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Towards a non-local microscopic description of scattering observables of nucleons on deformed nuclei

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A good understanding of neutron scattering mechanisms and prediction capacity of associated cross sections is crucial to many nuclear technologies, among which all kinds of reactors based on fission process. For deformed nuclei, the computation of scattering observables for the elastic channel and the first, low-lying excited states requires coupled channel calculations. Local, phenomenological optical and macroscopic transition potentials are the most commonly used in coupled channel analyses, and various microscopic approaches are being developed in order to improve prediction power and theoretical understanding, like the Nuclear Structure Method [1] or nuclear matter approaches [2]. Potentials obtained microscopically are nonlocal, and while there exists methods to localize a potential that yield good results for elastic scattering [3] recent studies [4] [5] [6] have emphasized the importance of treating explicitly this nonlocality, especially for inelastic channels.
We have developed a code that can solve coupled channel equations with nonlocal microscopic optical potentials, while treating the nonlocality with no approximation. We lead our study on 208Pb, with potentials derived from the Melbourne G-matrix and ground state and transition densities stemming from the Random Phase Approximation nuclear structure model. We consider 1 and 2- phonons excitations within the coupled channel framework. Extensive experimental data for both elastic and inelastic scattering of neutrons is available on 208Pb, and we use this target to validate our approach and investigate effects of nonlocality in the coupled channel framework before focusing on deformed nuclei.

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Authors: Mr NASRI, Amine (CEA); Mr DUPUIS, Marc (CEA); Mr BLANCHON, Guillaume (CEA)

Co-authors: Mr ARELLANO, Hugo F. (university of Chile); Mr BAUGE, Eric (CEA)

Presenter: Mr NASRI, Amine (CEA)

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