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Are there Non-Statistical Effects in $^{173}Yb(n,\gamma)^{174}Yb$?

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ABSTRACT: The resonance-averaged capture of neutrons in ^{173}Yb has been studied at energy of 2 keV. With a statistical significance of 99.5 % an enhancement of E1-transition to the neutron 2QP levels in ^{174}Yb is observed.

1. INTRODUCTION

In the rare earth region several cases of correlation between partial radiation widths and reduced neutron widths of neutron resonances were observed /1/. The most distinct effect was found in the $^{173}Yb(n,\gamma)^{174}Yb$ reaction. All cases of this so-called "R-correlation" are in qualitative agreement with Soloviev's theory /2/. Nevertheless, serious difficulties in their quantitative interpretation pose a question whether the R-correlation really exists.

So far, it is not quite evident how to treat the strength of correlated transitions in terms of radiative strength function. Leaning upon a concept of Lane /3/, one can conclude that the strength of uncorrelated parts of correlated partial radiation widths is equal to that of the uncorrelated widths. Within this concept observation of enhancement of some transitions with respect to those that are presumably uncorrelated may thus serve as an indirect evidence for the R-correlation. This motivated us to undertake the the present experiment.

2. DATA AND THEIR ANALYSIS

We studied the neutron capture in ^{173}Yb by the method of resonance-averaged capture. The measurements were performed using the BNL Filtered Beam Facility at neutron energies of 2 and 24 keV. An enriched target of Yb_2O_3 with a thickness of 0.032 atoms of ^{173}Yb per barn has been used.

Averaged intensities of E1-transitions, yielded from 2 keV measurements, were reduced to energy-independent form by using the reduction factor $\sigma_{\gamma abs}(E_\gamma)E_\gamma^2$, where $\sigma_{\gamma abs}$ is the photoabsorption cross section. The resulting reduced intensities are plotted in Fig. 1. The data points, represented by filled symbols, belong to primary E1-transitions.

Within the concept of Lane /3/ one can express the enhancement of correlated transitions in terms of the average coefficient of correlation R:

$$Q \simeq 1/(1 - R).$$

For the above-mentioned transitions to the neutron 2QP levels a value R = 0.30 has been obtained /1/. The observed value of Q_{exp} is thus noticeably lower than the expected value $Q \simeq 1.4$. Therefore, if the R-correlation really exists, this result suggests that the concept of Lane is not fully justified. A similar conclusion has been independently drawn in /6,8/.

All results of this work are based on the results of the J^{π} assignments mentioned in Sec. 2. A combination of the data from /6/ with those, extracted from our 24 keV measurements, speaks strongly for the correctness of the assignments. The only critical case is the J^{π} value of the 2QP level at 2123 keV. A high intensity of the transition to this level suggests that a correct J^{π} value is 2^+ or 3^+. Nevertheless, looking at the data in /4/, the original $J^{\pi} = 4^+$ assignment seems more probable. In addition, analysis of the discrete resonance data /6/ left this assignment unchanged.

The present data give an indirect evidence for the observed non-statistical effects in the $^{173}Yb(n,\gamma)^{174}Yb$ reaction. It should be stressed, however, that this conclusion is made with a limited significance of 99.5 % and is valid only if the adopted J^{π} assignments are correct.

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