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**MEASUREMENT AND ANALYSIS OF 14 MeV NEUTRON-INDUCED
DOUBLE-DIFFERENTIAL NEUTRON EMISSION CROSS SECTIONS NEEDED
FOR FISSION AND FUSION REACTOR TECHNOLOGY**

Summary Report of the Second Research Co-ordination Meeting
organized by the International Atomic Energy Agency
and held in Vienna, Austria, 18 - 20 June 1990

Prepared by Wang DaHai

October 1990

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

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SUMMARY

The Second IAEA Research Coordination Meeting on Measurements and Analysis of 14 MeV Neutron-Induced Double-Differential Neutron Emission Cross Sections (DDCS) needed for Fission and Fusion Reactor Technology was held at the IAEA Headquarters in Vienna during 18 - 20 June 1990. This report summarizes the conclusions and recommendations which were agreed by all participants.

The principal objectives of the RCM were to review the status and progress of the measurement programmes of each participating laboratory, to discuss the experimental and analysis techniques used, and to decide on the programme for the next year.

The RCM was organized by Mr. Wang DaHai as scientific secretary and was chaired by Dr. A. Takahashi. The adopted agenda and list of participants are given in Appendices I and II to the full report.

The reports on work already done and planned for 1990-1991 by each participant of the CRP were presented and discussed.

The main conclusions of the RCM are as follows:

- (1) Most of the DDCS proposed at the previous RCM have been measured at about 14 MeV for the following elements: V, Cr, Fe, Nb, Ta, W and Bi.
- (2) A new double time-of-flight method to measure DDCS at 10 MeV has been developed by the Chinese CRP participant. It is desirable to measure additional DDCS data for ^{238}U and ^{209}Bi at this energy for which there are no data as yet available.
- (3) Measurements of the DDCS for Li-6, Li-7, Be-9, Mg, S and Mo should be included in the work programme of the CRP for the next year in order to improve the data status for these elements/isotopes.

The next (final) RCM was proposed to be held in the first quarter of 1992 at the Chiang Mai University, Thailand.

Full Report

(1) Organization of the meeting

The second meeting of the participants in the IAEA Co-ordinated Research Programme (CRP) on Measurement and Analysis of 14 MeV Neutron-Induced Double-Differential Neutron Emission Cross Sections needed for Fission and Fusion Reactor Technology was convened by the IAEA Nuclear Data Section at the IAEA Headquarters in Vienna. The Research Co-ordination Meeting (RCM) was organized by the Scientific Secretary Mr. Wang DaHai and chaired by Dr. A. Takahashi.

The principal objectives of the RCM were:

- to review the status, progress and plans of the measurement programmes of each participating laboratory;
- to review and discuss the experimental and analytical techniques used, and problems encountered;
- to intercompare the results of experiments already made and to decide on the programme for the next year.

The Agenda of the meeting is listed in Appendix I, the twelve scientists (the six principal investigators of the CRP and six observers) who attended the meeting are listed in Appendix II.

(2) Report by participants to the Second RCM

The six CRP participants presented reports on their work, and after discussion, the proposed programme for the next year was summarized (see Appendix III).

(3) Summary of the conclusions and recommendations

After presentation of reports by each individual investigator and several additional meeting participants, followed by extensive discussions, the participants of the RCM came to the following conclusions concerning the work to be undertaken under the CRP in its final period 1990/1991:

- (a) Most of the DDCS proposed at previous RCMs have been measured at about 14 MeV for the following elements:

V, Cr, Fe, Nb, Ta, W and Bi.

- (b) Measurement techniques have been improved under this CRP. For example, the Institute of Atomic Energy (IAE) in Beijing has developed a new double time-of-flight (TOF) method to measure DDCS at 10 MeV neutron energy eliminating the disturbing interference of D-D break-up neutrons. It is desirable that this institute perform additional measurements for ^{238}U and ^{209}Bi at this energy for which there are no data as yet available.

- (c) Considering the high priority of DDCS for ^6Li , ^7Li and ^9Be , new measurements and data evaluations at 14 MeV will be included in the work programme for the final period of this CRP. The Osaka and/or Tohoku University will undertake this task for all three nuclides and possibly the IRK Vienna will undertake a measurement for ^9Be .
- (d) The TU Dresden will continue the evaluation work for ^{238}U DDCS at 14 MeV by collecting data from the IAE Beijing and the Osaka University, and will also check the consistency of the evaluated data against existing integral measurements.
- (e) Due to the lack of data for neutron emission energies below 1 MeV, additional measurements covering this energy region are still required and encouraged. The associated particle TOF method could be more convenient for these measurements, as the low energy measurement requires only a short flight path. It is recommended that the Esfahan Nuclear Technology Center consider to undertake this task.
- (f) The IRK Vienna has started to investigate the problem of the accuracy of multiple scattering corrections, it will continue this work and provide a final separate report at the next (final) RCM.
- (g) The influence of the neutron flux distribution at the site of the sample on the DDCS results has been studied at the TU Dresden. This work will be continued, and a separate final report will be provided at the next (final) RCM.
- (h) The meeting was informed that DDCS data of the following elements are needed for the shielding design of fusion reactors: Na, Mg, P, S, Cl, K, Ca and F. While measurements for these elements are outside the agreed scope of the CRP, the meeting took note that new measurements for Mg and S may be undertaken by IRK Vienna, and the Osaka University will undertake measurements for K for which there are no data available.
- (i) Considering that the outputs from this CRP should provide a new experimental data base for future FENDL-related evaluations, the IRK Vienna and the TU Dresden shall undertake evaluations of all experimental data for V, Cr, Fe, Nb, Ta, ^{238}U , Mo, W and Bi (see Appendix III) and provide separate reports for the next (final) RCM. The TU Dresden will in addition provide calculated results using the "EXIFON code" for all of the above elements.
- (j) The programme for the final CRP period 1990-1991 has been intensively discussed and the work to be undertaken by the CRP participants is summarized also in Appendix III.
- (k) Each CRP participant is asked to provide a final report on the results of his experimental work for the next (final) RCM for eventual inclusion in the Final Report of the CRP. The reports should include (1) what measurements have been done, (2) what methods were used, (3) the results obtained, and (4) tables of the final data including lists of errors in a condensed format which will be communicated by Professor Vonach, IRK Vienna, to all participants.

- (1) The main tasks of the next (final) RCM will be to review the final results of all work performed under the CRP. They will be published in a comprehensive Final Report on the CRP with contributions as specified before:
- (i) Summary of the experimental results of every CRP participant (see point 11 above);
 - (ii) Summary of the results of evaluations by IRK Vienna, TU Dresden and Osaka University (see points 3 and 9 above);
 - (iii) Summary of the theoretical calculations by TU Dresden (see point 9 above).

Each participant is reminded to send his final experimental data to his regional nuclear data centre for incorporation into the international EXFOR file.

Next Meeting

The participants of this RCM-II agreed that the 3rd (final) RCM should be held at the beginning of 1992. The Chiang Mai University (Thailand) offered informally to host this meeting at Chiang Mai.

Coordinated Research Programme on
"Measurement and Analysis of 14 MeV Neutron-Induced
Double-Differential Neutron-Emission Cross Sections Needed for
Fission and Fusion Reactor Technology"

Second Research Coordination Meeting
Vienna, 18-20 June 1990

Agenda

(1) Opening of the Meeting

(2) Reports by CRP participants on their work

- A. Takahashi (Japan)
- W. Pairsuwan (Thailand)
- Qi Bujia (China)
- J. Rahighi (Iran)
- T. Elfruth (GDR)
- H. Vonach (Austria)

(3) Discussions and Conclusions/Recommendations

- Status of DDCS data covered by the CRP
- Technical problems with experiments

Reports by Dr. S.P. Simakov:

"Differential neutron emission and inelastic cross sections for ^{208}Pb and ^{209}Bi at 14.1. MeV incident energy", and

Dr. V.D. Dmitriev:

"Measurements of fission neutron spectra of ^{235}U , ^{238}U and ^{232}Th at 2.0 MeV and 14.7 MeV incident neutron energy".

- New requirements for DDCS data

Dr. D.Muir:

"DDCS data needs for the FENDL file

- Programme for 1990-1991

(4) Next Meeting

Coordinated Research Programme on "Measurement and Analysis of 14 MeV
Neutron-induced Double-differential Neutron Emission Cross Sections
needed for Fission and Fusion Reactor Technology"

Second Research Co-ordination Meeting

Vienna, 18 - 20 June 1990

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A. Pashchenko
Wang DaHai (Scientific Secretary)

	V	Cr	Fe	Nb	Ta	U238	Mo	W	Bi	Li6	Li7	Be9	Ni	Mg	S	K
	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp. Eva.	Exp.
G Winkler Rk Vienna, Austria		(X)	(X)	(X)	(X)		(X)	(X)	(X)			?	(X)	(X)	(X)	
Jun Beijing, P.R. China				X		X										
K Siedel TU Dresden, DDR	X	(X)		X	X	X										
J. Rahighi Tehran Nuclear Data Centre, Iran			(X) ⁺⁺													
A. Takahashi Tohoku University, Japan	X	X	X	X	X	(X)	X	X	X	(X)	(X)	(X)	(X)	X	(X)	(X)
V. Vilaithong Khajang Mai University Thailand	(X) ⁺		(X)		(X)											
Tohoku University Japan	X	X	X	X		X				X	X	X				
S.P. Simakov PPI Obninsk, USSR								(X)	X			(X)				

- X work done in 1989
- (X) work planned for 1990 - 1991
- O work planned for 1990 - 1991, E_n = 10 MeV
- + high resolution
- theoretical calculation
- ++ including low energy range (< 1.5 MeV)
- ? depending on the samples available

Summary of Activities 1989 and Programme
for 1990 - 1991