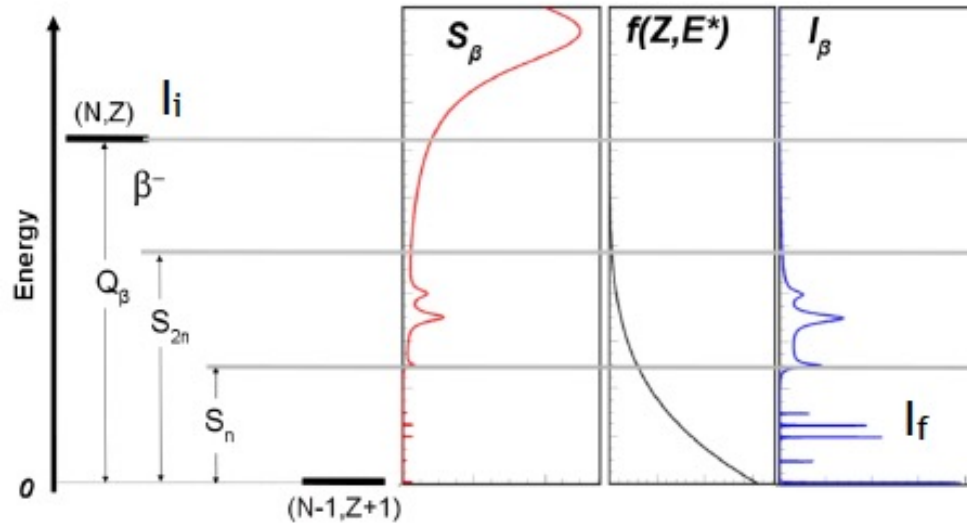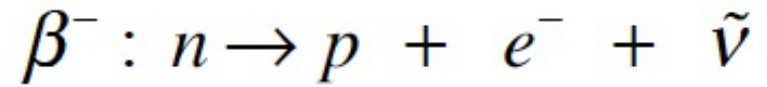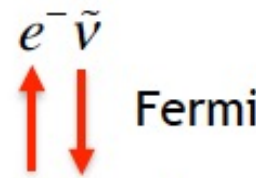# Adoption of the BETASHAPE code

T. Kibédi (ANU), F.G. Kondev (ANL), A. Nichols (U Surrey),
B. Singh (McMaster U) & X. Mougeot (CEA-LNHB)

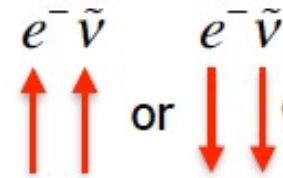# Beta decay - Introduction

$$\beta^- : n \rightarrow p + e^- + \tilde{\nu}$$

$$\Delta I = \left| I_i - I_f \right| = L_\beta + s_\beta$$

$e^- \tilde{\nu}$ Fermi $e^- \tilde{\nu}$ $e^- \tilde{\nu}$ or   Gamow-Telle

$$s_\beta = 0 \qquad\qquad s_\beta = 1$$

$$0^+ \rightarrow 0^+ \qquad\qquad 1^+ \rightarrow 0^+$$

transition probability

S_{if} - strength function

$$B_{if} \simeq \frac{\left| <\psi_f | \tau_k^{\pm} \; or \; \sigma\tau^{\pm} | \psi_i> \right|^2}{2J_i + 1} = Const \frac{I_{\beta_{if}}}{f(Z, Q_\beta - E_f) \times T_{1/2}} = Const \frac{1}{ft}$$

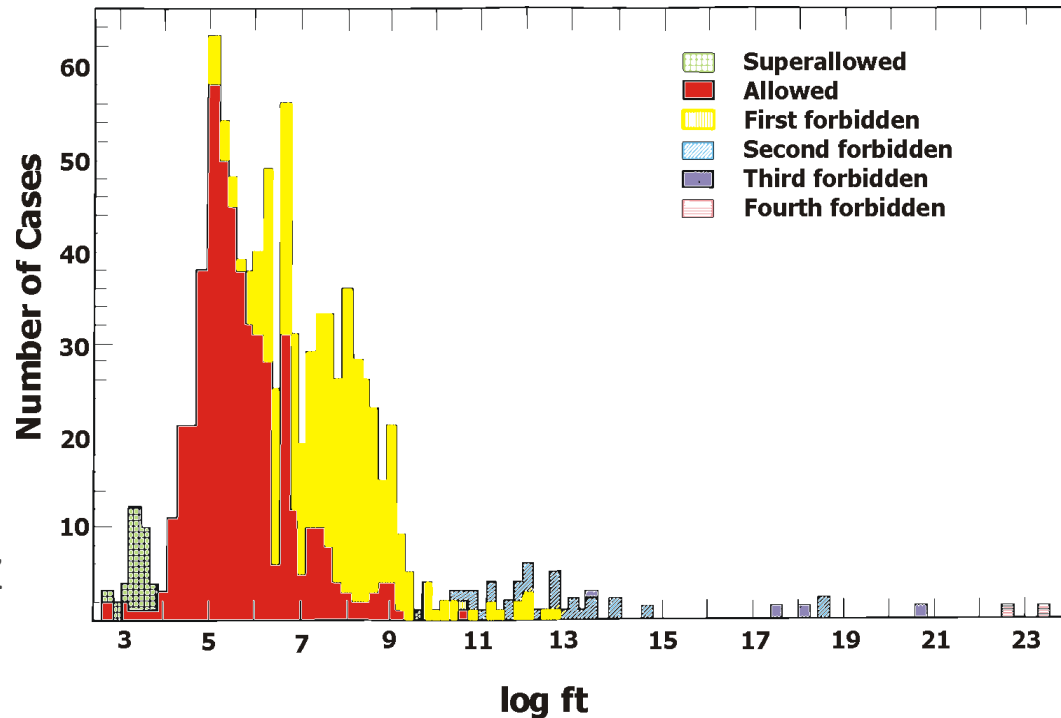# Review Of Log *ft* Values In β Decay[*]

B. Singh, J.L. Rodriguez, S.S.M. Wong & J.K. Tuli

- allowed
  $\pi_i.\pi_f=+1$ & $|\Delta J_{if}|=0, 1$

- first forbidden
  $\pi_i.\pi_f=-1$ & $|\Delta J_{if}|=0, 1$

first forbidden unique
$\pi_i.\pi_f=-1$ & $|\Delta J_{if}|=2$

- super allowed
0+ to 0+ near N=Z

log *ft (allowed)* 3-**10** -> hindered by ~10^7!

nuclear structure is important

- *l* forbidden (near closed shells)
- K forbidden (deformed nuclei)
- isospin forbidden
- configuration hindrances

Beta-decay information in ENSDF

- included for the 3 main three weak interactions decay modes: β^-, β^+ and EC
  - ▶ B and E records in the ENSDF-formatted file
- evaluated quantities:
  - ▶ $J\pi_i$ and $J\pi_f$ – determine the degree of forbiddenness of the transition involved
  - ▶ $T_{1/2}$ of the parent level, Q value (from AME2020) and BR (from adopted levels)
  - ▶ $I\beta_i$: beta-decay feeding intensities – usually not measured directly, but inferred from γ-ray studies: intensity balance considerations (discrete $\beta-\gamma$ spectroscopy data) or TAGS – require additional evaluated data: $E\gamma_i$, $\%I\gamma_i$, CC, Mult, MR, completeness of decay scheme, etc. - many taken from adjacent related reaction and decay datasets
- deduced quantities (from the LOGFT code):
  - ▶ log ft values (actual term is f – integrated Fermi function)
  - ▶ $<E\beta_i>$ - used in applications, e.g. decay-heat summation calculations
  - ▶ EC K, L & M shell & subshells emission probabilities

calculation of f and $<E\beta_i>$ requires beta-energy spectra and their shapes

Legacy LOGFT code

NUCLEAR DATA TABLES 10, 205–317 (1971)

LOG-f TABLES FOR BETA DECAY*

N. B. GOVE and M. J. MARTIN

Oak Ridge National Laboratory, Oak Ridge, Tenn. 37830

- simple analytical models → lack of accuracy
- forbiddenness limitation (allowed, first- and second-forbidden unique) – must include 1U and 2U in the ENSDF-formatted file
- does not provide beta spectra and correlated (anti-)neutrino spectra – required by increased number of users
- does not provide EC-subshell emission probabilities
- the legacy LOGFT code has not been maintained

BETASHAPE code

Reliability of usual assumptions in the calculation of β and ν spectra

X. Mougeot[*]

CEA, LIST, Laboratoire National Henri Becquerel, Gif-su...
(Received 25 March 2015; published 18 M...

Improved calculations of electron capture transitions for decay data and radionuclide metrology

X. Mougeot

602 PC111, Saclay 91191, Gif-sur-Yvette Cedex, France

Towards high-precision calculation of electron capture decays

X. Mougeot

CEA, LIST, Laboratoire National Henri Becquerel (LNE-LNHB), Bât. 602 PC111, CEA-Saclay, 91191, Gif-sur-Yvette Cedex, France

- developed over several years by X. Mougeot (CEA-LNHB, France)
- tested extensively
- stable version is available for all three OS - Windows, Linux & MacOS X

Proposal

NSDD network

- adopt the BETASHAPE code in future ENSDF evaluations – starting January 1, 2023?
- provide a comment in the abstract about usage of BETASHAPE, including references to the code: 2015Mo10, 2018Mo04,2019Mo35

Code developers

- provide documentation regarding the assumptions made and usage of the code
- distribution via the NSDD GitHub

IAEA-NDS

- provide link to the code from the NSDD website
- provide notifications to the network of updates to the code

http://www.lnhb.fr/rd-activities/spectrum-processing-software/