Thermal Neutron Scattering Data

(V. Semkova, N. Otsuka, 2016-06-03, Memo 4C-3/404)

A Consultants' Meeting "Experimental Nuclear Reaction Data (EXFOR) Compilation of Thermal Neutron Scattering Data" was held in Vienna from 2 to 4 November 2015. The Meeting was attended by six participants (F. Cantargi, D. V. Baxter, Li (Emily) Liu, E.l Farhi, Y. Kiyanagi, and J. I. Marquez Damian) and IAEA-NDS staff members (S. Simakov, N. Otsuka and V. Semkova). The Meeting was organized following the recommendations of the 30th Meeting of the International Nuclear Data Committee to collect the results from experiments related to thermal scattering law (TSL) data development and make them available from the EXFOR database. Information relevant to the discussions, presentations from the participants, meeting report etc. is included in the Meeting's webpage: http://www-nds.iaea.org/index-meeting-crp/CM-RF-2013/. In the present WP the main conclusions and recommendations from the meeting will be presents as well as list of publications missing in EXFOR. The basic thermal scattering quantities and the compilation rules, also discussed during the meeting, are included in WP-216-08 and Memo 4C-3/403.

One of the main questions discussed during the meeting was the types of data that have to be compiled in EXFOR. Often the thermal scattering experiments reports the directly measured quantities such as dynamical structure factor, generalised density of states etc. From the other point of view in the evaluated nuclear data files the thermal scattering is expressed in terms of $S(\alpha,\beta)$ scattering law. It was recommended to compile the total and differential cross sections in EXFOR while the raw, derived or complimentary data to be included in a separate database for TSL evaluations.

For the neutron scattering measurements the time-of-flight technique is commonly applied, which require detailed description of the experimental conditions. In addition information of the sample composition and structure is required for the proper interpretation of the data. The participants of the meeting provided a template with essential information that the compilers are advised to include in the compilation.

Table 1. Template for submission of time-of-flight spectra, from Refs [A-F]

1. Main Reference		[A]
2. Facility/Instrument		[B]
3. Neutron production Neutron production beam Nominal average beam energy Nominal average peak current or reactor power Repetition rate (pulses per second) Pulse width Primary neutron production target Target nominal neutron production intensity		
4. Moderator Primary neutron source position in moderator		

Moderator material Moderator dimensions (internal) (thickness, height×width×depth,…) Density (moderator material) Temperature (K) Moderator-room decoupler (Cd, B, …)		
5. Other experimental details referred to the instrument Distance (m) (moderator –chopper) Distance (m) (chopper –sample) Distance (m) (sample –detector) (range with mean value if necessary) Angle of flight path to the moderator normal Neutron beam dimensions at sample position (mm × mm, diameter in mm, …)		[C]
Range of incident energy possible Angular range for the instrument Overlap suppression (Filter material and thickness, chopper, …) Other fixed beam filters Additional information		
6. Detector Type Material Surface Dimensions (mm × mm. diameter in mm) Thickness (mm) Distance from sample (m) (or range with mean) Detector(s) position relative to neutron beam Detector(s) solid angle		
7. Sample Type (metal, powder, liquid, crystal) Temperature (K) Pressure (bar) Crystal or powder structure (e.g., single, grain and/or powder size) Chemical composition, phase Sample composition (at/b) Sample density (g/mm^3) Sample mass (g) Geometrical shape (cylinder, sphere, …) Orientation of the sample referring to the flight path Surface dimension (mm × mm, diameter in mm,) Nominal thickness (mm) in beam Additional comment		[D]

8. Other experimental details referred to the dataset Incident energy or range (meV) Angular range for the measurement Containment description Other measurements performed (e.g., empty can or sample out for background, vanadium for detector calibration, filter for energy calibration) Additional comment		[E]
9. Data Reduction Procedure Dead time correction Back ground subtraction Flux determination (reference reaction, …) Normalization Detector efficiency Self-shielding Time-of-flight binning Angular grouping Multiple scattering Software Procedure before and after software implementation Additional comment		[F]
10.Response function Initial pulse Target / moderator assembly Detector		
11. Error analysis Source of uncertainties propagated to the total uncertainties		

B. DATA FORMAT

As applicable, each dataset will record the same: incident energy, scattered angle, temperature, and pressure.

Column	Content	Unit	Comment
1	Incident Energy	meV	Mandatory as applicable
2	Outgoing Energy	meV	Mandatory as applicable
3	Scattering Angle	degree	Mandatory as applicable
4	Experimental observable	b, b/sr, or b/(sr·eV)	Mandatory: Transmission, cross section or ratio
5	Total Uncertainty		Not mandatory, but strongly recommended
6	Uncorrelated uncertainty		Mandatory: Uncertainty due to counting statistics, for example
7	Additional information		Not mandatory

REFERENCES

[A] The main reference for the work (website, journal, saved documents, or private communications) is mandatory.
[B] The reference for the facility and/or instrument (website, journals, and/or saved documents) is mandatory.
[C] The reference for other experimental details (website, journals, and/or saved documents) can substitute the entry in the same section.
[D] The reference for details of sample (website, journals, and/or saved documents) can substitute the entry in the same section.
[E] If needed, the reference for details of containment (website, journals, and/or saved documents) can be provided.
[F] The reference for details of reduction (website, journals, and/or saved documents) is mandatory and is very important.

An EXFOR completeness checking was performed for publications reporting data at thermal neutron energies. The articles missing in EXFOR are listed in Table 2.

Table 2. List of publications missing in EXFOR.

Author	Reference	Lab.	Quant.	Centre	Comment
U. Schmidt	ATKE,12,385,1967	2GERMUN	CS	NEA-DB	
S.N. Purohit	C,67ANNARB,1,407,1967	1USARPI	DAE	NNDC	
K.N. Zaitsev	J,AE,42,53,1977	4RUSMIF	CS	CJD	
R.P.May	J,JAC,15,15,1982	2FR ILL	CS	NEA-DB	
O. K. Harling	J,JCP,50,5279,1969	1USABNW	DAE	NNDC	+BNWL-436,1967
J.V. Lisichkin	J,JINR-p3-86-779,1986	4ZZZDUB	DAE	CJD	
J.M. Neill	J,NSE,33,265,1968	1USAGA	CS	NNDC	
W.L. Whittemore	J,NSE,33,31,1968	1USAGA	DAE	NNDC	
M.Utsuro	J,NST,18,739,1981	2JPNKTO	CS	NEA-DB	21751 SIG->SIG/TMP add TEMP
E. Farhi	J,NST,52,844,2014	2FR ILL	CS	NEA-DB	
T. Springer	J,NUK,6,87,1964	2GERJUL	DA	NEA-DB	
H.-D. Lemmel	J,NUK,7,265,1965	2GERMUN	DA	NEA-DB	
S. Kornbichler	J,NUK,7,281,1965	2GERMUN	DA	NEA-DB	
S.T. Stepanov	J,SJA,37,1094,1974	4RUSMIF	CS	CJD	
S.T. Stepanov	J,SJA,45,997,1978	4RUSMIF	CS	CJD	
K.N. Zaitsev	J,SJA,70,238,1991	4RUSMIF	CS	CJD	
K. Heinloth	J,ZP,163,218,1961	2GERMUN	CS	NEA-DB	21341 to add data at t = 110 deg.
D.J. Hughes	R,BNL-325,1958		CS	NNDC	
M.Dritsa	R,EANDC(OR)-63L,1967	2GRCATH	CS	NEA-DB	22613 002 -> two entries room temp.

					200 deg. C
W.L. Whittemore	R,GA-4490,1958	1USAGA	CS	NNDC	
W.L. Whittemore	R,GA-5554,1964	1USAGA	CS	NNDC	
J.M. Neill+	R,GA-6753,1965	1USAGA	CS	NNDC	
G.W. Carriveau	R,GA-8345,1967	1USAGA	DA	NNDC	
L.J.Esch	R,KAPL-3908,1970	1USAKAP	DAE	NNDC	
F. Bischoff	R,RPI-328-87,146,1966	1USARPI	DAE	NNDC	
F. Bischoff	R,RPI-328-87,73,1967	1USARPI	DAE	NNDC	+KAPL-3908,1970
S.Dritsa	EANDC(OR)-63,1967	2GRCATH	CS	NEA-DB	20038003 SIG->SIG/TMP
Novikov	FEI-1548,1984	4RUSFEI	CS	CJD	