adiabatic One-Level Approximation with Correct Angular Momentum

J. Revai, A.V. Matveenko

E4-12394

The low lying spectrum of the ^{9}Be nucleus is calculated in an $\alpha + \alpha + n$ three-body model. The molecular approach to this three-body problem based on the exact evalution of the two-center wave functions for separable $n-\alpha$ potentials is considered in detail. The numerical results are obtained in a generalized Born-Oppenheimer approximation which preserves total angular momentum and parity.

The investigation has been performed at the Laboratory of Theoretical Physics, JINR.

SIMPLE MODELS FOR ALMOST CENTRAL ASYMMETRIC HEAVY-ION COLLISIONS At MODERATE ENERGIES

L.P. Csernai, G. Fái

KFKI- 1979-66

The process when a light projectile is colliding almost centrally with a heavy target is described by one-dimensional hydrodynamical model and by a phenomenological model.

VISCOUS HYDRODYNAMICAL MODEL FOR RELATIVISTIC HEAVY-ION REACTIONS

L. P. Csernai, B. Lukács

KFKI- 1979-58

In one-dimensional hydrodynamical model the dynamics of heavy-ion collision is described. The density and temperature increase and the width of the evolving shock front is evaluated in the initial phase. The differential cross section and the rapidity spectrum of the nucleons emitted from the explosion, caused both by the flow and by the thermal energy, is calculated. The description of phase transitions occurring in shock waves is also discussed.

A New Method for Calculation of Eigenstates for a System of a Core and Two Valence Nucleons

F. A. Gareev,[1] S.N. Ershov,[1] J. Revai,[1+]
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2. The Niels Bohr Institute, University of Copenhagen, DK-2100 Copenhagen Ø Denmark

Physica Scripta. 19 /1979/ 509 515

A method for calculation of eigenvalues and eigenstates for a system of a core and two valence nucleons is suggested. It consists of approximating the potential by a sum of separable terms, for which the Lippman-Schwinger equation is solved exacty. The wave functions have the exact "three-particle" asymptotic form, and approximate the "two-particle" asymptotics.

+ On leave from the Central Research Institute for Physics Budapest, Hungary

HADRON CHEMISTRY IN HEAVY ION COLLISIONS

I. Montvay and J. Zimányi

Nuclear Physics A 316 /1979/ 490-508.

The relaxation times necessary to establish chemical equilibrium among different hadrons in hot, dense hadronic matter are investigated in a statistical model. Consequences for heavy ion collisions are exploited in the framework of a simple reaction model. The possibility of Bose-Einstein pion condensation around the break-up time of the nuclear fireball is pointed out.

"BOSE-EINSTEIN CONDENSATION" OF PIONS IN ENERGETIC HEAVY ION COLLISIONS?

J. Zimányi, G. Fái, B. Jakobsson

KFKI-1979-23

Experimentally observable consequences of a possible "Bose-Einstein condensation" of pions in energetic heavy ion collisions are demonstrated. An excess of low energy pions in recent data may indicate a Bose-Einstein condensation-like phenomenon.

ATOMIC ENERGY RESEARCH INSTITUTE

OF THE CENTRAL RESEARCH INSTITUTE FOR PHYSICS

The Atomic Energy Research Institute of the Central Research Institute for Physics is not involved in nuclear physics measurements, data analysis and evaluation activities. However, different evaluated nuclear data files distributed by the IAEA are processed and used for the preparation of multigroup constant libraries applied in reactor physics calculations. These activities are organized in cooperation with other institutes of CMEA countries.

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Experimental facilities

1. Irradiation facility with 3.7 PBq /100 kCi/^{60}Co for large samples with dose rate of 26 kGy/h /3 MR/h/ in air
2. Irradiation facility with 1.85 PBq /50 kCi/^{60}Co for small samples with dose rate 0.286 MGy/h/33 MR/h/ in air
3. 6 MeV transportable betatron
4. 4000 channel analyser /8180, Canberra/
5. 4000 channel analyser /ICA, KFKI/
6. 1000 channel analyser /NTA 1024, EMG/
7. Computer /TPAi, KFKI/
8. Ge /Li/ detector 30 cm^3 /Canberra/
9. Ge /Li/ detector 60 cm^3 /Canberra/
10. NaI/Tl/ low background detector /Nuclear Enterprises/ ∅ 5"x5" in 20 cm iron shielding with a background index 0.3 cpm/cm^3
11. Fast neutron beam of the VVRS-M type Research Reactor of Central Research Institute of Physics for (n,n'γ) reaction studies.

Determination of certain element content by gamma activation analysis.

A. Veres, I. Pavlicsek

Using the isomeric activation reaction $(\gamma,\gamma')A^*$ where A is the nucleus and A^* is its isomer, a rapid method is available for the determination of Se, Br, Sr, Ag, Cd, In, Hf, Ir, Au, Pt, Er content of samples investigated with max. volume of 5 cm^3. A γ-irradiation facility was developed in which a 1.11 PBq /30 kCi/^{60}Co

source was arranged so that the γ-flux density at the irradiation point was about $10^{13} cm^{-2} s^{-1}$. The silver content of coins of Roman and other origin has been investigated. We studied, for example, a 1.4 g gold commemorative medal with the inscription "Wolfgang Amadeus Mozart 1756-1791". The irradiation time was 30 s, the measurement time was 15 s repeated many times. After 50 cycles about 5100 count were obtained over 600 background counts. In order to calculate absorption, self-absorption and other corrections adequate gold and silver reference samples were preparated for each type of coin.

INVESTIGATION OF THE NUCLEUS ^{100}Mo BY MEANS OF ANGULAR DISTRIBUTION MEASUREMENT OF GAMMA-RAYS FROM THE (n,n'γ) REACTION

G. Molnár, I. Diószegi, B. Fazekas and Á. Veres

The investigation of the nucleus ^{100}Mo is the first step of a research program aimed at the study of transitional nuclei in the A=100 mass region.

Angular distribution measurements of the γ-rays from the fast neutron induced (n,n'γ) reaction were carried out on monoisotopic ^{100}Mo. From the analysis of the angular distributions spin/parity values of several levels and multipole mixing ratios of some γ-ray transitions were obtained.

One of the most interesting results is the discovery of an extremely low-lying 0^+ excited state of mostly two-quasiparticle origin which may be the band head of a still unknown β-rotational band. The multipole mixing ratio E2/M1 obtained for the transition between the first and the second excited 2^+ states follows the systematics predicted from the experimental values of this ratio for other Mo isotopes.

This work is still in progress.

GAMMA-RAY TRANSITIONS IN ^{100}Mo FROM THE FAST-NEUTRON--INDUCED /n,n'gamma/ REACTIONS

G. Molnár, I. Diószegi and Á. Veres

Structure of Medium-Heavy Nuclei 1979,
Conference Series Number 49, The Institute of Physics,
Bristol and London, 1979,

The first results of an (n,n'γ) experiment carried out at the 5 MW reactor of the CRIP are reported.

The energies and intensities of the gamma-ray transitions observed at 90° angle to the incident neutron beam are given. Twenty-seven transitions were observed for the first time. To place these transitions in the level scheme, several new levels had to be introduced.

INSTITUTE OF NUCLEAR RESEARCH
OF THE HUNGARIAN ACADEMY OF SCIENCES

DEBRECEN

EXPERIMENTATION FACILITIES

1./ A Van de Graaff accelerator with 5 MV nominal voltage, used with proton- deuteron- alpha- and heavy ion beams. The measuring center of the accelerator is equipped with a Nuclear Data 50/50 data acquisition and handling system, coupled to a PDP 11/40 computer.

2./ A Van de Graaff accelerator with 1 MV nominal voltage.

3./ In-beam superconducting magnetic spectrometer for investigation of electron conversion.

4./ In-beam electrostatic spectrometer to study inner shell ionisation phenomena induced by charged particles.

5./ A Cockroft-Walton accelerator up to a voltage of 700 kV. This accelerator is applied to generate proton- deuteron- and electron beams for reaction studies for irradiation purposes and for inner shell ionisation investigations.

6./ Neutron generator
to produce D+D neutrons at a voltage of 150 kV, with a maximal D^+ ion current of 500 μA /analysed beam/.

7./ Electrostatic electron spectrometers for ESCA studies

8./ Computer facilities include a PDP 11/40 computer. Access to a CDC 3300 computer is made possible through a fully equipped UT-200 terminal.

9./ Beta-, gamma- and X-ray spectrometers of different types are available in the Institute to carry out investigations in different fields of nuclear spectroscopy and its applications, including research in other branches of science and practical applications.

SEARCH FOR FOUR-NUCLEON CORRELATION IN ^{28}Si

J. Cseh

ATOMKI Közlemények 22. No.2.

A group of 0^+ states in ^{28}Si near 13 MeV were found. The fact that they are seen only in α -scattering measurements is considered as an indication of strong four-nucleon correlation in these states.

STUDY OF EXCITED STATES OF ^{96}Nb IN THE ^{96}Zr(p,nγ)^{96}Nb REACTIONS

Gulyás, J., Dombrádi, Zs., Zolnai, L., Krasznahorkay, A., Fényes, T.

Izv. AN SSSR, ser. fiz. 44, 129 /1980/.

Key words: Nuclear reactions ^{96}Zr(p,nγ)^{96}Nb, E_p=1.6, 2.7, 3.3 MeV; measured E_γ, I_γ, γγ -coincidences. ^{96}Nb deduced levels. J, π, γ - branching. Enriched target, Ge/Li/ and low energy /hyperpure Ge/ γ -spectrometers.

EXCITED LEVELS OF ^{94}Nb FROM ^{94}Zr(p,nγ)^{94}Nb REACTION

Gulyás, J., Dombrádi, Zs., Koltay, E., Krasznahorkay, A.,

To be published in Izv. AN SSSR, ser. fiz.

Key words: Nuclear reactions ^{94}Zr(p nγ)^{94}Nb, E_p=2.7 and 3.3 MeV; measured E_γ, I_γ. ^{94}Nb deduced levels. J, π, γ-branching. Enriched target, Ge/Li/ and low energy /hyper-pure Ge/ γ-spectrometers.

IN-BEAM NUCLEAR STRUCTURE STUDIES IN THE A~100 REGION

T. Fényes

Proc. Int. Symp. "Future Directions in Studies of Nuclei far from Stability", Nashville, Tennessee, September 10--13, 1979. Nort Holl. Publ., Amsterdam

A short survey is given about the work performed by the Nuclear Spectroscopy Research Group of the Institute in the last few years. The nuclei under investigation (^{97,98,100}Tc and ^{94,96}Nb) were produced via (p,n) reactions from enriched targets. The γ-, $\gamma\gamma$-coincidence, and conversion electron spectra of the reactions were taken with Ge/Li/, "thin-window" hyperpure Ge, and superconducting magnet transporter Si/Li/ spectrometers. The energies and the intensities of the observed radiations as well as the excitation functions of the reactions were measured. Level schemes; multipolarities of transitions; energies, spins, and parities of nuclear levels have been deduced. The level schemes have been compared with the results of recent shell model calculations.

ANGULAR DISTRIBUTIONS OF THE p_1 GROUP FROM THE REACTION $^{10}B(\alpha,p_1\gamma)^{13}C$ IN THE $2.6 \leq E \leq 3.1$ MeV ENERGY REGION OBTAINED BY SHAPE STUDIES OF THE DOPPLER BROADENED GAMMA-LINE

Á. Kiss, E. Koltay, B. Nyakó, E. Pintye, Gy. Szabó

Using conventional techniques the determination of angular distributions of the p_1 group from the reaction $^{10}B(\alpha,p)^{13}C$ is difficult because of unseparable background peaks in the spectra. The application of the line shape angular distribution method based on the line shape study of the Doppler-broadened 3.09 MeV gamma-line of ^{13}C gives a possibility to determine the angular distribution of the proton group in question.

In this work 22 angular distributions of the emitted protons from the reaction $^{10}B(\alpha,p_1)^{13}C$ in the alpha energy range 2.56 to 3.06 MeV are presented. R-matrix analysis of the obtained energy dependence of Legendre-ccefficients to determine the parameters of the E_x= 13.66, 13.72 and 13.76 MeV levels is in course.

GETTING COINCIDENCE INFORMATION FROM ANALYSIS OF SUM PEAKS IN SINGLE Ge/Li/ SPECTRA

I. Török, I. Uray, P.Bornemisza-Pauspertl, P. Kovács

to be published in Nuclear Instruments and Methods

Analysis of sum peaks from a single spectrum obtained from large volume Ge/Li/ detector in many cases gives more coincidence information, than traditional two-detector coincidence measurements. Approximate methods are given to get and use coincidence information from sum peaks of a single spectrum. Comparisons are given between traditional two detector coincidence and sum peak analysis methods for getting coincidence information. The possibilities and limitations of the sum peak analysis method are discussed, illustrated by different measurements as examples.

SYSTEMATIC INVESTIGATIONS ON LIFETIMES OF SOME ^{14}N STATES IN THE $^{13}C/p,\gamma/^{14}N$ REACTION

M.S. Antony*, Á. Kiss, E. Koltay, B. Nyakó, Gy. Szabó

to be published in Izv.Akad.Nauk S.S.S.R. Ser. Fiz.

Lifetimes of the E_x= 2.312, 3.947, 5.690, 6.204 MeV states in ^{14}N have been measured by the attenuated Doppler shift method in the reaction $^{13}C/p,\gamma/^{14}N$ at E_p= 1.15 MeV using Ti, Mo, Ni, Cu, Ag, Ta, Au and W backings. Both $F/\tau/$ and line-shape analysis were carried out. The results show systematic dependence of the lifetimes on the slowing down time of the recoiled nuclei in different backing materials.

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ACTIVATION CROSS-SECTIONS OF Os-ISOTOPES FOR SOME REACTIONS WITH 14.7 MeV NEUTRONS

P. Bornemisza-Pauspertl and P. Hille *

Using the activation technique, 14.7 MeV neutron cross sections of Os-isotopes were measured. Induced γ-activities were counted with a calibrated Ge/Li/-spectrometer. Cross-sections are given relative to $\sigma^{27}Al(n,\alpha)$ = =112 mb; $\sigma^{184}Os(n,2n)^{183g}Os$= 1449±99 mb; $\sigma^{184}Os(n,2n)^{183m}Os$= = 488±39 mb; $\sigma^{186}Os(n,2n)^{185}Os$= 2004±120 mb; $\sigma^{190}Os(n,\alpha)^{187}W$= = 0.82±0.06 mb; $\sigma^{190}Os(n,n')^{190m}Os$= 11±1.1 mb.
The total (n,2n) -cross-sections found agree with theoretical estimates, but disagree with smaller values given in the literature.

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INVESTIGATION OF THE EXCITED STATES OF ^{23}Na IN (α,α), (α,p) AND (α,γ) REACTIONS

J. Cseh, E. Koltay, Z. Máté, E. Somorjai, L. Zolnai

The levels of ^{23}Na were investigated in the excitation energy range between 11.5 and 13.5 MeV in the reactions $^{19}F(\alpha,\alpha)^{19}F$, $^{19}F(\alpha,p)^{22}Ne$ and $^{19}F(\alpha,\gamma)^{23}Na$.

The experiments were performed on the beam of the 5 MeV Van de Graaff mashine here. The differential cross sections for charged particle exit channels were detected by surface-barrier detectors at the 90°, 125.3°, 140.8°, 149.5° and 172.1° C.M. degrees. Simultaneous γ excitation function was measured with a NaI crystal. At some resonances below the neutron threshold γ-spectra were taken with a 80 cc. GeLi detector.

The experimental excitation functions of the (α,γ) and (α,p) reactions are compared with the prediction of a multi-level multi-channel R-matrix code. The resonance parameters are found as the result of a fitting procedure. The analysis is in progress.

EXCITED STATES OF ^{28}Si IN REACTIONS (α,α) AND (α,γ)

J. Cseh, E. Koltay, Z. Máté, E. Somorjai, L. Zolnai

The ^{28}Si excited states were experimentally examined by the reactions $^{24}Mg(\alpha,\alpha)^{24}Mg$ and $^{24}Mg(\alpha,\gamma)^{28}Si$ in the bombarding energy range of 3.15-5 MeV.

The experiments were performed on the 5 MV Van de Graaff generator of our institute.

The differential cross sections in the (α,α) reaction were simultaneously measured by silicon surface-barrier detectors at the angles /c.m./ 90°, 125.3°, 140.5°, 149.5° and 167°.

In the (α,γ) reaction excitation function, on--resonance spectrum and angular distribution measurements were performed using large volume NaI and GeLi detectors.

The experimental (α,α) excitation functions were compared with those computed by a multi-level multi-channel R-matrix code.

The resonance parameters are found as the result of a fitting procedure. The data obtained from the (α,α) scattering are completed by the ones from the (α,γ) reaction.

The analysis is in progress.

INSTITUT OF EXPERIMENTAL PHYSICS

KOSSUTH UNIVERSITY

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EXPERIMENTAL FACILITIES

1. A 0.2 mg Cf-252 /fission/ neutron source;
2. 200 kV /2 mA/ neutron generator /home made/ with analysed beam;
3. 180 kV /1.2 mA/ Activatron-111 neutron generator, it can be pulsed, pulse period: down to 10 microsec;
4. 280 kV neutron generator with time-of-flight system for fast neutrons based on klystron bunching method;
5. Pu-Be neutron sources from 0.1 to 5 Ci;
6. 28, 30 and 40 cm^3 Ge/Li/ detectors, HP-Ge and Si/Li/ spectrometers;
7. 4000 channel DIDAC /Intertechnique/ analyser and MULTI-20 Plurimat N data processing system with magnetic tape; AI-1024 type MCA; 1024 channel Canberra analyser;
8. Low-backgorund proportional counter for measuring weak beta and/or gamma rays, e.g. tritium, with a sensitivity of a few pCi; $4\pi/p$ flow gas counter.

MEASUREMENT OF THE EXCITATION FUNCTION FOR THE $^{238}U/n,2n/$ REACTION

P. Raics, S. Nagy, S. Daróczy, J. Csikai

and

N.V. Kornilov,[x] B.V. Zhuravlev,[x] O.A. Salnikov[x]

Cross sections of the $^{238}U/n,2n/^{237}U$ reaction have been determined by the activation method at 15 different neutron energies. Neutrons with energies in the range of 6.54-10.50 MeV were produced via the $D/d,n/^{3}He$ reaction on the EGP-10M tandem generator /FEI, Obninsk/ using a 40 mm long gas target [1], while in the range of 13.54-14.76 MeV via the $T/d,n/^{4}He$ reaction on the NG-200 neutron generator /IEP, Debrecen/ using air cooled solid TiT target on Mo-backing [2]. The neutron flux density was measured in the lower energy region by the $^{238}U/n,f/$ reaction using a small fission chamber as well as by the $^{27}Al/n,\alpha/^{24}Na$ and $^{56}Fe/n,p/^{56}Mn$ reactions using the activation method; while in the higher energy region by the $^{27}Al/n,\alpha/^{24}Na$ reaction. The results of this later experiment are in good agreement with those of an earlier one, in which a water cooled TiT target was used for the irradiations and the neutron flux densities were measured by activation technique using different threshold reactions to take the scattered neutrons into account [3, 4].

The gamma-spectra of the irradiated uranium oxide samples /2-3 g, 19 mm diameter/ were measured by absolutely

calibrated Ge/Li/ detectors, the spectra and the decay curves were analysed by computer. The results of the present experiment are given in Table 1.

Table 1.

$E_n \pm \Delta E_n$ MeV / E_n:68 % /	σ/n,2n/ mbarn
$6.54^{+0.09}_{-0.07}$	72± 5
$6.78^{+0.08}_{-0.06}$	251±13
$7.00^{+0.10}_{-0.07}$	402±18
$7.50^{+0.10}_{-0.07}$	831±30
$7.99^{+0.10}_{-0.08}$	1077±31
$8.50^{+0.10}_{-0.08}$	1244±41
$8.99^{+0.10}_{-0.08}$	1344±35
$9.49^{+}_{-}0.08$	1371±36
10.00±0.08	1413±37
10.50±0.08	1466±63
13.54±0.11	1066±48
13.76±0.10	997±45
$14.10^{+0.10}_{-0.12}$	873±40
14.42±0.11	780±35
$14.76^{+0.14}_{-0.17}$	678±30

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[x] Fiziko-Energeticheskij Institut, Obninsk, USSR.

[1] N.V. Kornilov et al., Measurement of cross sections for the $^{238}U/n,2n/$ reaction from 6.5 to 10.5 MeV, presented on the IX. Symposium on Interaction of Fast Neutrons with Nuclei, 26-30 Nov. 1979, Gaussig /GDR/, to be published in the proc. in a ZfK report; and to be published in Atomnaya Energiya

[2] P. Raics et al., to be published

[3] P. Raics, Investigation of the $^{238}U/n,2n/^{237}U$ reaction around 14 MeV and its application to the determination of the $^{238}U/^{235}U$ ratio, /thesis, Kossuth Univ, Debrecen, Hungary, 1978, in Hungarian/

[4] P. Raics, S.Daróczy, S. Nagy, Effect of scattered neutrons in the 14 MeV reaction cross sections determined by the activation method, publ. as ref.1.

SHELL EFFECTS IN NUCLEAR RADII AND BINDING ENERGIES

I. Angeli

Shell effects in binding energies are directly connected to those in nuclear radii. This offers the possibility of predicting /relative/ radii. The connection follows automatically if the fine structure in nuclear radii is introduced into a binding energy formula.

Reference:

I.Angeli, Physics Letters, 82B /1979/ 313.

/n,t/ CROSS-SECTION MEASUREMENTS FOR ^{9}Be AT AROUND 14 MeV

F. Cserpák and J. Csikai

To follow the systematic investigations for the determination of gross trends in the /n,t/ cross sections, measurements were carried out to obtain the excitation function of the ^{9}Be /n,t/^{7}Li process. Vacuum extraction and tritium beta counting method was used. The results are the followings:

E_n/MeV/ /bombarding energy/	/mb/ Total cross section
13.52	15.5±2.5
13.75	16.0±2.5
14.12	19.1±2.6
14.45	22.0±2.8
14.71	18.9± ?
14.80	22.6±3.4

The cross section at 14.8 MeV well coincide with that of Biró /20±4 mb/ and at 14.12 MeV with the result of Wyman /18.0±1.5 mb/. However, there is no agreement with the results of Benveniste et al. /1/. They measured only the partial cross section for the production of 0.478 MeV level in Li^7, but these cross sections are generally larger than the ours.

In the future we plan to repeat the measurements with improved precicion as well as to carry out calculation with the Hauser-Feshbach model.

1/ J.Benveniste et al. Nucl.Phys. 19 /1960/ 52.

LOW-ENERGY CROSS SECTIONS FOR $^{6}Li+d$ REACTIONS

J. Szabó, M. Várnagy and Z.T. Bődy

After measuring the $^{6}Li/d,n/^{7}Be$ reaction cross section $^{6}Li/d,\alpha/^{4}He$ and $^{6}Li/d,p/^{7}Li$ reaction cross sections have also been determined between 100 and 180 keV deuteron energy by means of direct detection of α's and protons using cellulose nitrate track detectors. Both reactions are important from the point of view of nuclear astrophysics as well as the development of controlled thermonuclear reactors /CTR/. Different methods of extrapolation were employed and compared down to the energy region of astrophysical interest.

References:

1/ J.Szabó, Z.T.Bődy, S.Szegedi and M.Várnagy; Nucl. Phys. A289 /1977/ 526

2/ Z.T.Bődy, S.Szabó and M.Várnagy; Nucl.Phys. A 330 /1979/ 495

3/ J.Szabó, M.Várnagy and Z.T.Bődy;Proc. VIIIth International Symposium on the Interaction of Fast Neutrons with Nuclei /Gaussig /GDR/ 13-17, Nov. 1978/, ZfK-382 /1979/p.185

4/ M.Várnagy, J.Szabó and Z.T.Bődy; Proc. 10th International Conference on Solid State Nuclear Track Detectors /Lyon, 2-7 July 1979/, Solid State Nuclear Track Detectors, Ed.H.Francois, Pergamon Press, Oxford, New York, 1980. p.881.

ATTEMPTS TO FIND A SYSTEMATICS FOR /n,2n/ EXCITATION FUNCTIONS

Z.T. Bödy

In order to describe /n,2n/ excitation functions, the Weisskopf formula

$$\sigma_{n,2n} = \sigma_0 \left[1 - \left(1 + \frac{\varepsilon}{T}\right) e^{-\frac{\varepsilon}{T}}\right], \quad \varepsilon = \frac{A}{A+1} E_n + Q_{n,2n}$$

was chosen and a search was made for a systematics for the parameters σ_0 and T.

It was found /1/ that a good reproduction of experimental data could be achived with

$$T_{odd\text{-}even} = \frac{6.7}{A^{1/3} N^{1/6}} \text{ /MeV/ for } 20 \leq A \leq 120,$$

where A is the mass number and $N = N_Z + N_N$ is the number of nucleons outside the closed shells /subshells/, and

$$T_{odd\text{-}even} = 1.16 \text{ /MeV/ for } 120 \leq A \leq 200.$$

Furthermore,

$$T_{even\text{-}even} = T_{odd\text{-}even} \quad /1 + 0.37 A^{-1/2}/$$

and

$$T_{odd\text{-}odd} = T_{odd\text{-}even} \quad /1 - 0.37\, A^{-1/2}/.$$

For calculating σ_0 the use of $\sigma_{n,2n}$ values at 14.7 MeV /2/ and the T values obtained before could be recommended.

The formula

$$\sigma_{n,2n} = \sigma_0 \left[1 - \frac{B(e)}{B(1)} \right]$$

$$B(e) = \sum_{l=0}^{K} \binom{K}{l} \frac{e^{2l+2}}{2l+2} \left(\frac{e^{2l+3}}{2l+3} + 1 - e \right), \quad e = \frac{|Q_{n,2n}|}{\varepsilon} \quad \text{with}$$

obtained as a statistical equilibrium limit in pre-equilibrium formalism has also been tested. It seems that this formula with fitted σ_0 and K cannot be distinguished from the Weisskopf formula within experimental errors. Here K is in close relation with the nuclear temperature, it is a linear function of 1/T.

1/ Z.T.Bődy, Proc. of VIIIth Internat. Symp. on Interaction of Fast Neutrons with Nuclei, Nov. 13-17, 1978. Gaussig /GDR/, ZfK-382 /1979/p.150.

2/ Z.T.Bődy, J.Csikai, Atomic Energy Rev. 11 /1973/153.

APPLICATION OF RADIOANALITICAL METHODS IN PETROLEUM CHEMISTRY

S.Szegedi, Á.Pázsit, Cs.M.Buczkó

The applicability of X-ray fluorescence method /XRA/ and thermal neutron activation analysis /NAA/ for the determination of Cl and S concentration in crude oils has been investigated. A ^{55}Fe exciting source and a Si/Li/ detector for X-ray fluorescence method as well as a 250 µg ^{252}Cf neutron source in water moderator and a Ge/Li/ detector for neutron activation analysis were used in the investigations. Sensitivity for Cl and S by XRA method is 0.02 w% and for Cl by NAA method 0.1 w%.