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PROGRESS REPORT TO EANDC FROM AUSTRIA

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P. Weinzierl, Editor

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ATOMINSTITUT DER ÖSTERREICHISCHEN HOCHSCHULEN, VIENNA

1. Cross Sections

1.1. The activation cross section of several nuclides for neutrons of intermediate energies
F. Bensch, H Ledermann (to be published)

The activation cross section of Au-197, Ho-165, Dy-164, and Sm-152 has been measured absolutely by means of photoneutron sources within the range 24 keV $\stackrel{<}{=} E \stackrel{\leq}{=} 974$ keV. The results for Au-197 are in good agreement with reference values. The results for Ho-165 and Dy-164 complete literature data. The cross section values of Sm-152 have been requested in the RENDA compilation, no appropriate Sm-152 data were available previously.

The neutron energy E_n is given in keV, the activation cross section 5 in millibarn, and the total error in %.

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	En	24	138	264	378	974
Au-197	õ	685	298	227	201	96
	%	7.0	9.5	7.0	33.0	10.5
	5	1492	643	330	314	134
Ho-165						
	%	6.5	8.5	7.0	31.5	11.0
	6	386	160	145	199	102
Dy-164						
-	50	6.Û	19.5	8.5	28.0	16.0
	ő	569	307	195		122
Sm-152						
	%	8.0	12.0	8.0		12.5

1.2. The (**y**,n)-cross section of beryllium and deuterium near the threshold energy

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F.Bensch, F.Vesely
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(to be published)

In a previous publication, the yield factors/^Uw of several

photoneutron sources have been measured It is possible to derive the (γ, n) -cross sections according to the experimental quantities μ_{w} .

The gamma energy Ey is given in MeV, the (y,n)-cross section δ_{yn} in 10^{-28} cm², and the total error in %.

beryllium	Eŗ	ð _ö n		
		this work	JAKOBSON 1961	
	1.692	12.62 <u>+</u> 3%	11.6 <u>+</u> 9%	
	2,086	2.81 <u>+</u> 4.5%	3.0 <u>+</u> 10%	
	2.754	5.51 <u>+</u> 3%	6.0 <u>+</u> 10%	
deuterium		0 En		
-		this work	SNELL 1950	
	2.504	9.26 <u>+</u> 3%	10.6 + 10%	
	2.754	13.35 <u>+</u> 3%	14.3 ± 7.5%	

2. Neutron Spectrometry

2.1 Spin-flip-selector and spin-flip-chopper

H. Rauch, H. Freisleben, R.Papp, J. Kostinek (Proc. Instr. Inel. Neutr Scatt. Research, p. 181, 14.24, Vience 1970, Nucl. Instr a. Meth, 2 papers in print) The development of the spin-flip-chopper which produces a pulsed neutron beam behind the analyzer of a polarized neutron spectrometer by means of purely electronical methods, was continued with an improved experimental set-up. Pulse repetition rates up to 25 kc, arbitrary duty cycles and high peak intensity are produced The electronic system provides that the resolution $(4^{-1}, 2^{-2})$ is determined by the double Bragg-reflection only.

The spin-flip-selector consists of two spin-flip choppers running at a distinct distance with an adjustable phase difference. Such an instrument has an extremely high resolution $20 - 10^{-4}$ and avoids the division of the intensity in many time channels. The combination of these electronical chopper methods with the statistical- and Fouriermethod is planned. 2.2 Double chopper spectrometer for cold neutrons G P Westphal, H Rauch, G Breitfuss (Nucl Instr a. Meth, in print)

This device is designed for the wave-length range from 4 to 16 Å and consists of two phased triple-slotted choppers with divergent slits. The active rotor part is made of laminated epoxy with a high content of boron and Gd_2O_3 which provides good shielding properties against unwanted background The rotor diameter is 30 cm and the chopper is tested for 3000 to 12000 rev./min The wave length resolution can be changed from 2,7 to 15 %. The phase stability of the system is better than 0,04 degree. The device is proposed for use in solid and liquid state research.

2.3. Neutron reflection properties of bent single crystals
W. Karas, H. Rauch, E. Seidl (phys. stat. solidi a 5, 2 (1971)

The effect of plastic deformation by bending on the rocking curves of lead single crystals was investigated by means of two axis crystal spectrometer The mosaic spreads were calculated by taking into account the experimental broædering and the effect of secondary extinction A kind of hysteresis for the mosaic spread was observed when the crystals were re-bent

2.4. Magnetic reflection on MnO near the Néel point H Rauch, H Bauer (work in progress)

The elastic magnetic Bragg-reflection at a MnO single crystal near the antiferromagnetic transition point is measured with a two axis spectrometer to investigate the grain dependence and the influence of internal stresses. The extinction effects are corrected by a complicated computer calculation.

2.5 Neutron focusing and total reflection H Rauch, M Friedmann, E. Nussbaum (Nucl. Instr a. Meth <u>86</u>, (1970) 55; Atomkernenergie <u>15</u> (1970) 275)

The focusing action of a totally reflecting multichannel

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arrangement was tested for cold and thermal neutrons. The channels (40 pieces) have a curvature of 40 m and lengths varying between 53 and 157 cm. At the focal area a marked intensity gain is obtained.

A work concerning the neutron total reflection at plane Bloch walls is in progress.

2.6. Neutron diffraction on a ruled grating and coherence properties H. Rauch, A. Graf, H. Kurz (work in progress)

Continuing an earlier work on this subject (2.f. Phys. 220 (1969) 419), measurements concerning the cold neutron diffraction on various ruled Ni-gratings were performed to investigate the reflection properties of such lattices and the coherence properties of the neutron wave. Some calculations based on the dynamical scattering theory are done for the development of a neutron interferrometer similar to a Laue-Fall interferrometer known in X-ray interferrometry.

2.7. Diffraction of cold neutrons by the flux lines of type II superconductors H.W. Weber, H. Rauch

(work in progress)

To obtain the lattice parameter and further information on the internal structure of the magnetic flux lines in superconductors the small angle Bragg diffraction on very pure Nb- and V single and polycrystals is measured. The results will be used for a critical comparison with the theory of the mixed state.

3. Neutron Detectors

3.1. Position sensitive P¹⁰F₃ detector G.P. Westphal, H. Pirker, C.M. Fleck (Nucl. Instr. a. Meth., in print)

> A new pulse dividing circuit is tested in connection with the known position sensitive $B^{10}F_3$ detectors based on a resistive wire anone. A resolution of 0,6 cm fwhm was obtained for a collimated neutron beam. The electronic system shows a dividing accuracy of 0,2%.

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4.1. Neutron depolarization measurements on Dy
H. Rauch, A. Zellinger, E. Seidl, M. Waldauf
J. f. angew. Phys.; in print)

The antiferro-ferromagnetic transition of poly- and single crystalline Dy-samples is investigated by means of the neutron depolarization action of the ferromagnetic domains. Almaphed time dependence of the ferromagnetic domain structure was observed near the transition point which demonstrates a strong magnetic after-effect and a kind of a magnetic superviscosity. A connection between this magnetic after-effect and the strong magnetostriction is assumed.

- 4.2. Neutron depolarization in superconductors
 H.W. Weber, H. Rauch, A. Krüger, E. Seidl (Phys. Lett. <u>34A</u> (1971) 35
 - Z. f. Phys., in print)

Under investigation is the flux line structure in the mixed state of several Nb and V samples. The maximum depolarization indicates the entrance of the entire sample into the critical state. The depolarization value is related to the flux line lattice distortions. Measurements with V single crystals are carried out to find correlations between the crystal structure and the arrangement of the flux lines.

- 5. Isomeric States
- 5.1. Investigation of isomeric states C.M. Fleck, W. Schindler, F. Holzer, E. Seymann (Nucl. Instr. a. Meth. <u>82</u> (1970) 325; Nucl. Instr. a. Meth., in print)

In continuation of earlier work the used method was checked for a possible loss of information in determining half lives. It was shown that the use of a definite width of time intervals depending on background and number of intervals will give the optimal information. Fission products of thermal U-235-fission are checked for isomeric states by both, pulsed thermal neutrons and delayed coincidence technique. 5.2. Non-destructive Analysis with short living isomeres I: 20 ms Ge 71^m

O. Brandstätter, F. Girsig, F. Grass, R. Klenk, R. Bauer (Atomkernenergie <u>15</u> (1970) 285,

Trans VIth Int. Symp Mikrcanalys. Graz 1970, Vol.E., 33)

An automatic pneumatic tube system with the only 15 ms transfer time was developed Synchronisation with the reactor pulse is possible and converted transitions can be studied in near future using a liquid scintillator. A computer program enables the automatic data processing. In pulse operation Yb could be determined in the nanogram range. Ge could be determined in the microgram range in meteorites

6. Reactor Fuel Burn-Up

6.1. Release of rare fission gases
C M. Fleck, H. Böck, P Brunner (work under contract of IAEA)

> By means of an incore irradiation facility and a $\beta - \zeta$ low level counting equipment (Ge(IE)-detector used) the rare fission gases release of UZr-hydride samples is studied at temperatures up to 1000°C at different burn-ups.

6.2. Burn-Up-Measurements

C.M. Flock, J. Curda, G. Martinez

By means of a new technique incore-and out-of-the-coremeasurements of burn-up are carried out.

1. Nuclear Physics, Experimental

(Z. f. Naturf 263 (1971) 451)

- 1.1. Study of the D(n,2n)-Reaction with 14 MeV-neutrons.
 The work described in the last years report is continued.
 W. Breunlich, S. Tagesen
- 1.2. (n,n', ~)-cross sections for double even nuclei.
 W. Breunlich, H. Vonach, G. Stengl, H. Göbel
 Cross sections for inelastic excitation by 14 MeV neutrons
 of the lowest 2⁺ → 0⁺ / transition in 19 double even nuclei
 between ⁴⁶Ti and ⁸⁸Sr have been measured. Total (n,n', ~)-cross
 sections are estimated on the basis of the statistical model.
- 1.3. Proton spectra and angular distributions for (n,p)-, (n,np)and (n,pn)-reactions on ⁵⁰Cr, ⁵⁴Fe and ⁶⁴Zn
 W. Breunlich, R.H. Jindra, B. Strohmaier

Experimental work with a counter telescope is in progress as well as theoretical work to get quantitative results on the influence of isospin as compared to the conventional statistical model without isospin

1.4. Measurement of gamma-ray-spectra in 14 MeV-neutron capture N. Frenes, W. Hofmann, M. Uhl, H. Warhanek

The work described in the last report has been continued. An anticoincidence shield for reducing the cosmic ray background in the gamma-detector has been designed. Measurements of the efficiency of a Ge(Li)-detector for gamma rays between 10 and 20 MeV have been started. In the near future gamma-spectra for neutron capture in Cr and Si will be measured.

1.5. A pulsed neutron generator

G. Stengl

Work described in the last report is continued. The first part of the work will be completed this year. The aim is to run the neutron generator with 200 kV and a pulse duration of 1 nseeat a peak current of > 10 mA. In a second step the high voltage will be changed to 400 kV. The planned studies of inelastic neutron scattering however will already start after completing the first part of the reconstruction this year.

1.6. Measurement of energy spectra and angular distributions of charged particles emitted in nuclear reactions induced by 14 MeV-neutrons.

P. Hille, M. Uhl, K. Richter, W. Weisz

Work described in the last report has been completed as far as the 58 Ni(n,p)-reaction is concerned. The program has been enlarged and will be continued. The essential part of the experimental set up will be a cylindrical multiwire-proportional-chamber in coincidence with a central energy-sensitive detector. For testpurposes a first model of a multiwire-chamber has been built.

1.7. Activation analysis of Boron in Mo-samples using 14 MeV-neutrons.P. Hille, G. Stengl and P. Wolf

A new method for the activation analysis of B is developed using the 13 MeV/-radiation of the 0.8 sec activity of ⁸Li, produced by the reaction ¹¹B(n, χ)⁸Li. The calibration of the method using a plastic-scintillator as a 3 -detector is done either by using the χ^{2} -activity cf ¹¹Be formed by ¹¹B(n,p)Be¹¹ or, especially for small B-concentrations, by making use of the comparable 3 -energy produced by the oxygen content of the samples in the reaction ¹⁶O(n,p)¹⁶N.

1.8. Decay of 114 Ag

K. Kletter, P. Hille

Work is in progress to study the short lived activity of 114 Ag produced by the reaction 114 Cd(n,p) 114 Ag with 14 MeV-neutrons. A pneumatic tube system is used to transport the activated samples to the detectors. The r-spectra are measured by a Ge(Li)-spectrometer. Coincidence measurements are carried out using Ge(Li)- and NaJ(Tl)-detectors for r-r-coincidences and a plastic-scintillator for r-r-coincidence measurements.

1.9. The reaction ⁶⁷Zn(n, -)⁶⁴Ni with 14 MeV neutrons. G. Röhr and M. Uhl

Energy- and angular distribution of the emitted \sim -particles were studied with nuclear emulsions; the energy distribution of the \sim -particles will be measured for a fixed emission angle also with a counter telescope. The results will be compared with statistical model predictions.

1.10 (n,p)-cross sections of Cd, Sn- and Te-isotopes for 14 MeV-neutrons

W. Struwe, G. Winkler

Work is in progress to see whether (n,p)-cross sections for 14 MeV-neutrons show shell-effects at the magic protonnumber 50. The cross sections are measured using the activation technique.

2. Nuclear Physics, Theoretical

2.1, Statistical model calculations of (n,n',)-reaction cross
 sections in the mass region A = 46 - 88.
 M. Uhl

Using an accurate version of the statistical model cross sections for the production of excited levels after $(n,n'(\mu))$ processes were calculated and compared with experimental results; no systematic descrepancies between the experimental values and the statistical model predictions were found. The connection between the systematic behaviour of the $(n,n'(\mu))$ and the (n,2n)-cross section is discussed.

2.2. Predictions of the statistical model for neutron induced nuclear reactions.

I. Wagner, M. Uhl

As announced in the last report an extensive comparison of statistical model predictions with experimental data in the literature was continued. Excitation functions of (n,p)- and (n,2n)-activation cross sections and isomeric ratios for medium weight nuclei between Ti and Cd were calculated. The influence of the model parameters was studied. In the same connection some (n,p)-, (n,2n)- and (n,n')-cross sections for 14 MeV-neutrons in this mass region were measured. $\binom{69}{69}$ Ga(n,p) $\binom{69}{2}$ n^m, $\binom{71}{63}$ Ga(n,p) $\binom{71}{2}$ n^m, $\binom{75}{48}$ S(n,p) $\binom{75}{76}$ Ge, $\binom{107}{48}$ Ag(n,p) $\binom{107}{107}$ Ag $\binom{107}{48}$ $\binom{107}{48}$ Ag(n,n') $\binom{107}{70}$ Ag $\binom{107}{48}$ Ag $\binom{107}{8}$ Ag(n,n') $\binom{107}{70}$ Ag $\binom{107}{8}$ Ag $\binom{107}$

PHYSIKINSTITUT, REAKTORZENTRUM SAIBERSDORF, OESTERREICHISCHE STUDIEN-GESELLUCHAFT FUER ATGEDNERGIE GAS M.B.H.

- 1. Nuclear Physics
- 1.1. Study of Parity Admixture in the 279 keV State of Tl²⁰³. F. Dydak

During 1970 two mass separated sources were measured continuously. Besides a number of control measurements were performed to check a good working order and gave some small corrections. The data evaluation is under way

1.2. Study of the angular correlation in neutron decay by measurement of the recoil proton spectrum

F Bauer, R Dobrozemsky, H Paul, P Ressmann, D Jemred, P einzierl

The entire system including precision protone source (for calibration purposes), tangential beam tube insert, spherical condenser spectrometer and coincidence detector system for decay protone is now in a test stage outside the reactor. Also the electronic control system for sutomatic operation of the experiment is finished.

1.3. Life Time Measurements of Levels in Odd Muclei Following Thermal Meutron Capture.

G Mara, P Richs

Using the delayed coincidence method measurements of two dimensional spectra in energy and time yielded the following life times:

nucleus	level (keV)	life time (nsec)	literature (nsec)
'Ib ¹⁶⁰	63.7 138.7	152 ± 17 6 24 ± 0.17	
Tm¹⁷⁰	204 5	0.9 ± 0.2	ج < 1
Ta ¹⁸²	270.4 173	2 12 ± 0.28 1.6 ± 0.3	
Au ¹⁹⁸	367.3 381.7?	118 ± 10 4,6 ± 0,8	128 ± 15

1.4. Thermal Neutron Capture Cross Sections for Separated Isotopes.

H. Kunze, P. Riehs

A Moxon Rae detector will be installed at an external beam of the ASTRA reactor. Relative radiative capture cross sections are to be measured for separated isotopes of high purity (typically 99% and several mg per sample) which were produced by the mass separator at Seibersdorf.

1.5. Spin Assignments for Resonances in Er¹⁶⁷ and Ta¹⁸¹. H.P. Axmann, P. Riehs

Measurement of low energy gamma-rays had been carried out in cooperation with the LINAC group of AERE Harwell and Seibersdorf.

<u>Er¹⁶⁷</u>: From intensity ratios between the 285 keV and 184 keV transition spin 3 values were found for the resonances at 22.0, 26.1, 39.5, 42.3, 60.0, 79.4, 85.5 and 107 eV. A spin 4 is assigned to the 20.3, 27,4, 32.9, 37.7, 50.3, 60.0, 69.5, 74.5, 131.7 and 142.0 eV resonances.

Ta¹⁸¹: The intensity ratios between intense gammatransitions show high fluctuations obviously due to the statistic of primary gamma-rays and allow only tentative assignments. Reduced fluctuation and higher separation for different spins is achieved in using the ratio between the gamma intensity at 270 keV and the Compton distribution arising from transitions of higher energies. This yielded the following spin assignements:

J = 3: 10.3, 20.3, 30.0, 35.1, 49.1, 77.6, 85.1, 105, 126, 144, 200 eV.

J = 4: 4.3, 13.9, 23.9, 35.9, 39.1, 63.1, 82.9, 99.3, 115, 136+138, 166, 175+176, 195 eV.

In Figure 1 the separation in spin-groups is demonstrated.



Figure 1

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2. Neutron Scattering

2.1. The inelastic Scattering of cold neutrons by liquid Aluminium

0.J. Eder and B. Kunsch

In the temperature range from $750 - 800^{\circ}$ C there seems to be a discontinuity in viscosity. Such a change can be looked at as caused by a change in structure, or a change in the potential. These two quantities, of course, being related. Since it is well known that the liquid structure is mainly determined by the hard core interaction of the atoms one cannot report any drastic changes in the structure factor.

Why should the potential change? Expanding the lattice of the liquid there can be assumed that at certain to temperatures the Fermi surface changes strongly. Such an effect can be expected to show up in the modes of motion of the Al-ions. We studied the inelastic scattering of cold neutrons by liquid Aluminium in the mentioned temperature interval and found some low energy modes which are now under further investigation.