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ENSDF Programmes and Model Exercises (ENSDF Analysis and Utility Codes)

J.K. TULI (for Thomas W. BURROWS)

National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973
U.S.A.

ENSDF Analysis and Utility Codes

Presentation for the ICTP-IAEA Workshop on Nuclear Structure and Decay Data: Theory and Evaluation

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Jagdish K. Tuli

(For Thomas W. Burrows)

Brookhaven Science Associates
U.S. Department of Energy

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ENSDF Analysis and Utility Codes

- Platforms
- Overview of the Programs
- Programs Used for Various Types of ENSDF Datasets
  - All Types of Datasets
  - Adopted
  - Decay
  - Reaction
- Additional Notes on Some of the Codes
- *Introduction to the CD-ROM*

ENSDF Analysis and Utility Codes
Platforms

- Most of the programs are available for the following:
  - ANSI standard Fortran 77 or Fortran 95
  - LINUX and UNIX (gnu f77 FORTRAN, INTEL FORTRAN 90, or Lahey/Fujitsu FORTRAN 95)
  - Windows 95/98/ME/NT/2000/XP/VISTA (COMPAQ/DEC Visual Fortran)
- For LINUX, UNIX, and Windows, executables are also provided.

ENSDF Analysis and Utility Codes
Overview

- ADDGAM — Adds gammas to an adopted dataset
- ALPHAD — Calculates α R_0's, Hindrance Factors and theoretical $T_{½}(\alpha)$'s
- *BrIcc/HSICC* (Band-Raman Internal Coefficients/ Hager-Seltzer Internal Conversion) — Interpolates internal conversion coefficients – BrIcc adopted.
- COMTRANS (Comments Translation) — Translates comment records in ENSDF dataset to a “rich text” format
- DELTA — Analyzes angular correlation data
- ENSDAT (Evaluated Nuclear Structure Drawings and Tables) — Produces high quality drawings and tables in the Nuclear Data Sheets style

ENSDF Analysis and Utility Codes
Overview - 3

- RadList (Radiation Listing) — Calculates atomic & nuclear radiations. Checks energy balance
- RULER — Calculates reduced transition probabilities
- TREND (Tabular Representation of ENSDF) — Tabular display of ENSDF data

ENSDF Analysis and Utility Codes
All Types of Datasets

- Applicable programs are FMTCHK, ENSDAT, PANDORA, and TREND.
- FMTCHK should be run after any manual changes to the file.
- ENSDAT may be used to visually check the data.
- If you are considering combining several datasets (*e.g.*, from XUNDL), PANDORA may be useful.
- TREND may be used to visually check the data.

ENSDF Analysis and Utility Codes

Adopted Levels, Gamma Datasets — 1

- Applicable programs are ADDGAM, GTOL, BrIcc, PANDORA, and RULER.
- ADDGAM and PANDORA are useful in constructing the dataset.
- PANDORA used iteratively to aid in physics decisions, checking assignments, and updating source datasets based on changes in the adopted data.
- GTOL useful only in obtaining the least-squares adjustment of the level energies.
  - Matrix may occasionally be singular.

ENSDF Analysis and Utility Codes
Adopted Levels, Gamma Datasets — 2

- RULER may be used in two modes:
  - Comparison mode to provide additional information in obtaining γ-multipolarity assignments.
  - Should also be run to provide the BEλW's and BMλW's.
  - BrIcc/HSICC should be run before RULER.
- BrIcc should be run to provide the internal conversion coefficients.
  - Note that there is no need to delete the "S G" records generated by code.

ENSDF Analysis and Utility Codes

Decay Datasets — 1

- Applicable programs are ALPHAD (for α decay), GABS, GTOL, BrIcc, LOGFT (for $\beta^{\pm}/\varepsilon$ decay), RadList, and RULER.
- ALPHAD should be used to obtain the hindrance factors and, for even-even ground-state nuclei, R_0. For other nuclei, an R_0 must be supplied.
- GABS may be used to combine the data from up to three sources to obtain I_γ-normalization (NR), the branching ratios (BR), and absolute I_γ's.
  - BrIcc should run on the input data or the α's from the adopted dataset should be used.

ENSDF Analysis and Utility Codes
Decay Datasets — 2

- GTOL may be used to:
  - Provide a least-squares adjustment of the level energies.
  - Check the uncertainties and placement of the γ's.
  - Obtain the intensities of particles feeding the levels.
    - Should be done before ALPHAD and LOGFT are employed.
  - May be useful in deriving I_γ-normalization (NR).
- BrIcc may be used to:
  - Check experimentally measured α's against theory.
  - If the adopted α's are not used, to produce this information for the data set.

ENSDF Analysis and Utility Codes
Decay Datasets — 3

- LOGFT is required to obtain the log *ft*'s, $I_{\beta+}$ and I_{ε}, and partial electron-capture fractions.
  - Should be done before using RadList.
  - If one is not using measured intensities, GTOL should be used to obtain $I_{\beta-}$ and $I_{\varepsilon+\beta+}$.
- RadList should be used to:
  - Check the calculated energy deposited with that based the Q-value and branching ratio.
  - To compare to experimentally obtained X-ray intensities
  - Check results against integral measurements (*e.g.*, $<E_{\beta\pm}>$)
  - Unresolved discrepancies should be noted in the dataset.
  - BrIcc and LOGFT should have been used before doing these checks.

ENSDF Analysis and Utility Codes
Decay Datasets — 4

- RULER may be used to check or further limit multipolarities based on other methods (*e.g.*, from experimental conversion coefficients).

ENSDF Analysis and Utility Codes
Reaction Datasets — 1

- Applicable programs are GTOL, BrIcc, and RULER.
  - For (thermal n,γ) datasets, RadList may also prove of use.
- GTOL's primary use is to do a least-squares adjustment of the level energies and to check the uncertainties and placement of the γ's.
  - If ΔE_γ's are not given and a good estimate of these cannot be obtained, it may be better to use the authors' level energy values.
  - Also useful for checking for intensity imbalance problems if relative intensities are given.

ENSDF Analysis and Utility Codes
Reaction Datasets — 2

- BrIcc may be used to check experimentally measured α's against theory.
  - Very useful to include α's and partial α's for (thermal n,γ) datasets.
- RadList may be used to check the energy balance of (thermal n,γ) datasets by tricking it.
  - Change the DSID on the ID record to indicate IT decay
  - Add an appropriate Parent record ($E_{level}=S_n$)
  - Add a BR of 1.0 on the Normalization record.

ENSDF Analysis and Utility Codes
Additional Notes - 1

- ALPHAD
  - For ΔR_0: Five values are calculated and reported:
    - $R_0(T_{½},E)$, $R_0(T_{½}+\Delta T_{½},E)$, $R_0(T_{½}-\Delta T_{½},E)$, $R_0(T_{½},E+\Delta E)$, $R_0(T_{½},E-\Delta E)$.
    - $\Delta R_0=\sqrt{(((|R_0(T_{½}+\Delta T_{½},E)-R_0(T_{½}-\Delta T_{½},E)|)/2)^2 + (((|(R_0(T_{½},E+\Delta E)-R_0(T_{½},E-\Delta E)|)/2)^2)}$.
  - If either the value or the Δ for E_{parent}, Q_α, or E_{level} is non-numeric and E_α and ΔE_α are numeric, E_α and ΔE_α are used in the calculations.
  - Order of precedence for non-numeric uncertainties: limits (*e.g.*, "GT" or "LT"), "AP", "CA", and "SY".

ENSDF Analysis and Utility Codes
Additional Notes - 2

- COMTRANS
  - Should <u>not</u> be run on ENSDF or XUNDL files submitted to the NNDC.
    - ^A4 → A4 → A{-4} → a{-4}
    - T→T{-1/2}→T{-1/2}T{-1/2}→T{-1/2} T{-1/2}T{-1/2}T{-1/2}→ …
  - Useful to run before using Isotope Explorer 2 or ENSDAT.
- ENSDAT
  - Keynumber list generated by ENSDAT may be used to check the keynumbers
  - Layout commands may be embedded in the input.
    - See ENSCOMDS.TXT
    - Need to be removed before submission to the NNDC
  - "View" option available if you have a PostScript viewer such as GhostView installed.

ENSDF Analysis and Utility Codes
Additional Notes - 3

- NSDFLIB — Subroutine package used in all programs, except DELTA, GABS, and LWEIGHT
  - ANSI standard FORTRAN77
  - ANSI standard FORTRAN95 with a couple of exceptions
- RadList
  - Calculated uncertainties may be overestimated.
    - Total energy deposited by γ's calculated as $\Sigma BR \times NR \times E_\gamma \times I_\gamma$ instead of $BR \times NR \Sigma E_\gamma I_\gamma$.
  - Uses the first partial conversion coefficient found.
    - If EKC is encountered before KC, EKC will be used in the calculations.

ENSDF Analysis and Utility Codes
Additional Notes - 4

- RULER — Some problems in the uncertainties when calculating BEλW's and BMλW's.
  - $1/T_{1/2}$, $1/(1+\alpha)$, or $1/(1+\delta^2)$ may result in asymmetric uncertainties.
  - Possible covariance's between α and E_γ or δ or between $I(\gamma+ce)$ and $\Sigma I(\gamma+ce)$.
  - First order Taylor expansion may not be valid (*e.g.*, for $E\gamma^5$).
  - An asymmetric $T_{1/2}$ may result in a symmetric $1/T_{1/2}$.
  - For non-physical results (*e.g.*, BE2W-ΔBE2W<0), Lyon's method should probably be used.