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Memo CP-E/020

Date: April 19, 2003
To: Distribution
From: OTUKA Naohiko and KATŌ Kiyoshi
Subject: Total spin transfer

Recently we received experimental data of "total spin transfer" (A.Tamii et al., Phys. Lett. **B459** (1999) 61, T.Kawabata et al., Phys.Rev. C**65** (2002) 064316). This quantity is defined as follows:

$$\Sigma = \{3-(D_{SS}+D_{NN}+D_{LL})\}/4=(S_{SS}+S_{NN}+S_{LL})/2,$$

where D_{ii} (ii=*SS*, *NN*, *LL*) are "spin-rotation-deporalization parameters", and S_{ii} = (1-D_{ii})/2 (ii=*SS*, *NN* and *LL*) is spin-flip probability for the i -direction, respectively.

Total spin transfer Σ is used as an index to distinguish spin-flip (ΔS=1) and non-spin-flip (ΔS=0) excitation. Σ≈1 (0) for ΔS=1(0) is regarded as a good approximation at forward angles of outgoing particle. At 0 degree, especially, this relation is exactly correct due to the spatial symmetry. In this sense, total spin transfer Σ is similar to "spin-flip probability" S_{NN}, for which also S_{NN} ≈0 for ΔS=0. However, S_{NN} takes various values in ΔS=1 excitations depending on the J^{π}. Therefore Σ is considered as a better index than S_{NN}.

A rule of "$D_{SS}+D_{NN}+D_{LL}$ =3(-1) for ΔS=0(1)" had been known in the measurements of (*p*,*n*) scattering. H.Sakai pointed out that this rule is effective to distinguish ΔS=1 and 0 excitations and introduced Σ in 1999 (H.Sakai, Nucl. Phys. **A654** (1999) 731c). The validity of Σ as an index of ΔS=0(1) is theoretically confirmed (T.Suzuki, Prog. Theor. Phys. **103** (2000) 859). Due to the recent progress of experimental technique (high luminosity beam, reliable measurement of forward scattered particle), D_{SS} and D_{LL} are widely measured as well as D_{NN} , and consequently Σ is recognized as an experimental observable. We propose some codes for total spin transfer :

Dictionary 24 (Modifiers)

TST	Total spin transfer

Dictionary 36 (Quantities)

,POL/DA/DE,,TST NO	Total spin transfer with respect to angle and energy
PAR,DA,,TST DA	Partial diff. cross section d/dA *total spin transfer

Related two proposals:

1. "NN,POL/DA,,SF" and ",POL/DA,,SF"

Now we have *two* codes "NN,POL/DA,,SF" and ",POL/DA,,SF" for "spin-flip probability S_{NN}". We propose that we keep "NN,POL/DA,,SF" while obsolete ",POL/DA,,SF" (we cannot find any entry which use the latter quantity code in EXFOR+CINDA Ver.1.10).

Dictionary 36 (Quantities)

~~,POL/DA,,SF~~	~~NO~~	~~Spin-flip probability S(nn)~~
		(*obsolete, use* "NN,POL/DA,,SF")

2. ",SIG,,SF"

Now ",SIG,,SF" is expanded as "spin-flip cross section" in our dictionary (we cannot find any entry which use this quantity code in EXFOR+CINDA Ver.1.10). But the definition of this quantity is ambiguous. If this quantity means "cross section multiplied by S_{NN} (spin-flip-probability)", it is better to use "NN,SIG,,SF" with a corrected expansion.

Dictionary 36 (Quantities)

~~,SIG,,SF~~	~~B~~	~~Spin-flip cross section~~
		(*obsolete, use* "NN,SIG,,SF")
NN,SIG,,SF	B	Cross section * Spin-flip probability S(nn)

We attach a coding sample for the proposed two new quantities ",POL/DA/E,,TST" and "PAR,DA,,TST".

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Sample of coded entry (E1776.004, 027):

T. Kawabata et al., Phys. Rev. C **65** (2002) 064316 Fig.4 and Table II

```
SUBENT        E1776004   20030311                                  E177600400001
BIB                 4          8                                  E177600400002
REACTION   (8-O-16(P,INL)8-O-16,,POL/DA/DE,,TST)                   E177600400003
           DATA: total spin transfer                               E177600400004
…
ENDBIB              8          0                                  E177600400011
COMMON              1          3                                  E177600400012
ANG                                                               E177600400013
ADEG                                                              E177600400014
 0.0                                                              E177600400015
ENDCOMMON           3          0                                  E177600400016
DATA                3         96                                  E177600400017
E-EXC      DATA       DATA-ERR                                    E177600400018
MEV        NO-DIM     NO-DIM                                      E177600400019
 5.61       -2.768     2.975                                      E177600400020
 5.856      -1.308     1.971                                      E177600400021
…
 28.796     0.406      0.062                                      E177600400114
 29.043     0.507      0.064                                      E177600400115
ENDDATA            98          0                                  E177600400116
ENDSUBENT         115          0                                  E177600499999
SUBENT        E1776027   20030311                                  E177602700001
BIB                 5          8                                  E177602700002
REACTION   (8-O-16(P,INL)8-O-16,PAR,DA,TST)                       E177602700003
           DATA: spin flip cross section(=angular distribution *  E177602700004
                 total spin transfer)                             E177602700005
…
ENDBIB              8          0                                  E177602700011
COMMON              1          3                                  E177602700012
E-LVL                                                             E177602700013
MEV                                                               E177602700014
 8.87                                                             E177602700015
ENDCOMMON           3          0                                  E177602700016
DATA                3          1                                  E177602700017
ANG-CM     DATA       DATA-ERR                                    E177602700018
ADEG       MU-B/SR    MU-B/SR                                     E177602700019
 4.4        19.0       2.0                                        E177602700020
ENDDATA             3          0                                  E177602700021
ENDSUBENT          20          0                                  E177602799999
```