Updated propositions for JPI assignment using logft values

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logft ranges in current propositions

In current ENSDF policy document, proposition No. 7 to No. 11:

7. If logft < 5.9, the transition is allowed: ΔJ=0 or 1, Δπ=no (no change in parity).
   Superallowed (ΔT=0) 0+→0+ transitions have logft in the range 3.48 to 3.50.
   Isospin forbidden (ΔT=1) 0+→0+ transitions have logft>6.4.
   If 3.6<log ft<6.4, the transition is not 0+→0+.
   (logft<5.1 for allowed if Z>=80)
8. If $\log f^{1u}t$<8.5 ($\log f't$<7.4), ΔJ=0,1; Δπ=yes or no, ($\log f^{1u}t=\log f't+1.079$).
9. If logft<11.0, ΔJ=0,1; Δπ=yes or no or ΔJ=2, Δπ=yes.
10. If logft<12.8, ΔJ=0,1,2; Δπ=yes or no.
11. If $\log f^{1u}t$>8.5 ($\log f't$>7.4) and if the Fermi plot has the curvature corresponding to a shape factor (p2+q2), then the transition is first-forbidden unique (ΔJ=2, Δπ=yes)

Current propositions are taken from the review of logft values in 1973RA10 and are outdated.

Some of the limits have been updated by 1998SI17 and recently by 2023TU02

Updated logft ranges of different beta decay categories

Permissible ranges of logft values based on empirical evidence

Category	ΔJ	Δπ	1973RA10	1998SI17	2023TU03
Super-allowed (ΔT=0)	0	NO	3.48 to 3.50	3.10 to 3.60	3.17 to 3.33 (T_z=0,-1) 3.47 to 3.53 (T_z=-2)
Isospin forbidden (ΔT≠0)	0	NO	>=6.4	6.4 to 10.3	6.66 to 10.92
Allowed	0 (not $0^+ \rightarrow 0^+$)	NO	(<4) to (>12)	4.1 to 10.6	2.98 to 12.53
	1 (not $0^+ \leftrightarrow 1^+$)	NO	(<4) to (>12)	3.0 to 10.0	2.57 to 12.37
Allowed (Gamow-Teller)	1 ($0^+ \leftrightarrow 1^+$)	NO	–	2.9 to 7.2	2.66 to 9.05
1st forbidden non-unique	0	YES	≥5.9 (Z<80) ≥5.1 (Z≥80)	5.9 to 11.0 (Z<80) 5.1 to 11.0 (Z≥80)	5.9 to 11.03 (Z<80) 5.20 to 9.80 (Z≥80)
	1	YES	≥5.9 (Z<80) ≥5.1 (Z≥80)	5.9 to 19.1 (Z<80) 5.1 to 19.1 (Z≥80)	5.9 to 20.08 (Z<80) 5.33 to 10.51 (Z≥80)
1st forbidden unique	2	YES	≥8.5	8.5 to 12.8	8.5 to 12.8
2nd forbidden non-unique	2	NO	≥11.0	10.6 to 14.2	10.92 to 14.23
2nd forbidden unique	3	NO	≥12.8	13.9 to 18.0	13.84 to 18.08

NOTE 1:
Red color indicates the range has changed compared to previous update

NOTE 2:
The limit of logft<**5.9** for allowed and that of 1st forbidden unique logft>8.5 are still taken from 1973RA10, by both 1998SI17 and 2023TU03.

Updated propositions with updated logft limits

Red (1973RA10) are current limits and green (2023TU03) are updated limits below:

7. If logft < 5.9, the transition is allowed: ΔJ=0 or 1, Δπ=no (no change in parity).
   Superallowed (ΔT=0) 0+→0+ transitions have logft in the range ~~*3.48 to 3.50*~~ 3.17 to 3.33 (T_z=0,-1) and 3.47 to 3.53 (T_z=-2)
   Isospin forbidden (ΔT=1) 0+→0+ transitions have logft>6.4.
   If 3.6<logft<6.4, the transition is not 0+→0+.
   (logft<~~*5.1*~~ 5.2 for allowed if Z>=80)
8. If $logf^{1u}t$<8.5 (logf't<7.4), ΔJ=0,1; Δπ=yes or no, ($logf^{1u}t$=logf't+1.079).
9. If logft<~~*11.0*~~ 10.9, ΔJ=0,1; Δπ=yes or no or ΔJ=2, Δπ=yes.
10. If logft<~~*12.8*~~ 13.8, ΔJ=0,1,2; Δπ=yes or no.
11. If $logf^{1u}t$>8.5 (logf't>7.4) and if the Fermi plot has the curvature corresponding to a shape factor (p2+q2), then the transition is first-forbidden unique (ΔJ=2, Δπ=yes)

For $logf^{1u}t$ and logf't in proposition #8, an explanation should be added that **$logf^{1u}t$** is for the decay calculated as **1st forbidden unique** and the corresponding **logf't** is for the same decay calculated as **allowed** for applying this rule.

Use of the propositions

A circular situation:

- Need to know JPI for calculating (accurate) logft values
- Use calculated logft values to assign JPI

Actual calculations:

- The legacy ***LOGFT*** code calculates all transitions as allowed, except for those explicitly marked as "1U" (it doesn't recognize 2U and 3U and can't calculate 2U and 3U)
- The ***BetaShape*** (also ***RadiationReport***) calculates
  1) allowed and forbidden unique accurately as they are (identified based on given J^{π})
  2) L-th forbidden non-unique as (L-1)-th unique (allowed if L=1)
  3) all others as allowed if the decay type is unknown

Use of the propositions:

In practice, a decay is calculated as allowed (and/or 1U) if decay type is unknown; then the calculated logft value is compared with the logft ranges in the propositions to find $\Delta \mathbf{J}$ and $\Delta \boldsymbol{\pi}$ of corresponding decay type

a) If logft meets the condition (<5.9) for allowed, then the decay is allowed
b) If not, follow the propositions to see if the decay can be easily and strongly categorized to one other type; or, redo the calculation by assuming other types (specifying J^{π}) and check again.

Something confusing (unclear)

Proposition #8: If $\log f^{1u}t<8.5$ ($\log f't<7.4$), $\Delta J=0,1$; $\Delta\pi$=yes or no, ($\log f^{1u}t=\log f't+1.079$).

$\log f^{1u}t=\log f't+1.079$?

1.079=log(12) is mentioned in 1971GO40 (Gove&Martin) due to a difference in f^{1u} definition, but why here?

This "equation" in proposition #8 is misleading:

- It is NOT a general equation of the relationship between the two quantities: $\log f^{1u}t$ and $\log f't$
- It is the relationship between the LIMITS of the two quantities
- Some cases don't follow this equation, e.g., ^{206}Tl ($J^{\pi}=0^{-}$) β^{-} decay to ^{206}Pb, 803 2^{+} level (1U)

log $f^{1u}t$=8.6 (calculated as 1st forbidden-unique)
log f't=8.3 (calculated as allowed)

Is "log f't" what it is understood to be (here for allowed)?

This actual relationship between $\log f^{1u}t$ and $\log f't$ is more likely to be (just my understanding):

$\log f^{1u}t <= \log f't+1.079$ (*)

So, the interpretation of "$\log f't<7.4$" in proposition #8 is that:
If $\log f't<7.4$, it must be $\log f^{1u}t<8.5$. But it is not true the other way around (see ^{143}Ce example above).

Then, why **$\log f't>7.4$** in proposition #11: "If $\log f^{1u}t>8.5$ ($\log f't>7.4$), ….., the transition is first-forbidden unique"?

Interpretation should be: if $\log f^{1u}t>8.5$, then $\log f't>7.4$, following the same relationship (*). Not the other way around