Hands-on practice on the Reaction4Exp platform

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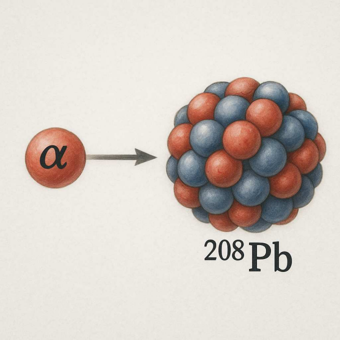
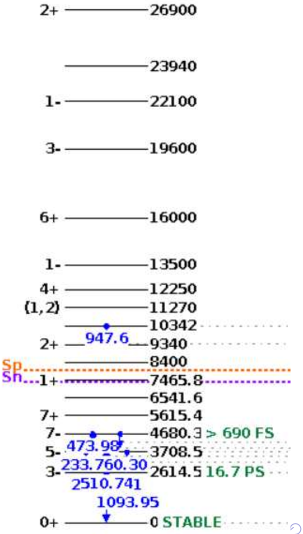
Elastic and Inelastic scattering





Elastic scattering

Woods-Saxon parameters for ^{4}He+^{208}Pb optical potential

V_0 [MeV]	r_0 [fm]	a_0 [fm]	W_v [MeV]	r_i [fm]	a_i [fm]	r_c [fm]
96.44	1.085	0.625	32	0.958	0.42	1.2

Remember: absolute (physical) radii $R_x = r_x(A_p^{1/3} + A_t^{1/3})$.

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✏ We will try four indicent energies:

$E_{\rm lab}$ (MeV)	$E_{\rm cm}$ (MeV)	k (fm^{-1})	η	$r_{\rm min}$ (fm)
10	9.81	1.36	16.3	24.1
22	21.6	2.01	11.0	10.9
27	26.5	2.23	9.94	8.9
60	58.9	3.32	6.67	4.0

Elastic scattering cross sections

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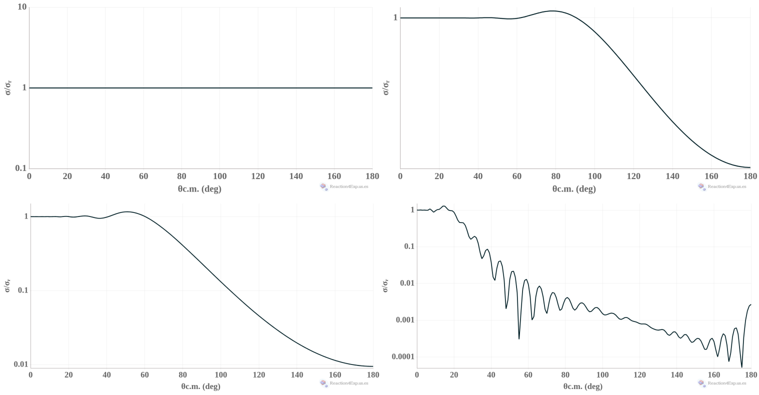
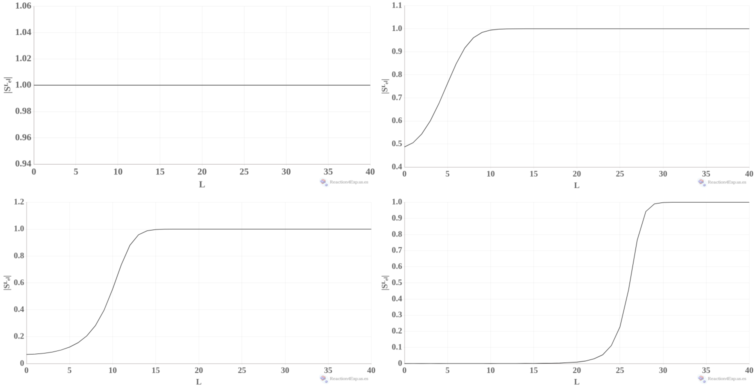


Elastic S-matrices



Inelastic scattering

Woods-Saxon parameters for ^{4}He+^{208}Pb(3^{-}) at 23.5 MeV

V_0 [MeV]	r_0 [fm]	a_0 [fm]	W_s [MeV]	r_i [fm]	a_i [fm]	r_c [fm]
92.5	1.384	0.625	22.24	1.265	0.592	1.2

Nuclear and Coulomb deformation parameters

β_N	β_C
0.103	0.113

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Nuclear and Coulomb deformation parameters

β_N	β_C
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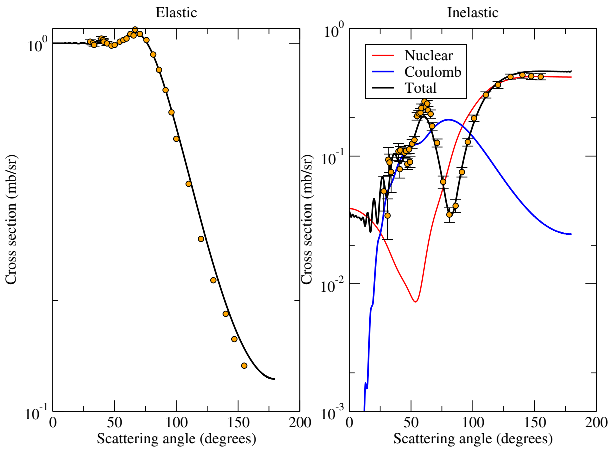
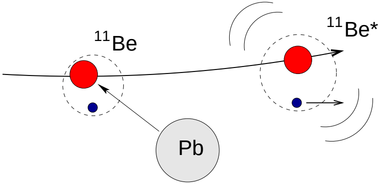
$$\delta_N = \beta_N \; R_N = 0.85 \text{ fm}$$
$$M_n(E3) = \beta_C \; 3 \; Ze \; R_C^3/4\pi = 795.08 \; e \text{ fm}^3$$

Elastic and inelastic cross sections using CC method

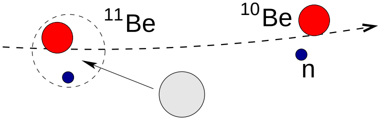


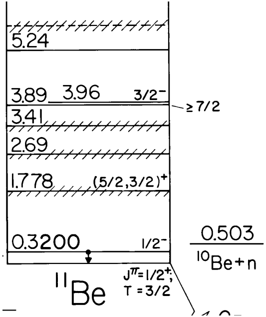
EPM: inelastic and Coulomb breakup

^{11}Be+^{197}Au at 39.6 and 31.9 MeV



^{11}Be+^{208}Pb at 69 MeV/u





Inelastic scattering to the excited bound state of ^{11}Be

^{11}Be+^{197}Au at 39.6 and 31.9 MeV

$$B(E1; gs \to 1/2^-) = 0.116\ \mathrm{e^2fm^2}$$

Remember: distribution type "discrete"

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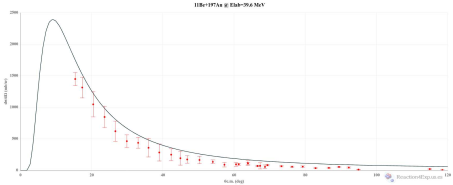

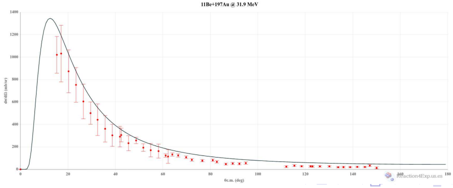

Coulomb breakup for ^{11}Be

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We need a $dB(E1)/d\varepsilon$ distribution from a theor. model

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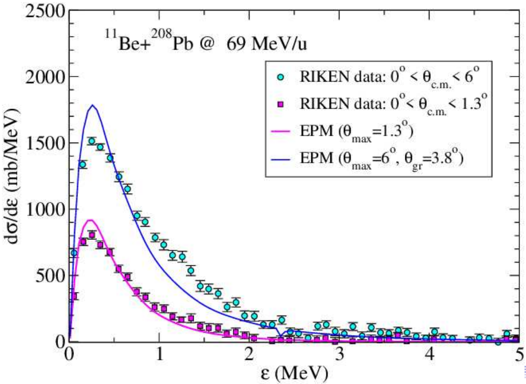

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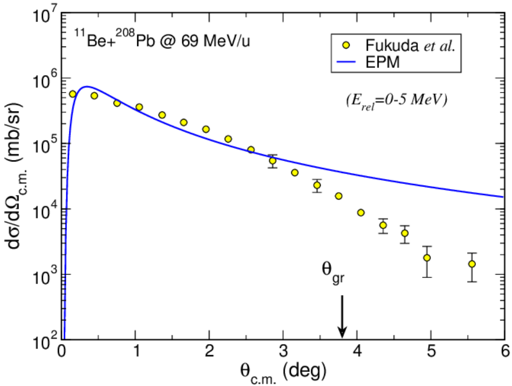
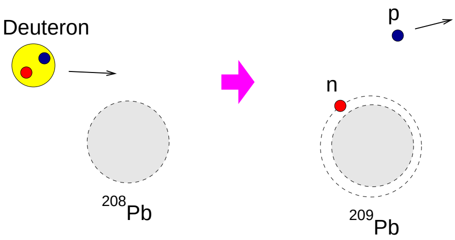


Transfer reaction

$^{208}\mathrm{Pb}(d,p)^{209}\mathrm{Pb}$ at 20 MeV



Potentials needed

For n-p ground state we use the Gaussian form:

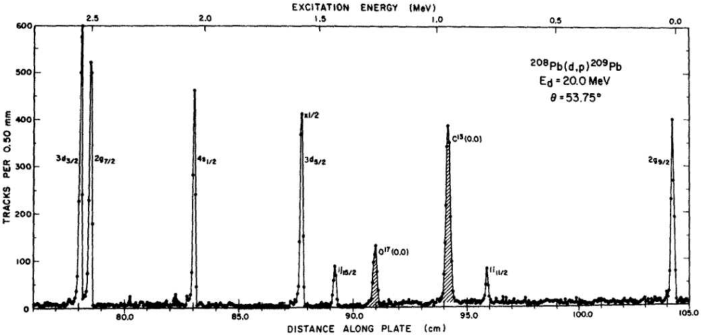
$$V_{pn}(r) = -72.15 \exp[-(r/1.484)^2]$$

system	V_0 [MeV]	r_0 [fm]	a_0 [fm]	W_s [MeV]	r_i [fm]	a_i [fm]	r_c [fm]
$d+^{208}$Pb	112.0	1.25	0.682	19.4	1.25	0.783	1.30
$p+^{208(9)}$Pb	52.0	1.25	0.65	10.0	1.25	0.76	1.25
$n+^{208}$Pb(gs)	adjust.	1.23	0.65				

Remember:

- $R_x = r_x A_t^{1/3}$
- Change the binding energy for the final nucleus

Excitation energies for ^{209}Pb



Excitation energies (MeV): 0.0, 0.79, 1.42, 1.56, 2.01

Transfer cross sections to several states of ^{209}Pb

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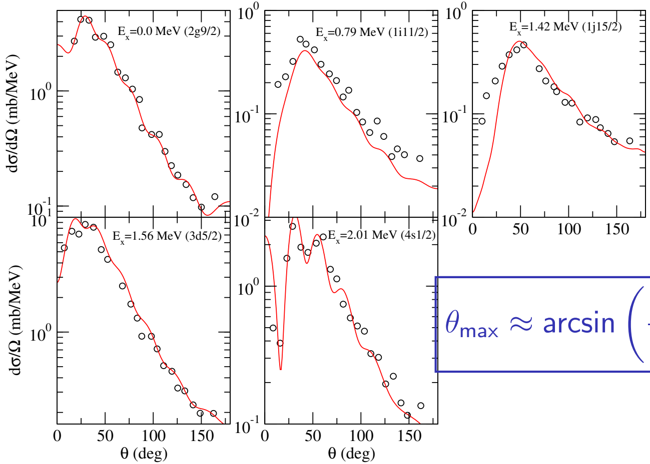

$$\theta_{\mathrm{max}} \approx \arcsin\left(\frac{\sqrt{\ell(\ell+1)}\hbar}{pR}\right)$$

Discussion and feedback on the platform

- With Reaction4Exp we can do calculations for elastic, inelastic, transfer and Coulomb breakup reactions as seen.
- Soon, breakup using CDCC will be available.
- Also available it is the obtention of double-folding optical potentials using the SPP code.

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- Feedback & suggestions

To finish...