AMP – Scattering amplitude or scattering length?

(N. Otsuka, 2020-01-11, Memo 4C-3/416)

Note (Summary) added to the working paper:

An assessment of n-p scattering data in EXFOR shows AMP has been used for scattering <u>length</u> rather than scattering amplitude in many cases. I propose to

1. change the expansion of the parameter code (AMP), reaction type (L), new CINDA code (AMP), and web quantity (L) to "scattering <u>length</u>".

2. use ,AMP,,MSC if the compiled quantity is the scattering amplitude.

Some EXFOR entries transmitted in PRELIM.2283 are for the coherent neutron scattering length data measured at the research reactor FRM (Garching, Germany) with the Christiansen filter technique. These entries reminded me an open question – Is the parameter code AMP for "scattering <u>amplitude</u>" (not scattering length)?

<u>Current situation of EXFOR entries</u>
LEXFOR "Thermal-neutron scattering" defines the parameter code AMP as the scattering **amplitude** (*f*), and explains that

> For neutrons, for which only s-wave scattering is possible (and for which the scattering is, therefore, isotropic), and for zero energy: $f = -a$, where a is the Fermi scattering length.

which distinguishes the scattering amplitude and scattering length properly. However, the many data sets compiled with the parameter code AMP from ~40 articles (of which ~30 articles are from the Garching group) give the scattering **length**.

As a simple test, I checked the sign of the values coded with (1-H-1(N,*)1-H-1,*COH,AMP) in the EXFOR Master (the n-p scattering length is negative and known to be -3.7 fm). Among 15 values in EXFOR, only one data set (22217.003) gives the positive value (3.7406 fm) for which the author gives is -3.7406 fm (Table 5 of Z.Phys.A337(1990)341).

It seems the 22217.003 compiler changed the sign to convert the scattering length to the scattering amplitude, which follows LEXFOR and Dictionaries and formally *correct*. But the most values compiled with REACTION SF6=AMP are probably the scattering **length**.

Current situation of EXFOR/CINDA dictionaries

It is interesting to see how the expansions of the AMP quantities depend on the level of the dictionaries.

Example: Codes relevant to bound atom coherent scattering quantity

Dictionary	Code	Expansion
32 (Parameter)	AMP	Scattering amplitude
236 (Quantity)	BA/COH,AMP	Bound-atom coherent scattering amplitude
213 (Reaction type)	L	Length or amplitude[*]
45 (New CINDA)	AMP	Length or amplitude[*+]
113 (Web quantity)	L	Scattering amplitudes

[*] Always used for <u>scattering</u> length/amplitude.
[+] Not used for new CINDA records converted from manual CINDA compilation.

Possible solution

The parameter code AMP is used in 911 data sets of 167 EXFOR entries. There are other compilations made by experts of this field (e.g., L.Koester, H.Rauch, E.Seymann, Atom. Data Nucl. Data Tables **49** (1991) 65), and I do not know whether we need intensive review and update of the affected EXFOR entries. (though a volunteer carrying such tasks is welcome!!).

A realistic solution could be to update the expansions of the codes as follows:

- "Scattering amplitude" → "scattering length" in Dicts. 32, 113 and 236,
- "Length or amplitude" → "scattering length" in Dicts. 45 and 213.

and combine MSC in SF8 with AMP in SF6 if the scattering amplitude is compiled.

N.B. The nomenclature could depend on the authors. For example, "scattering amplitude" introduced in Eq.(3) and tabulated in Table I of C.G. Shull et al., Phys.Rev.**81**(1951)527 (EXFOR 11043) is the scattering <u>length</u> in the current "standard" nomenclature.