Extracting Reliable Spectroscopic Factors from Transfer Reactions using Asymptotic Normalization Coefficients: A Case Study $^{14}C(d,p)^{15}C$

R.E. Tribble[1], M. McCleskey[1], L. Trache[1], A. Banu[1], V. Burjan[2], C.A. Gagliardi[1], V. Goldberg[1], V. Kroha[2], A. Mukhamedzhanov[1], B. Roeder[1], E. Simmons[1]

Contact e-mail: r-tribble@tamu.edu

For many decades, spectroscopic factors have played a prominent role in nuclear physics. They provide important information that can be used to characterize the structure of nuclear states and they provide a way to connect experimental results to theoretical nuclear structure calculations. Spectroscopic factors also play a key role in understanding direct capture contributions to stellar neutron capture-gamma cross sections.

A nuclear transformation that has been used routinely to measure neutron spectroscopic factors is the (*d*,*p*) transfer reaction. A typical measurement is analyzed by comparing an angular distribution to a single-channel Distorted Wave Born Approximation calculation in order to extract spectroscopic information. More sophisticated calculations are also available where channel couplings are taking explicitly into account. A common problem in all of these calculations is determining the appropriate geometry to use for binding the single particle to the core. The calculated cross section is sensitive to the well geometry since part of the result depends on contributions from transfer at the nuclear surface and beyond, i.e. peripheral transfer. At lower deuteron energies, say < 10 MeV/A, the peripheral component of the interaction can dominate the reaction. Even at energies of up to 30 MeV/A, the peripheral component can be sizable.

By choosing a different neutron transfer reaction, we can greatly accentuate peripheral transfer and thereby extract an Asymptotic Normalization Coefficient (ANC) for the same system. This information can be used to determine the peripheral component of a (*d*,*p*) reaction and thus lead to the extraction of a more reliable spectroscopic factor.

This approach is being tested in the $^{14}C + n \leftrightarrow {}^{15}C$ system. ANC's are being determined from the $^{13}C(^{14}C,^{15}C,)^{12}C$ reaction at 12 MeV/A. The ANC's will be used to help extract spectroscopic factors from the $^{14}C(d,p)^{15}C$ reaction, which has been studied at 30 MeV/A. The resulting spectroscopic factor will be compared to theoretical calculations and also will be used to calculate the $^{14}C(n,\gamma)^{15}C$ reaction rate to compare to previous measurements. An overview of the theory, the present status of the analysis and extensions of this technique to other systems, including radioactive ion beams, will be discussed.

[1]Cyclotron Institute, Texas A&M University, College Station, TX 77843, USA
[2]Nuclear Physics Institute, Czech Academy of Sciencs, 250 68 Řež near Prague, Czech Republic