Reaction channel contributions to the triton + ^{208}Pb optical potential

Hao Liu
Zetian Ma

Background

Optical model potential (OMP) can be used for light composite projectiles.

Calculations usually neglect contributions from collective excitations and rearrangement (transfer) processes, but they are important to pickup reactions on closed-shell targets.

How to include such processes? Use coupled channel (CC) calculation.

Introduce a potential V_{DPP} (dynamical polarization potential) to account for these processes.

Formal approach to calculating the DPP

$$V_{\mathrm{OM}}(r) = V_{\mathrm{FM}}(r) + V_{\mathrm{DPP}}(r)$$

V_{FM}:

- Folding model potential
- Only depends on the densities and an effective N-N interaction which may depend on the nuclear densities and the asymptotic energy, E.
- Depend smoothly on N, Z, and E
- Nonlocal as a result of exchange processes, but for elastic scattering, there is local equivalent potential.

V_{DPP}:

- Depends on specific characteristics (collectivity, the nature of the strongly coupled channels, etc.) in the passage it chooses pickup and inelastic channel.
- Nonlocal and l dependent

Formal approach to calculating the DPP: Feshbach theory

Operators P: the target nucleus ground state; Q : the excited states .

Dividing the Q space by writing$Q = p + q$ where p projects onto specific states to be considered, and q projects onto the rest.

The q space represents the very many states whose contribution may be considered to vary slowly with N, Z, and$E$.

Then:

$$V_{\mathrm{DPP}} = \sum_{m,m' \in p} V_{1m}(r) G_{mm'}(r, r') V_{m'1}(r')$$

where V_{1m} is local coupling potential between the elastic channel and all inelastic channels m within the space defined by p.

Methods to calculate DPP

Procedure: invert the elastic channel S matrix from the CC calculation to obtain an exact local and L-independent representation of the DPP corresponding to the particular channels included in the CC calculation.

$$V_{\mathrm{DPP}}(r) = V_{\mathrm{cc}}(r) - V_{\mathrm{bare}}(r)$$

V_{DPP}"is a local equivalent of the nonlocal and l-dependent formal DPP generated by the couplings."

Nonadditivity of the local equivalent DPPs for different couplings: the sum of the individual local equivalent DPPs is not the local equivalent DPP for the calculation where all the couplings are included simultaneously.