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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

PROGRESS REPORT FROM HUNGARY FOR 1987

Contributing Institutes:

Institute of Experimental Physics of Kossuth University, Debrecen
Institute of Nuclear Research, Debrecen
Central Research Institute for Physics, Budapest

June 1987

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

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INSTITUTE OF NUCLEAR RESEARCH

Debrecen

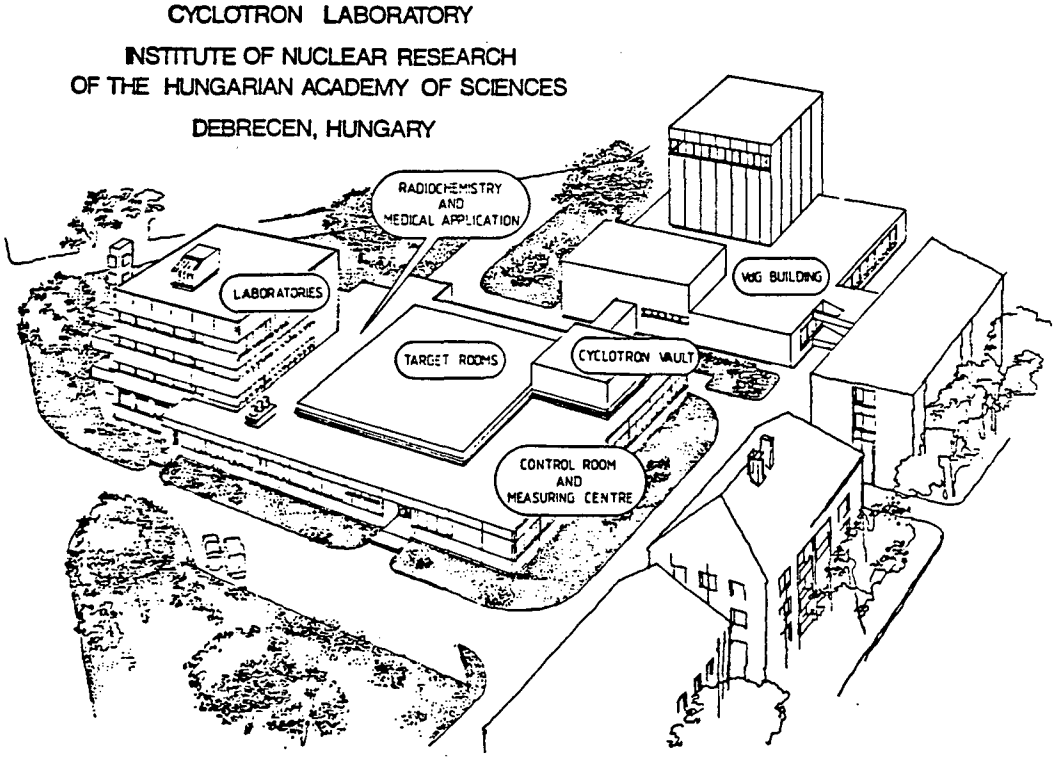
PROGRESS REPORT ON THE ACTIVITY OF CYCLOTRON LABORATORY OF ATOMKI

A. Valek

A new cyclotron laboratory, equipped with the compact cyclotron MGC-20E of Sovjet make has been put into operation in the Institute of Nuclear Research of the Hungarian Academy of Sciences in Debrecen at the end of 1985. The Figure below shows the perspectivic view of the laboratory building.

The cyclotron is used not only by the Institute of Nuclear Research, but other research and educational institutions as well. Presently ten basic and applied research projects are running: nuclear spectroscopy, nuclear reaction studies, nuclear life-time studies, atomic collisions, ion-atom collisions, isotope production, neutron source, analytical applications, neutron physics, elastic recoil detection.

It is planned to run the accelerator 4000 hours per year. As far as the research work and other activities are concerned one third of the total beam time is planned to be used for basic researches, one third for interdisciplinary researches and one third for applications.



^{40}Ar NUCLEUS STUDIED BY THE REACTION $^{36}S(\alpha,\gamma)^{40}$

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ABSTRACT

The properties of ^{40}Ar were known in some details up to 12 MeV except the energy range of 8.0 - 10.3 MeV where no experimental data had been available[1]. The $^{36}S(\alpha,\gamma)^{40}$Ar reaction with its Q-value of 6.8 MeV seemed to be a useful tool for studying highly excited states of ^{40}Ar in the above mentioned energy range. The nucleus ^{36}S has a low natural abundance (0.017 %) but the recent availability of highly enriched ^{36}S made possible the first investigation of the $^{36}S(\alpha,\gamma)^{40}$Ar reaction[2]. The energy and strength of 51 resonances and for 13 of them the decay scheme has been determined in the bombarding energy range E_α=2.3 to 3.55 MeV.

Recently, γ-ray angular distribution measurements were performed to determine the spin-parity values of 12 resonance levels. With the exception of one nonunique case, the J^π values proved to be 1^-. The dominance of E1 transitions might be a sign of a special mechanism of the reaction and a candidate for it is the population of a fragmented molecular state with core + α structure. In cases when the density and charge distribution is not the same this mechanism can produce E1 transition of considerable magnitude[3].

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2. M. Józsa, Á.Z. Kiss, E. Koltay, B. Nyakó, E. Somorjai, J. Keinonen, Nucl. Phys. A456, 365 (1986)
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ELASTIC SCATTERING OF ALPHA PARTICLES ON ^{62}Ni

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Absolute differential cross-sections for elastic scattering of α-particles on ^{62}Ni have been measured with the beams of the MGC cyclotrons of the Abo Academy and the Institute of Nuclear Research at bombarding energies 12.8, 13.7, 14.56, 16.34 and 18.13 MeV using standard surface barrier detectors. Thin evaporated self-supporting isotopically enriched ^{62}Ni (97.94%) targets were used .

The angular distributions were measured in steps of 4° between 20 and 168° and show the regular diffraction structure. The angular distribution at E_α=16.34 MeV is shown in figure 1. In this particular measurement the small solid angle of the detectors enabled to observe the well defined dips in the angular distribution.

The analysis of the data to get the low energy behaviour of the optical potential sets is in progress.

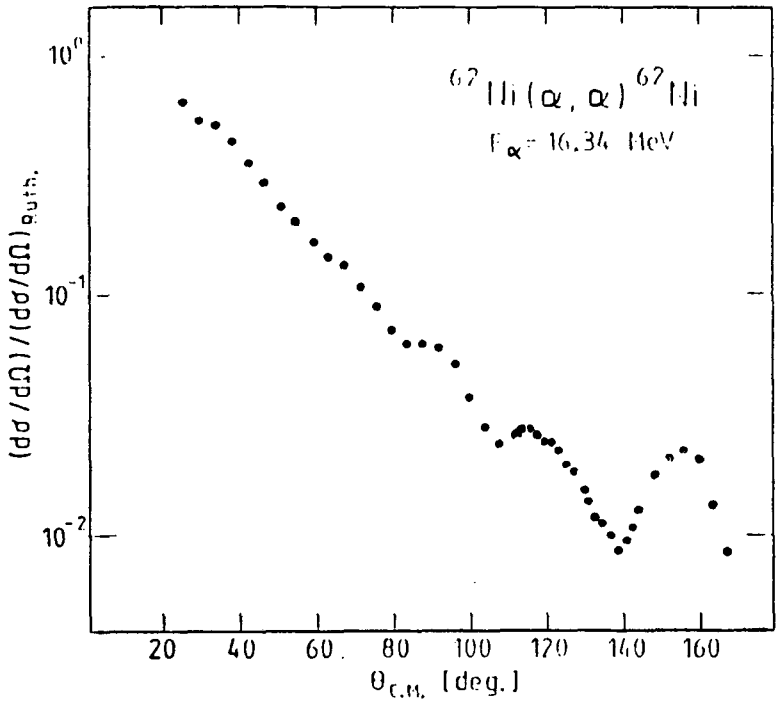

Fig. 1 Measured angular distribution of elastically scattered α-particles by ^{62}Ni at E_α=16.34 MeV.

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EXCITED STATES OF ^{110}In, ^{112}In AND ^{114}In OBSERVED IN (p,nγ) REACTIONS

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The γ-ray spectra of the ^{110}Cd(p,nγ)^{110}In, ^{112}Cd(p,nγ)^{112}In and ^{114}Cd(p,nγ)^{114}In reactions were measured with Ge(Li) and Ge(HP) spectrometers at different proton energies between 4.8 and 7.0 MeV. The energies and relative intensities of more than 90 transitions (including > 70 new ones) in ^{110}In, 50 transitions in ^{114}In and more than 170 γ-ray transitions in ^{114}In have been determined. The conversion electron spectra of the reactions were measured with a combined magnetic plus Si(Li) spectrometer. Internal-conversion coefficients of about 100 transitions were determined for the first time.

The level schemes of ^{110}In, ^{112}In and ^{114}In [1], γ-ray branching ratios, transition multipolarities, level energy, spin and parity values have been deduced. The energies of several ^{110}In, ^{112}In and ^{114}In [1] proton-neutron multiplet states were calculated on the basis of the parabolic rule derived from the cluster-vibration model. The comparison of experimental and theoretical results provided classification of many multiplet states.

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INSTITUTE OF EXPERIMENTAL PHYSICS

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Excitation functions for neutron energies up to 14 MeV on different targets important as construction materials

Recently, for the 7-10 MeV neutron energy range, the following excitation functions have been measured: $^{232}Th(n,2n)^{231}Th$[1], $^{239}Np(n,2n)^{236}Np(22.5h)$ [2,3], $^{58}Ni(n,p)^{58}Co$[4], $^{27}Al(n,\alpha)^{24}Na$[5,6], $^{27}Al(n,p)^{27}Mg$[5,6] and $^{28}Si(n,p)^{28}Al$[5,6]. In the next future, excitation functions will be measured up to about 14 MeV, first of all on targets which are important as construction materials or which are missing data in compilations, such as e.g.[7]. Some of there measurements were and will be done together with FEI, Obninsk, USSR.

[1] P.Raics et al., Phys.REv. C32 (1985)87

[2] N.V.Kornilov et al., IAEA-TECDOC-336, 1985, p.305 (Uppsala AGM)

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[7] V.Bychkov et al., Cross sections for neutron induced threshold reactions Moskva, Energoizdat, 1982 (in Russian)

(n,t) cross sections

Recently, a compilation of evaluation of (n,t) cross sections around 14 MeV was made[1], and the excitation function for triton emission on aluminum was measured up to 30 MeV[2]. At present, (n,t) cross sections are calculated by a modified STAPRE program for a number of targets[3]. These calculations are carried out together with FEI, Obninsk, and Joint Institute of Nuclear Research Dubna, both in USSR.

[1] Z.T.Bődy and K.Mihály, INDC(HUN)-22/L, February 1985

[2] R.Wölfle, S.Sudár and S.M.Qaim, Nucl.Sci.Eng., 91(1985) 162

[3] K.Mihály, priv. comm. February 1987.

(d,d) and (d,t) neutron energy and angular distributions

Simple expressions were given to calculate neutron energy and angular distributions in d+d and d+t reactions for the E_d=20-500 keV range. The results of there expressions were compared with measured and calculated thin and thick target energy and angular distributions of d+t neutrons [1,2]. Also, a simple method - based on the measurement of the former distributions - has been developed for the determination of the ratio of atomic and molecular ions in the deuteron beam[3].
At present, the determination of neutron energy distributions in a phantom using threshold reactions and "physical integration method" are in progress.

[1] J.Csikai et al., in Fast Neutron Physics, Proc. of Internat. Conf. in Dubrovnik, Yugoslavia, May 26-31, 1986, p.237

[2] J.Csikai et al., Investigations on the properties of d+d and d+t neutron sources,Advisory Group Meeting on Properties of Neutron Sources, Radium Khlopin Institute, Leningrad, USSR, 9-13 June, 1986

[3] J.Csikai et al., Nucl.Instr. and Meth., A239(1985)641

Fission fragment angular distribution measurements with an automatic JSC

Fission fragment angular distributions from the fast neutron induced fission of different Th, U and other transuran isotopes were[1] and will be measured at energies up to 14 MeV. Differential cross sections are also deduced. In the next future, the fission track evaluations with jumping spark counter (JSC)[2] will be automated. Two different mode of automatization are planned. First, a discrete, and second, a continous "groupping" of the tracks belonging to different angles of emission. The JSC will be controlled by a computer during the evaluation process.

[1] S.Ouichaoui, S.Juhász, M.Várnagy and J.Csikai; Angular distribution of fission fragments from ^{235}U, ^{238}U and ^{237}Np near the (n,2nf) threshold, Acta Phys.Hung. (in press)

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ENERGY AND ANGULAR DISTRIBUTION OF ^{252}Cf FISSION NEUTRONS IN THE LOW ENERGY RANGE

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Abstract

Angular and energy distribution of neutrons from spontaneous fission of Cf^{252} have been measured by a multiparameter time-of-flight spectrometer in the energy range from 50 keV up to 1.5 MeV. NE-912 glass detectors enriched in ^{6}Li at a distance of 350 mm from the target have been used for neutron detection. The fission fragments have been detected by two parallel -plate avalanche detectors, one of which, 5 mm far from the target gives the stop signal, while the other 35x180 mm large position sensitive detector at 72 mm far from the source divided into 36 segments of 4.5 mm width records the direction of fragment's flight. The distance between the two avalanche detectors, a flight path of 67 mm serves the distinction between the light and heavy fragments. The angular distribution of neutrons have been measured by a $\Delta\theta=6.5^{\circ}$ resolution in the 0°-180° region. The effect of scattered neutrons and delayed gamma-rays have been measured.

Evaluation of the measured data and theoretical calculations are in progress.