TALENT6: HWK 3

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Now let's consider the ^{3}H$(d,n)^4$He reaction. A two-level two-channel R-matrix parametrization is given in Table II of R.E. Brown, N. Jarmie, and G.M. Hale, *Fusion-energy reaction* ^{3}H$(d,\alpha)n$ *at low energies*, Phys. Rev. C **35**, 1999-2004 (1987), `https://doi.org/10.1103/PhysRevC.35.1999`:

TABLE II. Parameters for the two-level fit discussed in Sec. IV A. The level energies E_λ are channel independent. E_2 was held fixed in the fit.

Channel	a_c (fm)	B_c	L	γ_{1c} (MeV$^{1/2}$)	E_1 (MeV)	γ_{2c} (MeV$^{1/2}$)	E_2 (MeV)
d + t	5.00	−0.278 64	0	0.958 38	0.021 626	0.483 04	10.0000
α + n	3.00	−0.557 00	2	0.277 81	0.021 626	1.517 53	10.0000

All of the channels and levels are $J^\pi = 3/2^+$. Calculate the cross section and S factor, and plot them versus the deuteron lab energy E_d. Your cross section should peak at about 5 b, a remarkably large cross section for a reaction between charged particles. How does your S-factor plot compare to Fig. 1 in the paper? The S factor is defined by

$$\sigma = \frac{S}{E}\exp(-2\pi\eta),$$

where E is the center-of-mass energy and η is the Coulomb parameter. Note that one usually plots S versus E rather than the lab energy (you always need to read the fine print if you are going to compare your calcuation to the work of others).

I will also point out that Sofia Quaglioni and collaborators have just published a very nice ab initio calculation for this reaction: Guillaume Hupin, Sofia Quaglioni, and Petr Navrátil, *Ab initio predictions for polarized deuterium-tritium thermonuclear fusion*, Nature Communications **10**, Article number: 351 (2019), `https://doi.org/10.1038/s41467-018-08052-6`.