NEANDC(J)-94/U
INDC(JAP)-81/U

NOT FOR PUBLICATION

PROGRESS REPORT

(July 1982 to June 1983 inclusive)

September 1983

Editor
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Japanese Nuclear Data Committee

Japan Atomic Energy Research Institute
Tokai Research Establishment
Tokai-mura, Ibaraki-ken, Japan

Editor's Note

This is a collection of reports which have been submitted to the Japanese Nuclear Data Committee at the committee's request. The request was addressed to the following individuals who might represent or be in touch with groups doing researches related to the nuclear data of interest to the development of the nuclear energy program.

Although the editor tried not to miss any appropriate addressees, there may have been some oversight. Meanwhile, contribution of a report rested with discretion of its author. The coverage of this document, therefore, may not be uniform over the related field of research.

In this progress report, each individual report is generally reproduced as it was received by the JNDC Secretariat, and editor also let pass some simple obvious errors in the manuscripts if any.

This edition covers a period of July 1, 1982 to June 30, 1983. The information herein contained is of a nature of "Private Communication". Data contained in this report should not be quoted without the author's permission.

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ELEMENT S	A	QUANTITY	ENERGY MIN	MAX	LAB	TYPE	DOCUMENTATION REF	VOL	PAGE	DATE	COMMENTS
H	PLE	TOTAL	24+4	10+6	JAE	EXPT-PROG	NEANDC-J94U		3	SEP 83	TSUBONE+.TOF+FE FILTERED,TBP IN NIM.
LI	6	N, DEUTERON	14+7		YOK	EXPT-PROG	NEANDC-J94U		75	SEP 83	YAMADA+.ANG-DIST OF D IN FIG.
LI	7	EVALUATION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.
LI	7	TOTAL	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.NDG.
LI	7	ELASTIC	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.NDG.
LI	7	TOT INELAST	48+5	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.TWO LVLS.
LI	7	N, GAMMA	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.1/V LAW.
LI	7	NONELA GAMMA	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.NDG.
LI	7	N, 2N	83+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.NDG.
LI	7	N, DEUTERON	89+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.DWBA CAL.
LI	7	N,N TRITON	14+7		OSA	EXPT-PROG	NEANDC-J94U		71	SEP 83	TAKAHASHI+,C-W,E+ANG DIST.
LI	7	N,N ALPHA	28+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		20	SEP 83	SHIBATA.FOR JENDL-3.FIG GIVEN.
BE	9	N, 2N	14+7		OSA	EXPT-PROG	NEANDC-J94U		71	SEP 83	TAKAHASHI+,C-W,E+ANG DIST IN FIG.
C	12	EVALUATION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		22	SEP 83	SHIBATA.FOR JENDL-3.
C	12	TOTAL	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		22	SEP 83	SHIBATA.FOR JENDL-3.R-MATRIX,TBL+FIG
C	12	ELASTIC	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		22	SEP 83	SHIBATA.FOR JENDL-3.NDG.
C	12	TOT INELAST	48+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		22	SEP 83	SHIBATA.FOR JENDL-3.3 LVLS.
C	12	DIFF INELAST	48+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		22	SEP 83	SHIBATA.FOR JENDL-3.DWBA,NDG.
C	12	N, GAMMA	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		22	SEP 83	SHIBATA.FOR JENDL-3.FROM INV-SIG,NDG
C	12	NONELA GAMMA	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		22	SEP 83	SHIBATA.FOR JENDL-3.NDG

ELEMENT S	A	QUANTITY	ENERGY MIN	MAX	LAB	TYPE	DOCUMENTATION REF VOL	PAGE	DATE	COMMENTS
C	12	N, PROTON	17+7	20+7	JAE	EVAL-PROG	NEANDC-J94U	22	SEP 83	SHIBATA.FOR JENDL-3.SPLINE-FIT,NDG.
C	12	N, DEUTERON	15+7	20+7	JAE	EVAL-PROG	NEANDC-J94U	22	SEP 83	SHIBATA.FOR JENDL-3.DWBA,NDG.
C	12	N, ALPHA	62+6	20+7	JAE	EVAL-PROG	NEANDC-J94U	22	SEP 83	SHIBATA.FOR JENDL-3.SPLINE-FIT,NDG.
SC	45	N, XN X>2	10+7	25+7	KYU	THEO-PROG	NEANDC-J94U	59	SEP 83	WATANABE+.SIG+E-DIST,EXCITON MDL
FE	56	TOTAL	NDG		KYU	EVAL-PROG	NEANDC-J94U	65	SEP 83	TSUKAMOTO+,SIMULTANEOUS EVAL,NDG.
NI		N,N PROTON	10+7		KYU	THEO-PROG	NEANDC-J94U	63	SEP 83	UENOHARA+.MULTI-STEP H-F MDL.
GA		RESON PARAMS		10+4	JAE	EXPT-PROG	NEANDC-J94U	7	SEP 83	OHKUBO+.TOF LINAC,54LVLS,NDG.
GA		STRNTH FNCTN		10+4	JAE	EXPT-PROG	NEANDC-J94U	7	SEP 83	OHKUBO+.TOF LINAC,S0=1,2
AS	75	N, XN X>2	10+7	25+7	KYU	THEO-PROG	NEANDC-J94U	59	SEP 83	WATANABE+.SIG+E-DIST,EXCITON MDL
NB	93	TOTAL	NDG		KYU	EVAL-PROG	NEANDC-J94U	65	SEP 83	TSUKAMOTO+,SIMULTANEOUS EVAL,NDG.
NB	93	DIFF INELAST	14+7		KYU	THEO-PROG	NEANDC-J94U	55	SEP 83	WATANABE+.E+ANG DIST,EXCITON MDL,FIG
NB	93	NONELASTIC	NDG		KYU	THEO-PROG	NEANDC-J94U	64	SEP 83	UENOHARA+.TBP IN NST.
NB	93	N, PROTON	14+7		KYU	EXPT-PROG	NEANDC-J94U	50	SEP 83	KOORI+.E+ANG DIST OF P IN FIGS.
MO		NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U	68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO		N, PROTON	15+7		NAG	EXPT-PROG	NEANDC-94U	69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 788.
MO		N, ALPHA	15+7		NAG	EXPT-PROG	NEANDC-94U	69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 788.
MO	92	NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U	68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO	92	N, 2N	15+7		NAG	EXPT-PROG	NEANDC-94U	69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 788.
MO	94	NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U	68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO	94	N, 2N	15+7		NAG	EXPT-PROG	NEANDC-94U	69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 788.

ELEMENT S	A	QUANTITY	ENERGY MIN	MAX	LAB	TYPE	DOCUMENTATION REF	VOL	PAGE	DATE	COMMENTS
MO	95	NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U		68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO	95	N, PROTON	15+7		NAG	EXPT-PROG	NEANDC-94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 788.
MO	96	NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U		68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO	96	N, PROTON	15+7		NAG	EXPT-PROG	NEANDC-J94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 781.
MO	97	NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U		68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO	97	N, PROTON	15+7		NAG	EXPT-PROG	NEANDC-J94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 781.
MO	98	NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U		68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO	98	N, PROTON	15+7		NAG	EXPT-PROG	NEANDC-J94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 781.
MO	98	N,N PROTON	15+7		NAG	EXPT-PROG	NEANDC-J94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 781.
MO	98	N, ALPHA	15+7		NAG	EXPT-PROG	NEANDC-J94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 781.
MO	100	NONELASTIC	NDG		KYU	EVAL-PROG	NEANDC-94U		68	SEP 83	SEI+,MULTI-STEP H-F + PRE-EQ MDL,NDG
MO	100	N, 2N	15+7		NAG	EXPT-PROG	NEANDC-J94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 781.
MO	100	N, PROTON	15+7		NAG	EXPT-PROG	NEANDC-J94U		69	SEP 83	AMEMIYA+.PUBLISHED IN NST 19 781.
AG		N, XN X>2	10+7	25+7	KYU	THEO-PROG	NEANDC-J94U		59	SEP 83	WATANABE+.SIG+E-DIST,EXCITON MDL,FIG
AG	107	TOTAL	24+4	10+5	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228
AG	107	N, GAMMA	32+4	70+5	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228
AG	107	RESON PARAMS		70+3	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228
AG	107	STRNTH FNCTN		70+3	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228
AG	109	TOTAL	24+4	10+5	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228
AG	109	N, GAMMA	32+4	70+5	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228

ELEMENT S	A	QUANTITY	ENERGY MIN	MAX	LAB	TYPE	DOCUMENTATION REF	VOL	PAGE	DATE	COMMENTS
AG	109	RESON PARAMS		70+3	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228
AG	109	STRNTH FNCTN		70+3	JAE	EXPT-PROG	NEANDC-J94U		5	SEP 83	MIZUMOTO+.PUBLISHED IN 82ANTWERP 228
SN	122	RESON PARAMS		30+4	JAE	EXPT-PROG	NEANDC-J94U		8	SEP 83	NAKAJIMA+.LINAC TOF,26LVLS,NDG.
SB	121	RESON PARAMS		70+3	JAE	EXPT-PROG	NEANDC-J94U		7	SEP 83	OHKUBO+.TOF LINAC,TRANSMISSION,NDG.
I	127	N, XN X>2	10+7	25+7	KYU	THEO-PROG	NEANDC-J94U		59	SEP 83	WATANABE+.SIG+E-DIST,EXCITON MDL
LA	139	N, GAMMA	72+0	25+3	JAE	EXPT-PROG	NEANDC-J94U		6	SEP 83	NAKAJIMA+.PUBLISHED IN NST 20 183.
LA	139	RESON PARAMS	72+0	25+3	JAE	EXPT-PROG	NEANDC-J94U		6	SEP 83	NAKAJIMA+.PUBLISHED IN NST 20 183.
EU	154	RES INT ABS	NDG		JAE	EXPT-PROG	NEANDC-J94U		32	SEP 83	SEKINE+.GE-LI,2100+-2100 BARNS
EU	154	N, GAMMA	25-2		JAE	EXPT-PROG	NEANDC-J94U		32	SEP 83	SEKINE+.GE-LI,1840+-90 BANRS
EU	155	RES INT ABS	NDG		JAE	EXPT-PROG	NEANDC-J94U		32	SEP 83	SEKINE+.GE-LI,15300+-2700 BARNS
EU	155	N, GAMMA	25-2		JAE	EXPT-PROG	NEANDC-J94U		32	SEP 83	SEKINE+.GE-LI,3760+-170 BARNS
GD	111	DIFF INELAST	FIS		JAE	EXPT-PROG	NEANDC-J94U		35	SEP 83	SAKURAI.TO ISOMERIC STATE,TBD.
GD	155	N, GAMMA	10+3	22+5	JAE	EXPT-PROG	NEANDC-J94U		9	SEP 83	NAKAJIMA+.LINAC TOF,TANK SCIN,NDG.
GD	155	RESON PARAMS		50+2	JAE	EXPT-PROG	NEANDC-J94U		9	SEP 83	NAKAJIMA+.LINAC TOF,TRANS,NDG.
GD	157	N, GAMMA	10+3	22+5	JAE	EXPT-PROG	NEANDC-J94U		9	SEP 83	NAKAJIMA+.LINAC TOF,TANK SCIN,NDG.
GD	157	RESON PARAMS		20+3	JAE	EXPT-PROG	NEANDC-J94U		9	SEP 83	NAKAJIMA+.LINAC TOF,TRANS,NDG.
TB	159	SPECT N,GAMM	41+5		TIT	EXPT-PROG	NEANDC-J94U		75	SEP 83	IGASHIRA+.VDG,NAI,CF STAT MDL,FIG.
HO	165	SPECT N,GAMM	42+5		TIT	EXPT-PROG	NEANDC-J94U		75	SEP 83	IGASHIRA+.VDG,NAI,CF STAT MDL,FIG.
TA	181	TOTAL	24+4	10+6	JAE	EXPT-PROG	NEANDC-J94U		4	SEP 83	TSUBONE+.TOF+FE FILTERED,NE110 SCIN.
TA	181	SPECT N,GAMM	42+5		TIT	EXPT-PROG	NEANDC-J94U		75	SEP 83	IGASHIRA+.VDG,NAI,CF STAT MDL,FIG.

ELEMENT S	A	QUANTITY	ENERGY MIN	MAX	LAB	TYPE	DOCUMENTATION REF	VOL	PAGE	DATE	COMMENTS
TA	181	RESON PARAMS	10+2	37+3	JAE	EXPT-PROG	NEANDC-J94U		10	SEP 83	TSUBONE+.PUBLISHED IN NST 20 707.
TA	181	STRNTH FNCTN	24+4	10+6	JAE	EXPT-PROG	NEANDC-J94U		4	SEP 83	TSUBONE+.S1=0.57+-0.31,S2=1.22+-0.12
TA	181	STRNTH FNCTN	10+2	37+3	JAE	EXPT-PROG	NEANDC-J94U		10	SEP 83	TSUBONE+.PUBLISHED IN NST 20 707.
OS	190	N, GAMMA	PILE		JAE	EXPT-PROG	NEANDC-J94U		37	SEP 83	NISHIMURA+.SIG=12.0+-0.6 B TO ISOMER
AU	197	N, GAMMA	NDG		KYU	EVAL-PROG	NEANDC-94U		66	SEP 83	UENOHARA+.PUBLISHED IN 82ANTWERP 639
AU	197	SPECT N,GAMM	15+4	62+5	TIT	EXPT-PROG	NEANDC-J94U		81	SEP 83	IGASHIRA+.VDG,NAI,5.5 MEV BUMP,FIG.
AU	197	N, 2N	10+7	25+7	KYU	THEO-PROG	NEANDC-J94U		59	SEP 83	WATANABE+.SIG+E-DIST,EXCITON MDL,FIG
AU	197	N, XN X>2	10+7	25+7	KYU	THEO-PROG	NEANDC-J94U		59	SEP 83	WATANABE+.SIG+E-DIST,EXCITON MDL,FIG
HG	199	DIFF INELAST	78-1	63+6	JAE	EXPT-PROG	NEANDC-J94U		34	SEP 83	SAKURAI.TBP IN JAERI REPORT.
PB		N, 2N	14+7		OSA	EXPT-PROG	NEANDC-J94U		71	SEP 83	TAKAHASHI+,C-W,E+ANG DIST IN FIG.
BI	209	N, 2N	14+7		OSA	EXPT-PROG	NEANDC-J94U		71	SEP 83	TAKAHASHI+,C-W,E+ANG DIST.
TH	232	TOTAL	24+4		KTO	EXPT-PROG	NEANDC-J94U		48	SEP 83	FUJITA+,TBP IN NST.
TH	232	DIFF INELAST	14+5		KTO	EXPT-PROG	NEANDC-J94U		49	SEP 83	FUJITA+,TBP IN NST.
TH	232	N, 2N	FISS		KTO	EXPT-PROG	NEANDC-J94U		47	SEP 83	CHATANI+,PUBLISHED IN NIM 205 501.
TH	232	FISS PROD GS	FAST		JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT.
TH	232	FISS PROD BS	FAST		JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT.
U	233	EVALUATION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	TOTAL	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	ELASTIC	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	TOT INELAST	40+4	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.

ELEMENT S	A	QUANTITY	ENERGY MIN	ENERGY MAX	LAB	TYPE	DOCUMENTATION REF	VOL	PAGE	DATE	COMMENTS
U	233	N, GAMMA	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	N, 2N	58+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	N, XN X>2	14+7	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	FISSION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	NU	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	DELAYD NEUTS	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	233	FISS PROD GS	25-2		JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT.
U	233	FISS PROD BS	25-2		JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT.
U	233	RESON PARAMS	10-1	30+4	JAE	EVAL-PROG	NEANDC-J94U		25	SEP 83	ASANO+.PUBLISHED IN NST 19 1037.
U	235	FISSION	NDG		KYU	EVAL-PROG	NEANDC-94U		67	SEP 83	UENOHARA+.LEAST SQUARES FIT,NDG.
U	235	FISSION	NDG		KYU	EVAL-PROG	NEANDC-94U		66	SEP 83	UENOHARA+.PUBLISHED IN 82ANTWERP 639
U	235	FRAG NEUTS	NDG		KTO	EXPT-PROG	NEANDC-J94U		39	SEP 83	OKANO+,DELAYED-N FROM RB-94,PN=.0974
U	235	FISS PROD GS	15+7		NAG	EXPT-PROG	NEANDC-J94U		70	SEP 83	TOTSUKA+.PUBLISHED IN NST 19 765.
U	235	FISS PROD GS	25-2	14+7	JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT,FIG.
U	235	FISS PROD BS	25-2	14+7	JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT,FIG.
U	238	TOTAL	24+4	10+6	JAE	EXPT-PROG	NEANDC-J94U		62	SEP 83	TSUBONE+,PUBLISHED IN 82ANTWERP P.65
U	238	TOTAL	24+4	10+6	JAE	EXPT-PROG	NEANDC-J94U		4	SEP 83	TSUBONE+.TOF+FE FILTERED,NE110 SCIN.
U	238	N, GAMMA	NDG		KYU	EVAL-PROG	NEANDC-94U		66	SEP 83	UENOHARA+.PUBLISHED IN 82ANTWERP 639
U	238	FISSION	NDG		KYU	EVAL-PROG	NEANDC-94U		67	SEP 83	UENOHARA+.LEAST SQUARES FIT,NDG.
U	238	FISSION	NDG		KYU	EVAL-PROG	NEANDC-94U		66	SEP 83	UENOHARA+.PUBLISHED IN 82ANTWERP 639

ELEMENT S	A	QUANTITY	ENERGY MIN	MAX	LAB	TYPE	DOCUMENTATION REF	VOL	PAGE	DATE	COMMENTS
U	238	FISS PROD GS	FAST	14+7	JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT.
U	238	FISS PROD BS	FAST	14+7	JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT.
U	238	STRNTH FNCTN	24+4	10+6	JAE	EXPT-PROG	NEANDC-J94U		4	SEP 83	TSUBONE+.S1=1.68+-0.28,S2=0.70+-0.34
U	238	STRNTH FNCTN	24+4	10+6	JAE	EXPT-PROG	NEANDC-J94U		62	SEP 83	TSUBONE+,PUBLISHED IN 82ANTWERP P.65
PU	239	FISSION	NDG		KYU	EVAL-PROG	NEANDC-94U		66	SEP 83	UENOHARA+.PUBLISHED IN 82ANTWERP 639
PU	239	FISS PROD GS	25-2	FAST	JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT,FIG.
PU	239	FISS PROD BS	25-2	FAST	JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT,FIG.
PU	241	FISS PROD GS	25-2		JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT,FIG.
PU	241	FISS PROD BS	25-2		JAE	EVAL-PROG	NEANDC-J94U		30	SEP 83	TASAKA+.DECAY HEAT CALC,CF EXPT,FIG.
CM	246	EVALUATION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	TOTAL	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	ELASTIC	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	TOT INELAST	43+4	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	N, GAMMA	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	N, 2N	65+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	N, XN X>2	12+7	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	FISSION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	NU	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	DELAYD NEUTS	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	246	RESON PARAMS	10-5	30+4	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.

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ELEMENT S	A	QUANTITY	ENERGY MIN	MAX	LAB	TYPE	DOCUMENTATION REF	VOL	PAGE	DATE	COMMENTS
CM	247	EVALUATION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	TOTAL	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	ELASTIC	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	TOT INELAST	62+4	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	N, GAMMA	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	N, 2N	52+6	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	N, XN X>2	12+7	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	FISSION	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	NU	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	DELAYD NEUTS	10-5	20+7	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
CM	247	RESON PARAMS	10-5	30+4	JAE	EVAL-PROG	NEANDC-J94U		26	SEP 83	KIKUCHI.TBP IN JAERI-M REPORT.
MANY		N, PROTON	14+7		KYU	THEO-PROG	NEANDC-J94U		54	SEP 83	KUMABE.PUBLISHED IN 82SMOLENCE P.305
MANY		N, ALPHA	14+7		KYU	THEO-PROG	NEANDC-J94U		54	SEP 83	KUMABE.PUBLISHED IN 82SMOLENCE P.305
MANY		FRAG NEUTS	NDG		WDA	THEO-PROG	NEANDC-J94U		85	SEP 83	TACHIBANA+.DELAYED-N EMIS PROB,TBL.
MANY		STRNTH FNCTN	NDG		HOS	THEO-PROG	NEANDC-J94U		1	SEP 83	FURUOYA+.PUBLISHED IN PTP 69 1035.
MANY		STRNTH FNCTN	NDG		HOS	THEO-PROG	NEANDC-J94U		2	SEP 83	FURUOYA+.TBP IN PTP 70 NO.2.

The content table in the CINDA format was compiled by the JNDC CINDA group;

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I. HOSEI UNIVERSITY

Department of Physics

I-1 **The s-Wave Neutron Strength Function in the 3-s Giant Resonance Region**

Izumi FURUOYA and Ryuzo NAKASIMA

A paper on this subject has been published in Progress of Theoretical Physics, Vol.69, No.3, 1035, March, 1983, (Progress Letters) with an abstract as follows:

Effects of coupled channel and doorway state on the s-wave neutron strength function in the mass region of A=30 $\sim$ 100 are examined. The large fluctuations near A=50 and a gap at A=40 seen in the experimental data are explained by our calculation.

I-2 The s-Wave Neutron Strength Function in the Deformed Region

Izumi FURUOYA and Ryuzo NAKASIMA

A paper on this subject will be published in Progress of Theoretical Physics, Vol.70, No.2, August, 1983 with an abstract as follows:

The effect of the doorway state on the s-wave neutron strength function of the deformed nucleus is examined. It is found that the shape of the 4-s giant resonance in the strength function is reproduced fairly well by both effects of the doorway states and the coupled channels. In particular, the irregular hump ranging from A=160 to A=170 cannot be interpreted by coupled channel calculation alone but by additional effect of the doorway states. As an example of the isotopic trend, the numerical comparison is presented for Er isotopes.

II. JAPAN ATOMIC ENERGY RESEARCH INSTITUTE

A. Linac Laboratory, Division of Physics

II-A-1

Utilization of Fe-filtered Neutron Beam for Total Cross Section Measurements up to 1 MeV

Izumi Tsubone*, Yutaka Nakajima, Yutaka Furuta, and Yukinori Kanda**

A paper on this subject will be published in Nuclear Instruments and Methods with an abstract as follows.

An iron filtered neutron beam has been made to be available at the time-of-flight facility of the Japan Atomic Energy Research Institute electron linac in order to measure more accurate total cross sections in the keV region. Twenty five neutron peaks from 24.4 keV to 1 MeV, which gave extremely large signal-to-background ratio of 10^3 - 10^4, were observed with a ^{6}Li-glass and a plastic scintillator at a 100 m station. The usefulness of the present filtered neutron beam facility was made sure by measureing the total cross section of polyethylene. These values are in excellent agreement with values computed from evaluated data in JENDL-1 and ENDF/B-V.

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II-A-2

Neutron Total Cross Sections of Tantalum-181 and Uranium-238 from 24.3 keV to 1 MeV and Average Resonance Parameters

Izumi Tsubone*, Yutaka Nakajima, Yutaka Furuta and Yukinori Kanda**

The neutron total cross sections of ^{181}Ta and ^{238}U have been obtained in the energy range from 24.3 keV to 1 MeV by means of transmission measurements using the Japan Atomic Energy Research Institute linac. The measurements were carried out with the iron-filtered neutron beam technique and the time-of-flight method, using a 100 m station and a NE-110 plastic scintillator as a neutron detector. For ^{238}U, correction for the resonance self-shielding effect was taken into account below 270 keV by measuring transmission of the samples of different thicknesses. By fitting the total cross sections with the average R-matrix formula, the neutron strength functions S_ℓ and distant level parameters R_ℓ^∞ for s-, p-, and d-wave were deduced to be: R_0^∞=-0.003$\pm$0.03, S_1x10^4=0.57$\pm$0.31, R_1^∞=-0.01$\pm$0.03, S_2x10^4=1.22$\pm$0.12, and R_2^∞=-0.15$\pm$0.3 for ^{181}Ta, and R_0^∞=-0.072$\pm$0.028, S_1x10^4=1.68$\pm$0.28, R_1^∞=0.23$\pm$0.08, S_2x10^4=0.70$\pm$0.34, and R_2^∞=-0.33$\pm$0.13 for ^{238}U. The effective scattering radii were resulted in 7.90$\pm$0.03 and 9.30$\pm$0.04 fm for ^{181}Ta and ^{238}U, respectively.

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II-A-3

Neutron radiative capture and transmission measurements of ^{107}Ag and ^{109}Ag

M. Mizumoto, M. Sugimoto, Y. Nakajima, M. Ohkubo,

Y. Furuta and Y. Kawarasaki

A paper on this subject was presented at the International Conference on Nuclear Data for Science and Technology, p.228, Antwerp, 1982 with an abstract as follows.

Neutron capture and total cross sections of ^{107}Ag and ^{109}Ag have been measured using the time-of-flight facility at the Japan Atomic Energy Research Institute electron linear accelerator. Capture measurements were carried out with a 3500 l large liquid scintillation detector at 52 m flight path and transmission measurements were made with ^{6}Li-glass detectors at 56 m and 190 m flight paths. Resonance energies and neutron widths were determined up to 7 keV both for ^{107}Ag and ^{109}Ag. The s-wave strength functions and average level spacings were found to be $S_0 = (0.42 \pm 0.05) \times 10^{-4}$, $D_0 = 22 \pm 2$ eV for ^{107}Ag and $S_0 = (0.44 \pm 0.05) \times 10^{-4}$, $D_0 = 21 \pm 2$ eV for ^{109}Ag. The average capture cross sections were deduced in the energy range of 3.2 to 700 keV with an estimated accuracy of 4 to 8 %. The data to 100 keV were well fitted with the average resonance parameters. Recent evaluated data for ^{109}Ag disagree significantly with our results.

II-A-4

Radative Neutron Capture in La-139 below 2.5 keV

Yutaka Nakajima, Nobuyuki Ohnishi[*,+], Yukinori Kanda[*],
Motoharu Mizumoto, Yuuki Kawarasaki, Yutaka Furuta,
and Akira Asami[++]

A paper on this subject has been published in J. Nucl. Sci. Technol. 20 (1983) 183 with an abstract as follows:

The radiative neutron capture cross section of ^{139}La has been measured in the energy region of 70 - 2,540 eV using the 52 m neutron time-of-flight facility at the Japan Atomic Energy Research Institute elecrton linac. Neutron capture events were detected with a 3,500 l liquid scintillator tank. Individual resonances were analyzed using the area analysis method to obtain the capture widths. Capture data were corrected for the multiple scattering of neutrons in a sample by means of the Monte Carlo technique. Capture areas $g\Gamma_n\Gamma_\gamma/\Gamma$ for 20 resonances and capture widths Γ_γ for 5 resonances were newly obtained. The present average capture cross section above 1.6 keV can be well reproduced by the statistical model calculation with the available average resonance parameters, but below 1.6 keV is found to deviate from its prediction.

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II-A-5

Neutron Resonance Parameters of Ga and ^{121}Sb

M.Ohkubo, Y.Kawarasaki, M.Mizumoto, Y.Nakajima, M.Sugimoto and Y.Furuta

Ga Neutron transmission measurements on natural gallium(^{69}Ga 60.1%, ^{71}Ga 39.9%) were carried out at a 47 m TOF station of the JAERI linac. Resonance parameters of 54 levels up to 10.4 keV have been analyzed. Preliminary average level spacing and the s-wave strength function were obtained to be $\langle D \rangle = 185$ eV, $S_0 = 1.2 \times 10^{-4}$, respectively. The resonance parameters determined in the present measurements are in good agreement with the previous ones of Maletsky et al.[1] on separated isotopes, in the overlapping energy region below 5.1 keV.

^{121}Sb Transmission measurements on separated isotope of ^{121}Sb were carried out at the 47 m station in the energy region below 7 keV. The resonance analyses are in progress.

Reference:

1) H.Maletsky, L.B.Pikelner,I.M.Calamatin and E.I.Sharapov; JINR-P3-4]52(1968)

II-A-6

Measurements of Neutron Resonance Parameters of ^{122}Sn

Yutaka Nakajima, Makio Ohkubo, Masayoshi Sugimoto,

Yutaka Furuta, and Yuuki Kawarasaki

The neutron transmission measurements have been carried out on a separated isotope ^{122}Sn (enriched to 92.20 %) at a 190 m flight path of the neutron time-of-flight facility of the Japan Atomic Energy Research Institute linac up to 30 keV. Dips of 26 resonances were observed in the present measurements. Thirteen of them were newly found. Nine of them were observed only in a previous capture experiment, and only their resonance energies were known until now.

The resonance analyses are in progress.

II-A-7

Neutron Resonance Parameters and Radiative Capture Cross Sections of ^{155}Gd and ^{157}Gd

Yutaka Nakajima, Izumi Tsubone*, Motoharu Mizumoto,
Yutaka Furuta, Makio Ohkubo, Masayoshi Sugimoto,
and Yuuki Kawarasaki

The neutron transmission measurements have been carried out on the separated isotopes of ^{155}Gd(enriched to 91.77 %) and ^{157}Gd(enriched to 88.63 %) at a 100 m flight path of the neutron fime-of-flight facility of the Japan Atomic Energy Research Institute linac up to 500 eV and up to 2 keV, respectively.

The capture cross sections of the same isotopes were measured at a 55 m flight path with a 500 l liquid scintillation detector. The capture cross sections were deduced from 1 keV to 220 keV for both isotopes.

The resonance analyses are in progress.

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II-A-8

Neutron Resonance Parameters and s-wave Strength Function of Ta-181

Izumi Tsubone*, Yutaka Nakajima and Yukinori Kanda**

The neutron resonance parameters of ^{181}Ta were determined for 632 levels from 100 to 3,720 eV. The neutron transmissions were measured with 56 m and 190 m flight paths of the neutron time-of-flight facility at the Japan Atomic Energy Research Institute linac for two and three thickness samples, respectively. The transmissions for the different thickness samples were analyzed simultaneously by the multi-level Breit-Wigner shape analysis program, and resonance energies and neutron widths were derived. Above 2,030 eV the resonance parameters were newly obtained in this experiment.

The s-wave neutron strength function of ^{181}Ta was found to change the value at about 1.7 keV; below 1.7 keV the s-wave strength function is $(1.66 \pm 0.13) \times 10^{-4}$ and above 1.7 keV $(1.06 \pm 0.09) \times 10^{-4}$. A part of this work will be published in J. Nucl. Sci. Techol., 20[8], 707 (1983) as a short note. The full paper is in preparation.

Figure 1 shows the cummulative values of $g\Gamma_n^0$ vs. neutron energy.

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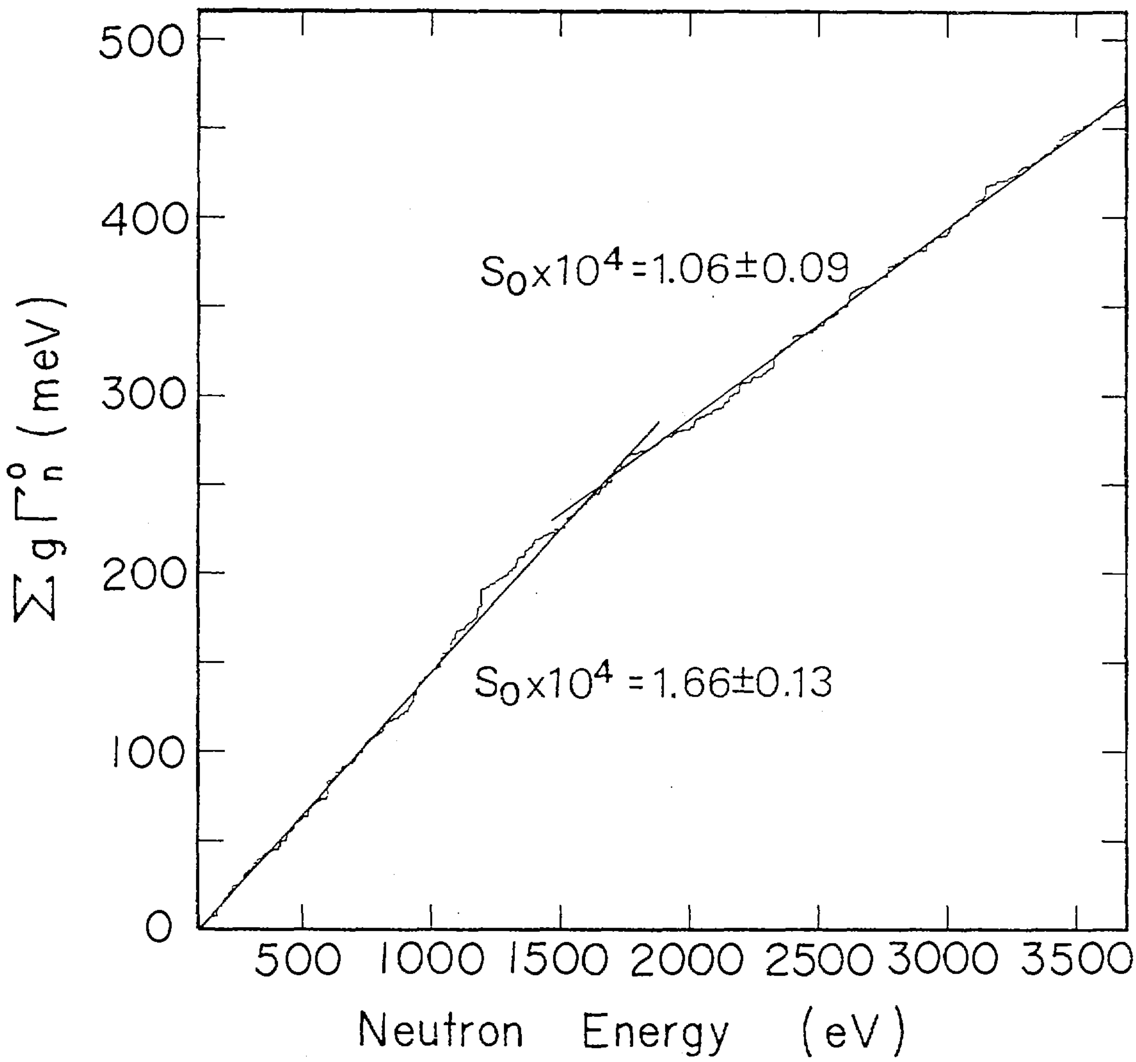

Fig. 1 Plot of $\Sigma g\Gamma_n^o$ versus neutron energy.

II-A-9

The calculation of the efficiency of ^{6}Li-glass and ^{10}B-NaI detectors by the program ELIS

Masayoshi Sugimoto and Motoharu Mizumoto

A paper on this subject was published as JAERI-M 82-193 with the following abstract:

The Monte Carlo program ELIS was developed to obtain relative efficiencies of a ^{6}Li-glass scintillator and a ^{10}B NaI detector, which were used as the incident neutron detectors in the measurements of neutron radiative capture at the Japan Atomic Energy Research Institute electron linear accelerator (JAERI linac). The calculation is based on the standard cross sections in the evaluated nuclear data files, such as JENDL-1 for ^{6}Li(n,α) reaction and ENDF/B-V for ^{10}B(n,$\alpha\gamma$) reaction, and takes into account the multiple scattering effect in the detector system, e.g. the ^{6}Li-glass scintillator and the photomultiplier window, using the conventional Monte Carlo technique. The calculated results are reliable within a few percents in a statistical meaning. However, the total uncertainties of the results are mainly due to the uncertainties or the covariances of the standard cross sections used in the calculation. This report describes the procedures of the preparation of the cross section data file and the calculational method of the relative efficiency, and discusses the uncertainties of the obtained results.

B. Nuclear Data Center, Division of Physics and Working Groups of Japanese Nuclear Data Committee

II-B-1 Activities of Japanese Nuclear Data Committee

The Japanese Nuclear Data Committee(JNDC) was convened once in 1982 fiscal year to discuss plans of working-group activities as well as to examine the activities made in the last fiscal year. The Steering Committee met eight times in this period to promote plans of the Committee and Subcommittees, to discuss every problem on the activities of the Working Groups, and to furnish advice to the JAERI Nuclear Data Center(JAERI/NDC) on the business of the secretariat.

Working Groups of the JNDC had ninety-five meetings totaly from April 1982 to March 1983. They worked in cooperation with the JAERI/NDC to evaluate nuclear cross-section data, to test reliability of the Japanese Evaluated Nuclear Data Library(JENDL), and to evaluate nuclear structure and decay data. Compilation of the second version of Japanese Evaluated Nuclear Data Library, JENDL-2, was finally accomplished, and was released at the end of 1982. Evaluation of the nuclear structure and decay data was promoted, and the results of mass chain evaluation for A = 126, 128 and 129 were submitted to the NNDC (BNL). Work for A = 118, 120 and 122 has been continued further. For summation calculation of the decay heat, Nuclear Data Library and its processing code were made.

Benchmark tests for the JENDL-2 were carried out. Sensitivity analyses of the sodium void coefficients were done in order to explore a cause of their overestimate. Fission and capture cross sections of U and Pu isotopes below a few keV were unexpectedly influential. Double differential group cross sections were made from the JENDL-2 data. They will be used to analyze the experimental data of the JAERI Fusion Neutronics Source(JAERI-FNS).

Evaluation work for the third version of Japanese Evaluated Nuclear Data Library, JENDL-3, started at April 1982. For the purpose of promoting this work, five Working Groups were formed in the Subcommittee on Nuclear Data of the JNDC. Counceling Committee has been formed in order to check and review the activities of the JNDC from the viewpoint of long-term strategy.

A seminar on nuclear data was held at JAERI-Tokai on 24 and 25 November, 1982, by JNDC. Lectures were presented on (1) 20th anniversary of the founding of the JNDC, (2) review of the nuclear data activities in Japan, (3) current topics pertaining to the nuclear data evaluation, (4) nuclear data requirements on FBR burnup calculation and on fusion neutronics and (6) progress of JENDL-3 project. Panel discussion on the future scope of the nuclear data project in Japan was held with aim to stimulate the nuclear data experiments. About fifteen papers were presented, and discussions were made earnestly.

Structure of the JDNC is illustrated in Fig. 1.

Japanese Nuclear Data Committee (JNDC) in 1983

JNDC Secretariat:
Nuclear Data Center (JAERI)

Progress Report Editorial Group:
(3), S. Kikuchi

Steering Committee: (11),
S. Igarasi (Secretariat)

Committee: (33),
K. Harada (JAERI)

Counseling Committee: (10),
K. Sugiyama (TOH)

CINDA Group: (7), S. Tanaka (JAERI)

WRENDA Group: (9), S. Igarasi (JAERI)

Subcommittee on Nuclear Data: (39),
Y. Kikuchi (JAERI)

Subcommittee on Reactor
Constants: (39), Y. Seki (MAPI)

Subcommittee on Nuclear Structure and
Decay Data: (50), R. Nakasima (HOS)

Subcommittee on Nuclear Data: Y. Kikuchi (JAERI)

- Working Group on Nuclear Data Evaluation: (21), S. Iijima (NAIG)
- Working Group on Fission-Product Nuclear Data: (11), M. Kawai (NAIG)
- Working Group on Nuclear Data for Fusion: (11), Y. Kanda (KYU)
- Working Group on Nuclear Data for Photon Production: (11), H. Kitazawa (TIT)
- Working Group on Compilation of JENDL: (9), T. Asami (JAERI)

Subcommittee on Reactor Constants: Y. Seki (MAPI)

- Working Group on Group Constants for Fusion and Shielding: (23), M. Nakazawa (TOK)
- Working Group on Integral Tests for JENDL: (20), A. Hasegawa (JAERI)

Subcommittee on Nuclear Structure and Decay Data: R. Nakasima (HOS)

- Working Group on Evaluation for Generation and Depletion of Nuclides: (17), Y. Naito (JAERI)
- Working Group on Evaluation of Decay Heat: (16), Z. Matumoto (JAERI)
- Working Group on Nuclear Structure Data: (17), T. Tamura (JAERI)
- Working Group on Atomic, Molecular and Nuclear Data for Biomedical Applications: (11), Y. Onai (CCR)

Fig.1 Structure of the Japanese Nuclear Data Committee

The number in parentheses is the number of members.

II-B-2

Compilation of Japanese Evaluated Nuclear Data Library, Version 2 (JENDL-2)

Japanese Nuclear Data Committee (JNDC)

The compilation of the JENDL-2 general purpose file has finished at the end of 1982, and the file was released recently. Table 1 lists the nuclides or elements whose data have been stored in JENDL-2.

JENDL-1[1)] was released in 1977 with the aim of being used mainly in design calculations of fast reactor. However, for the use in wider fields of application, i.e. fusion research, radiation shielding, nuclear fuel cycle etc., addition of some important nuclides has been required. Besides, various problems have been pointed out in the benchmark tests[2)] for JENDL-1. In this situation, JNDC and JAERI Nuclear Data Center started the work for JENDL-2 in 1978. The number of nuclides to be contained in JENDL-2 was sharply increased from 72 (including 28 FP nuclides) in JENDL-1 to 170 (including about 90 FP nuclides). The upper limit of neutron energy was extended up to 20 MeV from 15 MeV.

The work on data evaluation and compilation has been done mainly by the Working Groups in JNDC and by Nuclear Data Center. The developement and the improvement of calculation codes and processing codes have been made for this work. In the data evaluations the main effort was devoted to collect information from recent experiments as many as possible and to obtain reliable parameter sets for model calculations on a common basis. Especially the highest priority was given to the reevaluation of the data on ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, Cr, Fe and Ni. The whole reevaluation of the JENDL-1 data was also made for most of nuclides. An outline of the data evaluation for JENDL-2 has already been described elsewhere[3)].

The JENDL-2 data for the above eight nuclides were used for the analyses in the JUPITER project[4] before the formal release of JENDL-2, responding to the urgent request. A combined library of the JENDL-2 data for these eight nuclides and the JENDL-1 data for the others, called JENDL-2B Library, was used in the JUPITER analysis. The benchmark tests have been performed[5] on the JENDL-2B Library, and have indicated that the JENDL-2B data gave more satisfactory results than those of JENDL-1 as a whole.

References:

1) S. Igarasi, T. Nakagawa, Y. Kikuchi, T. Asami and T. Narita: "Japanese Evaluated Nuclear Data Library, Version 1 ----JENDL-1---", JAERI - 1261 (1979)

2) Y. Kikuchi, A. Hasegawa, H. Takano, T. Kamei, Y. Hojuyama, M. Sasaki, Y. Seki, A. Zukeran and I. Otake: "Benchmark Tests of JENDL-1", JAERI - 1275 (1982)

3) Y. Kikuchi and Members of JNDC: Proc. of Intern. Conf. on Nuclear Data for Science and Technology, held at Antwerp in Sept. 1982, (D. Reidel Publishing Comp.,1983) p.615.

4) T. Inoue, K. Shirakata, K. Kinjo, T. Ikegami and M. Yamamoto: J. At. Energy Soc. Japan 23, 310 (1981) (in Japanese)

5) Y.Kikuchi, T. Narita and H. Takano: J. Nucl. Sci. Tech. 17, 567 (1980)

Table 1 List of Nuclides in JENDL-2 General Purpose File

H, D, ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{12}C, ^{19}F, ^{23}Na, ^{27}Al, Si,

Ca, ^{40}Ca, ^{42}Ca, ^{43}Ca, ^{44}Ca, ^{46}Ca, ^{48}Ca, ^{45}Sc, ^{51}V, Cr, ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr,

^{55}Mn, Fe, ^{54}Fe, ^{56}Fe, ^{57}Fe, ^{58}Fe, ^{59}Co, Ni, ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni, ^{64}Ni,

Cu, ^{63}Cu, ^{65}Cu, ^{93}Nb, Mo, ^{174}Hf, ^{176}Hf, ^{177}Hf, ^{178}Hf, ^{179}Hf, ^{180}Hf, ^{181}Ta,

Pb, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{228}Th, ^{230}Th, ^{232}Th, ^{233}Th, ^{234}Th,

^{233}Pa, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, ^{239}Np,

^{236}Pu, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{242}Am, ^{242m}Am, ^{243}Am,

^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm.

II-B-3

Present Status and Benchmark Tests of JENDL-2

Yasuyuki KIKUCHI and Members of JNDC

A paper on this subject was published in "Nuclear Data for Science and Technology", Proc. Int. Conf., 6-10 September 1982, Antwerp, p.615, with the following abstract:

The second version of Japanese Evaluated Nuclear Data Library (JENDL-2) consists of the evaluated data from 10^{-5} eV to 20 MeV for 176 nuclides including 99 fission product nuclei. Complete reevaluation has been made to heavy actinide, fission product and main structural material nuclides. Benchmark tests have been made on JENDL-2 for fast reactor application. Various characteristics in core center have been tested with one-dimensional model for total of 27 assemblies, and more sophisticated problems have been examined for MOZART and ZPPR-3. Furthermore analyses of JUPITER project give useful information. Satisfactory results have been obtained as a whole. However, the spectrum is a little underestimated above a few hundred keV and below a few keV. The positive sodium void reactivity worth is much overestimated. As to the latter, the sensitivity analysis with the generalized perturbation method suggests that the fission cross section of ^{239}Pu below a few keV has an important role.

II-B-4

Evaluation of Neutron Nuclear Data for ^{7}Li

K. Shibata

Neutron nuclear data of ^{7}Li were evaluated for JENDL-3 in the energy range from 10^{-5} eV to 20 MeV. Evaluated quantities are the total, elastic and inelastic scattering, tritium-production, photon-production, (n,γ), (n,2n) and (n,d) reaction cross sections.

The total cross section was estimated from the measurements of Meadows and Whalen[1)], Foster, Jr. and Glasgow[2)], Goulding et al.[3)] and Lamaze et al.[4)] For the inelastic scattering two discrete levels (0.478 MeV and 4.63 MeV) were taken into account. The tritium-production (^{7}Li(n,n')αt) cross section was evaluated on the basis of the experimental data of Smith et al.[5)] and Liskien et al.[6)], and the result is shown in Fig. 1 by comparing with ENDF/B-IV. The (n,γ) cross section was assumed to be 1/v-form up to 20 MeV normalized to the thermal value of 45.4 mb which was recommended in the fourth edition of BNL-325. The (n,d) reaction cross section was calculated with the DWBA by assuming the proton-pickup mechanism. Finally, the (n,2n) reaction cross section was adjusted so that the elastic scattering cross section given as the difference between the total and the sum of the partial cross sections might be consistent with the experimental data.

References:

1) J.W. Meadows and J.F. Whalen, Nucl. Sci. Eng. 41 (1970) 351.
2) D.G. Foster, Jr. and D.W. Glasgow, Phys. Rev. C3 (1971) 576.
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5) D.L. Smith, M.M. Bretscher and J.W. Meadows, Nucl. Sci. Eng. 78 (1981) 359.

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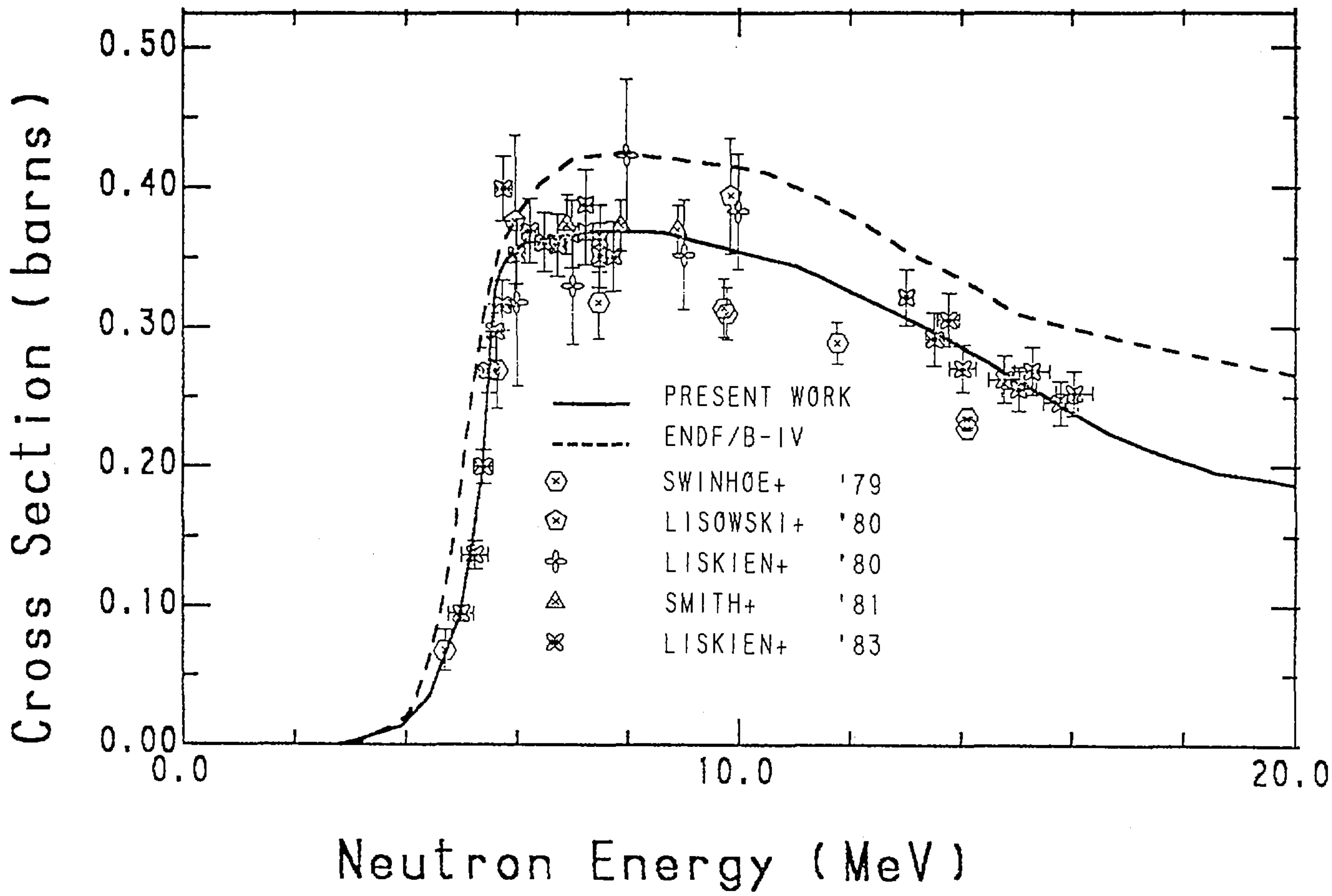

Fig. 1. ^{7}Li(n,n')αt cross section.

II-B-5

Evaluation of Neutron Nuclear Data for ^{12}C

K. Shibata

Evaluation of neutron nuclear data for ^{12}C was performed in the energy range from 10^{-5} eV to 20 MeV. Evaluated quantities are the total, elastic and inelastic scattering, photon-production, (n,γ), (n,p), (n,d) and (n,α) reaction cross sections.

The total cross section below the threshold energy of the inelastic scattering was calculated on the basis of the R-matrix theory[1,2]. The R-matrix is given by

$$R = \sum_{\lambda} \gamma_{\lambda}^{2}/(E_{\lambda} - E) + R^{\infty},$$

where γ_{λ} is the reduced width amplitude and E_{λ} is the level energy. The background term R^{∞} consists of two parts, i.e.,

$$R^{\infty} = R_0 + R_1 \cdot E_n,$$

where both R_0 and R_1 are real constants and E_n represents the incident neutron energy. These parameters were adjusted so that the calculated total cross section might fit the available experimental data. The best-fit values are given in Table I, and Fig. 1 shows the calculated result.

Concerning the inelastic scattering, three discrete levels were taken into account. The angular distributions for the inelastic scattering to the second and third excited states were calculated with the distorted-wave born approximation (DWBA) using the computer code DWUCK4[3], while the one for the first excited state was obtained from the experimental data.

The (n,γ) cross section was assumed to be 1/v-form up to 100 keV normalized to the thermal value of 3.53 mb which was recommended in the fourth edition of BNL-325. Above 100 keV, the inverse reaction data were used in order to estimate the cross section from the detailed balance.

The (n,d) cross section was calculated with the DWBA, and the (n,p) and (n,α) cross sections were estimated from the experimental data by using the spline-function fitting.

The elastic scattering cross section was given as the difference between the total and the sum of the above-mentioned partial cross sections.

References:

1) E.P. Wigner and L. Eisenbud, Phys. Rev. 72 (1947) 29.

2) A.M. Lane and R.G. Thomas, Rev. Mod. Phys. 30 (1958) 257.

3) P.D. Kunz, unpublished.

Table I. R-matrix parameters.

ℓ	j	E_λ (MeV)	γ_λ ($MeV^{1/2}$)	R_0	R_1 (MeV^{-1})
0	1/2	-1.862	0.816	0.0245	0.0
1	1/2	3.876	0.230	0.09	0.05
1	3/2	-1.262	0.224	0.261	0.05
		4.56	0.055	0.261	0.05
2	3/2	2.70	0.38	0.250	0.0
		3.254	0.974	0.250	0.0
2	5/2	1.911	0.13	0.065	0.0
3	5/2	2.596	0.077	0.0	0.0

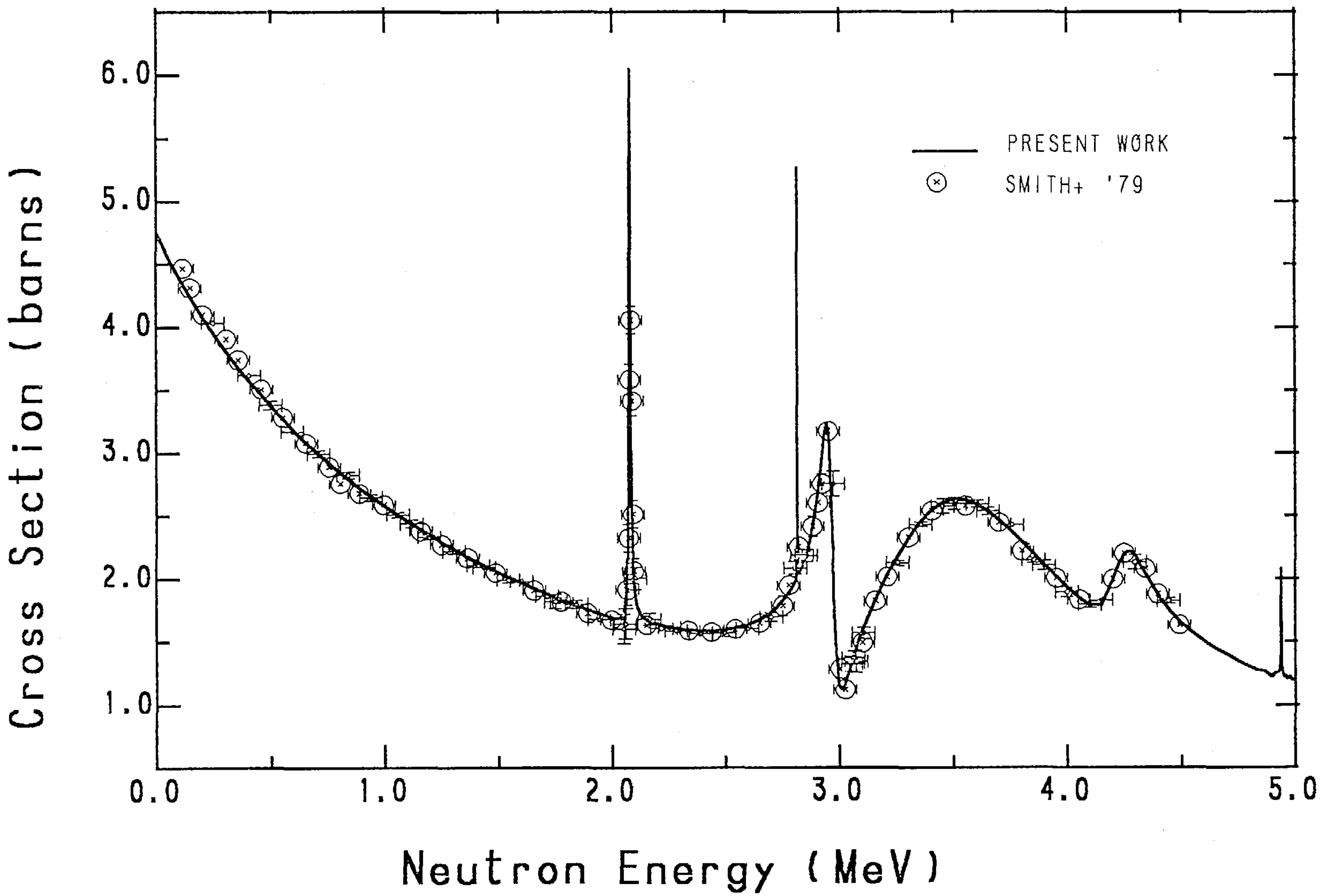

Fig. 1. Total cross section of ^{12}C.

II-B-6

Evaluation of Neutron Nuclear Data for Uranium-233

N. Asano*, H. Matsunobu*, and Y. Kikuchi**

A paper on this subject was published in the Journal of Nuclear Science and Technology[1] on December 1982.

Abstract

Neutron nuclear data of ^{233}U have been evaluated in the energy range from 10^{-5} eV to 20 MeV. Evaluated quantities are the total, fission, capture, elastic and inelastic scattering, (n,2n) and (n,3n) reaction cross sections, and the average numbers of prompt and delayed neutrons emitted per fission. The thermal and resonance cross sections have evaluated on the basis of the measured data. The resolved resonance parameters are given up to 100 eV and the unresolved resonance parameters between 100 eV and 30 keV. The total and fission cross sections have been evaluated in the higher energy region on the basis of the recently measured data, while the theoretical calculation with the optical, statistical and evaporation models has been used for evaluation of the other cross sections. The presently adopted optical potential parameters have reproduced well the experimental total cross section in the entire energy range as well as the measured data of the s-wave strength function. The structure observed in

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* Sumitomo Atomic Energy Industries, Ltd.

** Japan Atomic Energy Research Institute

the $\bar{\nu}_p$ values below 1 MeV is reproduced by the semi-empirical formula based on the fission fragment kinematics. The presently evaluated fission cross section is considerably lower than that of ENDF/B-IV between 10 and 50 keV. This low fission cross section is expected to resolve the k_{eff} discrepancy pointed out from the benchmark tests in ^{233}U critical assemblies.

Reference:

1) N. Asano, H. Matsunobu, and Y. Kikuchi, J. Nucl. Sci. Technol. 19, 1037 (1982)

II-B-7

Evaluation of Neutron Nuclear Data for ^{246}Cm and ^{247}Cm

Yasuyuki KIKUCHI

A paper on this subject will be published as JAERI-M report with the following abstract:

Neutron nuclear data of ^{246}Cm and ^{247}Cm were evaluated. Evaluated quantities are the total, elastic and inelastic scattering, fission, capture, (n,2n), (n,3n) and (n,4n) reaction cross sections, the resolved and unresolved resonance parameters, the angular and energy distributions of the emitted neutrons, and the average number of neutrons emitted per fission. The fission cross section was evaluated mainly on the basis of measured data. The other cross sections were calculated with the optical and statistical models because of scarce measured data. Discussion is given on the nuclear model calculations.

Figures 1 and 2 show the evaluated cross section of ^{246}Cm and ^{247}Cm.

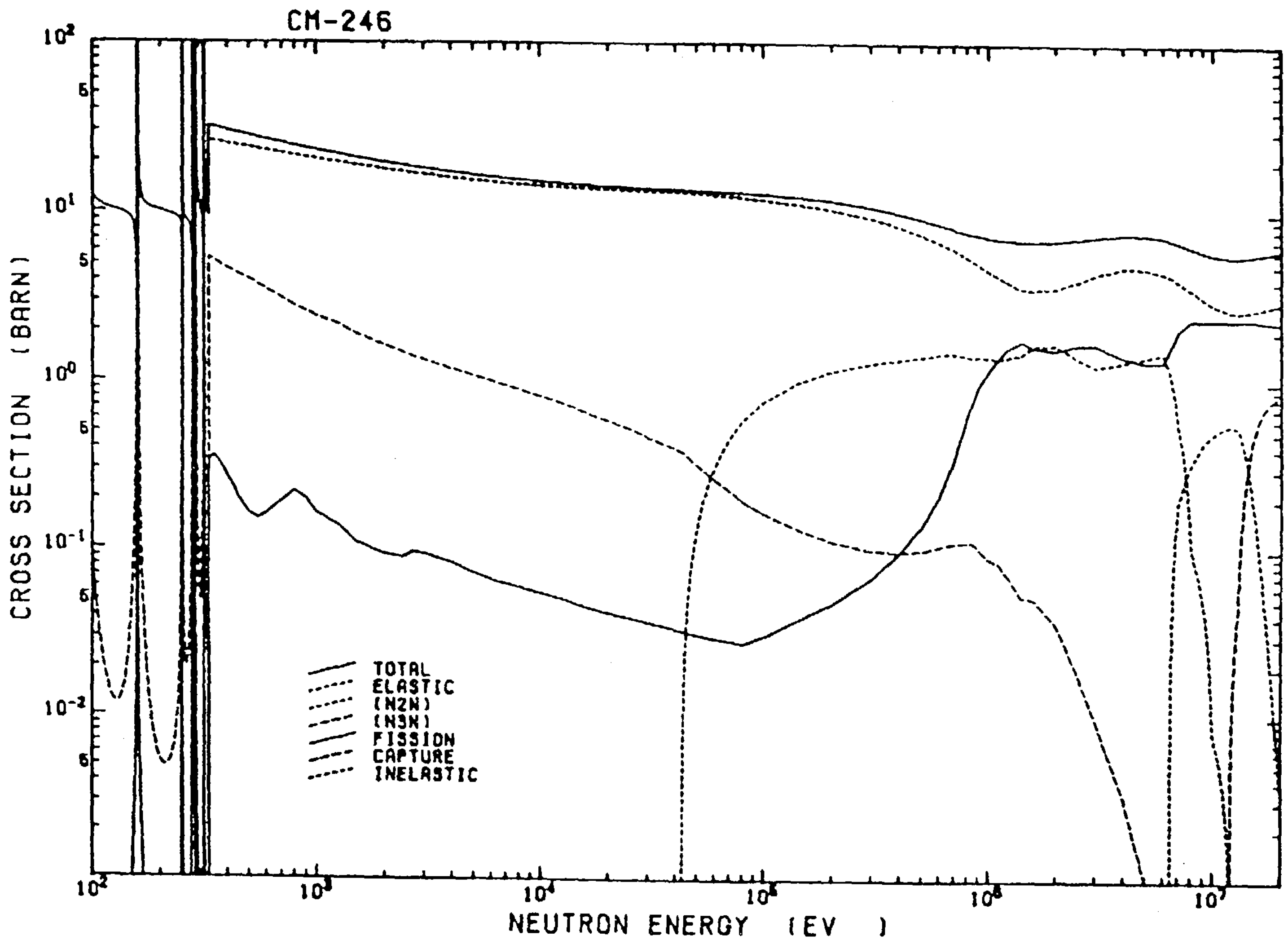

Fig. 1 Evaluated cross sections of ^{246}Cm

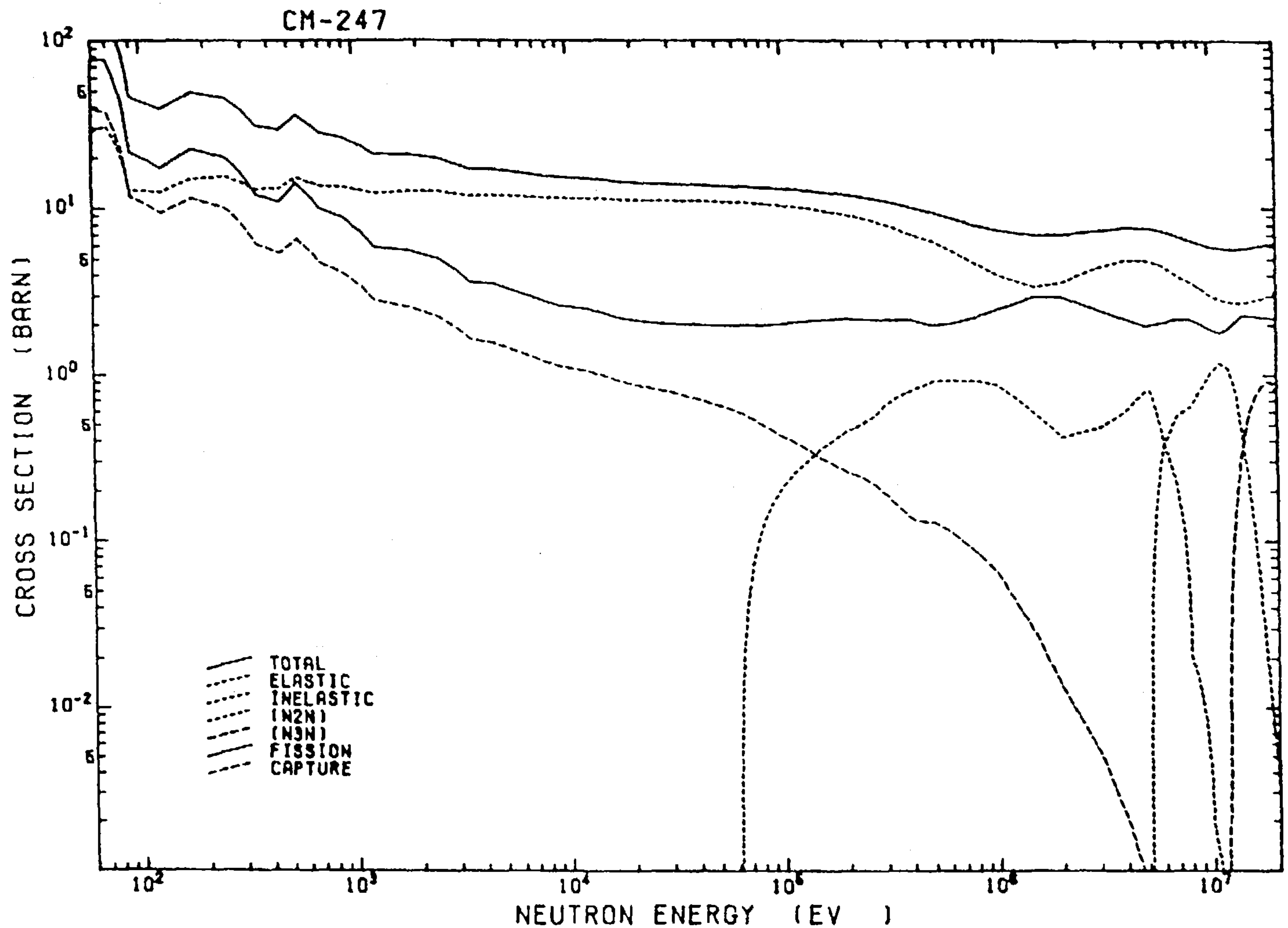

Fig. 2 Evaluated cross sections of ^{247}Cm

II-B-8

Evaluation of Decay Heat Data for ^{235}U, ^{239}Pu, ^{241}Pu and ^{233}U

K. Tasaka, H. Ihara, M. Akiyama*, T. Yoshida**, Z. Matumoto and R. Nakasima***

Evaluation of decay heat data was performed by summation calculation using JNDC FP decay data library[1] completed in 1981. The calculated decay heats were compared with available measurements such as those of ^{235}U, ^{239}Pu and ^{241}Pu from ORNL, ^{235}U, ^{238}U and ^{239}Pu from LANL, and ^{235}U from Univ. of Tokyo[2]. Figure 1 shows the comparison between calculated curves and measured decay heat data of ^{235}U, ^{239}Pu and ^{241}Pu from ORNL for the cooling times less than 10^5 second. Satisfactory agreement was obtained, although some discrepancies still remain at cooling times around 3000 second. Similar agreement had been obtained for the other data.

Calculated results have been fitted to an analytical function with 31 exponential terms for thermal neutron fission of ^{235}U, ^{239}Pu, ^{241}Pu and ^{233}U, fast neutron fission of ^{235}U, ^{238}U, ^{239}Pu and ^{232}Th, and 14 MeV neutron fission of ^{235}U and ^{238}U.

References

1) H. Ihara, Z. Matumoto, K. Tasaka, M. Akiyama, T. Yoshida and R. Nakasima, JAERI-M 9715 (1981).

2) K. Tasaka et al., JAERI-report (to be published in 1983).

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** NAIG Nuclear Research Laboratory, Nippon Atomic Industry Group Co., Ltd.

*** Department of Physics, Hosei University

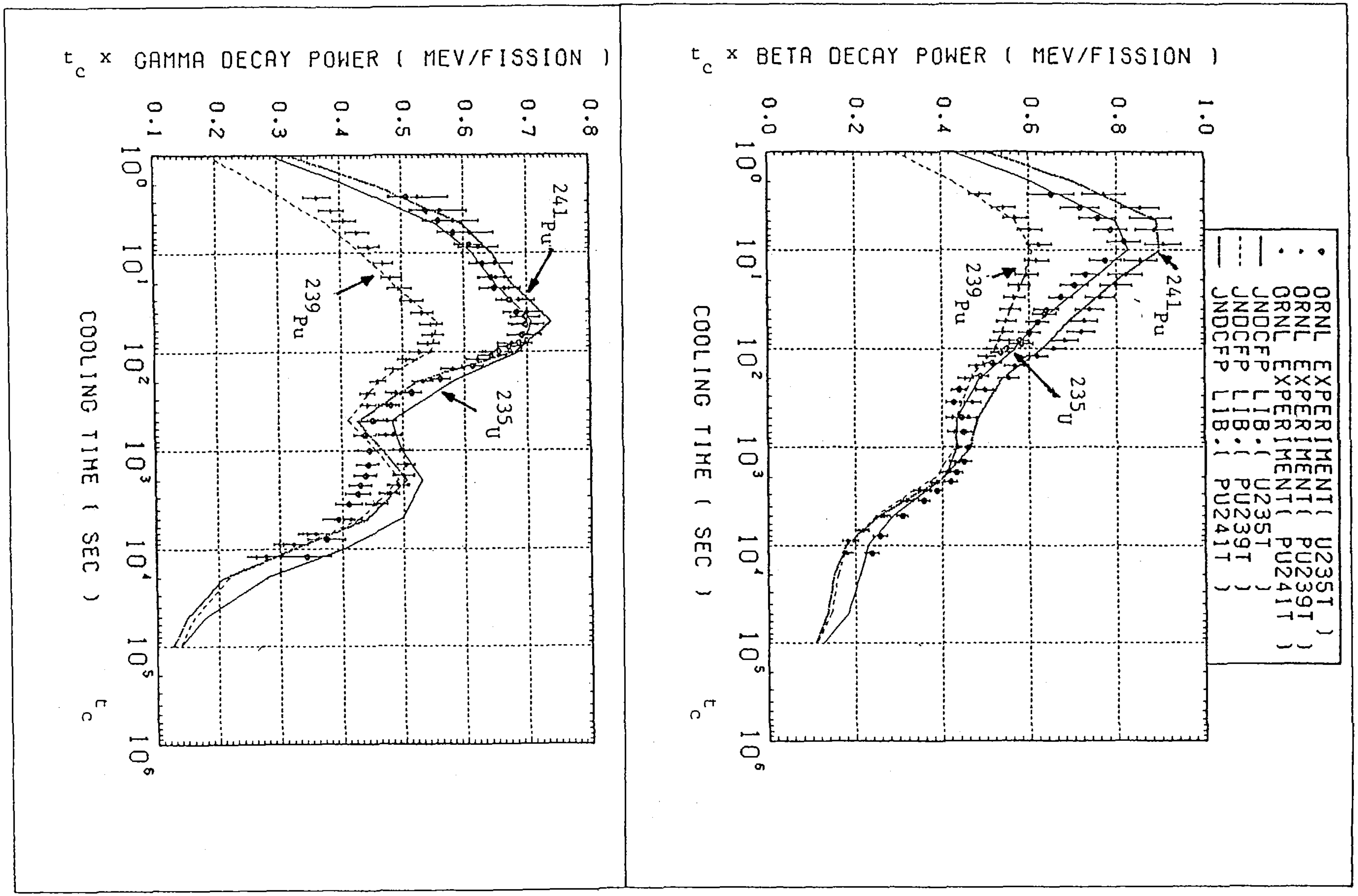

Fig. 1. Comparison between estimated results and measured data of beta (upper) and gamma (lower) decay heats for thermal neutron fission of ^{235}U, ^{239}Pu and ^{241}Pu

C. Production Development Section

Division of Radioisotope Production

II-C-1

Successive Neutron Capture of ^{153}Eu

T. Sekine, S. Ichikawa, and S. Baba

Successive neutron capture of ^{153}Eu was studied by means of activation method. Thermal neutron cross sections and resonance integrals were obtained for the (n,γ) reactions at the second and the third capture.

Highly-enriched (>99%) ^{153}Eu samples were prepared by using a mass separator. About 10 μg of ^{153}Eu were separated electromagnetically from europium oxide with natural isotopic abundances, and implanted into aluminum foil. The samples were irradiated during 11 days together with flux-monitor wires of Co/Al alloy, Ag/Al alloy, and niobium. The irradiations were carried out at three different positions in the core of the JRR-2 reactor with different neutron spectra; the values of Westcott's epithermal index $r(T/T_0)^{1/2}$ were 0.003, 0.009, and 0.069.

After irradiation, radioactivities of ^{154}Eu, ^{155}Eu, and ^{156}Eu, produced by one-, two-, and three-neutron capture of ^{153}Eu, respectively, were determined by γ-ray spectrometry. The γ rays from ^{154}Eu and ^{156}Eu were measured with a coaxial

Ge(Li) detector, while those from ^{155}Eu were measured with a planar Ge(Li) detector. From the yields of the radionuclides and the values of neutron flux and $r(T/T_0)^{1/2}$, the thermal neutron cross sections and the resonance integrals were deduced for the $^{154}Eu(n,\gamma)^{155}Eu$ and $^{155}Eu(n,\gamma)^{156}Eu$ reactions. The results are shown in Table 1 together with earlier reported values[1,2,3].

References:

1) R. J. Hayden, J. H. Reynolds and M. G. Ingram, Phys. Rev., 75 (1949) 1500
2) E. Adam, ZFK-201 (1970)
3) R. S. Mowatt, Can. J. Phys., 48 (1970) 1933

Table 1 Cross sections of $^{154}Eu(n,\gamma)^{155}Eu$ and $^{155}Eu(n,\gamma)^{156}Eu$ reactions.

Reaction	Cross section (b)*		
	Present work	Literature	
$^{154}Eu(n,\gamma)^{155}Eu$	σ_0 = 1840±90	$\hat{\sigma}$ = 880	[1]
	I_0' = 2100±2100	$\hat{\sigma}$ = 1500±400	[2]
$^{155}Eu(n,\gamma)^{156}Eu$	σ_0 = 3760±170	$\hat{\sigma}$ = 7900	[1]
	I_0' = 15300±2700	$\hat{\sigma}$ = 4040±125	[3]

*) σ_0 is the cross section for 2200 m sec^{-1} neutrons, I_0' the resonance integral subtracted by its 1/v component, and $\hat{\sigma}$ the effective cross section.

D. Project Engineering Section

Division of JMTR Project

II-D-1

Experimental Study on Neutron Dosimeters with Low Threshold Energies

K. Sakurai

This paper is a doctoral thesis at Science University of Tokyo, and was submitted to JAERI Report.

An important point requiring consideration in studing radiation damage for reactor materials is neutron dosimetry with 0.1 - 1.0 MeV. There are only a few dosimeters sensitive to neutron with energy from 0.1 to 1.0 MeV for thermal neutron reactor, and the practical use is currently made only of those based on the dosimeters $^{103}Rh(n,n')^{103m}Rh$ and $^{237}Np(n,f)FP$. New dosimeters $^{199}Hg(n,n')^{199m}Hg$, $^{93}Nb(n,n')^{93m}Nb$ and $^{107}Ag(n,n')^{107m}Ag$ were studied to measure neutron with energy from 0.1 to 1.0 MeV. This paper describes the neutron cross section measurement for the $^{199}Hg(n,n')^{199m}Hg$ reaction from 0.78 to 6.3 MeV and the use of cross section data for neutron spectrum unfolding, measurement of neutron fluence above 0.1 MeV with the dosimeter $^{93}Nb(n,n')^{93m}Nb$, and use of dosimeter $^{107}Ag(n,n')^{107m}Ag$ for neutron spectrum unfolding.

II-D-2

Pressure Vessel Surveillance Dosimetry in the JMTR

K. Sakurai

Neutron fluences above 0.1 and 1.0 MeV are evaluated using the dosimeter $^{54}Fe(n,p)^{54}Mn$. Neutron spectra near the pressure vessel are calculated with ANISN and PALLAS-2DCY codes. $^{54}Fe(n,p)^{54}Mn$ effective cross sections above 0.1 and 1.0 MeV are calculated from the neutron spectrum and neutron cross section data in ENDF/B-V. The values are 139.6 and 216.8 mb for 0.1 and 1.0 MeV, respectively. Neutron fluences for the surveillance testing pieces have been evaluated in the JMTR on this information.

II-D-3

Use of New Threshold Detector $^{111}Cd(n,n')^{111m}Cd$ for Reactor Neutron Dosimetry

K. Sakurai

Because of its low threshold energy of about 396 keV, the $^{111}Cd(n,n')$ ^{111m}Cd reaction is important as a neutron dosimeter, especially for a nuclear reactor. The isomeric state at 396 keV of ^{111}Cd decays with a half-life of 48.6 minutes and can be produced by neutron inelastic scattering by either direct excitation or more probably following excitation to higher levels which deexcite immediately to this isomeric state. This does not decay directly to the ground state, but is deexcited by a 151 keV transition in cascade with a 245 keV transition. The branching ratio is 94.2 % for 245 keV gamma-rays. The measurement of fission spectrum averaged cross section, the compilation of the energy dependent cross section for reactor neutron dosimetry and the irradiation experiment at JMTRC are in progress.

II-D-4

Gamma-heating Rate Calculation with DOT-3.5 for the JMTR Core

K. Sakurai

Gamma-heating rates for the JMTR core are calculated with DOT-3.5 code. The calculational models are for the standard core configuration and the 60th operation core configuration. Especially, the dependency on the core configuration is carefully evaluated. The absolute values of the gamma-heating rate are compared with experimental values which were measured with TLD for standard core configuration in the JMTRC(Ref. JMTR Irradiation Handbook, p. 135, 1980). The analysis is in progress.

II-E-1 New Measurement of the Isomer Production Cross Section for the $^{190}Os(n_{th},\gamma)^{191m}Os$ Reaction by means of X-ray Spectroscopy

K. Nishimura, T. Suzuki and T. Sekine

A new method for measuring the isomer production cross section was studied. The production cross section of the isomeric state ^{191m}Os in the $^{190}Os(n_{th},\gamma)$ reaction was determined by means of X-ray spectroscopy. The ^{191m}Os nuclide decays to the ground state of ^{191g}Os with half life of 13.1 h mostly through the internal conversion.

An osmium metal powder sample of 99.99% purity was irradiated for 48 hours at the thermal neutron field ($\phi = 1.68 \times 10^{11} n/cm^2 sec$) of the JRR-3. The intensity of the Os K X-rays was measured for 108 hours as a function of cooling time by a pure Ge detector (LEPS) with 0.5 keV resolution. A typical K X-ray spectrum obtained is shown in Fig. 1.

By analysing the peak area of 61.45 keV for the Os $K\alpha_2$ X-rays (the shaded portion shown in Fig. 1), the isomer production cross section σ^m was obtained as 12.0 b $\pm$ 5%. This value may be compared with the reported one of 8.55 b $\pm$ 18% [1), which was determined by the growth-decay analysis of the ground state ^{191g}Os.

In the present analysis, the internal conversion coefficient α, the relative K X-ray intensity I_k, and the K-shell fluorescent yield ω_k were used.

Simultaneously with the above K X-ray measurement, the 129-keV γ rays of ^{191}Ir were also measured by the LEPS detector and the ground-state production cross section σ^g for ^{191g}Os was obtained as 1.9 b[2]. By combining this value with σ^m, the isomeric yield ratio of $\eta = \sigma^m/(\sigma^m + \sigma^g)$ is estimated to be 0.87 ± 0.05. This ratio may be compared with the experimental η of 0.69 ± 0.22[1] and the theoretical η of 0.77[3], respectively.

References:

1) S. K. Mangal and P. S. Gill, Nucl. Phys. 41, 372 (1963)

2) T. Sekine et al., To be published.

3) L. Ya. Arifov, B. S. Mazitov and V. G. Ulanov, Sov. J. Nucl. Phys. 34, 572 (1982)

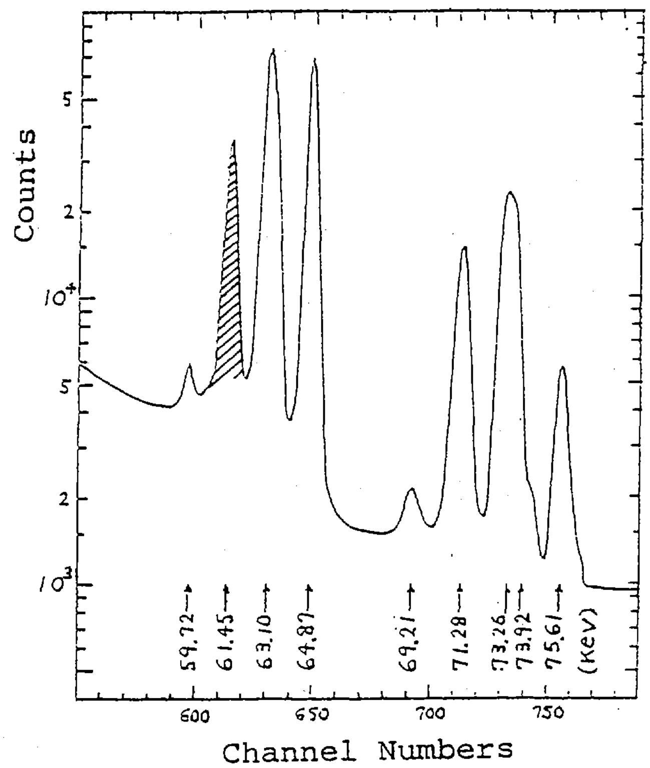

Fig. 1 A typical Os K X-ray spectrum.

III. Kyoto University

Research Reactor Institute

III-1 Determination of Pn value of ^{94}Rb by a β-γ Spectroscopic Method

K. Okano, Y. Funakoshi and Y. Kawase

A new method of measurements of delayed neutron emission probability has been developed utilizing a β-γ spectroscopic technique and an on-line isotope separator. As an illustration of the applicability of this method, Pn value of ^{94}Rb has been determined as 9.74±0.62%. This value is compared with previous values in the Table below. Further measurements on other delayed neutron emitters are now in progress.

Details of the experimental apparatus and procedure are described in another publication[1].

Reference:

1) K. Okano, Y. Funakoshi and Y. Kawase, Annu. Rep. Res. Reactor Inst. Kyoto Univ. Vol.16 (1983) (in press)

Table Pn value of ^{94}Rb

Reported value(%)	ISOL	Reference
11.1±1.1	ORSAY On-line mass spectrometer	I. Amarel et al., J. Inorg. Nucl. Chem. 31 (1969) 577.
8.46±0.92	CERN and LOUVAIN On-line mass spectrometer	E. Roeckl et al., Nucl. Phys. A222 (1974) 621.
9.6±0.8	LOHENGRIN	M. Asghar et al., Nucl. Phys. A247 (1975) 359.
13.7±1.0	SOLAR	P. L. Reeder et al., Phys. Rev. C15 (1977) 2108.
9.7±0.5	OSTIS	C. Ristori et al., Z. Physik A290 (1979) 311.
10.1±0.6	OSIRIS	E. Lund et al., Z. Physik A294 (1980) 233.
9.74±0.62	KUR-ISOL	Present result

III-2 Precise Determination of Half-lives of Some Short-lived Fission Products

K. Okano, Y. Kawase and Y. Funakoshi

For the determination of Pn values of fission product nuclides by a β-γ spectroscopic method, the half-lives of the nuclides concerned must be known to some precision. For short-lived fission product nuclides, however, it is not rare that the reported values of half-lives do not agree with each other within the stated errors. We have therefore determined the half-lives of ^{93}Sr, ^{94}Sr and ^{143}Ba with some precision using a 142 cc Ge(Li) detector and KUR-ISOL. The results are listed in the Tables below together with the reported values.

References:

1) G. C. Carlson et al., Nucl. Phys. A125 (1969) 267.
2) B. Ehrenberg and S. Amiel, Phys. Rev. C6 (1972) 618.
3) W. Herzog and W. Grimm, Z. Physik 257 (1972) 424.
4) B. Grapengiesser et al., J. Inorg. Nucl. Chem., 36 (1974) 2409.
5) I. Amarel et al., Phys. Letters 24B (1967) 402.
6) W. Grimm and W. Herzog, Z. Physik 259 (1973) 67.
7) T. Tamai et al., Inorg. Nucl. Chem. Letters 9 (1973) 245.
8) S. Amiel et al., Proc. of the 3rd Int. Conf. on Nuclei far from Stability, CERN 76-13 (1976) 501.
9) N. G. Runnalls et al., Phys. Rev. 179 (1969) 1188.

10) B. Grapengiesser et al., Proc. of the Int. Conf. on the properties of nuclei far from the region of beta-stability, CERN 70-30 (1970) 1093.

11) T. Tamai et al., Inorg. Nucl. Chem. Letters 9 (1973) 973.

12) J. C. Pacer et al., Phys. Rev. C17 (1978) 710.

Table 1. Half-life of ^{93}Sr

	Present results		Previous results			
	γ-ray (keV)	Half-life (min)	Ref.1)	Ref.2)	Ref.3)	Ref.4)
Half-life (min)	168	7.302±0.013				
	876	7.305±0.018				
	888	7.293±0.020				
	1269	7.273±0.067				
	mean	7.30±0.02	7.32±0.1 (439±6sec)	8.22±0.14	7.43±0.03	6.95±0.07

Table 2. Half-life of ^{94}Sr

	Present result		Previous results				
	γ-ray (keV)	Half-life(sec)	Ref.5)	Ref.6)	Ref.7)	Ref.4)	Ref.8)
Half-life (sec)	1427.6	75.1±0.4	76.5±1.7	74.1±0.3	78.9±0.8	75.3±0.7	76.6±1.0

Table 3. Half-life of ^{143}Ba

	Present results		Previous results				
	γ-ray (keV)	Half-life(sec)	Ref.9)	Ref.10)	Ref.11)	Ref.8)	Ref.12)
Half-life (sec)	211	14.28±0.10					
	291	14.54±0.22					
	799	14.38±0.24					
	mean	14.35±0.09	13.2±0.3	12±1	20±1	15.17±0.38	14.5±0.5

III-3

Measurement and Analysis of Energy Spectra of Neutrons in Structural Materials for Reactors

Itsuro Kimura, Shu A. Hayashi, Katsuhei Kobayashi,
Shuji Yamamoto, Ahmet Saim Selvi*,
Hiroshi Nishihara**, Satoshi Kanazawa**,
Takamasa Mori*** and Masayuki Nakagawa***

In order to assess evaluated neutron cross section data of main important structural materials for fission and fusion reactors, measurement and analysis of energy spectra of neutrons in sample piles or scattered by sample slabs have been continuously carried out.

(1) The final result for molybdenum was published before[1] and then a paper for titanium was submitted to J. Nucl. Sci. Technol..

(2) A review paper was presented at the International Conference on Nuclear Data for Science and Technology at Antwerp, Belgium in September 1982 as a special invited paper[2]. In this paper, the neutron spectra in iron, nickel and chromium and so forth are shown. The experimental spectra for iron and nickel reasonably agree with those theoretically calculated from about 1 keV to 2 MeV, while the experimental result for chromium noticeably exceeds the predicted value below 100 keV. Now the reason of this discrepancy is being investigated.

(3) The spectra of the neutrons both in a spherical pile of thoria and scattered by a metallic thorium slab was reanalyzed with ENDF/B-4 and JENDL-2 and the result was presented at the Japan-US Seminar on Thorium Fuel Reactor at Nara, Japan in October 1982[3]. In the energy region from 0.8 MeV to 2.5 MeV, the

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predicted spectrum with ENDF/B-4 agrees with the experimentally observed more closely than that with JENDL-2 for both cases.

(4) The neutron spectrum in a spherical pile of copper was measured and calculated[4]. A preliminary result is shown in Fig. 1, from which it is seen that there exist noticeable disagreement between the measured spectrum and the theoretically predicted. This is probably due to scanty experimental data of the neutron cross section for copper. After the investigation of the reason of the above disagreement, the result will be published soon.

(5) The spectrum of the neutrons scattered by a tungsten was most recently measured and the result was compared with the calculated. Good agreement can be seen between them. This result will be presented at the Fall Meeting of Atomic Energy Society of Japan in this September[5].

(6) A new spherical pile of manganese is now in preparation. Soon the neutron spectrum in this pile will be studied by both experimentally and theoretically.

References:

(1) T. Mori, et al. : J. Nucl. Sci. Technol., 19 427 (1982)
(2) I. Kimura, et al. : Nuclear Data for Science and Technology (K. H. Bockhoff (ed.)) , pp. 98-105, ECSC, EEC, EAEC, Brussels and Luxembourg (1983).
(3) I. Kimura, et al. : "Evaluated Nuclear Data for Thorium Fuelled Reactors and Their Integral Test by Neutron Spectrum and Decay Heat", Presented at the US-Japan Seminar on Thorium Fuel Reactor, Nara, Japan (1982).
(4) S. A. Hayashi, et al. : Preprint of Fall Meeting of the Atomic Energy Society of Japan, F29, p. 301 (1982).
(5) K. Kobayashi, et al. : to be presented at the Fall Meeting of the Atomic Energy Society of Japan.

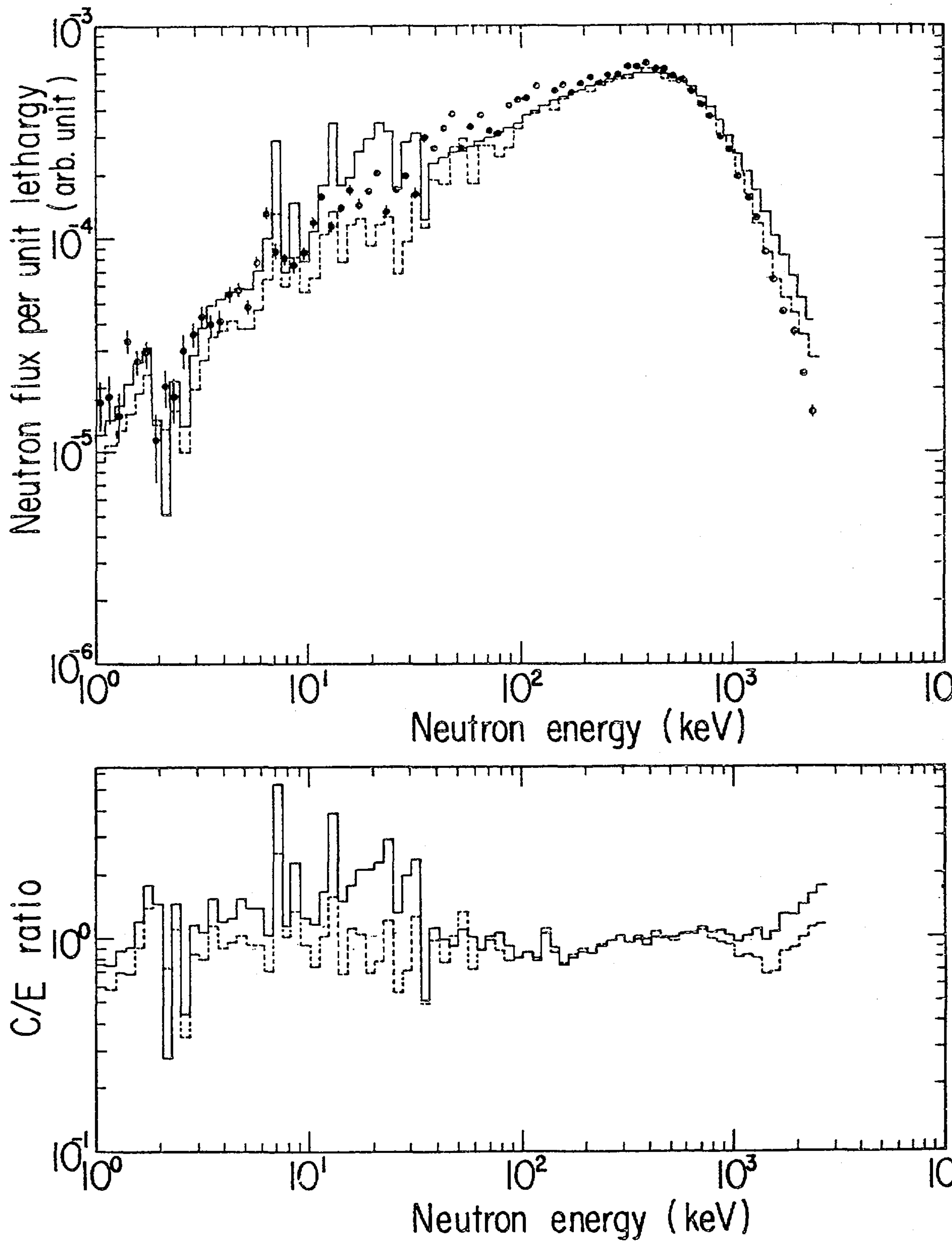

Fig. 1 (Top) Fast neutron spectra in a spherical pile of copper. ⧫⧫: experimental points, ‾|_ : calculated by ANISN P_8S_{16} with JENDL-2, ‾‾|_ _ : calculated by the same code with ENDF/B-4. (Bottom) The ratios of the calculated spectrum in the copper pile to the measured one. The symbols are the same as the top figure.

III-4 A MEASUREMENT OF THE AVERAGED CROSS SECTION FOR THE $^{232}Th(n,2n)^{231}Th$ REACTION WITH A FISSION PLATE

Hiroshi CHATANI

A paper on this subject was submitted to the Nucl.Inst.Methods 205(1983)501. $^{232}Th(n,2n)^{231}Th$ reaction cross section averaged over the fission spectrum was measured by use of a 90% enriched uranium fission plate. The ^{232}Th sample and fast neutron monitor foils of Mg,Ti and Ni were irradiated with fission neutrons from the fission plate at the heavy water thermal neutron facility of Kyoto University Reactor. The irradiated ^{232}Th sample was chemically purified. Gamma rays from these samples were measured with a $30 cm^3$ Ge(Li) detector. The cross section value obtained is 15.5±1.2 mb, and agrees with the predicted values by Pearlstein[1)] and Zijp et al.[2)] within the experimental errors.

References:

1) S.Pearlstein, Nucl.Sci.Eng. 23(1965)238.

2) W.L.Zijp and H.J.Nolthenius, IAEA-208, Tech.Document, Vol.2 (1978)p.327.

III-5

Measurement of the Relationship between the Doppler and the Self-shielding Effects in the Total Cross Section of ^{232}Th for 24 keV Fe-Filtered Neutrons

Yoshiaki FUJITA*, Robert M. Brugger**,
Don M. Alger**, and William H. Miller**

The measurement of this study was performed at the Research Reactor Facility of the University of Missouri. The result has been submitted to Journal of Nuclear Science and Technology with the following abstract:

A relationship between the Doppler effect and self-shielding effect has been experimentally studied by measuring the effective average total cross sections of the metal and sintered dioxide of ^{232}Th for 24 keV Fe-filtered neutrons. The relationship is a theoretical prediction that the apparent value of the total cross section measured with the neutrons of an adequate energy spread is expressed by a single parameter $N/\sqrt{\Theta}$ for the high temperature limit, N being the thickness and Θ the effective temperature of the samples. The temperature has been varied from room-temperature to 900 C and the thickness from about 0.3 cm to about 3.8 cm. The results of the measurements support the theoretical prediction for both cases of the metal and dioxide. The Doppler and self-shielding effects for the metal and dioxide agree within the experimental errors. From previous measurements it was expected that these might show some dependence on molecular binding.

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* Research Reactor Institute, Kyoto University
** Research Reactor Facility and Department of Nuclear Engineering, the University of Missouri

III-6

Measurement of the Nuclear Inelastic Scattering Cross Section of ^{232}Th for 144 keV Si-Filtered Neutrons

Yoshiaki FUJITA*, Takaaki OHSAWA**, Robert M. Brugger***
Don M. Alger*** and William H. Miller***

The measurement of this study was performed at the Research Reactor Facility of the University of Missouri. The result has been submitted to Journal of Nuclear Science and Technology with the following abstract:

The nuclear inelastic scattering cross section of ^{232}Th has been measured at 144 keV using a Si-filtered neutron beam at MURR. The energy spectrum of the scattered neutrons was measured with a spherical hydrogen-gas counter and a pulse-height-unfolding procedure. Data were taken at nine scattering angles from 30 to 150 degrees in 15 degree increments. The results provide new experimental information below 250 keV. The angle-integrated cross section is 0.74 $\pm$ 0.05 barns, which agrees with the evaluation JENDL-2 and with a coupled-channel calculation where the inelastic scattering through the direct-excitation process of the collective rotational motion of a deformed nucleus is included as well as that through the compound-nucleus-formation process. Experimental results have been obtained also for the angular dependence of the elastically scattered neutrons at 144 keV.

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IV. KYUSHU UNIVERSITY

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IV-A-1

Pre-Equilibrium Emission of Protons from $^{93}Nb(n,p)^{93}Zr$ Reaction at 14 MeV

N. Koori, Y. Ohsawa* and I. Kumabe

The energy spectrum and angular distributions of protons emitted from the $^{93}Nb(n,p)^{93}Zr$ reaction at 14.1 MeV have been measured with a position sensitive counter-telescope[1]. The energy spectrum integrated over the solid angle is shown in Fig.1 ; the angular distributions are shown in Fig.2 for the energy intervals of 4.3∿14.1 MeV (a), 4.3∿9.0 MeV (b) and 9.0 ∿14.1 MeV (c). The total cross section above the detection threshold energy of 4.3 MeV is 42.3 ± 3.9 mb ; this value agrees reasonably with the measurement by Grimes et al.[2].

The theoretical analyses were performed on the basis of the simple pre-equilibrium model combined with the statistical evaporation model[3,4], the generalized exciton model[5] and the multi-step direct reaction (MSDR) model[6-8]. The energy spectrum is well reproduced by the pre-equilibrium model combined

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with the statistical evaporation model, although the model cannot predict the angular distribution. The prediction by the generalized exciton model is slightly smaller than the measured cross sections in the energy region where the statistical evaporation process is dominant. The MSDR model calculation agrees reasonably with the pre-equilibrium model calculation for n=3.

The angular distributions are successfully reproduced by means of the generalized exciton model. The calculation based on the MSDR model indicates a little discrepancy in the absolute cross section in spite of general agreement in the shape of the angular distribution.

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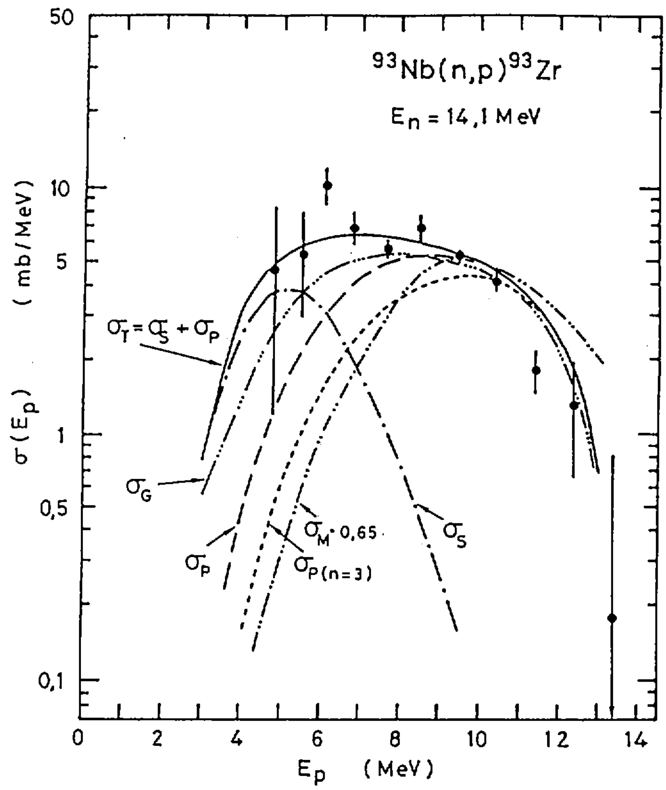

Fig. 1 Energy spectrum integrated over the solid angle for the ^{93}Nb(n,p)^{93}Zr reaction at 14.1 MeV. Calculated spectra : σ_S is obtained by the statistical evaporation model, $\sigma_{P(n=3)}$ by the pre-equilibrium model (n=3), σ_P by the pre-equilibrium model (total), σ_G by the generalized exciton model, and σ_M by the multi-step direct reaction model (one-step case). The spectrum σ_T is obtained as the sum of spectra σ_S and σ_P.

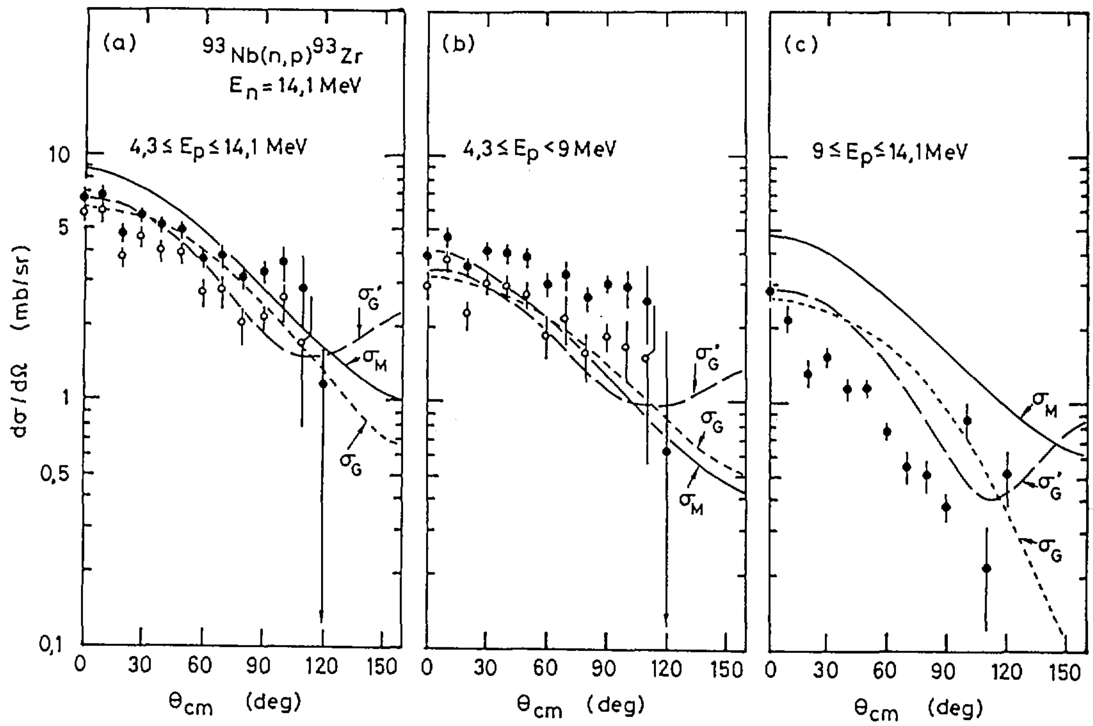

Fig. 2 Angular distributions for the $^{93}Nb(n,p)^{93}Zr$ reaction at 14.1 MeV. Solid circles : Measured differential cross sections. Open circles : Differential cross sections after the subtraction of the isotropic contribution from the statistical evaporation process. Dotted curves (σ_G) are calculated by means of the generalized exciton model with the theoretical eigenvalues of Legendre polynomial series, and curves (σ_G') with the adjusted eigenvalues. Solid curves (σ_M) indicate the angular distributions for the one-step case in the frame of the MSDR theory, which should be compared with the values indicate by open circles in (a) and (b).

IV-A-2 Analysis of 14 MeV (n,p) and (n,α) Cross Sections with Pre-equilibrium Model and Effective Q-values

I. Kumabe

A paper on this subject was published in Proceedings of the Europhysics Topical Conference on Neutron Induced Reactions, June, 1982, Smolence p. 305 with an abstract as follows :

The measured cross sections of 14 MeV (n,p) and (n,α) reactions for nuclei with mass number larger than 100 are analyzed in terms of the pre-equilibrium exciton model and an effective Q-value, which is smooth functions of mass number and atomic number and is free from fluctuations near closed shells. The deviations from 1.0 of the ratios of experimental to theoretical cross sections calculated using the effective Q-values Q_e for the (n,p) reaction and the average Q-values $(Q_t + Q_e)/2$ for the (n,α) reaction are markedly reduced as compared with the use of the true Q-values Q_t.

IV-A-3 Analysis of 14 MeV (n,n') Scattering with Generalized Exciton Model

Y. Watanabe, M. Hyakutake and I. Kumabe

Akkermans et al.[1] have given the computer code PREANG which calculates emission spectra and angular distributions of particles emitted in pre-equilibrium nuclear reactions. This code employs the generalized master equation approach of the exciton model as proposed by Mantzouranis et al. It was demonstrated that the generalized master equation can be transformed to a set of simple tridiagonal matrix equations, directly yielding the Legendre coefficients of the angular distributions. They analyzed the neutron inelastic scattering data for 34 elements measured by Hermsdorf et al.[2] at 14.6 MeV. The results show underestimation of angular distributions at backward angles. A good overall fit of all angular distributions is obtained by adjustment of only two global parameters μ_1 and μ_2. However it is difficult to give a quantitative physical explanation for the proposed adjusted parameters.

Recently Gruppelaar et al.[3] proposed some improvements in calculation and processing of double-differential cross sections using the generalized exciton model of pre-equilibrium and equilibrium emission. The improved model takes into account the following four factors ; (1) reconsideration with respect to the state-density problem, (2) incident-energy dependent refraction effects,

(3) Pauli principle and (4) the use of the Kikuchi-Kawai expression for two-body collisions in nuclear matter. A significant refinement of this model is obtained by accounting explicitly for the energy-angle correlation of the initial emission. Comparison with experimental 14.6 and 25.7 MeV (n,n') data and with the systematics of Kalbach and Mann shows quite good agreement.

We modified the code PREANG by following the model of Gruppelaar et al.[3] except for the factor of reconsideration with respect to the state-density problem.

Double differential neutron emission cross sections for various nuclei bombarded by 14 MeV neutrons have been measured in Kyushu University[4] and in Osaka University[5]. We analyzed these data using the modified code. In this paper preliminary results of the analysis are presented.

Comparison of the experimental angular distributions measured in Kyushu University with calculated ones is shown in Fig.1. The calculated results are indicated by solid curves. The curves are in fairly good agreement with the experimental data, although a little underestimation is seen for high-energy neutrons at backward angles. In these calculations we used $K = 390\ \mathrm{MeV}^3$ and $g = A/13$.

Secondary neutron spectra from a ring sample were measured in Osaka University[5]. Scattering angle was changed with distance between the neutron source and a ring sample, so that incident neutron energy varied from 14.8 MeV (0°) to 13.5 MeV (150°) corresponding to laboratory scattering angles. Therefore experimental angular distribution can not be obtained.

Thus comparisons between the experimental and calculated energy spectra were carried out using the modified code as is shown in Fig.2. The calculated spectra are in fairly good agreement with experimental ones except for backward angles ($\theta_L > 100°$). In this calculation we used $K = 470$ MeV^3 and $g = A/13$.

References

1) J.M. Akkermans and H. Gruppelaar, Phys. Rev. C22 (1980) 73.

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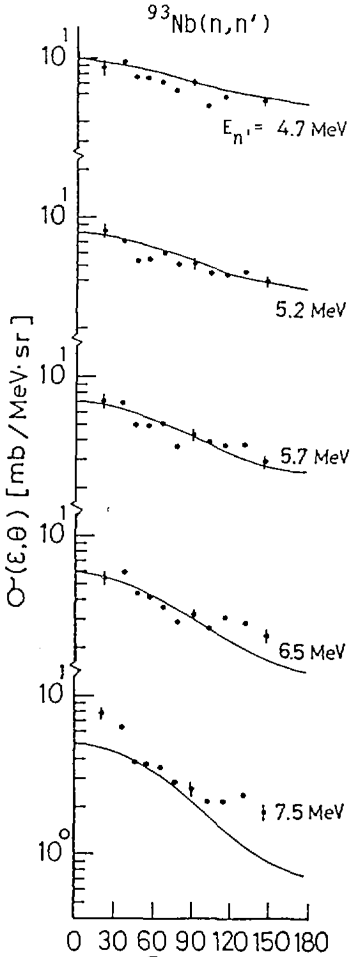
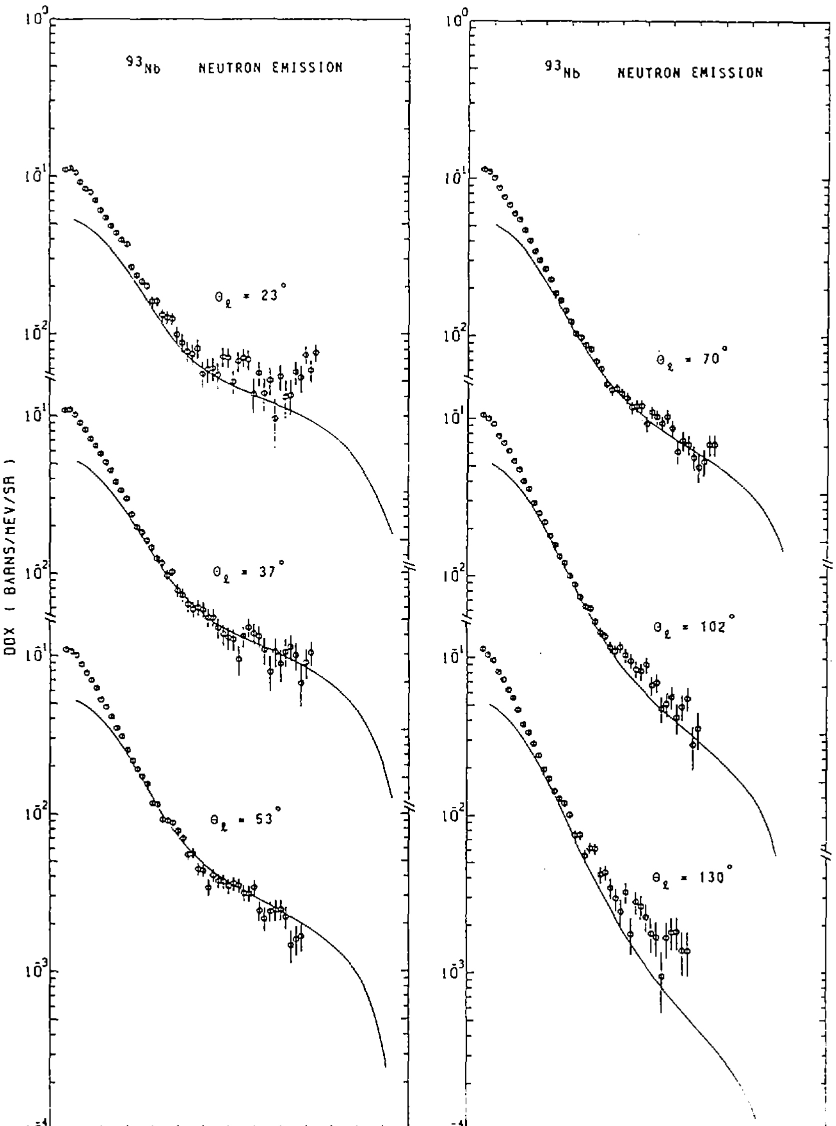


^{93}Nb(n,n')
$E_{n'}$ = 4.7 MeV
5.2 MeV
5.7 MeV
6.5 MeV
7.5 MeV
σ(ε,θ) [mb/MeV·sr]
0 30 60 90 120 150 180
Θ CM

Fig. 1



^{93}Nb NEUTRON EMISSION
θ_ℓ = 23°
θ_ℓ = 37°
θ_ℓ = 53°
θ_ℓ = 70°
θ_ℓ = 102°
θ_ℓ = 130°
DDX (BARNS/MEV/SR)
NEUTRON ENERGY (MEV)

Fig. 2

IV-A-4 **Analysis of (n,xn) reaction cross sections up to 25 MeV**

Y. Watanabe, Y. Inenaga, M. Hyakutake and I. Kumabe

Multi-particles emission becomes important in the calculation of cross sections at incident neutron energy above about 10 MeV. For the calculation of these cross sections it is necessary to take into account the competition between decay channels and also the pre-equilibrium process.

The code, which calculates the neutron-induced reaction cross sections up to 25 MeV, was developed. This code takes into account the following factors,

1. angular momentum and parity conservation and discrete level for low excitation state
2. neutron, proton, alpha particle and γ-ray for decay channel
3. three particle emission
4. each transmission coefficiency for each particle emission

and also, the following model and parmeters are used,

1. the evaporation model and the level density of Gilbert et al. and Cook et al. for the equilibrium process
2. the exciton model and the effective Q-value[1] for the pre-equilibrium process

Using this code the excitation curves for (n,xn) reactions (^{45}Sc, ^{75}As, ^{107}Ag, ^{197}Au)[2] and energy spectra of neutron emission at 14 MeV (As, Ag, I, Au)[3] were analyzed.

In Fig.1 are shown neutron emission spectra for Ag and Au at 14 MeV incident neutron. Fig.2 shows the excitation curves for (n,2n) and (n,3n) reaction cross sections and isomeric cross section. The agreement between the measured and calculated values is good. The agreement between the measured and calculated values was generally good for other nuclei.

It has been proved that this code is valuable tools for analysis of neutron reaction cross sections.

References

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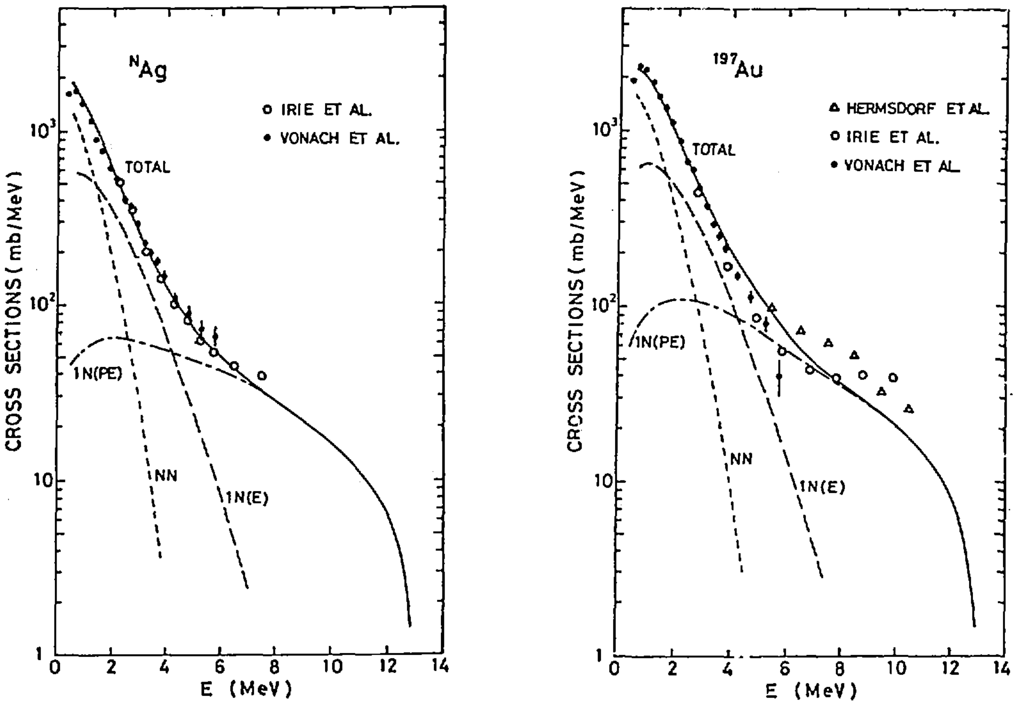

Fig. 1 Calculated and experimental neutron emission spectra from 14 MeV neutrons on Ag and Au.
E : equilibrium process, PE : pre-equilibrium process, NN : neutrons after 1-st neutron emission.

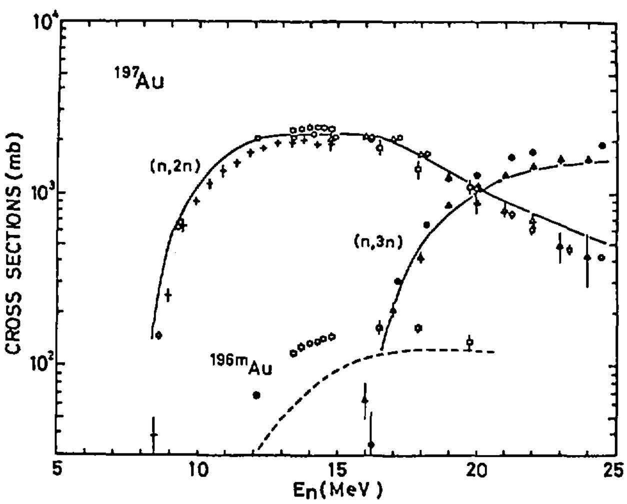

Fig. 2 Calculated and experimental cross sections for $^{197}Au(n,2n)^{196}Au$, $^{197}Au(n,3n)^{195}Au$ and $^{197}Au(n,2n)^{196m}Au$ reactions.

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IV-B-1

Neutron Total Cross Section Measurements of ^{238}U at the Fe-Filtered Neutron Energy Bands in keV Region

I. Tsubone, Y. Kanda, Y. Nakajima* and Y. Furuta*

The neutron total cross section of ^{238}U has been measured in the energy range from 24 keV to 1 MeV at a 100 m flight path station of the neutron time-of-flight facility of the Japan Atomic Energy Research Institute linac. Neutrons were filtered by a 30 cm-thick iron and detected by a NE-110 plastic scintillation counter. Attention was paid to taking into account the self-shielding effect below 200 keV. Fitting the measured total cross section with the average R-matrix, the neutron strength function for p- and d- wave were found to be $S_1 \times 10^4 = 1.60 \pm 0.08$ and $S_2 \times 10^4 = 0.95 \pm 0.50$, and the average distant level parameters for s-, p- and d-wave to be $R_0^{\infty} = -0.081 \pm 0.005$, $R_1^{\infty} = 0.13 \pm 0.04$, and $R_2^{\infty} = -0.01 \pm 0.68$, respectively.

The study was presented at Antwerp Conference (September, 1982).

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IV-B-2

Emission of sub-Coulomb-barrier protons from Ni isotopes

Y. Uenohara, K. Mori, M. Sei*, and Y. Kanda

A peak at low region of a proton spectrum in 14 MeV-Neutron-induced reactions is understood to be composed of sub-Coulomb-barrier protons. It is found by Grims et al. in 14 MeV-neutron experiments by an intense neutron source, Rotating Target Neutron Source-I. They predicted that the spectra calculated from the multi-step Hauser-Feshbach model agreed with the experimental ones.

We have calculated in the same ways the proton spectra in the neutron-induced reactions for Ni isotopes near 10 MeV. It has been concluded that the protons emitted by (n,np) reactions can be distingwished from the protons from the other reactions on the proton spectra if the incident neutron energies beyond about 3 MeV from the threshold energy of the (n,np) reaction. The experiments are proposed and being made by Grimes expecting to check the reaction mechanism of emission of sub-Coulomb-barrier protons.

The study is published in Engineering Sciences Reports, Kyushu Univ. 4 [1] (1983), in Japanese.

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IV-B-3

A method for Decision of Nuclear Reaction Model Parameters

Y. Uenohara, M. Tsukamoto* and Y. Kanda

In nuclear data evaluations, several nuclear models are applied to calculate neutron cross sections and spectra of emitted particles. Many proper parameters are included in the formulae of the models. They have been obtained numerically so that the model calculations agree with available experimental data. A typical example is the parameter search on optical model in which the parametrers are determined by interative calculations as to minimize chi-squares composed from residuals and experimental errors. For the other models, however, the methods similar to the optical model have almost never been applied. Their parameters have been chosen by comaring the calculated results with available experimental data rather qualitatively and comprehensively. It is difficult for such a method to determine optimum values when there are many parameters. We applied the Bayes estimation in statistics to these problems. Sensitivity matrices of observable quantities to the model parameters are approximated with the B-spline functions in order to decrease the computing time.

We have tried to estimate the level density parameters, which are used in the multistep compound nucleus model and the pre-equilibrium model, with respect to ^{93}Nb(n,x) reactions. The present parameters resulted in the cross sections and emitted particle spectra which agree well with their measurements.

To be published in J. Nucl. Sci. Tech..

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IV-B-4

Simultaneous Evaluation Method for Partial Cross Section with Logarithmic Formulae

M. Tsukamoto*, Y. Uenohara and Y. Kanda

The Bayes estimation with B-spline functions is useful in nuclear data evaluations. The estimated partial cross sections by this method can be adjusted by applying linear least square method with constraint so that the sum of them is equal to the total cross sections. The adjusted ones, however, are possible to be negative values sometimes. In order to avoid the troublesome problems, we have adopted the logarithms of the partial cross sections. The logarithms of the toatl cross sections cannot be represented by the linear combinations of logarithmic partial cross sections. It is assumed that it is equal approximately to the summation over the reaction channels with the first order Tayler expansion and applied the linear least square method with constraint. This method have been applied to the evaluation of neutron-induced partial and total cross sections for ^{93}Nb and ^{56}Fe.

The present method is very useful to adjust the partial and total cross sections evaluated independently for nuclear data file.

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IV-B-5

Simultaneous Evaluation of Neutron Cross Section and their Covariances for Some Reaction of Heavy Nuclei

Y. Uenohara and Y. Kanda

We have developed the simultaneous evaluation method and been applied to evaluate the cross sections and their covariances of ^{235}U(n,f), ^{238}U(n,f), ^{238}U(n,γ), ^{249}Pu(n,f) and ^{197}Au(n,γ).

In this method, the excitation functions of cross sections and cross section ratios have been represented by B-spline functions and the logarithms of data have been taken in order to linearize them and to use the linear least square formulae including a weight matrix deduced from experimentl informations.

We have shown that the need for a large memory can be eliminated in the caluculation if a sufficiency which is a concept defined in Statistics is applied.

The study was presented at Antwerp Conference (Septenber, 1982)

IV-B-6

An Evaluation Method for Two-dimentional Nuclear Data

Y. Uenohara and Y. Kanda

The measured neutron cross sections are two-dimentional data composed of incident energies and cross sections. Both of them have proper uncertainties. In applications of least square method in the evaluations of the cross sections, the uncertainties on the incident energies were taken into account by reducing them to the uncertainties on the cross sections and the measured cross sections have been considered as the one-dimensional data. We have studied an evaluation method in which the cross sections are handled as two-dimensional data; An example is the evaluations of the fission cross section ratios of ^{238}U to ^{235}U. The measured data have been represented with respect to the abcissa(energy) and the ordinate(cross section ratio) by the first order B-spline functions independently with a common parameter which is the distance between neighboring data successibly. It has been shown that the energy uncertainties strongly influenced into the resulted covariances in an energy region near one MeV where the ratios increase abruptly and are same as the values for the one-dimensional treatment in others.

IV-B-7

Calculated Cross Sections Induced by MeV Neutrons for Isotopes near Mo.

M. Sei*, Y. Uenohara and Y. Kanda

An object of this study is evaluations of neutron induced reaction cross sections for seven Mo isotopes in natural abundance. Available data measured for them are scarce. Parameters used in the model formulae have been estimated from the ones induced from esperimental values for the isotopes near Mo.

We have used a computer code GNASH programmed originally by Young and Arthur and revised slightly by us. It is based on multi-step compound nucleus process, Hauser-Feshbach model and pre-equibrium model. Major parameters used in it are optical model parameters responsible for transmission coefficients of particles, gamma strength functions, parameters of the pre-equibrium model and level density parameters. Sensitivities of them for resulted cross sections are examined. It reveals that the last two are important.

They are determined to reproduce available experimental data for ^{89}Y, ^{90}Zr, and ^{93}Nb. They are applied to calculate the reaction cross sections for ^{92}Mo, ^{98}Mo, and ^{100}Mo. Reproducibilities for their available data are good. Then, they are used to obtain the reaction cross sections for seven Mo isotopes and natural Mo are calculated with the parameters.

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V-1 Neutron Activation Cross Section of Molybdenum Isotopes at 14.8 MeV

S. Amemiya, K. Ishibashi, T. Katoh

A paper on this subject was published in Journal of Nuclear Science and Technology 19, pp 781 - 788 (1982).

The neutron activation cross sections of Mo isotopes have been measured for the 14.8 MeV neutron. The cross sections have been determined with reference to the known $^{27}Al(n,\alpha)^{24}Na$ and the $^{27}Al(n,p)^{27}Mg$ reactions. The cyclic activation method was employed for the gamma-ray measurement of short-lived nuclei. A 55 cm^3 Ge(Li) detector was used for the gamma-ray spectra. Cross section data are presented for (n,2n), (n,p), and (n,α) reactions on Mo isotopes. The exponential dependence on (N - Z)/A of the (n,p) reaction cross sections are discussed. The cross section of (n,np) reaction on ^{98}Mo is also presented.

V-2 Decay of Ce-147 to Levels of Pr-147

M.Totsuka, S. Fujita, K. Mio, K.Kawade, H.Yamamoto, T. Katoh, T. Nagahara+

A paper on this subject was published in Journal of Nuclear Science and Technology 19, pp 765 - 767, (1982).

The decay of a short-lived nucleus ^{147}Ce to levels of ^{147}Pr was investigated with Ge(li) detectors in singles and coincidence modes. Radioactive sources were prepared by a chemical separation, a rapid electrophoresis, from the fission products of ^{235}U. The half-life of ^{147}Ce is 57 ± 5 s. A total of 14 gamma-rays including 4 new ones were observed and 13 gamma-rays are incorporated in a new level scheme of ^{147}Pr including a new level at 2.7 keV.

Energies and relative intensities of gamma-rays in the decay of ^{147}Ce are shown in Table 1.

Table 1

E_γ(keV)	I_γ	E_γ(keV)	I_γ
92.9 ± 0.3	66 ± 6	374.4 ± 0.3	51 ± 5
175.0 ± 0.7	4 ± 1	*452.0 ± 0.4	34 ± 4
199.0 ± 0.3	27 ± 3	465.0 ± 0.5	13 ± 2
269.2 ± 0.5	100 ± 5	467.7 ± 0.4	43 ± 4
289.2 ± 0.5	29 ± 6	799.6 ± 0.5	6 ± 2
359.2 ± 0.5	17 ± 3	802.5 ± 0.4	6 ± 2
361.7 ± 0.5	9 ± 2	832.2 ± 0.3	20 ± 3

*Not placed in the proposed decay scheme.

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VI-1

Secondary neutron spectra of Be(n,2n), Pb(n,2n), Bi(n,2n) and ^{7}Li(n,n't)

Akito Takahashi

Double differential neutron emission cross sections with 14 MeV source measured at the OKTAVIAN facility were presented[1] at the 1982 Antwerp conference, for 13 elements. Measurements have been continued for F, Si, Ti, Mn and Bi. Numerical data tables were published[2] for D, Li, Be, C, O, F, Al, Si, Cr, Fe, Ni, Mo, Cu, Nb and Pb. The measured energy range of secondary neutron is 14 MeV to 0.5 MeV (partially 14 to 2 MeV).

In order to obtain data for wide range of secondary neutron energy, new measurements are under way. Secondary neutron spectra of Be(n,2n), Pb(n,2n), Bi(n,2n) and ^{7}Li(n,n't) have been measured with 14 MeV incident energy, for the secondary energy range 14 MeV to 50 KeV, and compared with ENDF/B-IV (not for Bi). Examples for Be and Pb are shown in Figs. 1 and 2. For Be(n,2n) reaction, excitation of 11.28 MeV state as well as 1.68 MeV state[1] was not observed as shown in Fig.1, so that measured spectra were very different from ENDF/B-IV in the range 5 MeV to 50 KeV. For Pb(n,2n), harder spectra than ENDF/B-IV were obtained as shown in Fig.2. Results for the above 4 elements will be presented at the Fall Meeting of the Atomic Energy Society of Japan, Sept. 1983.

References:

1) Takahashi, A., et al. : Proc. Conf. Nuclear Data for Science and Technology, pp.360-367, Antwerp, 1982

2) Takahashi, A., et al. : "Double Differential Neutron Emission Cross Sections, Numerical Tables and Figures (1983)", OKTAVIAN Report A-83-01, Osaka University, June 1983.

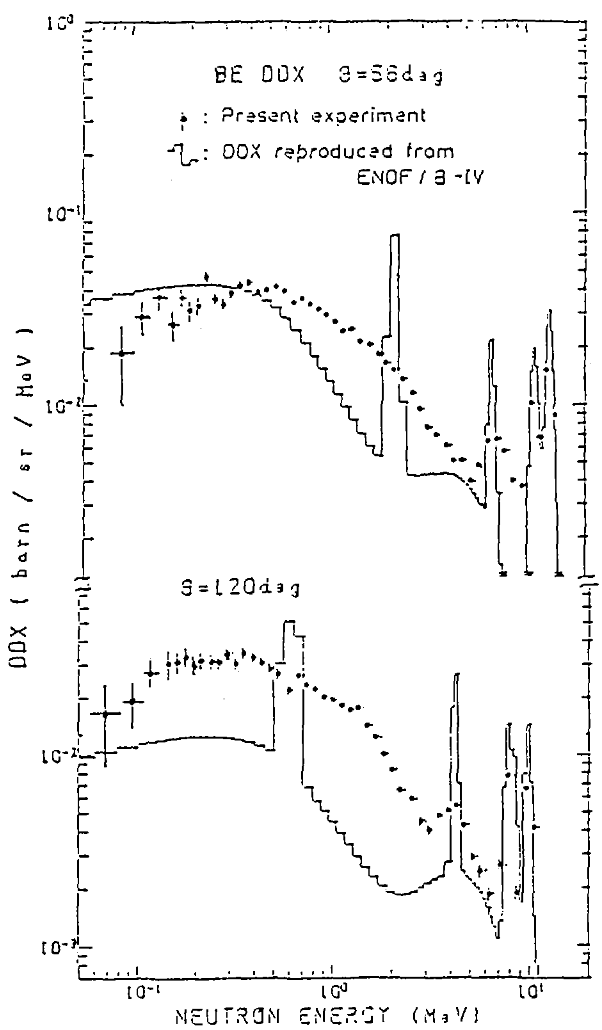

Fig.1

Neutron emission spectra of Be with 14 MeV source, for 56 and 120 deg in LAB system, in comparison with ENDF/B-IV

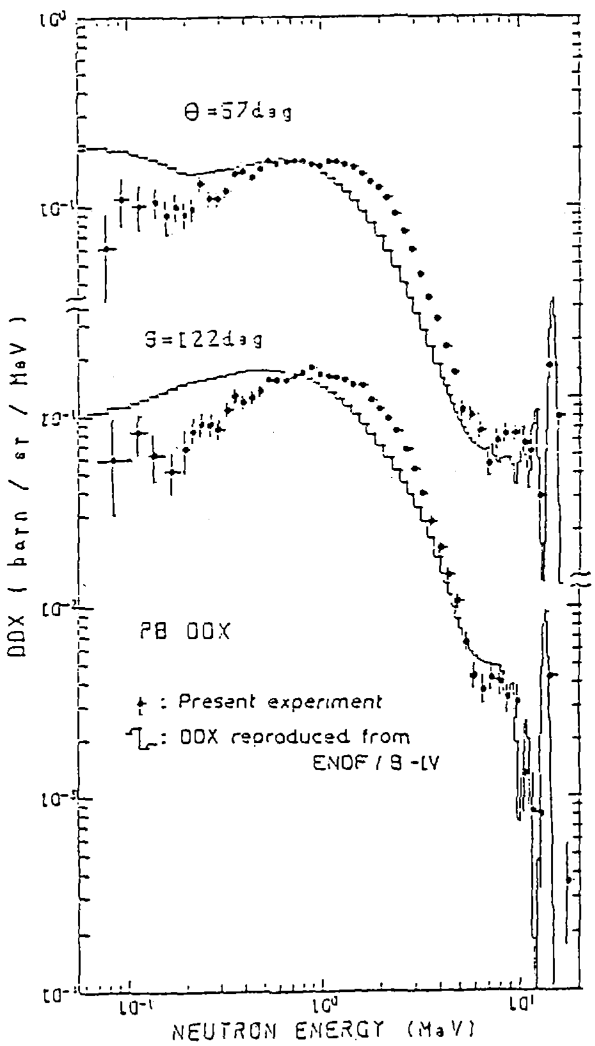

Fig.2

Neutron emission spectra of Pb with 14 MeV source, for 57 and 122 deg in LAB system, in comparison with ENDF/B-IV

VI-2

Measurement of transmitted neutron spectra through lithium and iron slabs

Akito Takahashi

Measurements of leakage neutron spectra from lithium, graphite and stainless steel slabs and lead spherical shells have been carried out[1) to assess nuclear data and transport codes. Spectra were measured for three emission angles and in the energy range 14 to 0.3 MeV. Results were compared with calculations by one-dimensional S_n and Montecarlo codes using ENDF/B-IV and ENDF/B-V.

New measurement for wider energy range, 14 MeV to 10 KeV, has been done for lithium and iron slabs. Neutron detectors are NE213 and KG2L (^{6}Li glass). The NE213 detector system has been adjusted to cover the range 14 MeV to 50 KeV. Dimensions of slabs are 20 and 30 cm in thickness and 60x60 cm^2 in transverse size, for lithium, and 10 and 20 cm in thickness with 40x40 cm^2 transverse size, for iron. Absolute angular flux spectra at 0 degree have been obtained in unit of (n/cm^2/sec/lethargy)/(one source neutron/cm^2). Result for the 30 cm thick lithium slab is shown in Fig.1, in comparison with 1-d S_n calculation (NITRAN) using ENDF/B-IV data. This work will be presented at the Fall Meeting of the Atomic Energy Society of Japan, Sept. 1983.

Reference:

1) Takahashi, A., et al. : Proc. 12th Symp. Fusion Technology, pp.687-692, KFA Juelich, Sept. 1982

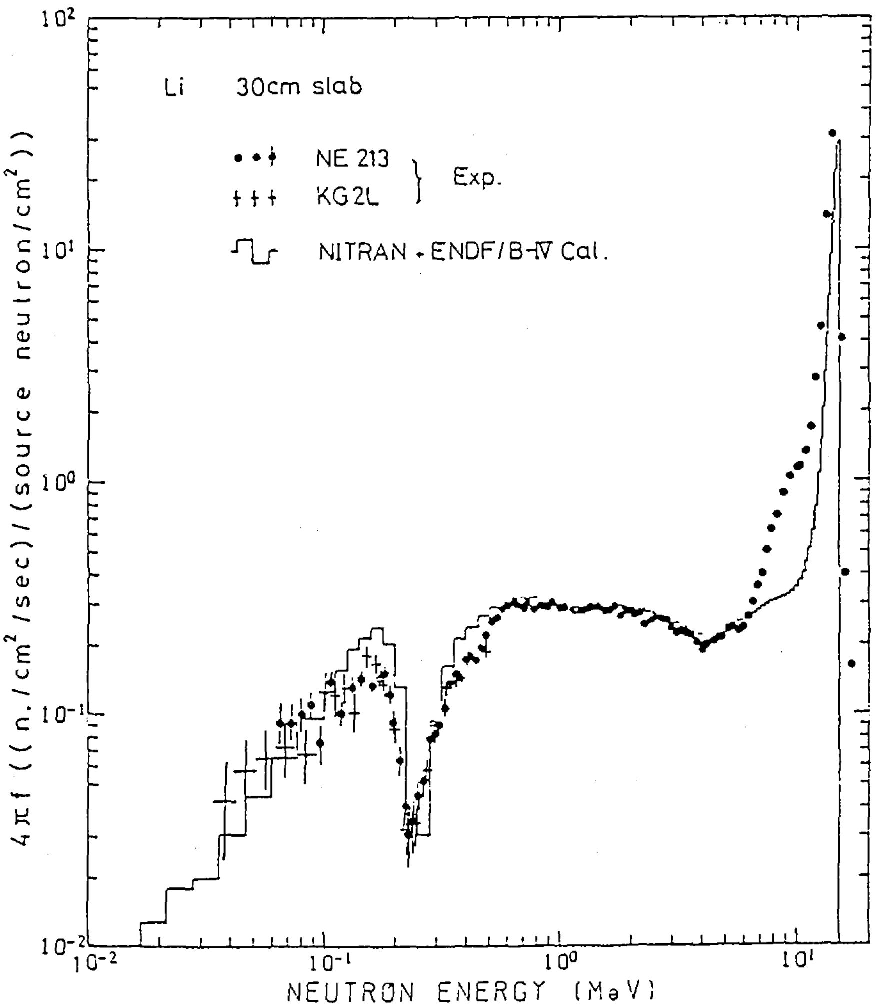

Fig.1 : Transmitted neutron spectra through 30 cm lithium slab. Angular flux spectra per unit lethargy are given. Experiment was done by 9 m TOF.

VII. RIKKYO (ST. PAUL'S) UNIVERSITY

Department of Physics

VII-1 Backward Cross Section for the $^{6}Li(n,d)^{5}He$ Reaction at 14.1 MeV

H. Yamada*, Y. Ando and S. Shirato

The differential cross section for the $^{6}Li(n,d)^{5}He$ reaction was measured at the backward c.m. deuteron angles of 110^{o}, 116^{o} and 144^{o} using 14.1 MeV neutrons. A ^{6}Li metal target of 2.35 mg/cm^{2} thick and a counter telescope consisting of two gas proportional counters and two silicon detectors of 16 μm and 270 μm thick were employed. The preliminary data are shown in Fig. 1, together with the published forward data[1,2] and the DWBA calculation[1]. The data accumulation using the single telescope as well as the coincidence measurement of reaction products from ^{6}Li with the associated α-particles from the ^{3}H-d neutron source is in progress.

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References:

1) S. Higuchi, K. Shibata, S. Shirato and H. Yamada, Nucl. Phys. A384 (1982) 51.

2) V. Valković, G. Paić, I.Slaus, P. Tomas, M. Cerineo and G. R. Satchler, Phys. Rev. 139 (1965) B331.

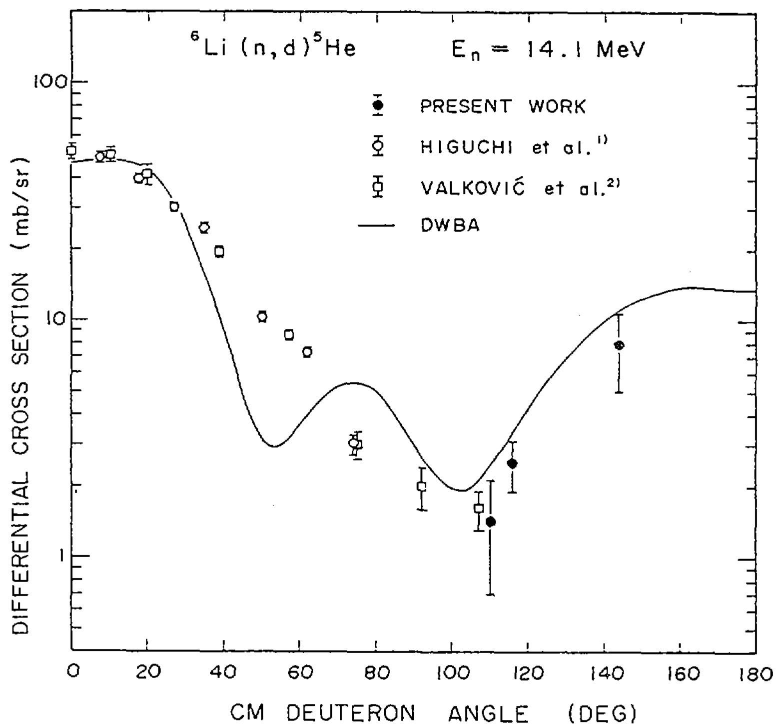

Fig. 1.

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VIII-1

Gamma-Ray Spectra from Capture of 400-keV Neutrons in Tb, Ho and Ta

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Capture gamma-ray spectra from Tb, Ho, and Ta have been measured at the neutron energies of 410 ± 15, 420 ± 35, and 420 ± 35 keV, respectively. Pulsed neutrons were produced by the $^{7}Li(p,n)^{7}Be$ reactions which were induced by a proton burst of 1.5 ns width at 2-MHz repetition rate from the T.I.T. 3-MV Pelletron accelerator. Each sample was located at 15 cm from the neutron source, and capture gamma-rays emitted from the samples were detected by a 7.5 cmϕ x 15 cm NaI(Tl)-detector centered in an annular NaI(Tl)-crystal which was surrounded by a heavy shield consisting of paraffin, boric acid, and lead. The detector system operated as an anti-Compton spectrometer, and the detection efficiency and response function were determined with gamma-rays from calibrated radioactive sources and from the $^{27}Al(p,\gamma)^{28}Si$, $^{9}Be(p,\gamma)^{10}B$, and $^{19}F(p,\alpha\gamma)^{16}O$ reactions.

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The distance between the sample and spectrometer was 109 cm, and the spectrometer axis made an angle of 125° with respect to the proton beam direction.

The capture gamma-ray spectra, shown in Figs. 1 ~ 3, were obtained after background subtraction, spectrum unfolding, and gamma-ray self-shielding correction. The gamma-ray intensity $\nu(E_\gamma)$ is normarized to satisfy the following equation:

$$\int_0^{E_B+E_n} E_\gamma \cdot \nu(E_\gamma) dE_\gamma = E_B + E_n ,$$

where E_γ, E_B, and E_n are gamma-ray energy, neutron separation energy, and incident neutron energy, respectively. The solid-line histograms in Figs. 1 and 2 were calculated by the statistical model code CASTHY[1], using the gamma-ray strength function of Brink and Axel[2] and the level density distribution of Gilbert and Cameron[3]. The dashed-line histograms were also calculated by CASTHY, but the constant temperature model formula of Joly et al.[4] was used as the level density distribution. The observed spectrum for Tb shows a bump at 2.5 MeV and that for Ho also shows a bump at 3 MeV, but the statistical model calculations do not give these bumps. In the case of Ta, the observed spectrum does not show a clear bump, but shows a change of the gradient of the spectrum at 4.5 MeV. This might correspond to a bump.

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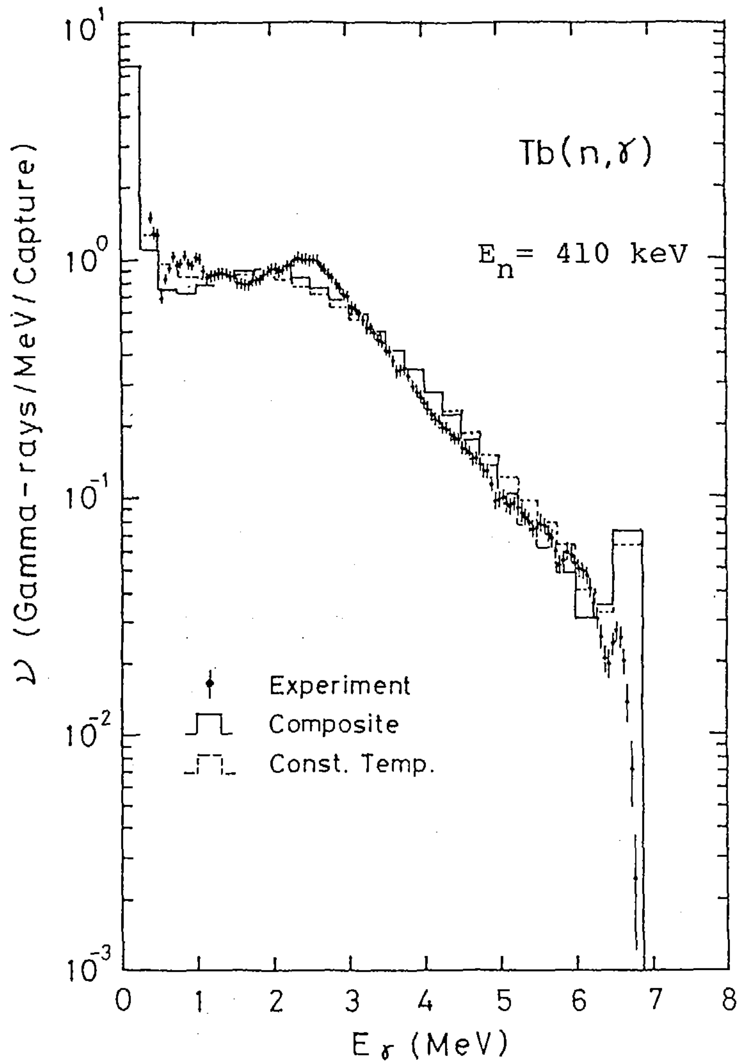

Fig. 1 Capture gamma-ray spectra from the Tb(n,γ) reaction.

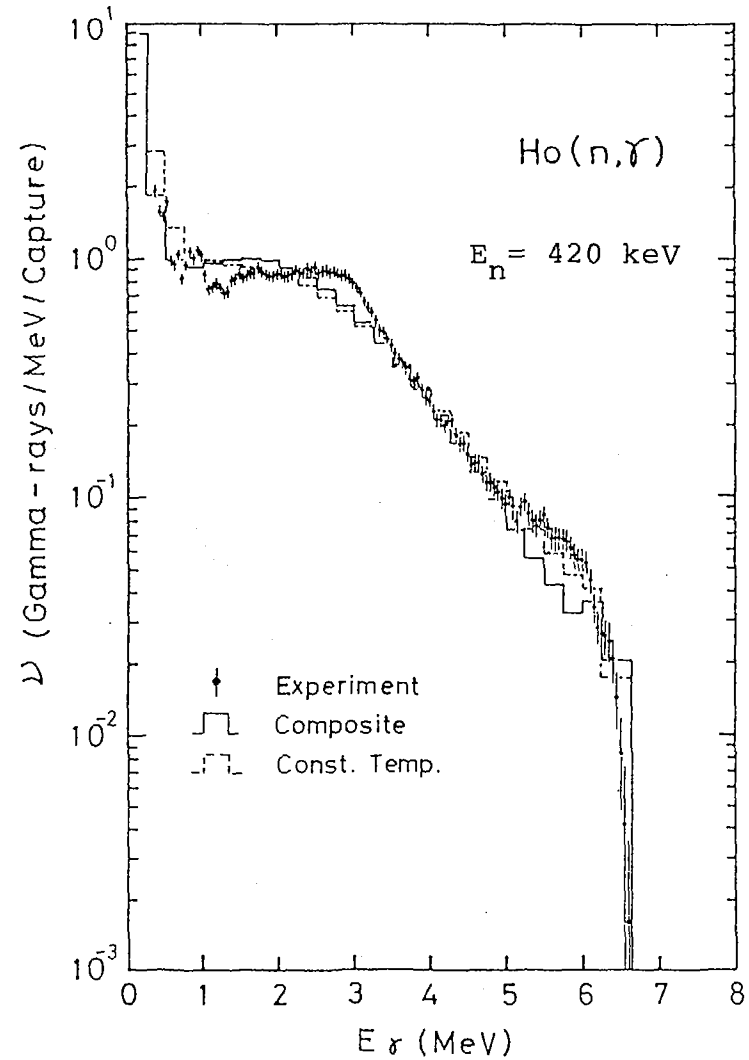

Fig. 2 Capture gamma-ray spectra from the Ho(n,γ) reaction.

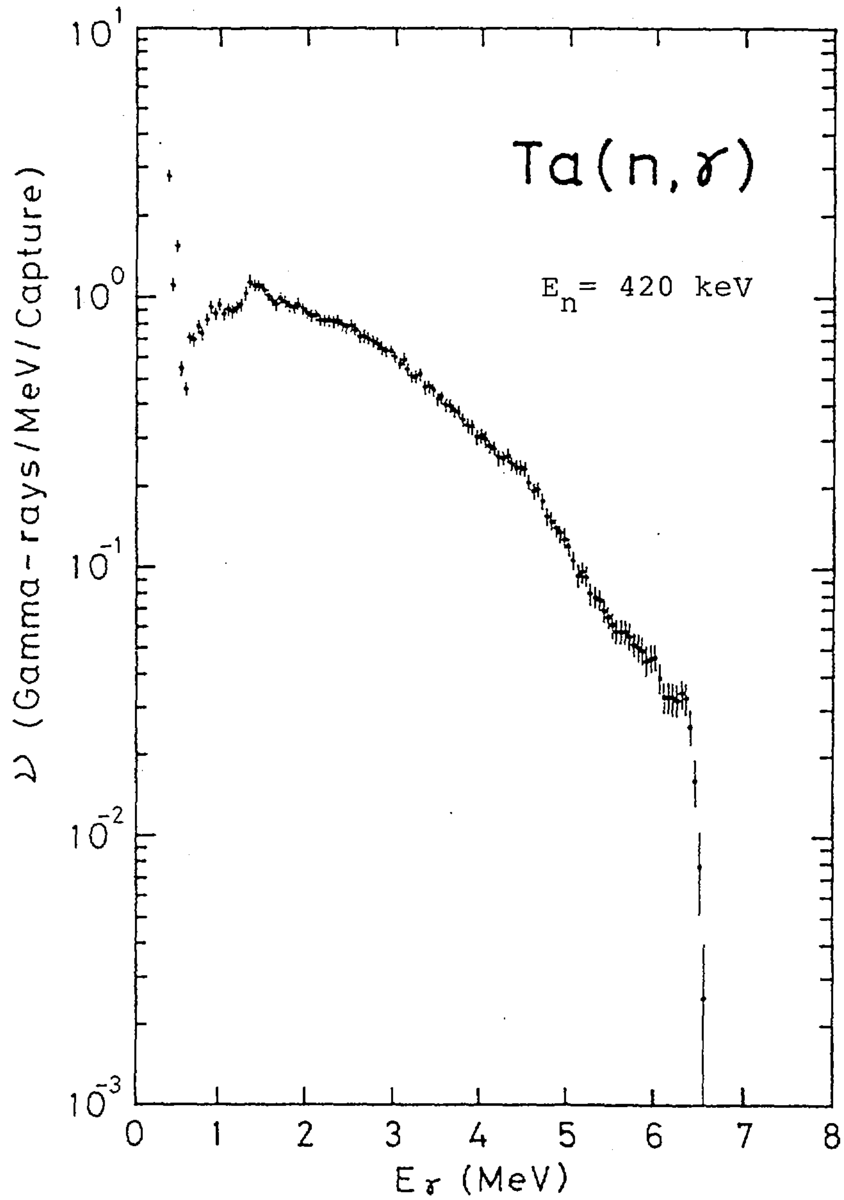

Fig. 3 Capture gamma-ray spectrum from the Ta(n,γ) reaction.

VIII-2

Gamma-Rays from Capture of keV Neutrons in Au

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Capture gamma-ray spectra from Au have been measured at the neutron energies of 15, 24, 40, 200, 416, and 622 keV in order to investigate the 5.5-MeV bump previously observed in capture gamma-ray spectra[1),2)]. The experimental procedure and data processing have been described in the preceding report.

The capture gamma-ray spectra obtained by the present measurements, shown in Figs. 1 and 2, exhibit fine structures in the 5.5-MeV bump. By a comparison of these spectra, it seems that two types of peaks exist in the bump. One changes its energy position with incident neutron energy, and the other one does not. As concerns the integrated gamma-ray energy in the bump, its ratio to the total gamma-ray energy in the whole spectrum is about 0.2, and does not change in the neutron energy range of the present measurements.

References :

1) E. D. Earle, I. Bergqvist and L. Nilsson, A. B. Atomenergi Report, No. AE-515 (1977).

2) S. Joly, D. M. Drake and L. Nilsson, Phys. Rev., C20, 2072 (1979).

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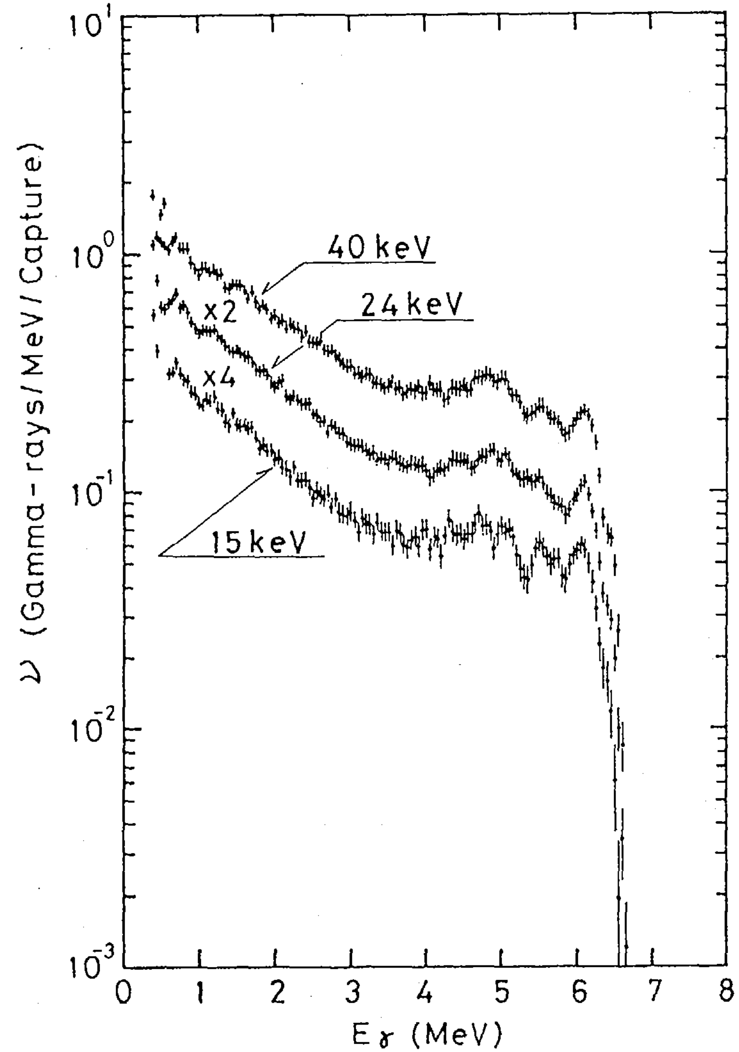

Fig. 1 Capture gamma-ray spectra of Au for neutrons between 15 and 40 keV.

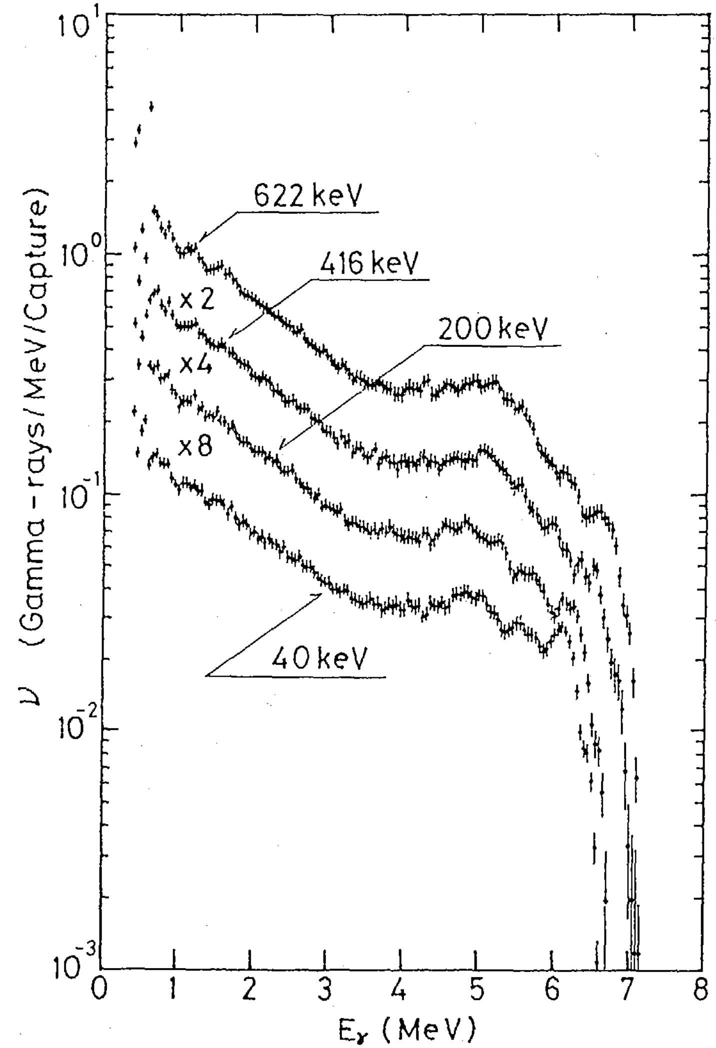

Fig. 2 Capture gamma-ray spectra of Au for neutrons between 40 and 622 keV.

IX. UNIVERSITY OF TOKYO

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IX-1

Neutron Production from Thick Targets of C, Fe, Cu and Pb by 30- and 52-MeV Protons[1)]

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The neutron energy spectra emitted in the direction of 0, 15, 30, 45, 75 and 135 degrees to the beam axis were obtained by unfolding the pulse-height distributions measured with a NE-213 scintillator, when the 30- and 52-MeV proton beams were injected into thick targets of C, Fe, Cu and Pb. The angular distribution of neutrons above 3 to 4 MeV was obtained by integrating the measured spectra. The measured spectra were compared with a Monte Carlo calculation based on the Fermi free gas model of intranuclear-cascades and evaporation. This comparison revealed that the calculated spectra are harder and stronger in the forward direction, but softer and weaker in the backward direction

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than the experimental spectra. The agreement between the two is good at around 75 deg. This experimental result showed that this calculational model is not adequate in the energy region below about 100 MeV, where nuclear structure has a great influence on neutron production. The total neutron yield was obtained by estimating the neutron yield below a few MeV by fitting the spectra measured above that energy to the Maxwellian distribution and showed good agreement with other experimental results.

Reference:

1) T. Nakamura, M. Fujii and K. Shin, Nucl. Sci. Eng., 83, 444 (1983).

X. WASEDA UNIVERSITY

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X-1 Semi-Empirical Estimation of Delayed Neutron Emission Probabilities, II

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In a previous paper[1)], we proposed a semi-empirical method for estimating the β strength function, and used the strength function thus obtained to calculate the delayed-neutron emission probabilities (P_n) of ^{87}Br and ^{137}I. Recently, we have applied the same method to estimation of P_n of some other odd-A precursors ignoring the condition[1)] on N and Z relative to the magic numbers, and obtained the results given in Table.

As mentioned in ref.1), the β strength of an odd-Z precursor (N_1,Z_1) is estimated with use of experimental data on nuclei (N_1,Z_1+1), (N_1-2,Z_1) and (N_1-2,Z_1+1), and that of an even-Z precursor (N_1,Z_1) is estimated with use of experimental data on nuclei (N_1-1,Z_1), (N_1,Z_1+2) and (N_1-1,Z_1+2). At present, we have 20 precursors to which our method may be applicable, though the condition of equality of spin-parities[1)] is not assured for some of them because of the lack of spin-parity assignment. The coefficient k (see eq.(1) in ref.1)) is taken to be 33 MeV.

In Table, β-decay Q-values, neutron separation energies, upper limits of the excitation energies above which we cannot

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estimate the strength reliably, and experimental half-lives are shown in the first four columns. Calculated rates of delayed-neutron emission (λ_n) and the values of P_n, which are obtained from these calculated rates and the experimental half-lives, are given in the next four columns for two choices of the competition factor. In Case I, the competition factor is taken to be unity, and in Case II, it is evaluated from the optical-model transmission coefficient and the average radiative width. For even-Z precursors, we only give the results in Case I, because each odd-odd final nucleus has many low-lying levels making the competition factor close to unity. Experimental values of P_n are given in the ninth column.

Very often, low-energy β transitions and high excitation levels seem to have escaped from observation, and this kind of incompleteness of experimental data used as input data usually leads to underestimation of P_n. For some precursors, even negative P_n values have been obtained; this unreasonable results have probably been caused by incompleteness of the input data. The dagger attached to a nuclidic symbol shows that the input experimental data used for this precursor is suspected of having this kind of incompleteness.

The overestimation of P_n for ^{87}Se is exceptional. It has been caused by the low ft (log ft =3.9) input transition[2] from ^{89}Kr to 4.631 MeV level of ^{89}Rb. This low ft transition is not seen in the data of ref.3), and may be in error.

We have also studied the β strengths of many nuclides including those in Table by the method of ref.1), though the results are not given in this short report. From all these results on the β strength and delayed-neutron emission, it seems that our method is useful provided that good input data on neighbouring nuclei are available.

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1) T.Tachibana and M.Yamada, Nucl. Phys. A395(1983) 235

2) C.M.Lederer and V.S.Shirley, Table of isotopes, 7th ed. (Wiley, New York, 1978)

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Table. Delayed neutron emission probability

	Q_β (MeV)	S_n (MeV)	E^u_{exc} (MeV)	$T_{1/2}$ (s)	Case I λ_n (s^{-1})	Case I P_n (%)	Case II λ_n (s^{-1})	Case II P_n (%)	P_n^{exp} (%)
^{27}Na	8.96	6.44	6.7	0.30	4.1×10^{-3}	0.17	1.5×10^{-3}	0.06	0.11
^{49}K	11.0	5.15	8.8	1.26	0.33	59.0	0.32	58.2	86.0
^{87}Br	6.84	5.52	6.0	55.6	6.5×10^{-4}	5.20	3.1×10^{-4}	2.46	2.57
^{89}Br †	8.14	5.17	6.8	4.4	1.6×10^{-2}	10.1	1.0×10^{-2}	6.48	14.2
^{91}Br †	9.21	4.65	7.9	0.54	5.4×10^{-2}	4.20	4.4×10^{-2}	3.40	19.2
^{95}Rb †	9.1	4.25	7.8	0.38	0.18	10.1	3.8×10^{-2}	2.08	8.9
^{97}Y	6.67	5.58	6.0	3.7	8.9×10^{-5}	0.05	8.6×10^{-5}	0.05	0.06
^{127}In	6.49	5.65	5.5	1.15	6.0×10^{-5}	0.01	0.0	0.0	<0.04
^{127m}In†	6.65	5.65	5.6	3.76	1.6×10^{-4}	0.09	1.5×10^{-4}	0.08	0.68
^{129}In†	7.6	5.27	6.6	0.59	1.3×10^{-2}	1.07	1.9×10^{-4}	0.02	0.25
^{129m}In	7.8	5.27	6.8	1.2	1.5×10^{-2}	2.58	1.4×10^{-2}	2.49	2.5
^{131}In†	8.82	5.17	7.8	0.27	9.0×10^{-3}	0.35	-6.8×10^{-3}	-0.27	1.72
^{137}I	5.89	4.03	5.0	24.5	4.1×10^{-3}	14.3	1.0×10^{-3}	3.56	6.7
^{139}I †	6.56	3.79	5.6	2.3	7.1×10^{-3}	2.36	6.6×10^{-4}	0.22	9.1
^{87}Se †	8.0	6.32	6.2	5.8	2.7×10^{-3}	2.22			0.16
^{89}Se †	9.2	5.91	7.41	0.41	-5.2×10^{-3}	-0.31			5.0
^{93}Kr †	7.3	5.87	5.6	1.29	2.9×10^{-5}	0.005			1.9
^{97}Sr †	7.45	5.93	5.8	0.44	0.0	0.0			0.27
^{137}Te†	6.83	5.36	5.5	4.0	-4.2×10^{-4}	-0.24			2.5
^{141}Xe†	6.0	5.83	4.7	1.7	0.0	0.0			0.05