Use of NUMBER-CM and compilation of 0th order Legendre coefficients

(N. Otsuka, S. Dunaeva, 2021-08-18, Memo CP-D/1021,
M. Mikhailiukova, 2022-06-28, Memo 4C-4/0233)

Memo CP-D/1021 seeks an approval to (1) use the heading NUMBER for the fitting coefficients given in the centre-of-mass system, (2) make the heading NUMBER-CM obsolete, and (3) compile the 0th order Legendre coefficients (DA,,LEG) with a new quantity code ,SIG,,D4PI (cross section divided by 4pi) separately from the coefficients of higher orders. It was followed by Memo 4C-4/0233.

Memo CP-D/1021

1. Do we need heading NUMBER-CM?

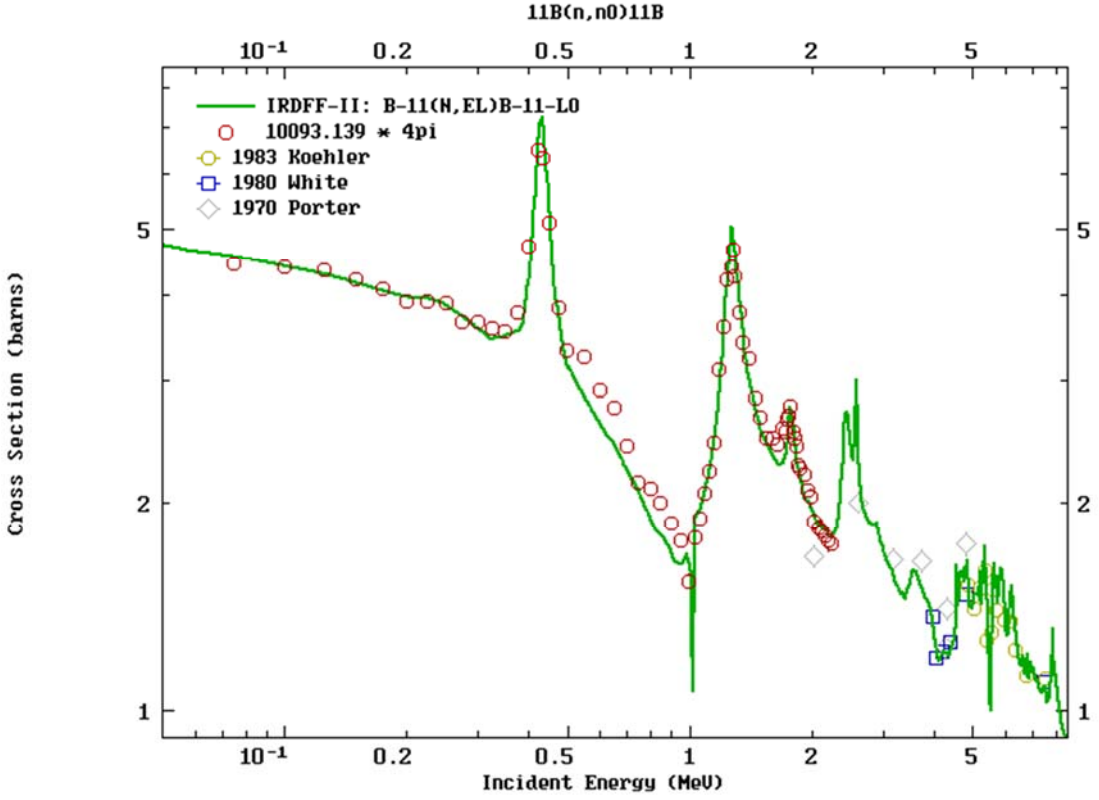
It is obvious that the fitting coefficients are to express an angular dependent quantity in the centre-of-mass system when the coefficients are coded under the heading DATA-CM. We propose to make the heading NUMBER-CM obsolete, and to always use the heading NUMBER for indication of the order of the coefficient.

The historical background is not clear. In the archive dictionary 24, NUMBER-CM and ANG-CM are defined with "198202" while DATA-CM is defined with "198503". There might be discussion on addition of DATA-CM in the NRDC 1984 meeting. However, its meeting summary (Memo CP-D/131) is not available at NDS.

2. Compilation of 0th order Legendre coefficients

Our current rule is to compile the 0th order Legendre coefficient (=σ/4π) with ,DA,,LEG and NUMBER=0. Its relation with the cross section is not clear from the quantity code. It can be compiled with higher order coefficients in the same subentry, and it is not trivial for end users to plot the compiled 0th order coefficients with the usual cross sections.

Example – ^{11}B(n,n0)^{11}B elastic scattering cross sections (EXFOR 10093.139)
EXFOR 10093 does not provide a (5-B-11(N,EL)5-B-11,,SIG) dataset, but the 0th order Legendre coefficients in 10093.139 multiplied by 4π can be compared with the elastic scattering cross sections in other EXFOR entries in a plot.



The 0th order coefficients must be more utilized by this way.
In order to make to the 0th order Legendre coefficients more usable for end users (e.g., through conversion to normal cross section in end-user outputs such as C4 and C5), we would like to propose a new quantity code for their compilation separately from higher order coefficients.

Dictionary 34 (Modifiers)

D4PI	Divided by 4pi

Dictionary 236 (Quantities)

,SIG,,D4PI	Cross section divided by 4pi

Memo 4C-4/0233

In CP-D/1021 (=WP2022-30) there is a proposal:

"(3) compile the 0th order Legendre coefficients (DA,,LEG) with a new quantity code ,SIG,,D4PI (cross section divided by 4pi) separately from the coefficients of higher orders."

In LEXFOR (last version), page F.19 and in EXFOR dictionary 236 there is the formula for this coding:

d-Sig/d-Omega = a(0) + Sum(a(L)*P(L))), where

P(L) – Legendre polynomials, P(0)=1;

a(L) – Legendre polynomial coefficients.

In the articles authors use this formula for fitting of measured absolute angular distributions DA (point-wise, usually are on figures only in the article) and present only Legendre coefficients in a table. These coefficients (in units like mb/sr) are compiled with coding DA,,LEG in (e.g.) Subent2. If point-wise DA are available for compiler (sent by authors or digitized from figure), then they are compiled in other (e.g) Subent3 with coding DA. Subents are connected by code (DEP,Subent3) in Subent2 STATUS line. But some times point-wise data are not available and only Legendre coefficients are compiled.

If a(0) would be presented in other Subent4 then user could be mistaken by usage formula for fitting without a(0) to calculate the fitting curve of measured data and would obtain wrong result.

Really a(0) is a constant value what means some average and a(1), a(2),… are coefficients for contribution of sum(a(L)*P(L)) as deviation of DA from this constant value a(0).

a(0) could be determined by different ways – estimated from literature, estimated as average of measured absolute data, and so on. And then a procedure of fitting could be different – a(0) could be fixed or varied at fitting.

Typical example is given in EXFOR 40584(J.Sov.Nucl.Phys.,v.37,p.641,1983)

Conclusions:

1) a(0) value is reported by the authors as a fitting coefficient (not as $\sigma/4\pi$), and we should compile a(0) and higher order coefficients a(L) in the same data Subent,

2) users who need σ should not obtain the value by multiplying a(0) by 4π but should perform integration of the angular differential cross section using the formula with full set of Legendre polynomial coefficients.