AZURE Input File

Rules Regarding the Creation of the Nuclear Physics Input file: e.g. F19ap.dat

1) All entries are read as real numbers. Half integral angular momenta should be entered as decimal fractions. The physical angular momenta values are converted internally into integers whose values are twice their physical values.

2) Each line in the physics input file corresponds to the parameters associated with a state in the compound nucleus for unique entrance and exit reaction channels. A "reaction" channel is defined as a unique pair of particles identified in Lane & Thomas with the index (α) for the entrance channel and (α') for the exit channel. *Note that decays which leave the residual nucleus in different excited states are different reaction channels.* (For example: inelastic scattering to different final states).

3) AZURE can be instructed to include more than one entrance channel (α) populating levels in the same compound nucleus. These levels need not necessarily be the same set of states for different entrance reaction channels. All entries for a given entrance reaction channel should be grouped together with the index 'aa' (α in Lane & Thomas).

4) Order of entry in the nuclear physics input file:

i. As stated above, all of the same entrance reaction channels should be grouped together with index 'aa' (α in Lane & Thomas).

ii. The excited levels of the compound nucleus must be arranged contiguously in groups of the same J^{π}. Within each J^{π} group, the ordering of the levels is unimportant except that AZURE will set the boundary conditions for that J^{π} group equal to the shift for the energy of the first level in the group. There is no alternative to this choice in the current version of AZURE. (But it will be here soon!)

iii. Each level will have an entry (another line) for each open exit reaction channel.

iv. The first entry for each level **MUST** be the elastic channel since Azure utilizes the information in this line to determine the parameters of the entrance channel particle pair (M, Z, J^{π}).

v. *All levels*, regardless of J^{π} grouping, must have entries for the same set of exit channels. There is some physical and R-matrix justification for this, but this requirement is also essential in order for AZURE to keep the bookkeeping correct. If the user wishes to exclude a particular exit channel, this is easily done by setting the corresponding reduced with 'Gam' to zero in the input file. The exit reaction channels are identified with the index R, which is integral and sequentially increasing. The elastic channel *must* have R=1.

vi. N.B. There is much redundancy in this table, but care should be taken to complete all entries. Otherwise, AZURE will fail because of incorrect READ commands. Future versions may streamline this process.

5) Detailed Description of the Columns in the Nuclear Physics Input File.

Col. 1: The spin (J) of the compound state.

Col. 2: The parity (+/- 1) of the compound state.

Col. 3: The excitation Energy (MeV) of the levels in the compound nucleus. These values can be interpreted by AZURE in two ways using the file 'physical.flg' (0 or 1). Equal to zero means that AZURE will assume the energies are of the R-matrix levels ($\chi_{\lambda J}$), while equal to one indicates that these are the physical energies of the state. In this latter case, AZURE will calculate internally the values ($E_{\lambda J}$) so that the resonances will appear at their expected physical positions.

Col. 4: Alpha (index aa: integral, sequentially increasing) identifies the entrance reaction channel. All entries pertaining to the same alpha must be grouped contiguously.

Col. 5: The index R (integral, sequential, increasing) which identifies the exit channel reaction and is equal to Lane & Thomas (α').

Col. 6: Lid. This is a level I.D. index used in AZURE bookkeeping. It is an integer but need not be sequential. All entries (ie. different decay channels) for the same level will have the same Lid.

Col. 7: y/n (0 or 1). AZURE will exclude/include this entry in the calculations.
This switch should be used very carefully.
Remember: 1. If an exit channel is turned off, it must be turned off in *ALL* levels
2. The elastic channel *must* be on for each level.

Col. 8: Gamma (KeV) The reduced widths.

Col. 9: The spin of the outgoing light particle.

Col. 10: The parity of the light outgoing particle. (1= +, 0= -)

Col. 11: The spin of the heavy outgoing particle.

Col. 12: The parity of the heavy outgoing particle. (1= +, 0= -)

Col.13: The energy of the excited exit states.

Col. 14 & 15: These are the masses of the light and heavy particles for the exit channels. (For the elastic channel, entrance and exit values are identical. AZURE uses this fact to

identify the entrance channel particle parameters.) AZURE can be instructed to use regular or inverse kinematics through the use of the flag 'kinematics.flg' (0 or 1 for regular or inverse). N.B. In inverse kinematics, AZURE expects that the experimental data file will be the laboratory value for the energy and angle of the "light" particle.

Col. 16& 17: Z1 and Z2 are the charges of the light and heavy particles respectively in the exit channel. AZURE recognizes a neutron channel from Z1 =0, M1>0 and a gamma channel from Z1=0.

Col. 18: Q value of the reaction to the compound state.

Col. 19: Q value of the decay from the compound state.

Col. 13: (Not yet in existence) This index identifies the type of gamma reaction channel, g(0/1)=(resonance/direct capture). For resonance gammas only, AZURE will accept primary decays to any final state. The present version of AZURE will not yield correct results for the decay when the primary is evaluated. For both resonance and direct capture, both channels must populate the same final state.