"PACKING" OF THE EXCITATION LEVELS OF LIGHT NUCLEI NEAR THE THRESHOLDS

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An analysis of available experimental data on excitation levels of light nuclei is carried out with the purpose of determining the correlation between the thresholds and levels. The excitation level is found to increase near the thresholds.

IT was indicated by Baz'[1] that several singularities should be observed in light nuclei at excitation energies close to the threshold of the two-particle decay, i.e., when $A^* \rightarrow X + Y$. In particular, the probability of appearance of excitation levels near the threshold should increase. It is of interest to analyze the known experimental data[2] in order to verify the existence of such an effect.

Such an attempt was made by Inglis[3]. However, he considered a small number of cases, so that his conclusions are not sufficiently convincing. Yet the number of analyzed cases can be increased by considering thresholds such that one of the decay products is formed in the excited state, i.e., when

$$A^* \rightarrow X^* + Y.$$

We have considered the known levels of the light nuclei from He^5 to C^{11} inclusive. The level scheme of B^{11}, shown in Fig. 1, illustrates clearly the analysis method: for each thresholds such that one of level and find the quantity

$$\xi = \Delta_1 / \Delta_2,$$

where Δ_1 is the energy difference between the positions of the given threshold and the excitation level, and Δ_2 is the average distance between the excitation levels near the threshold, determined

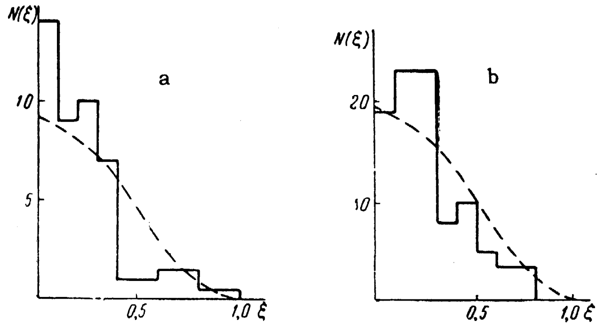

FIG. 2. Distribution of the probability of occurrence of levels near: a – neutron threshold, b – thresholds with emission of charged particles.

from the three levels closest to threshold.

Thus, statistics are accumulated on a large number of thresholds and the functions $N(\xi)$ determined, where $N(\xi_0)$ is the number of events corresponding to the given ξ_0. Altogether, 143 thresholds were considered. These data are given in the form of histograms on Figs. 2a (neutron thresholds), and 2b (thresholds with emission of charged particles). In the absence of correlation between the positions of the levels and the thresholds, the distribution function $\tilde{N}(\xi)$ would have the form shown by the dashed curves of Fig. 2.

The method used to plot this curve can be readily explained from Fig. 3. Let the threshold

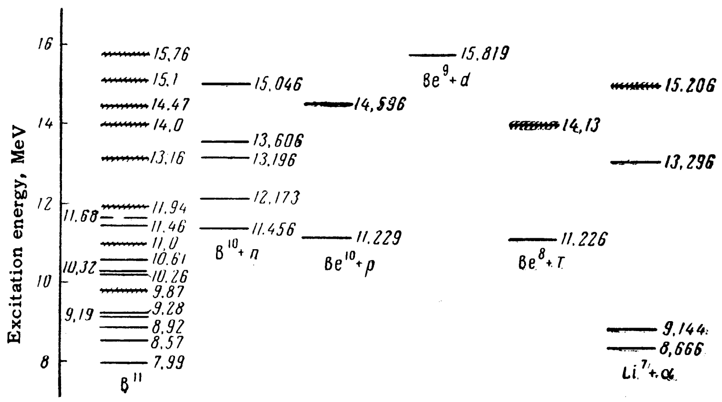

FIG. 1. Part of the scheme of B^{11} excitation levels with corresponding thresholds.

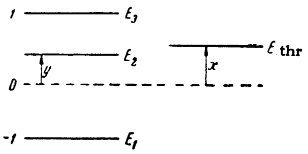

FIG. 3

be located at the point x, and let the probability of finding the level closest to the considered threshold at the point y be f(y). Then the probability of finding the level at a distance ξ from this threshold is $f(x+\xi) + f(x-\xi)$. In such a case, in the absence of correlation we have

$$\widetilde{N}(\xi) = \int_{-(1-\xi)}^{1-\xi} [f(x+\xi) + f(x-\xi)]\, dx.$$

The function f(y) was determined empirically for all the cases under consideration, using the distribution of the levels E_2 between E_1 and E_3. From a comparison of the histograms of Fig. 2 with the curves obtained under the assumption of the absence of correlation, it is seen that in both cases, for small ξ, there are noticeable deviations exceeding the possible statistical errors.

Thus, in the case with neutron thresholds there is a tendency towards a condensation of the levels near the thresholds. It turns out that when $0 \leq \xi \leq 0.1$ we have

$$N(\xi)/\widetilde{N}(\xi) = 1.45 \pm 0.25.$$

For thresholds corresponding to the decay into charged particles, the condensation of the levels is observed at a certain distance from the threshold. In this case the maximum ratio is

$$N(\xi)/\widetilde{N}(\xi) = 1.40 \pm 0.25$$

at $0.1 \leq \xi \leq 0.3$.

The condensation of the excitation levels of light nuclei near thresholds apparently confirms the existence of different nucleon groups on the "surface" of the excited nucleus.

In conclusion, the authors thank A. I. Baz' for valuable comments.

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