Necessary ingredients & frameworks for nuclear reaction calculations

Nuclear physics: nuclear interaction is underdetermined
(= parameters for the model)
Reactions: complexity of the processes requires assumptions

Our work:
1. Comparison between experiments-theories,
2. Interpretation based on assumptions
3. Control assumptions before drawing conclusions

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A word about DWBA and CC calculations

We should not believe DWBA is working -
unless we could prove it is a good approximation for our calculations of nuclear reactions.

Which means that we need to compare Channel Coupling calculations and DWBA
and check if there are discrepancies coming from the excitation scheme of the nucleus of interest.

If the excitation scheme is what you need to extract from experiments compared to calculations
then you need to make CC calculation anyway to check the DWBA validity,
Specially when you treat a deformed nucleus,
or when you treat a nucleus for which you ignore what the deformation is for the ate you consider.

Sometimes you are in big trouble if you miss the CC scheme.

DWBA and CC – exemplified -

Amine Nasri. *Microscopic nonlocal potentials for the study of scattering observables of nucleons within the coupled channel framemork.* Nuclear Theory [nucl-th]. Université Paris-Saclay, 2018. HAL Id: tel-02111689
https://tel.archives-ouvertes.fr/tel-02111689
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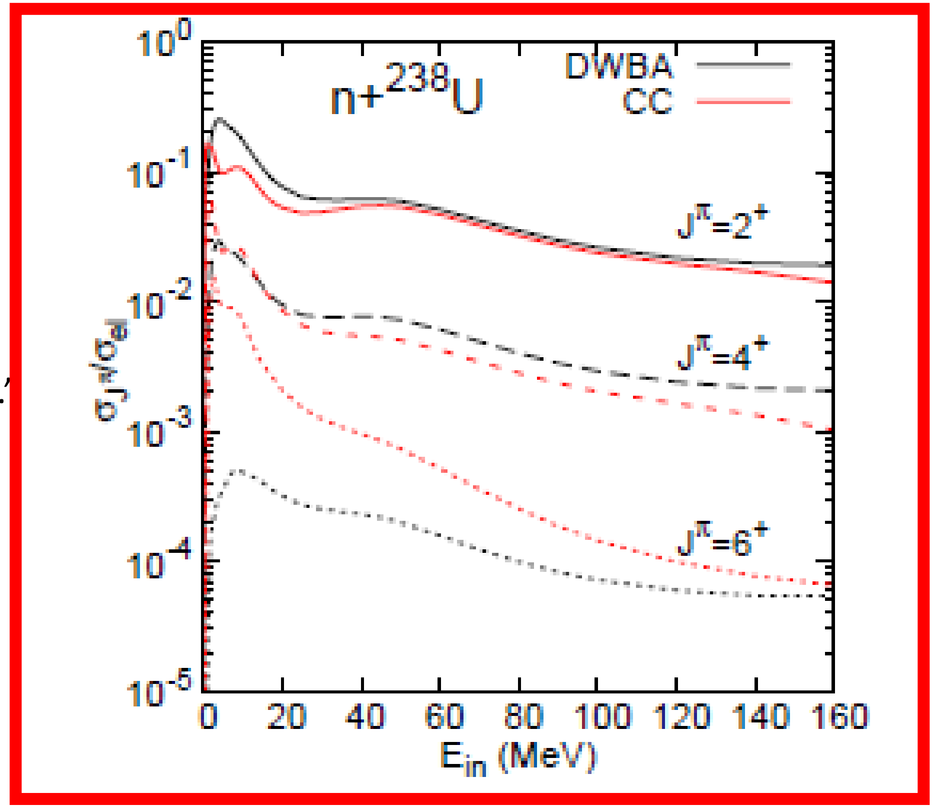
1.2 Coupled channels and DWBA

(Fig 1.7 p.8) *Ratios of direct inelastic scattering cross section to direct elastic scattering cross section for incident neutrons on 238U.*
low energy states 2+, 4+, 6+, 8+
(located at 46, 149, 307 and 508 keV, respectively).'



"although the DWBA was proved to be a good description of reactions involving spherical nuclei, cases where the target nucleus is strongly deformed (with a deformation parameter > 0.2) showed that the DWBA is not longer valid [25] and it is necessary to use the CC approach.
A comparison between ^{208}Pb,
a spherical nucleus and ^{238}U, a strongly deformed nucleus is a good way to illustrate the relevancy of the DWBA."...**The coupling between the gs and the 2+ excited state is too strong to be neglected compared to the optical potential.**

M. Dupuis, E. Bauge, S. Hilaire, F. Lechaftois, S. Péru, N. Pillet, and C. Robin.
Progress in microscopic direct reaction modeling of nucleon induced reactions. EPJA, **51:168** (2015).

Results about the Hoyle state through microscopic OMP analysis

Missing monopole strength of the Hoyle state in the inelastic α+12C scattering ☆
Dao T. Khoa, Do Cong Cuong PLB 660, 331-338 (2008)
https://doi.org/10.1016/j.physletb.2007.12.059

"In conclusion, a realistic (complex) density dependence was introduced into the M3Y-Paris interaction, based on the Brueckner–Hartree–Fock calculation of nuclear matter, for the folding model study of the $\alpha+^{12}C$ scattering at Elab=104–240 MeV. Given an accurate estimation of the bare $\alpha+^{12}C$ optical potential, our folding model analysis has shown consistently that there should be an enhancement of absorption in the exit $\alpha+ C*(0_2^+)$ channel due to the short lifetime and weakly bound structure of the Hoyle state, which accounts for the "missing" monopole strength of the Hoyle state observed earlier in the DWBA analysis of inelastic $\alpha+^{12}C$ scattering."

Folding-model analysis of inelastic α + C scattering at medium energies, and the isoscalar transition strengths of the cluster states of ^{12}C D.C. Cuong, D.T. Khoa, Y. Kanada-En'Yo, PRC **88**, 064317 (2013) *https://doi.org/10.1103/PhysRevC.88.064317*

Hindrance of the excitation of the Hoyle state and the ghost of the 2_2+ state in ^{12}C
Khoa, D.T., Cuong, D.C., Kanada-En'yo, Y. PLB **695**, 469-475 (2011)

Alpha scattering and the folding model - OMP

Double-folding model:
complex OP
&inelastic scattering FF
using the AMD nuclear densities
and the CDM3Y6 interaction

PHYSICAL REVIEW C 88, 064317 (2013)