Test case: ^{7}Be compound

Calculate cross sections for the data of Barnard et al. [1], McCray [3], Elwyn et al. [2] and Spiger and Tombrello [4] from the level parameters (energies and reduced width amplitudes) given in Table 2 provided by Satoshi Kuniuda. [Note: To avoid any confusion, Table 2 contains the poles that have non-zero reduced width amplitudes in at least one channel. Additional poles, with reduced width amplitudes that are zero for all channels, may be required by some codes for angular momentum and spin conservation reasons, so code developers will also share their input files when performing this and other similar exercises.]

Cross sections must be given in the frame of reference of the data (^{3}He$(\alpha,\alpha)^3$He, ^{6}Li$(p,\alpha)^3$He, and ^{6}Li$(p,p)^6$Li in the laboratory frame and ^{3}He$(\alpha,p)^6$Li in the center-of-mass frame of reference).

The calculations should be made using $B_c = -l_c$ (orbital angular momentum) and maximum orbital angular momentum is 1 for the proton channel and 4 for the α channel. Channel radii should be determined as $a_c = 1.4$ [fm] $(A_1^{1/3}+A_2^{1/3})$ and should be the same for all channels within a particle pair. Here A_1 and A_2 are the *integer* mass numbers, not exact masses.

Table 2: R-matrix parameters in the $B = -l$ basis
Pole energies in the centre-of-mass frame of the elastic channel.
Reduced width amplitudes are given in MeV$^{1/2}$.

$J^\pi = 1.5^-$				
E	H1+Li6	H1+Li6	H1+Li6	He4+He3
(MeV)	LS: 1, 1/2	LS: 1, 3/2	LS: 3, 3/2	LS: 1, 1/2
-1.586097	−1.34077	−0.41816	0.00000	1.05725
$J^\pi = 2.5^-$				
E	H1+Li6	H1+Li6	He4+He3	
(MeV)	LS: 1, 3/2	LS: 3, 1/2	LS: 3, 1/2	
5.746671	0.94880	0.00000	0.18770	
7.088367	−0.34947	0.00000	1.18381	
$J^\pi = 3.5^-$				
E	H1+Li6	H1+Li6	H1+Li6	He4+He3
(MeV)	LS: 3, 1/2	LS: 3, 3/2	LS: 5, 3/2	LS: 3, 1/2
3.483949	0.00000	0.00000	0.00000	0.79362

References

[1] A.C.L. Barnard, C.M. Jones, and G.C. Phillips. The scattering of He3 by He4. *Nuclear Physics*, 50:629 – 640, 1964. ISSN 0029-5582. doi: http://dx.doi.org/10.1016/0029-5582(64)90235-4. URL `http://www.sciencedirect.com/science/article/pii/0029558264902354`.

[2] A. J. Elwyn, R. E. Holland, C. N. Davids, L. Meyer-Schützmeister, F. P. Mooring, and W. Ray. Cross sections for the ^{6}Li(p,^{3}He)^{4}He reaction at energies between 0.1 and 3.0 MeV. *Phys. Rev. C*, 20:1984–1992, Dec 1979. doi: 10.1103/PhysRevC.20.1984. URL `http://link.aps.org/doi/10.1103/PhysRevC.20.1984`.

Table 1: Particle pair information for ^{7}Be compound system. Masses are in amu (taken from AME2016), separation and excitation energies in MeV, and channel radii in fm. Note: Channel radii are calculated using integer masses. Constants are taken from NIST and are the same as those used in ENDF8.

particle pair 1		
light particle:	^{4}He	
	J =	0
	π =	+
	M =	4.002603
	Z =	2
heavy particle:	^{3}He	
	J =	0.5
	π =	+
	M =	3.016029
	Z =	2
Excitation Energy =	0	
radius =		
particle pair 2		
light particle:	^{1}H	
	J =	0.5
	π =	+
	M =	1.007825
	Z =	1
heavy particle:	^{6}Li	
	J =	1
	π =	+
	M =	6.015122
	Z =	3
Excitation Energy =	0	
constants		
a_c =	1.4 ($A_1^{1/3}$+$A_2^{1/3}$)	fm
Q-value [^{6}Li(p,α)] =	-4.01972	MeV
$\hbar c$ =	197.3269788	MeV fm
μ =	931.4940954	MeV/c^2
α^{-1} =	137.035999139	

[3] J. A. McCray. Elastic scattering of protons from Li^6 nuclei. *Phys. Rev.*, 130:2034–2042, Jun 1963. doi: 10.1103/PhysRev.130.2034. URL http://link.aps.org/doi/10.1103/PhysRev.130.2034.

[4] R. J. Spiger and T. A. Tombrello. Scattering of He^3 by He^4 and of He^4 by tritium. *Phys. Rev.*, 163:964–984, Nov 1967. doi: 10.1103/PhysRev.163.964. URL http://link.aps.org/doi/10.1103/PhysRev.163.964.