Asymptotic normalization coefficient and spectroscopic factor from $^{48}Ca(d,p)^{49}Ca$ and $^{48}Ca(n,\gamma)^{49}Ca$

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In our previous works [1,2] we have suggested a new combined method to determine the spectroscopic factors (SFs) from transfer reactions using the information about the asymptotic normalization coefficients (ANCs). Introduction of the ANC will allow us to determine the parameters of the bound state potential and obtain more accurate SF. The determined Sfs can be used to calculate the neutron radiative capture reactions.

To test our method we applied it for analysis of the direct radiative capture reaction $^{48}Ca(n,\gamma)^{49}Ca$. We note that ^{48}Ca is considered to be a double magic nucleus, hence the ^{49}Ca ground state is well described as a single-particle neutron wave function bound to the core ^{48}Ca with the spectroscopic factor close to unity.

To apply our method first we determined the ANC for $^{49}Ca \to {}^{48}Ca + n$ from the sub-Coulomb transfer reaction $^{48}Ca(d,p)^{49}Ca$ [3]. After that we determined the SF for the configuration $^{48}Ca + n$. Fortunately in the case under consideration direct measurements for $^{48}Ca(n,\gamma)^{49}Ca$ are available [4] and we can compare the SF and ANC determined from the radiative capture process with the ones obtained from the $^{48}Ca(d,p)^{49}Ca$ reaction. The sub-Coulomb $^{48}Ca(d,p)^{49}Ca$ reaction is entirely peripheral and by normalizing the DWBA cross section to the experimental one at backward angles we determined the ANC for $^{49}Ca \to {}^{48}Ca + n$, C = 5.22 fm$^{-½}$. To determine the single-particle ANC b we used the Woods-Saxon potential with standard geometry, the radius parameter r_o = 1.25 fm and diffuseness a = 0.65 fm. It gives the single-particle ANC b = 5.79 fm$^{-½}$ and the SF is $S = C^2/b^2 = 0.81$. Now we consider the $^{48}Ca(n,\gamma)^{49}Ca$ data [4]. The neutron binding energy of the ground state of ^{49}Ca is 5.148 MeV and capture cross section is determined by both ANC and SF. For the Woods-Saxon potential with parameters given above from the fit of the theoretical capture cross section to the experimental one we get SF=0.73 and the ANC C = 4.96 fm$^{-½}$. Taking into account the systematic experimental uncertainties for the sub-Coulomb *(d,p)* and *(n,γ)* data 5% difference in the extracted ANCs and 10% difference in SFs is an excellent agreement. More accurate measurements of the sub-Coulomb *(d,p)* reaction, which can be done at the Cyclotron Institute, Texas A&M University, can even decrease this difference. Thus we can conclude that for ^{49}Ca both *(n,γ)* and *(d,p)* provide very close ANC and SF, i. e. *(d,p)* reaction can be used to determine the SF and calculate direct radiative *(n,γ)* reaction cross sections.

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