# INPUT DATA CARDS FOR PROGRAM ANGCOR

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The program ANGCOR is used to calculate angular correlations of particle, gamma or fission decay from a nucleus excited by a direct reaction, e.g. inelastic scattering, stripping or pickup reactions, charge exchange reactions, etc. A full description of the program and the formalism used in it are to be found in the internal report KVI 67i (1979). Here only a short summary of the various functions will be presented.

The program calculates m-state population amplitudes for the final state populated in a direct or multi-step reaction from B-functions or D-amplitudes obtained from the programs DWUCK or CHUCK,respectively, or reads them directly from the program DWBA82 for every scattering angle. These m-state population amplitudes are further used in conjunction with particle, gamma or fission decay amplitudes to calculate angular correlations for these various decay processes.

In addition to these simple decay schemes, the program has the possibility to calculate particle decay from two or more intermediate coherently interfering channels. For gamma decay the possibility exists for calculating angular correlation of gamma decays (with mixed multipolarities) in a later stage of a cascade, where this gamma ray maybe preceded by unobserved gamma or particle decay. Geometrical attenuation factors for the cases where the gamma decay detector subtends a finite solid angle from the source can also be included. Averaging over the opening angle of the ejectile is also possible.

The input and notations of this program have been made to conform with those of DWUCK and CHUCK where possible.

Note: all cards are in free format, except for CARD 1

| COLUMN | VARIABLE | VALUE | USAGE |
|---|---|---|---|

CARD 1. Title.

TITLE

TITLE Any alphanumeric title.

CARD 2. Control integers, number of gamma cascades and number of experimental data points.
(ICO(I),I=1,9),NC,M1

ICO(1) = 0 Particle-gamma angular correlation.
= 1 Particle-particle angular correlation.
= 2 Particle-particle-gamma angular correlation; the intermediate particle decay is unobserved.
= 3 Particle-fission fragment angular correlation.

ICO(2) = 0 Do not print information from subroutines RHOKQ and RHOLSJ.
= 1 Print.

ICO(3) = 0 Calculate $RHO_{KQ}^{MM'}$ from $RHO_{KQ}$.

= 1 Calculate $\overline{RHO}_{KQ}^{(LSJ,L'S'J')}$ from $RHO_{KQ}$

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                    Note:   this option is only present for historical
                            reasons. The results should be the same for
                            both options.

        ICO(4)   = 0    Only one intermediate state is excited.
                 = 1    Two or more intermediate states are excited. this
                        option is available only for particle decay (i.e. only
                        if ICO(1).EQ.1). In this case only one j-transfer is
                        allowed per intermediate state.

        ICO(5)   = 0    BETA-functions are read from DWUCK file.
                        Note:   in DWUCK ICON(8) should be set to  1  to
                                print the BETA-functions.
                 = 1    Transition amplitudes (D) are read from CHUCK file
                        Note:   in CHUCK ICON(8) should be set to  N  to
                                print the transition amplitudes for state
                                number  N  in the coupled channel scheme
                                whose decay is to be studied.
                 = 2    M-state population amplitudes obtained from program
                        DWBA82. in this case DWBA82 should be run once for
                        every new ANGCOR calculation with a different
                        scattering angle.
        Note:    ANGCOR reads the BETA-functions, the D-amplitudes or m-state
                 population amplitudes from TAPE2 on which they are written by
                 KVI versions of DWUCK, CHUCK or DWBA82, respectively.

        ICO(6)   = 0    New DWUCK/CHUCK/DWBA82 information.
                 = 1    Same DWUCK/CHUCK/DWBA82 information as previous case.

        ICO(7)   = 0    Do not print DWUCK BETA's/CHUCK D's/DWBA82 population
                        amplitudes.
                 = 1    Print.

        ICO(8)   = 0    Print angular correlation output.
                 = 1    Do not print. (Only chi2 will be printed).

        ICO(9)   = 0    Z-axis is the beam axis for cases where m-state
                        population amplitudes are obtained from DWUCK or
                        CHUCK or is the scattering axis if they are
                        obtained from DWBA82.
                 = 1    Transform z-axis to recoil axis.

        NC       .LE.3  Number of cascades in case of gamma decay. If ICO(1)
                        .EQ.2, NC is also the number of gamma cascades and is
                        restricted to .LE.2 .

        M1       .GE.0  Number of experimental data points (M1.LE.10).
                 .LT.0  Same experimental data as in previous case.


CARD 2A. Number of intermediate states card. (Use only if ICO(4).NE.0).
---- --
        NCH

        NCH     Number of intermediate channels excited in the reaction for
                which decay has to be added coherently.


CARD 3. Reaction spins definition card. (Use only if ICO(6).EQ.0).
---- -
        LP,ISA,JA,ISB,[(JB(N),ISTR(N)),N=1,NCH],(RSCALE(N),N=1,NCH-1)

        LP       Number of partial waves used in the calculation; must be
                 equal to the value used in DWUCK or CHUCK. (.LE.150).

        ISA      Twice the spin of the projectile.
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        JA       Twice the angular momentum of the target nucleus.

        ISB      Twice the spin of the ejectile.

        JB(N)    Twice the angular momentum of the Nth intermediate state
                 populated in the direct or multistep reaction and whose decay
                 is to be studied.

        ISTR(N)  Twice the spin transfer for the Nth intermediate state.
        Etc.

        NOTE:    In case of gamma decay or fission only one intermediate
                 state is allowed.

        RSCALE(N)A scaling factor of (N+1)th intermediate state cross section
        Etc.     to allow various ratios of excitations of various states in
                 case DWUCK BETA-functions are used. Note that if CHUCK
                 D-amplitudes are used this factor becomes redundant.


CARD 4. Transfer angular momentum card. (Use only if ICO(6).EQ.0).
---- -
        NLTR,LTR(1),...,LTR(NLTR),JTR(1),...,JTR(NLTR)

        NLTR     Number of separate angular momentum transfers. (.LE.8).

        LTR(I)   The value of the Ith orbital angular momentum transfer.
        Etc.

        JTR(I)   Twice the value of the Ith angular momentum transfer.
        Etc.

        Note:    if ICO(4).NE.0, NLTR should be equal to NCH and there should
                 be only one value of LTR and of JTR for each of the NCH
                 intermediate states considered.
        Note:    if ICO(5).EQ.2.and.ICO(4).EQ.0, NLTR should be equal to 1. In
                 this case, ANGCOR reads the calculated m-state population
                 amplitudes from DWBA82.


CARD SET 5.  Decay channel parameters.
==== === =

CARD 5A.Particle decay parameters. (Use only if ICO(1).EQ.1.OR.2).
---- --
        First card of this set.
        JC,ISC,NLDEC

        JC       Twice the angular momentum of the residual nucleus.

        ISC      Twice the spin of the decay particle.

        NLDEC(N) Number of separate angular momentum decays
        Etc.     for Nth intermediate channel, (NLDEC(N).LE.3).


        NLDEC(1) cards followed by NLDEC(2) cards Etc. with:
        LDEC(I),JDEC(I),DELTA(I)

        LDEC(I)  Value of the Ith orbital angular momentum decay.

        JDEC(I)  Twice the value of the Ith total angular momentum decay.

        DELTA(I) Decay amplitude for the Ith decay with momenta LDEC(I) and
                 JDEC(I). Only real DELTA values are allowed in this version.
                 If only one L-decay amplitude is used per intermediate state,
                 the program assumes DELTA(N,1).EQ.1.
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Note:   if more than one L-decay is used per intermediate state then NLDEC:
        LDEC(I), JDEC(I) and DELTA(I) have to be specified for each
        intermediate state with the condition [SUM DELTA(I)**2 = 1]. The
        program enforces this condition all the time. The DELTA(I)'s are real
        but can be positive or negative.


CARD 5B.Gamma-ray decay parameters. (Use only if ICO(1).EQ.0.OR.2).
---- --
        NC cards with information about the NC transitions in the gamma-ray
        cascade.
        L(I),J2(I),ARCDEL(I)

        L(I)     Lowest multipolarity in the transition. (Mixing with
                 multipolarity  L+1  is assumed).

        J2(I)    Twice the spin value of the state to which the particular
                 transition leads.

        ARCDEL(I)Minimum value of ARCTAN(DELTA), with DELTA being the mixing
                 ratio between the  L+1 and L  transitions.

        Note:    DELTA=G   /G .
                       L+1  L


CARD 5C.Fission decay parameters. (Use only if ICO(1).EQ.3).
---- --
        KA,KB1

        KA       Twice the projection of JA on the nuclear symmetry axis.

        KB1      Twice the projection of JB on the nuclear symmetry axis.


CARD 6. Geometrical attenuation coefficients. (Use only if ICO(1).EQ.0.OR.2).
---- -
        (ZW(I),I=1,3)

        ZW(I)    Attenuation coefficients with which the  L = 2, 4 and 6
                 multipole terms in the angular correlation should be
                 multiplied. (See eq. 6 of Internal Report KVI 67i)

        Note:    this option is available only for gamma decay.


CARD 7. Angle set card.
---- -
        ANG,PHID,RECANG,RECPHI,RECPSI

        ANG      The c.m. polar angle of the scattered particle (ejectile),
                 i.e. with respect to the beam axis.

        PHID     Azimuthal angle of the decay particle, gamma-ray or fission
                 fragment.
        Note:    PHID = 0(180) represents decay in the reaction plane on the
                 same(opposite) side of the ejectile if compared to the beam
                 axis. PHID can take all values between 0 and 180.

        RECANG   The recoil angle (positive). This is only necessary if
                 ICO(9).EQ.1.

        RECPHI   Not used, enter 0.

        RECPSI   Not used, enter 0.
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        Note:    if ANG is the same as in the previous case and ICO(6).EQ.1,
                 the calculation of the m-state population amplitudes is
                 skipped.


CARD 8. Ejectile-detector opening angle.
---- -
        OPAN,STEPA,OPP,STEPP

        OPAN     Polar opening angle (in the c.o.m.) for the ejectile-detector.

        STEPA    Step over polar opening angle.

        OPP      Azimuthal opening angle for ejectile-detector.
        NOTE:    if rotation to a z-axis other than the beam axis is asked
                 for, no averaging over the azimuthal opening is allowed in
                 this version. OPP is set to zero by the program.

        STEPP    Step over azimuthal opening angle.


CARD 9. M1 cards with experimental data. (Only if M1.GT.0, see card 2).
---- -
        AN1(I),PH1(I),C1(I),EC1(I)

        AN1(I)   Ith polar angle with respect to the z-axis (see ICO(9)) for
                 which the angular correlation has been measured.

        PH1(I)   Ith azimuthal angle for which angular correlation has been
                 measured.

        C1(I)    Ith value of angular correlation. (Arbitrary units).

        EC1(I)   Absolute error in C1(I). (Same units as C1(I)).

        Note:    M1.LE.10 .


CARD 10.Plot scales.
---- --
        NPLOT,NANGP

        NPLOT    Vertical scale of the angular correlation plot.
        Note:    full scale corresponds to NPLOT times the regular (determined
                 by the program to allow plotting of all calculated angular
                 correlation points) scale of the angular correlations.

        NANGP    Number of intervals into which 180 of the polar angular
                 correlation plot (print) is subdivided. For example,
                 NANGP = 31 gives DTHETA = 180/(31-1) = 6 .

        Note:    the calculated values of the angular correlation are printed
                 together with the plot.
        Note:    here the program goes back and starts reading CARD 1 .
                 Program stops if it finds an EOI CARD at this position.
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