TALENT Course 6: Theory for exploring nuclear reaction experiments
Outline project proposal

Project name: Sensitivity of the ^{26}Al(d,p)^{27}Al direct transfer reaction to the uncertainties in the potentials

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Project outline and aims:
The satellite based observation of a characteristic γ-ray from the decay of ^{26}Al (E_γ = 1.81 MeV in ^{26}Mg), due to the lifetime ($\tau \approx 7.2 \times 10^5$ yr) of this radionuclide, was the first prove of ongoing nucleosynthesis in the Milky Way [1]. ^{26}Al^g is primarily produced in classical novae. The available energy for production/destruction of ^{26}Al processes in those environments means that these reaction are dominated by strong and often narrow resonances (see [2] and references therein). This results in the star evolution mechanism to be strongly dependent to the nuclear reaction input.
Most spectroscopic factors for proton rich nuclei have been suggested by the study of the mirror nuclei. However the advances in RIB method in laboratory such as TRIUMF has allowed direct study of proton rich nuclei.In particular, the ^{26}Al(d,p)^{27}Al reaction (at E_{beam}=6 MeV/u) was performed last year at TRIUMF. The interest lies in measuring spectroscopic factor and to compare them to the mirror nucleus ^{27}Si.
In this project, the angular distribution of the cross section for independent states in ^{27}Al will be investigated using, primarily, the Adiabatic Wave Approximation for the ^{26}Al+(p,n) system. That is considering the interaction of the proton and neutron with the target nucleus independently. Sensitivity of the cross sections to the choice of methods (zero-range, finite-range ...) and parameters (for the potentials) will be explored. ANC will be extracted and compared to those obtain for ^{27}Si [1].

Methodology:
The calculation will hopefully be made using the *fresco* code, potentially through the *brush* front code to the *fresco* input. The tutorial of Thursday week 2 developed a method to approach the problem of (d,p) transfer reactions. A first objective would be to effectively reproduce the ^{12}C(d,p)^{13}C experimental data with both *twofnr* and *fresco*. For the ^{26}Al case, experimental data (still preliminary) are available and can be used to evaluate the accuracy of the different method/potentials used .

Key references:
[1] D. D. Clayton *et al.*, Astrophys. J. **280**, 144 (1984).

[2] G. Lotay *et al.*, PRC **84** (2011) 035802.