RECENT STUDIES OF THE RADIATIVE NUCLEON CAPTURE IN THE REGION OF GDR

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ABSTRACT

Experimental results from the study of the excitation functions and energy dependence of the angular distribution coefficients for the radiative capture of nucleons in some lighter nuclei (^{39}K, ^{40}Ca, ^{88}Sr, and ^{89}Y) have been in last years sucessfully compared with the predictions of the direct-semidirect theory. The most important aspects of this comparison are briefly discussed.

INTRODUCTION

In the following the recent results of the nucleon capture studies in the region of dipole giant resonance (GDR) for lighter nuclei will be briefly reviewed. Some pecularities of the semiphenomenological direct-semidirect (DSD) capture model [1], which, besides the direct process considers also the excitation of the GDR state, are pointed out.

RESULTS

i) Measurement and analysis of the excitation function of $^{40}Ca(n,\gamma)^{41}Ca$ [2]. Results are treated by the DSD model after taking into account the contribution of the statistical process. The agreement is achieved using resonable set of free parameters after taking into account only the $T_<$ part of the GDR [3].

ii) DSD model analysis of a rather precise $^{40}Ca(\gamma,p)^{39}K$ excitation function $\sigma(E_\gamma)$ and γ-ray energy dependence of the Legendre polynomial expansion coefficient $a_2(E_\gamma)$ [4]. Calculation, based on the detailed balance principle, reproduces satisfactorily good both the $\sigma(E_\gamma)$, as well as a smooth $a_2(E_\gamma)$.

iii) Measurements and sucessful DSD model analysis of $^{88}Sr(n,\gamma)^{89}Sr$ and $^{89}Y(n,\gamma)^{90}Y$ excitation functions and angular distribution coefficients $a_1(E_n)$ and $a_2(E_n)$ [5]. To reproduce the $a_1(E_n)$, DSD model was extended to include also the quadrupole capture transitions, which, in spite of a small strength, influence very efficiently the value of $a_1(E_n)$ through the interference term. Results are encouraging and should be considered as a starting point for similar studies in other nuclei.

CONCLUSIONS

From described analyses and similar studies in the region of heavier nuclei [6] following conclusions can be drawn:

i) In the region of lighter nuclei there is no essential need for complex particle-nucleus vibration coupling,

which is important for the description of the capture in heavy nuclei.

ii) Energy dependence of angular distribution coefficient is sometimes better reproduced by simple direct than DSD capture model (see Fig. 1.).

iii) For the description of the transitions to high l-value states the selection of radial shapes of particle-dipole vibration coupling interaction function $V_1(r)$ and different optical model potentials $V(r)$ and $W(r)$ is rather stringent. The study of DSD model in such cases has not meaning only as a guide for better understanding of capture process but might be used (in future) also as a testing model for different optical potentials which usually do not contain the information about the behaviour of the nuclear interior wave function which plays an important role in the capture process. To clarify this point additional radiative capture measurements are to be performed in the whole mass region.

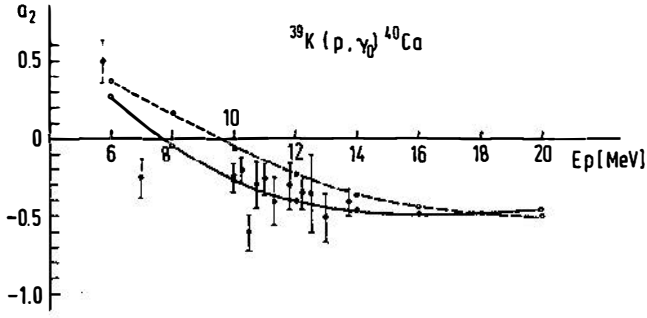

Fig. 1. An example of the reproduction of experimental values of $a_2(E_n)$ by the result of the calculation based on the direct (solid line) and DSD capture model (broken line).

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