S-Factor Calculation for Deuteron Stripping Reaction on ^{16}O and ^{40} Ca

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Here the two-body interaction is taken as an input. By considering interaction in separable form and introducing t-matrix the dimensionality of couple integral equation is reduced. As a result it saves time and gives approximately accurate result of reaction cross-section. The AGS version of Faddeev approach in angular momentum basis is used to solve the problem. Keeping the target at rest the S-factor is calculated in center of mass system.

When the two body potential is written in separable form as

$$< k' | V | k >= -\lambda\, g(k')g(k)$$

Then the two-body t-matrix is also become separable [1]

$$t(z) = Vk|\varphi_k^{n_k} > \tau_k^{n_k} < \varphi_k^{n_k} | Vk$$

Where $\tau_k^{n_k}$ is the two body t-matrix propagator

$$\tau_k^{n_k} = \frac{1}{z + \epsilon_{\beta_k}^{n_k}}$$

Based on separability approximation given by Lovelace [2] the AGS version of Faddeev equation becomes more suitable to solve few body problems by considering the appropriate angular momentum basis and separable t-matrix [3]. Then the one dimensional coupled integral equation is written as

$$\begin{aligned} T_{ij}(q_i, q_j, \beta_i, \beta_j : J) &= k_{ij}(q_i, q_j', \beta_i, \beta_j : J) \\ &+ \sum_{k\beta_k} \int u_k^2 du_k K_{ik}(q_i, u_k, \beta_i, \beta_k : J) \tau_k^{n_k}(z \\ &- u_k^2) T_{kj}(u_k, q_j', \beta_k, \beta_j : J) \end{aligned}$$

The singularities removed from the one dimensional coupled integral equation by using the method given by Sasakawa and Kowalski [4, 5] .

By using 15 point Gaussian quadrature for momentum points and momentum weights the reaction cross-section is evaluated for different projectile energy [6]. By using projectile energy and reaction cross-section in center of mass system the variation of coulomb repulsion is found out through S-factor calculation.

At a given projectile energy, the S-factor in center of mass system is given as [7]

$$S(E_{c.m.}) = \sigma(E_{c.m.}) E_{c.m.} Exp(\frac{E_G}{E_{c.m.}})^{\frac{1}{2}}$$

Where, E_G is the Gamow Energy

$$E_G = (2\pi\alpha Z_1 Z_2)^2 \times \frac{\mu c^2}{2}$$

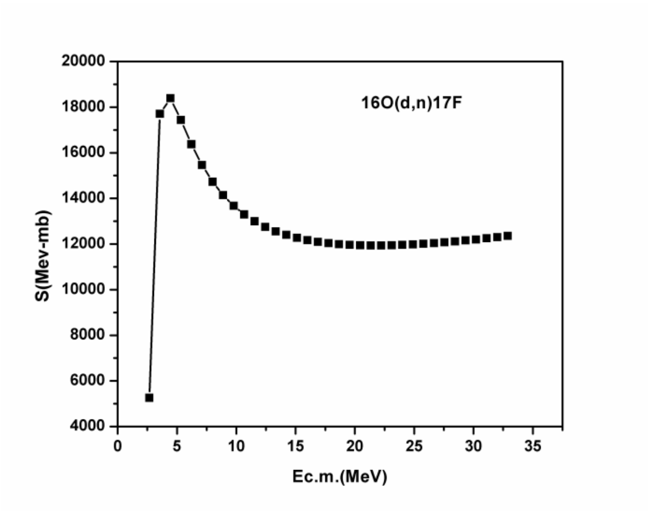

Figure 1: center of mass energy ($E_{c.m}$) vs. S-factor for ^{16}O (d, n) ^{17}F in $D_{5/2}$ state

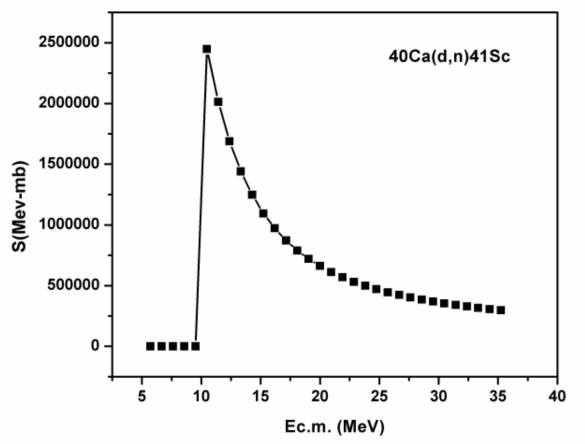

Figure 2: center of mass energy ($E_{c.m}$) vs. S-factor for ^{40}Ca (d, n) ^{41}Sc in $F_{7/2}$ state

Result and discussions:

It is observed from Fig.1 & 2 with increase in projectile energy the S-factor is increased rapidly and attains a peak value after onwards gradually decreased. It is found out that calcium and oxygen when react with deuteron the peak value of S-factor obtained at center of mass energy 10.48 MeV and 4.44MeV respectively. Since the dependence of reaction cross-section on center of mass energy ($E_{c.m.}$) is mainly due to the coulomb barrier. As S-factor factorized the coulomb component of the cross-section so here we evaluate the variation of S-factor with $E_{c.m.}$. The graph shows that with increase in $E_{c.m.}$ the effect of coulomb barrier gradually decrease after a certain value of $E_{c.m.}$. Our future scope is to evaluate the S-factor for compound nucleus in excited state and try to find out why some extent coulomb barrier increases and then decreases with increase in $E_{c.m.}$.

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