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Memo CP-D/646

Date: 10 June 2010
To: Distribution
From: V. McLane, N. Otsuka, O. Schwerer, S. Dunaeva
Subject: Reaction products that are unstable against prompt particle decay
Proposal for new branch code ISP

At the 2010 NRDC meeting, a conclusion was reached that intermediate nuclides that are unstable against prompt particle decay will be coded in SF4 when the states are exclusively identified by the experiment. The purpose of this memo is to define the rules for when the unstable nuclide is coded vs. when the break-up particles should be coded.

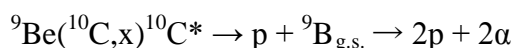
Proposed branch code ISP

As part of this exercise, we saw the need for a new branch code. We propose the addition of the following code to Dictionary 30:

ISP Partial with respect to a level in an intermediate nucleus that is not coded in SF4.

This code may be used in combination with PAR when levels are given for both the intermediate nucleus and the final nucleus.

Example:



REACTION (4-BE-9(6-C-10,P+X)5-B-9,ISP/PAR,SIG)

...

EN-SEC (E-LVL1,5-B-9)
(E-LVL2,6-C-10)

General rule for compilation of reaction products: When a reaction proceeds through an intermediate nucleus that is unstable and breaks up with the emission of particles (*e.g.* n, p, α), the reaction is coded with the products of the breakup as the output particles.

Example: The cross section for ${}^9\text{Be}(n,2n 2\alpha)$ is compiled as:

REACTION (4-BE-9(N,2N+A)2-HE-4,,SIG)

Reaction products that are unstable against prompt particle decay

The ground states of the following nuclides have been identified as unstable:

- ${}^5\text{He} \rightarrow \text{n} + \text{d}$
- ${}^5\text{Li} \rightarrow \text{p} + \alpha$
- ${}^6\text{Be} \rightarrow 2\text{p} + \alpha$
- ${}^8\text{Be} \rightarrow 2\alpha$
- ${}^9\text{B} \rightarrow \text{p} + 2\alpha$

Also, some nuclides have a particle decay threshold

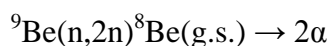
Example: ${}^6\text{C-12} \rightarrow 3 \alpha$; threshold $E_x = 7.65 \text{ MeV}$

Therefore, an exception is made to the above general rule for only those cases *where the reaction is not a function of the final product* and when one or both of the following is true:

- The reaction is a function of the unstable product, e.g., proceeds through a given excited state of the unstable product.
- The unstable product is identified unambiguously, and the data given is for only the reaction that proceeds through that reaction channel, e.g., where the unstable product is measured with a track detector.

In the above cases, the intermediate nucleus is coded in SF4. The branch code PAR is used to specify the level of the intermediate nucleus. The definition of the nucleus using the BIB keyword EN-SEC is optional.

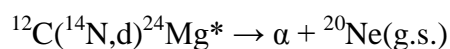
Example:



REACTION (4-BE-9(N, 2N)4-BE-8, PAR, SIG)

However, if the reaction is a function of one or more of the final products it must be coded with the final products in SF3 and SF4. In this case, if the reaction is also a function of a level the intermediate nucleus, the intermediate state is specified using the branch code ISP. The intermediate nucleus must be given under the BIB keyword EN-SEC.

Example:



REACTION (6-C-12(7-N-14, D+A)10-NE-20, ISP/PAR,

...

EN-SEC (E-LVL1, 12-MG-24)

(E-LVL2, 10-NE-20)

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