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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

THIRD MEETING OF THE IFRC SUBCOMMITTEE ON ATOMIC AND MOLECULAR (A+M) DATA FOR FUSION

Summary Report
IAEA, Vienna, 20-22 June 1984

Prepared by A. Lorenz and J. Hughes
Nuclear Data Section
International Atomic Energy Agency

November 1984

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

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I. Summary of the meeting

The third meeting of the IFRC Subcommitte on A+M Data for Fusion was convened at IAEA Headquarters in Vienna, Austria, 20-22 June 1984. The meeting was attended by five members of the Subcommittee, one member substitute, and staff of the IAEA Nuclear Data Section. The list of Participants is given in Appendix 1. The Adopted Agenda is given in Appendix 2. Dr. H.W. Drawin chaired the meeting, H.D. Hughes was the Secretary.

The Subcommittee agreed to have its next meeting in 1986, at the same time and place as the meeting of the A+M Data Centre Network, preferably in Europe (e.g. Paris or Vienna) and adjoining to the 1986 IAEA Plasma Physics meeting.

II. Meeting Proceedings

A. Subcommittee Membership

The IAEA welcomed the new members of the Subcommittee, Drs. V.A. Abramov and D.H. Crandall, who replace Drs. Y.V. Martynenko and P.H. Stone, respectively.

The current composition of the Subcommittee is given in Appendix 3.

B. IAEA A+M Data Unit Programme Review

The report submitted by A. Lorenz is given in Appendix 4. On the basis of this report, the Committee members discussed the work performed during the 1982-1984 period, considered the various aspects of the future programme and the special problems with which the unit is faced, and formulated several recommendations and suggestions.

C. A+M Data Unit Staff

Due to the loss of a post, the Unit will be faced with serious man-power problems. From mid-year 1984, the composition of the staff and distribution of work will be as follows:

Unit Head (A. Lorenz)	50% of time
Physicist programmer (J.D. Hughes)	Full time
Data processing/Secretary (K. Sheikh)	Full time

The Committee expressed concern about the loss of a post in the A+M Data Unit, and stressed that the overall scope of the Nuclear Data Section not be overburdened by other activities such as material properties data, at the expense of A+M Data.

The Committee concluded that a letter be sent on behalf of the Subcommittee by the Chairman of the Subcommittee to the IFRC, stressing that although the Subcommittee recognizes the importance of materials data, it did not want to see a dilution of the A+M Data Unit by getting involved in the development of a materials data base. Also, in view of the fact that the INTOR materials data base is already receiving large funding, it would be important to await the conclusions reached in the forthcoming INTOR report before making recommendations on any materials data base development.

In view of the reduced manpower of the A+M Data Unit, the Committee stressed that continued publication of the A+M Data Bulletin, and the buildup of a numerical A+M data base are of prime importance.

D. Numerical A+M Data

The Subcommittee reaffirmed its earlier statements that IAEA's primary concern in the field of numerical A+M data is with atomic collision data. Atomic structure data being well taken care of by the data centres of the US National Bureau of Standards, and surface effects (plasma-wall interaction) data encompassing a field too wide to be handled by the current resources available to the IAEA A+M Data Unit.

1. Numerical A+M Data Bank

The Subcommittee noticed with satisfaction that the first recommended numerical data have been compiled into a data bank. These data comprise evaluated cross-sections for ionization by electron collision which were published in "Recommended Cross Sections and Rates for Electron Ionization of Light Atoms and Ions", K.L. Bell et al, Culham laboratory Report CLM-R216 (1982). Data for elements Z = 1 - 8 and all of their ionization stages, from neutral to bare states are included in this file.

2. CRP on Atomic Collision Data for Diagnostics of Magnetic Fusion Plasmas

In response to a request by the members of this CRP, whose meeting was held during the three days preceeding the IFRC Subcommittee meeting (i.e. 18-20 June), a joint session of the Subcommittee and members of the CRP was held during the afternoon of Wednesday 20 June. The objective of this joint session was to discuss the future of the CRP and the generation of evaluated A+M data. The meeting started with a review of the three working group chairmen on the status of ionization, excitation and charge exchange data.

In conclusion, the Subcommittee recommended that

> The IAEA Coordinated Research Programme on Atomic Collision Data for Diagnostics of Magnetic Fusion Plasmas be terminated after its initial three-year term, namely at the

end of 1984. The Subcommittee commended the CRP for its work and effort to advise the IAEA. A combined report, summarizing the conclusion and recommendations of the individual working groups of the CRP, is to be published in Nuclear Fusion.

3. Recommendation of A+M Collision Data

The Subcommittee reviewed the 1982 report on the "Procedures to arrive at recommended data" (INDC(SEC)-84/GA, p. 5-6), and made the following summary statement in this regard, which in effect supersedes the statement made in 1982.

The Subcommittee does not claim any authority to review the technical efforts of bodies such as those of the CRP. When such bodies have assessed given data for recommendation to the fusion community, their own authority is considered sufficient to recommend such data.

The Subcommittee retains the responsibility to advise the IAEA on the nature of programmes in A+M data for fusion, and will provide guidance on the scope and nature of data to be addressed by the IAEA programme and the manner in which the data are to be disseminated.

4. Considerations of data priorities

In their discussions on priorities, the Subcommittee identified the needs for data useful for diagnostics and for plasma modelling as being of equally high importance, but the kind of data and the requirements for accuracy in the two fields are different. Since the CRP on Atomic Collision Data for Diagnostics is to be terminated by the end of 1984, the Subcommittee recommended that:

> A meeting of experts be convened by IAEA, involving atomic physicists and plasma modellers, who should formulate recommended data sets for the atomic processes relevant to plasma modelling, with emphasis on Fe.

This meeting should advise on the most appropriate format for presentation and distribution of the data. When the scientific results and conclusions of this meeting justify a publication, the Subcommittee recommends that they be published in Nuclear Fusion, eventually in a special issue of this journal.

In view of the fact that extensive preparations are necessary, the meeting should be announced about one year in advance. The meeting should be held in the fall of 1985, possibly at Culham or Garching. Participants in this meeting must be suggested by Subcommittee members, and if possible should themselves participate in the meeting.

5. Atomic Collision Data Exchange Compilation and Dissemination

The Subcommittee reaffirmed its earlier position that the primary function of the IAEA A+M Data Unit is to assemble a file of evaluated atomic collision data which had been recommended by atomic physicists and disseminate these data to the fusion research community.

The following steps in the compilation and dissemination of the data are foreseen by the Subcommittee:

- Data are recommended by meetings of experts or coordinated research programmes.

- The recommended data are compiled by the national data centres (USA, USSR, France, Japan), in the framework of their own national programmes.

- IAEA A+M Data Unit coordinates the international data centre network (composed of national data centres) for the establishment and maintenance of a systematic exchange of bibliographic and numeric data (including the development of the EXFOR data exchange format).

- National data centres transmit the data they compile to the IAEA Centre (using preferably the EXFOR exchange format).

- The IAEA Centre assembles all data transmissions received from the data centres into the A+M numerical data base (A+M/NDB).

- The IAEA Centre produces an index of the A+M/NDB at regular intervals and distributes this index periodically to the national data centres, which can request data that they do not have.

- The fusion community is informed periodically of the availability of recommended data by the IAEA, either through announcements in the Nuclear Fusion Journal, or by some other means.

- A full file of recommended numerical A+M Collision data together with a properly annotated index is sent to the major fusion labs in the required format.

- Special user services (retrieval and dissemination of selected data in specified formats) are provided by the national data centres in those countries where a centre exists, or by the IAEA data centres for requests from other countries.

6. Plasma-wall Interaction Data

As a conclusion to their discussion on plasma-wall interaction data, the Subcommittee made the following statement:

> The interaction processes of plasma with materials are quite important and are intensively addressed in various national programmes. While this area deserves greater international organization, in a manner that is being implemented by the IAEA for A+M collision data, present manpower is insufficient to address the plasma-material interaction (PMI) data through the IAEA. In addition, the required data for PMI must be acquired and tailored to the geometry and conditions of specific devices.

The Subcommittee did not suggest that the IAEA should attempt significant additional effort in this area at the present time, but as the discipline develops over the next years, the IAEA involvement might be re-assessed.

The biannual meeting on plasma surface interactions was organized by A. Miyahara with the specific title "Plasma - Surface Interactions in Controlled Fusion Devices", and was successfully held in May 1984 in Nagoya, Japan. Published results of these meetings and bibliographic references to other current PMI work, such as the recent measurements including angular distributions and lower energies, must be included in the A+M Data Bulletin.

The Subcommittee welcomed the announced publication of the state-of-the-art report that resulted from the IAEA CRP on Atomic Data for Plasma-wall Interaction Processes, in a special issue of the Nuclear Fusion journal during the summer of 1984.

E. Bibliographic Data

1. A+M Bibliographic Data Base (A+M/BDB) and A+M Data Bulletin

The Subcommittee acknowledged the arrangements made with members of the A+M Data Centre Network during the last A+M Data Centre meeting (June 1984) to supply IAEA with periodic input to the A+M Bibliographic Data Base that serves as the principal source for the publication of the A+M Data Bulletin and of the CIAMDA index. Furthermore,

> The Subcommittee strongly hoped that the publication of the IAEA A+M Data Bulletin can be maintained at its present satisfactory level despite the reduced manpower of the A+M Data Unit, and endorses the proposed collaboration between the data centres in the future preparation of the Bulletin.

In order to maintain the distribution of the Bulletin at a reasonable level, and the addresses of recipients up-to-date, the Subcommittee suggested that a return addressed postcard be included in the next issue of the Bulletin so as to give all recipients the opportunity to confirm their interest in this publication.

It was also suggested by the Subcommittee that references to data review articles, conference proceedings, and other publications containing data compilation and evaluations, which normally are not indexed in the A+M/BDB, be enterred in the data base, and included in the publication of the Bulletin and CIAMDA.

2. CIAMDA

The Subcommittee endorsed the proposal to publish the next issue of the index to references on A+M Collision data CIAMDA in 1985 in a new condensed format (illustrated in Attachment 1 of Appendix 4 of this report). It was recommended that the draft of CIAMDA85 be sent to the other data centres for approval prior to its publication.

CIAMDA85, expected to be approximately 900 pages, will indlude a general section listing data review articles, handbooks, conference proceedings and other publications containing data compilations and evaluations which are not indexed in CIAMDA. The indexed content will be properly annotated for ease of use. An example of the type of "index" that is foreseen is shown in Attachment 1 to Appendix 4 of this report.

F. A+M Data Centre Networks

The Subcommittee endorsed the data centre activities regarding the exchange of numerical data as proposed under C.4, and hoped that the centralized numerical data base, the A+M/NDB, will be well established at the IAEA by the time of the next Subcommittee Meeting.

It was supported by the Subcommittee that in view of the current period of development of the international A+M data exchange system, the data centres were to meet annually.

Appendix 1

Third Meeting

IFRC Subcommittee on A+M Data for Fusion

IAEA Headquarters, Vienna, 20-22 June 1984

List of Participants

(Members of the Subcommittee are marked by an asterisk)

*	Drawin, H.W.	Dept. de Physique des Plasmas et de la Fusion Controlee Association Euratom-C.E.A. sur la Fusion Controlee P.O.B. 6 F-92260 Fontenay-aux-Roses
	Hughes, J.	IAEA/Nuclear Data Section A+M Data Unit
	Nakai, Y. (Substitute for Dr. K. Harada)	Division of Physics Japan Atomic Energy Research Institute Tokai-Mura, Naka-Gun Ibaraki-Ken 319-11, Japan
*	Harrison, M.F.A.	Culham Laboratory United Kingdom Atomic Energy Authority Abingdon, Oxon. OX14 3DB United Kingdom
*	Hayakawa, S.	Department of Astrophysics Nagoya University Nagoya, Japan
	Katsonis, K.	IAEA/Nuclear Data Section A+M Data Unit
*	Lorenz, A.	IAEA/Nuclear Data Section A+M Data Unit
	Schmidt, J.J.	IAEA/Nuclear Data Section
*	Crandall, D.H.	ER-542, MS G-226, GTN U.S. Department of Energy Washington, D.C. 20545 U.S.A.
*	Abramov, V.A.	Institut Atomnoi Energii I.V. Kurchatova Ploshchad I.V. Kurchatova Moscow D-182, 123182 U.S.S.R.

Appendix 2

Third Meeting

IFRC Subcommittee on A+M Data for Fusion

IAEA Headquarters, Vienna, 20-22 June 1984

Adopted Agenda

1. Introductory Items

   - Selection of Chairman
   - Adoption of Agenda
   - Subcommittee Membership

2. A+M Data Unit

   2.1. Programme and function (see last meeting recommendation, p.3 INDC(SEC)-84))
   2.2. Staff changes

3. Numerical A+M Data

   4.1. CRP on Atomic Collision Data for Diagnostics of Magnetic Fusion Plasmas - (Wednesday, afternoon Session)
   4.2. Recommended A+M Collision Data
   4.3. Considerations of data priorities, evaluation and recommendation
   4.4. Review of last meeting recommendations on the "Procedures to arrive at recommended data"
   4.5. Plasma-wall interaction data
   4.6 Publication of the results of the CRP on Atomic Data pertinent to Plasma-wall Interaction Processes

4. Bibliographic A+M Data

   3.1. Status of the A+M bibliographic data base
   3.2. A+M Data Bulletin and related considerations
   3.3. Publication of CIAMDA (consideration of an abbreviated index)
   3.4. Review of last meeting recommendations

5. A+M Data Centre Network

   5.1. Report on the 4th A+M Data Centre Meeting
   5.2. Review of last meeting recommendation
   5.3. International numerical data base and systematic data exchange
   5.4. Service to users

6. Future A+M Data Meetings

   6.1.A+M Data Centre Network Meetings
   6.2. CRP Meetings
   6.3. Experts Meetings
   6.4. Next Advisory Group on A+M Data for Fusion

7. Next meeting of the Subcommittee

Appendix 3

IFRC Subcommittee on Atomic + Molecular Data for Fusion

Membership as of June 1984

Derrien, M.A.	INDC Chairman Representative	DEDR/DRNR/SEDC/SPNR Centre d'Etudes Nucleaires de Cadarache B.P. No. 1 F-13115 Saint-Paul-lez-Durance
Drawin, H.W.		Dept. de Physique des Plasmas et de la Fusion Controlee Association Euratom-C.E.A. P.O.B. 6 F-92260 Fontenay-aux-Roses
Harada, K.		Division of Physics Japan Atomic Energy Research Institute Tokai-Mura, Naka-Gun Ibaraki-Ken 319-11, Japan
Harrison, M.F.A.		Culham Laboratory United Kingdom Atomic Energy Authority Abingdon, Oxon. OX14 3DB United Kingdom
Hayakawa, S.		Department of Astrophysics Nagoya University Nagoya, Japan
Lorenz, A.	Scientific Secretary	IAEA/Nuclear Data Section
Abramov, V.A.		Institut Atomnoi Energii I.V. Kurchatova Ploshchad I.V. Kurchatova Moscow D-182, 123182 U.S.S.R.
Crandall, D.H.		ER-542, MS G-226, GTN U.S. Department of Energy Washington, D.C. 20545 U.S.A.

15 June 1984

Report of the IAEA A+M Data Unit

A. Lorenz

A. A+M Data Unit Staff and IAEA A+M Data Programme

As a result of a recent administrative decision to reduce the staff of the Nuclear Data Section, the post which has been occupied by K. Katsonis had to be given up. In effect, this has reduced the staff of the A+M Data Unit to two professional (P) and two clerical (G) staff, of which only one P and one G devote full time to A+M data. This is the situation as of mid-year 1984. With regard to personnel, D. Gremillet has left the A+M Data Unit at the beginning of 1984 and will be replaced by J.G. Hughes from Queen's University of Belfast as of 1 August 1984. K. Katsonis, who has been with the A+M data programme of the Agency from the beginning, will leave the IAEA mid-year 1984 to assume a position in the Gaphyor A+M data centre at Orsay. As a result of these personnel changes, the programmatic emphasis of the A+M Data Unit will need to be re-appraised in the light of priority needs of the fusion community and contributing committments of the other A+M data centres. In order to alleviate the situation internally to the Nuclear Data Section, starting mid-year 1984, A+M data programming and data processing will be shared with the rest of the data processing staff of the Section; also, A. Lorenz whose A+M contribution has been limited by other commitments and responsibilities to less than 30 %, should be able to devote more time to A+M data as of 1985.

At the present time, the Agency's A+M programme consists of the following principal activities:

- assessment of data needs and research coordination and support
- development of the A+M EXFOR for the storage and exchange of data, and the establishment of a numerical A+M data base, and
- continuous compilation of bibliographic reference data into the A+M/BDB (Bibliographic Data Base), and the publication of the A+M Data Bulletin.

While the first activity is performed exclusively by the Agency, the other two rely on the cooperation of other A+M data centres. Until now, the bibliographic reference compilation and the publication of the A+M Data Bulletin has depended almost exclusively on the input prepared by K. Katsonis; as a result of the Unit's staff changes, however, it will be necessary to rely to a large extent on the other data centres to scan some of the literature, and supply part of the input to the A+M/BDB on a systematic and continuous basis.

In order to be able to provide the best available numerical A+M data to the fusion research community, it is necessary to have the data assembled in a form that is easily processed for printing, graphing, or prepared for automatic computer input. Independent of priorities and requirements of individual data centres, it is to the advantage of each data centre to have such a data base to satisfy their own national or regional requirements. As each individual centre is hard put

(especially in these days of budgetary restrictions) to collect, compile and evaluate all of the required data on its own, it has everything to gain and nothing to loose to enter into co-operative agreements with the other centres and benefit from the work performed by them. This can only be achieved if all centres agree to use common formats for the effective and efficient exchange of the required data. As the centre which has been given the responsibility to create and maintain such a data base, the Agency's A+M Data Unit can only achieve this objective if it has the full support and cooperation of the other A+M data centres. As described below, the A+M Data Unit has developed and implemented the A+M EXFOR exchange format for atomic collision data, and the first transmissions in this format have taken place. It is hoped that in the course of these June 1984 meetings agreements will be reached by the A+M data centres to share the work to be done and to exchange these data on a systematic basis.

B. Bibliographic A+M Data

1. Status of the A+M Bibliographic Data Base

The IAEA A+M Bibliographic data base (A+M/BDB) system, that is used to produce the IAEA Data Bulletin and bibliographic indexes, such as CIAMDA, as well as to generate selected retrievals, has been completed and fully documented (see IAEA-NDS-AM-12 "Description of the IAEA Data Base of Bibliographic Data", IAEA-NDS-AM-13 "IAEA Data Base for Bibliographic A+M Data: Files, Description, Program Documentation, System Logic", and IAEA-NDS-AM-14 "IAEA Data Base for Bibliographic A+M Data: Data Base Management Procedures"). The A+M/BDB continues to be updated quarterly by the systematic scanning of 137 journals. The A+M/BDB contains now approximately 50 000 indexed citations to published articles, reports and books.

2. Publication of the Quarterly IAEA Bulletin on A+M Data

The IAEA A+M Data Bulletin has continued to be published on a quarterly basis, and is now distributed to approximately 1 100 scientists and institutions in 26 Member States.

3. A+M Data Index

In order to provide a quick overview of the existing A+M data literature, IAEA/NDS has created an A+M Data Index which lists in one consise information line the collision partners, energy range, reference citation and first author for each published reference to measured or calculated atomic collision data sets. A sample page of this index is attached (Attachment 1). The index has been created using the complete bibliographic data base contained in the A+M/BDB. The advantage of such an index is the ease of scanning an extremely large body of information without the need to refer to other tables or listings. Although the information content of each line is limited, the basic information given is enough to identify the indexed data set for anyone familiar with the atomic collision field.

In addition to be an index to numerical data published in the literature, the same index format can be produced from A+M EXFOR listings and used to advertise the availability and location of the actual numerical data, with specifications as to the size of the data set, whether the data are recommended, and any other information that can be given in an abbreviated form. A sample page of the index extracted from recent data transmissions from Belfast and Nagoya is attached (Attachment 2).

4. Future CIAMDA Publications

One of the criticism of the CIAMDA 80 format has been that it is awkward to scan. While this format (separating the body of the index into indexation, titles, and author listing) has been found adequate for the A+M Data Bulletin, which contains only 200 - 300 references in each issue, it becomes unwieldy when thousands of references must be scanned. The objectives of the Bulletin and of the Index are also different: the Bulletin is a current awareness publication, informing the reader of what is new, the Index on the other hand is designed as a reference to all of the existing information, requiring a quick access format. Thus, not only are the format requirements different, but so are the contents of the publications themselves. An index only needs an abbreviated citation, and a concise description of the data.

As the next publication of CIAMDA is planned for 1985, it is proposed to produce this index in the form of the Data Index described above (see Attachment 1). The full information, as originally contained in CIAMDA 80, as well as author ordered lists can always be obtained on request from the IAEA. In addition, the current version of the Data Index can always be searched for selective retrievals, and be provided as a free service to the users. Also, as all of the "full information" has been published in issues of the Bulletin since the production of CIAMDA 80, it would seem unnecessary to reproduce the contents of all of the 16 Bulletins (1980-1984) in one publication.

5. Compendium for Plasma-Wall Interaction Information

The Plasma-Surface Data CRP, conducted by R.A. Langley, and terminated in 1981, has resulted in a compendium of information on plasma-surface interaction. This compendium recently updated by the original contributing authors, and refereed for publication, will be published in a Special Issue of the IAEA Fusion journal in Summer 1984.

In this compendium, reviews of particle-solid processes pertinent to modelling plasma-wall interactions are presented, and sets of recommended data are given. Analytic formulae are used where possible otherwise data are presented in the form of tables and graphs. The incident particles considered are e^-, H, D, T, He, C, O and self ions. The materials include the metals: aluminium, copper, molybdenum, stainless steel, titanium and tungsten and the non-metals: carbon and TiC.

C. Numerical Data

1. CRP on A+M Collision Data

The second meeting of the participants in the IAEA Coordinated Research Programme (CRP) on Atomic Collision Data for Diagnostics of Magnetic Fusion Plasmas was convened by the IAEA Nuclear Data Section on 30 August - 2 September 1983 at the Institute of Plasma Physics, Nagoya University, Nagoya.

The objectives of CRP meetings are:

- to review the status of the data for those processes and reactants identified by the fusion community to have high priority;
- to assess the accuracy and validity of those data;
- to decide which of the required data can now be considered to be in a satisfactory state; and
- to identify those data which can be generated experimentally, calculated theoretically, or represented by empirical formulae.

The results of these annual surveys are designed to give overall guidelines for the work to be performed by the CRP participants as well as to provide new data input to the body of recommended collision data. The data reviewed by the CRP at its 1983 meeting, which it considered to be recommendable, is listed in Appendix 1.

The third meeting of this group was to be held in Vienna, 18-20 June 1984.

2. Development of the A+M EXFOR

The basic version of the A+M EXFOR format for the exchange of atomic collision data has been completed by the end of 1983, and its description, published in IAEA-NDS-AM-15 ("The EXFOR Manual for Atomic Collision Data", February 1984 version), was distributed to the A+M Data Centre Network at the beginning of 1984. The use of the A+M EXFOR format internally by the data centres is optional. At the IAEA the EXFOR format is used both for data exchange as well as for internal storage.

The A+M EXFOR system consists of the format description, dictionaries of keywords and abbreviations used in the coding of EXFOR entries, and of the basic checking program which processes (checks the correctness of) transmission tapes received from other centres and creates EXFOR entries from new input. In addition, development has started on a program to create a Data Index from the EXFOR data file (see B.3. above and Attachment 2).

3. Recommended A+M Collision Data

The procedures to arrive at recommended data are described in INDC(SEC)-84 (January 1983), Report of the Second Meeting of the IFRC Subcommittee on A+M Data for Fusion. These procedures are designed to produce in unique sets of recommended data. As defined by the IFRC Subcommittee:

> The IAEA numerical data base shall comprise "recommended" data, consisting of appropriately annotated unique data sets for each required species and reaction in the form of cross sections, (Maxwellian averaged) reaction rates, and/or parametric fits on the data, which should be released to the fusion research community in the most suitable and required formats. The data should be presented in tabular and graphical form in hard-copy reports, and in the form of computer listings or tapes.

4. Data Transmission and Exchange

The EXFOR data exchange format is designed for the unambiguous exchange of data between centres. This requires not only the initial agreement (and committments) of data centres to use the format, but also an implicit agreement on the cooperative use, maintenance and development of EXFOR dictionaries. Although initial dictionaries have been proposed in the basic version of the A+M EXFOR (see IAEA-NDS-AM-15), these are in most cases undeveloped and incomplete. The development and maintenance of dictionaries requires a systematic cooperative effort, which is accomplished at data centre meetings, and eventually by mail. One of the data centres, maintains the master file of the dictionaries and acts as coordinator, accepts new entries and distributes dictionary updates to the other data centres.

In an established intercentre agreement, the exchange of data between centres can proceed either via the coordinating centre or directly between centres. In the first alternative, centre A sends a transmission tape to the coordinating centre which then distributes it to the other centre; in the second alternative, centre A sends the same tape to all of the other centres, including the coordinating centre.

So far, IAEA has received two trial transmission tapes from Belfast; both have cleared the checking programme, and are merged in a provisional "A+M EXFOR Master File". The Data Index produced from this Mater File is available separately.

Although A+M data are stored at IPP at Nagoya in their internal AMDIS format, data index information on the current content of the AMDIS file has been transmitted to IAEA (on request) and translated into the IAEA Data Index format. The Nagoya file content has been merged with the data index of the Belfast transmission tapes; the combined index represents at this stage the currently compiled A+M collision data at these two centres.

The Data indexes of the Belfast transmissions and of the Nagoya file content have been merged and represent at this stage the currently compiled A+M collision data of these two centres.

5. Data Fitting: Analytical representation of charge transfer cross sections for fully stripped ions on hydrogen and helium atoms.

Analytical approximation for the charge exchange cross section in $H^+ + H$ and $He^{2+} + H$ collision system have been earlier provided by Riviere. Although compact in their form, these approximations have subsequently been found not quite suitable for analytic rate coefficient calculations. Moreover, two diferent functional forms have been used for the cross section at low and high energies. From the point of view of fusion applications, a unique functional form is desirable for the cross sections of all the collision ion-atom pairs under consideration. Polynomial representations are preferable for such applications. Therefore fitted charge exchange cross sections are represented by the following expression:

$$\sigma_{cx} = \sum_{n=0}^{N} a_n \, (\ln E)^n \qquad (1)$$

where a_n are fitting parameters. The functional form has also been used previously to represent analytically charge exchange cross sections for other systems.

The fitting parameters of (1) for collisions of H with light fully stripped ions ($Z < 14$) have been calculated by K. Katsonis (A+M Data Unit) in collaboration with R. Janev. Calculation of fitting parameters for collisions of He with light ions of fusion interest (He^{2+}, Li^{3+}, C^{6+}, O^{8+}) and a unified analytical representation of the charge transfer cross-sections for $Z \geq 14$ has been started. This work will be submitted for publication to the Agency's Fusion Journal.

Reaction	Process	E-min	E-max	Un	Meth	Reference	First author	ISN.source
He*+Rb	HZ	1.0E+01	1.0E+02	eV	THEO	J,JAP,37,2928,66	Sheldon J. W.	6490.CI
He*+Rb	HZ				THEO	J,JP/B,1,18,67	Bell K. L.	8659.CI
He*+Rb	HZ				EXP	J,JP/B,11,927,78	Johnson C.	9971.CI
He*+Rb*	HZ				EXP	J,PL/A,51A,5,75	Keiser G. M.	11827.CI
He*+Rb	HZ	0.0E+00	1.0E+01	eV	EXP	J,SPJE,43,35,76	Dmitriev S.	15324.CI
He*+Rb*	HZ				EXP	J,SPJE,43,35,76	Dmitriev S.	15324.CI
He(1+)+Rb	HZ	1.0E+04	1.0E+05	eV	THEO	J,JCP,68,2427,78	Tiwary S. N.	825.05
He(2+)+Rb	HZ	1.0E+05	1.0E+07	eV	THEO	J,PRA,4,955,71	Garcia J. D.	13107.CI
He(2+)+Rb	HZ	1.0E+05	1.0E+07	eV	EXP	J,PRA,11,1607,75	McDaniel F. D.	13702.CI
He*+Sr	HD	0.0E+00	1.0E+01	eV	EXP	J,PRL,26,599,71	Schearer L.	14309.CI
He*+Sr	HD	0.0E+00	1.0E+01	eV	EXP	J,PRA,10,1380,74	Schearer L.	13624.CI
He+Sr(1+)	HD	0.0E+00	1.0E+01	eV	THEO	J,JP/B,8,2708,75	Giusti-Suzor A.	9581.CI
He+Sr*	HS				EX/TH	J,OS1,36,13,74	Shabanova	11276.CI
He+Sr	HX				EXP	J,PL/A,65A,215,78	Fahey D. W.	11908.CI
He*+Sr	HX	0.0E+00	1.0E+01	eV	EXP	J,PRA,10,1380,74	Schearer L.	13624.CI
He+Sr(1+)	HX	0.0E+00	1.0E+01	eV	EXP	J,PRL,26,599,71	Schearer L.	14309.CI
He+Sr(1+)*	HX				EXP	J,UFZr,19,1943,74	Shpenik O.	15600.CI
He+Sr(1+)	HX				EXP	J,ZP,259,371,73	Weber E. W.	16459.CI
He+Sr(1+)*	HX				EXP	J,ZTF,45,79,75	Zapesochnyij	15915.CI
He(2+)+Sr	HX	1.0E+05	1.0E+07	eV	THEO	J,ZP,260,341,73	Weber E. W.	16460.CI
He*+Sr	HZ	0.0E+00	1.0E+01	eV	EXP	J,PRA,4,955,71	Garcia J. D.	13107.CI
He*+Sr	HZ	0.0E+00	1.0E+01	eV	EXP	J,PRL,26,599,71	Schearer L.	14309.CI
He*+Sr	HZ	0.0E+00	1.0E+01	eV	EXP	J,PRA,10,1380,74	Schearer L.	13624.CI
He(1+)+Sr	HZ				EXP	J,PRL,22,629,69	Schearer L. D.	14261.CI
He(1+)+Sr	HZ	0.0E+00	1.0E+01	eV	EXP	J,IVUZF,20,137,77	Zhukov V. V.	6382.CI
He(2+)+Sr	HZ	1.0E+05	1.0E+07	eV	THEO	J,PRL,31,1168,73	Arrathoon R.	14413.CI
He(2+)+Sr	HZ	1.0E+05	1.0E+07	eV	EXP	J,PRA,4,955,71	Garcia J. D.	13107.CI
He(2+)+Sr	HZ	1.0E+05	1.0E+07	eV	EXP	J,PRA,8,1258,73	Li T. K.	13419.CI
He(2+)+Sr	HZ	1.0E+05	1.0E+07	eV	EXP	J,PRA,11,1607,75	McDaniel F. D.	13702.CI
						J,PRA,13,992,76	Awaya Y.	13866.CI
He*+Y	HD	0.0E+00	1.0E+01	eV	EXP	J,CPL,43,175,76	Gerard K.	6059.CI
He(1+)+Y	HF	0.0E+00	1.0E+01	eV	EXP	J,JP/B,7,L332,74	Littlewood I. M.	9318.CI
He*+Y	HZ	0.0E+00	1.0E+01	eV	EXP	J,CPL,43,175,76	Gerard K.	6059.CI
He(1+)+Y	HZ	0.0E+00	1.0E+01	eV	EXP	J,JP/B,7,L332,74	Littlewood I. M.	9318.CI
He(1+)+Y	HZ	0.0E+00	1.0E+01	eV	EXP	J,PRL,31,1168,73	Arrathoon R.	14413.CI
He(2+)+Y	HZ	1.0E+05	1.0E+07	eV	EXP	J,PRA,9,267,74	McKnight R. H.	13497.CI
He(2+)+Y	HZ	1.0E+05	1.0E+07	eV	EXP	J,PRA,11,1607,75	McDaniel F. D.	13702.CI
						J,PRL,32,1155,74	Cue N.	14425.CI
He(1+)+Zr	HX	1.0E+05	1.0E+07	eV	EXP	J,PRL,29,329,72	Saltmarsh M. J.	14366.CI
He(1+)+Zr	HX	1.0E+05	1.0E+07	eV	EXP	J,PRL,29,329,72	Saltmarsh M. J.	14366.CI
He(2+)+Zr	HX	1.0E+05	1.0E+07	eV	THEO	J,PRA,4,955,71	Garcia J. D.	13107.CI
He(2+)+Zr	HZ	1.0E+05	1.0E+07	eV	EXP	J,PRA,8,1258,73	Li T. K.	13419.CI

Reaction	Process	Quantity	E-Min	E-Max	Units	Type	Method	Reference	Author	Exfor	Data	R
e+Xe	ION	SIG	5.00E+02	5.00E+03	EV	EXP	XST	J,JP/B,13,1249,80	Nagy P.	UB00067011	11	
e+Xe(+1)	ION	SIG	2.07E+01	8.30E+02	EV	EXP	XCB	J,JP/B,13,1877,80	M-?Duller, A.	JN00002040	38	
e+Xe(+3)	ION	SIG	3.92E+01	1.48E+03	EV	EXP	XCB	J,PR/A,27,724,83	Gregory, D.C.	JN00003086	50	
e+Xe(+6)	ION	SIG	8.87E+00	1.48E+02	EV	EXP	XCB	J,PR/A,27,2338,83	Gregory, D.C.	JN00003093	41	
e+Zn	ION	SIG	5.00E+00	5.00E+00	EV	EXP	XBE	J,JCP,44,916,66	Pottie, R.F.	JN00009165	1	
e+Zn	ION	SIG	1.00E+01	1.00E+04	EV	CALC	TBA	J,PRA,16,62,77	McGuire E.J.	UB00077007	25	
e+Zn	ION	SIG	1.10E+03	1.00E+05	EV	CALC	TBA	J,PRA,26,125,82	McGuire E.J.	UB00075005	16	
e+Zn	ION	SIG	1.80E+01	2.00E+03	EV	EXP	XCB	J,PRA,25,737,82	Rogers W.T.	UB00068001	17	
e+Zn(+1)	ION	SIG	1.82E+00	2.07E+02	EV	EXP	XCB	J,PR/A,25,737,82	Rogers, W.T.	JN00003103	24	
e+Zr	ION	SIG	1.00E+01	1.00E+04	EV	CALC	TBA	J,PRA,16,62,77	McGuire E.J.	UB00077013	25	
e+Zr	ION	SIG	3.48E+01	9.88E+02	EV	EXP	XCB	J,PRA,27,762,83	Falk R.A.	UB00061002	46	
e+Zr(+3)	ION	SIG	3.48E+01	9.87E-01	EV	EXP	XCB	J,PR/A,27,724,83	Falk, R.A.	JN00003073	46	
Ar+H	CHT	SIG	1.02E+05	1.02E+05	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035013	1	
H+B	CHT	SIG	9.93E+03	2.90E+04	AU	CALC	TCTM	J,JP/B,12,919,79	Salop A.	UB00040001	4	
H+B	CHT	SIG	4.05E+05	1.62E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039002	6	
H+B	CHT	SIG	4.05E+05	1.62E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039003	6	
H+B	CHT	SIG	4.05E+05	1.62E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039001	5	
H+B	CHT	SIG	3.61E-09	9.04E-08	ERG	CALC	TCCC	J,JP/B,11,699,78	Olsen R.E.	UB00038001	31	
H+B	CHT	SIG	7.50E+05	2.50E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033005	6	
H+B	CHT	SIG	1.85E+05	2.50E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033004	9	
H+B	CHT	SIG	1.85E+05	2.50E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033003	9	
H+B	CHT	SIG	1.10E+05	2.10E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033002	9	
H+B	CHT	SIG	1.10E+05	1.60E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033001	8	
H+B	CHT	SIG	1.04E+04	3.17E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035001	5	
H+B	CHT	SIG	1.52E+04	4.78E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035002	5	
H+B	CHT	SIG	6.22E+04	6.22E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035004	1	
H+B	CHT	SIG	2.03E+04	5.98E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035003	4	
H+B	CHT	SIG	2.70E+02	2.16E+06	EV	CALC	TDWA	J,PRA,19,1538,79	Ryufuku H.	UB00032003	14	
H+B	CHT	SIG	3.00E+03	3.50E+04	EV	EXP	XST	J,JP/B,12,4159,79	McCullough R.W.	UB00037001	16	
H+B	CHT	SIG	2.40E+04	2.40E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036002	1	
H+B	CHT	SIG	1.60E+04	1.60E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036001	1	
	CHT	SIG	3.20E+04	3.20E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036003	1	
H+Ba	CHT	SIG	1.40E+04	3.50E+04	EV	EXP	XST	J,JP/B,12,4159,79	McCullough R.W.	UB00037007	7	
H+Be	CHT	SIG	2.25E+02	1.80E+06	EV	CALC	TDWA	J,PRA,19,1538,79	Ryufuku H.	UB00032002	14	
H+C	CHT	SIG	1.10E+04	3.33E+04	AU	CALC	TCTM	J,JP/B,12,919,79	Salop A.	UB00040002	4	
H+C	CHT	SIG	1.00E-09	4.01E-07	ERG	CALC	TCCC	J,PRA,16,1811,77	Salop A.	UB00045001	15	
H+C	CHT	SIG	3.07E+04	3.07E+04	EV	CALC	TCCM	J,PRA,14,579,76	Olsen R.E.	UB00044001	1	
H+C	CHT	SIG	1.00E-09	1.00E-07	ERG	CALC	TCCC	J,JP/B,11,699,78	Olsen R.E.	UB00038002	28	
H+C	CHT	SIG	4.50E+05	1.80E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039004	6	
H+C	CHT	SIG	4.50E+05	1.80E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039007	6	
H+C	CHT	SIG	3.07E+04	3.07E+04	EV	CALC	TCCM	J,PRA,14,579,76	Olsen R.E.	UB00044003	1	
H+C	CHT	SIG	4.50E+05	1.80E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039006	6	
H+C	CHT	SIG	4.50E+05	1.50E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039005	5	
H+C	CHT	SIG	3.07E+04	3.07E+04	EV	CALC	TCCM	J,PRA,14,579,76	Olsen R.E.	UB00044002	1	
H+C	CHT	SIG	1.00E+05	2.10E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033007	11	
	CHT	SIG	1.00E+05	1.75E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033006	10	

Reaction	Process	Quantity	E-Min	E-Max	Units	Type	Method	Reference	Author	Exfor	Data	R
H+C	CHT	SIG	1.38E+06	2.50E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033011	4	
H+C	CHT	SIG	2.85E+05	2.50E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033010	9	
H+C	CHT	SIG	1.30E+05	2.10E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033009	10	
H+C	CHT	SIG	1.48E+05	2.10E+06	EV	EXP	XST	J,JP/B,12,3763,79	Goffe T.V.	UB00033008	10	
H+C	CHT	SIG	4.21E+04	4.21E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035007	1	
H+C	CHT	SIG	1.44E+04	7.04E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035006	7	
H+C	CHT	SIG	3.34E+04	3.34E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035005	1	
H+C	CHT	SIG	3.00E+02	8.00E+06	EV	CALC	TDWA	J,PRA,19,1538,79	Ryufuku H.	UB00034001	17	
H+C	CHT	SIG	3.20E+04	3.20E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036006	1	
H+C	CHT	SIG	2.40E+04	2.40E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036005	1	
H+C	CHT	SIG	1.60E+04	1.60E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036004	1	
H+C	CHT	SIG	6.00E+05	1.65E+06	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042004	5	
H+C	CHT	SIG	6.00E+04	1.35E+06	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042003	9	
H+C	CHT	SIG	4.00E+04	6.00E+05	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042002	5	
H+C	CHT	SIG	8.60E+03	6.00E+05	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042001	9	
H+C	CHT	SIG	8.00E+02	1.30E+04	EV	EXP	XST	J,JP/B,12,L157,79	Nutt W.L.	UB00041001	13	
H+C	CHT	SIG	5.00E+02	1.40E+04	EV	EXP	XST	J,JP/B,11,L181,78	Nutt W.L.	UB00043001	14	
H+Cd	CHT	SIG	2.00E+03	3.50E+04	EV	EXP	XST	J,JP/B,12,4159,79	McCullough R.W.	UB00037006	18	
H+Fe	CHT	SIG	5.28E+04	5.28E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035014	1	
H+Li	CHT	SIG	1.73E+02	1.38E+06	EV	CALC	TDWA	J,PRA,19,1538,79	Ryufuku H.	UB00032001	14	
H+Li	CHT	SIG	1.04E+05	1.50E+06	EV	EXP	XST	J,JP/B,11,L233,78	Shah M.B.	UB00031003	17	
H+Li	CHT	SIG	1.26E+05	1.19E+06	EV	EXP	XST	J,JP/B,11,L233,78	Shah M.B.	UB00031002	11	
H+Li	CHT	SIG	6.60E+04	1.04E+06	EV	EXP	XST	J,JP/B,11,L233,78	Shah M.B.	UB00031001	12	
H+Mg	CHT	SIG	2.00E+03	4.00E+04	EV	EXP	XST	J,JP/B,12,4159,79	McCullough R.W.	UB00037002	20	
H+N	CHT	SIG	3.58E+04	3.58E+04	EV	CALC	TCCM	J,PRA,14,579,76	Olsen R.E.	UB00044005	1	
H+N	CHT	SIG	5.25E+05	2.10E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039009	6	
H+N	CHT	SIG	3.58E+04	3.58E+04	EV	CALC	TCCM	J,PRA,14,579,76	Olsen R.E.	UB00044004	1	
H+N	CHT	SIG	3.58E+04	3.58E+04	EV	CALC	TCCM	J,PRA,14,579,76	Olsen R.E.	UB00044007	1	
H+N	CHT	SIG	5.25E+05	2.10E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039008	5	
H+N	CHT	SIG	5.25E+05	2.10E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039010	5	
H+N	CHT	SIG	3.58E+04	3.58E+04	EV	CALC	TCCM	J,PRA,14,579,76	Olsen R.E.	UB00044006	1	
H+N	CHT	SIG	5.25E+05	2.80E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039012	7	
H+N	CHT	SIG	5.25E+05	2.80E+06	EV	CALC	TCTM	J,PRA,16,531,77	Olsen R.E.	UB00039011	6	
H+N	CHT	SIG	1.90E+04	1.21E+05	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035010	8	
H+N	CHT	SIG	1.41E+04	9.83E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035009	8	
H+N	CHT	SIG	1.90E+04	7.16E+04	EV	EXP	XST	J,PRA,19,504,79	Crandall D.H.	UB00035008	5	
H+N	CHT	SIG	5.00E+02	9.85E+03	EV	EXP	XCB	J,JCP,33,1226,60	Stebbings R.F.	UB00046001	9	
H+N	CHT	SIG	2.40E+04	2.40E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036008	1	
H+N	CHT	SIG	3.20E+04	3.20E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036009	1	
H+N	CHT	SIG	4.00E+04	4.00E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036010	1	
H+N	CHT	SIG	1.60E+04	1.60E+04	EV	EXP	XST	J,PRA,21,139,80	Gardiner L.D.	UB00036007	1	
H+N	CHT	SIG	6.00E+04	1.35E+06	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042007	9	
H+N	CHT	SIG	7.50E+05	1.65E+06	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042009	4	
H+N	CHT	SIG	6.00E+05	1.65E+06	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042008	6	
H+N	CHT	SIG	4.00E+04	6.00E+05	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042006	8	
H+N	CHT	SIG	1.00E+04	5.50E+05	EV	EXP	XST	J,PRA,17,53,78	Phaneuf R.A.	UB00042005	10	
H+N	CHT	SIG	4.00E+02	1.00E+04	EV	EXP	XST	J,JP/B,12,L157,79	Nutt W.L.	UB00041002	12	
H+O	CHT	SIG	1.46E+04	4.44E+04	AU	CALC	TCTM	J,JP/B,12,919,79	Salop A.	UB00040003	4	