FEW-NUCLEON EFFECTS IN BINDING ENERGIES OF NUCLEI

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Shell effects have been studied in values of separation energies of two protons S_{2p} (from compilation /1/) in a broad scope of nuclei. Regularities in the separation energies of nucleons discovered earlier /2/ have been confirmed. In fig. 1 the ideogistogram of the distribution of S_{2p} for all N-even nuclei in the range Z=3—90 is shown (discreteness of energy scale is 100 keV, interval of summation is 300 keV, values with uncertanties less then 100 keV were used). Grouping of S_{2p} in maxima (fig. 1) reflects the systematic effect of nearness of values for Z and N, close to shell-model numbers Z=50, 64,82 and N=50,82 and 126. The interval of grouping (ε_0=1022 keV) marked on fig. 1 was obtained from two-proton separation energy in ^{212}Po ($S_{2p}=10\varepsilon_0=10220\pm1$ keV, two protons are located in the shell beyond the Z=82 shell). The proximity of S_{2p}-values to $15\varepsilon_0$ and $16\varepsilon_0$ turns out to be in some cases in the vicinity of several tens of keV. For example, in ^{208}Pb and ^{202}Hg (differing by two protons and four neutrons) values S_{2p} (15381±20 keV and 15323±20 keV) deviate from $15\varepsilon_0$ by 51 and 7 keV. The dependence of S_{2p} on atomic number Z for N-even nuclei is shown in fig. 2. Here, for convenience, values S_{2p} for the nuclei that differ by one proton and two neutrons are connected with a line. One may notice regions of constancy of S_{2p} and the values of $n\varepsilon_0$ (marked on the y-axis) corresponding to them (±150 keV). The distance between the nearly constant values of S_{2p} is influenced by two additional neutrons. Long-range correlations were found in the binding energies of nuclei that differ by several pairs of nucleons (clusters ^{4}He and ^{6}He) /3/. A fine structure analogous to the grouping in excitation energies E^x for a broad scope of nuclei /4/ was found in distributions of separation energies of one or two nucleons ((known with an uncertainty less then 30 keV). The simultaneous analysis of E^x and binding energies of nuclei is based on the suggestion of A. Bohr /5/ that these values contain information on residual interactions. The parameters of few-nucleon effects were derived 1) from linear trends in the A-dependence of separation energies of outer nucleons (protons beyond the Z=50 shell and neutrons beyond the N=82 shell) and 2) from the analysis of E^x in nuclei with two and three nucleons beyond the closed shells. The distribution of other nuclear characteristics including the distribution of S_{2p} (fig. 1 and 2) were used to check the values of parameters ($\varepsilon_0/3$=341 keV and 323 keV=$D_0/4$, where $\varepsilon_0=2m_e$ and D_0=1293 keV are electromagnetic splittings of masses of particles /2—4/.

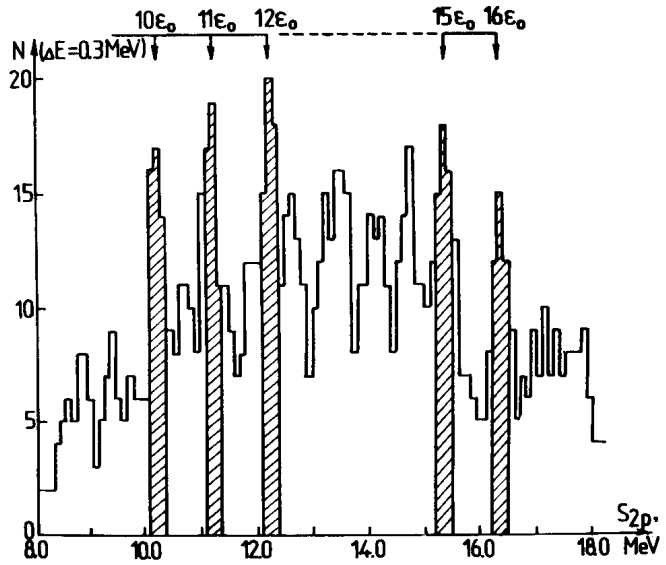

Fig. 1. Distribution of S_{2p} (separation energies of two protons) for N-even nuclei with Z=3—90

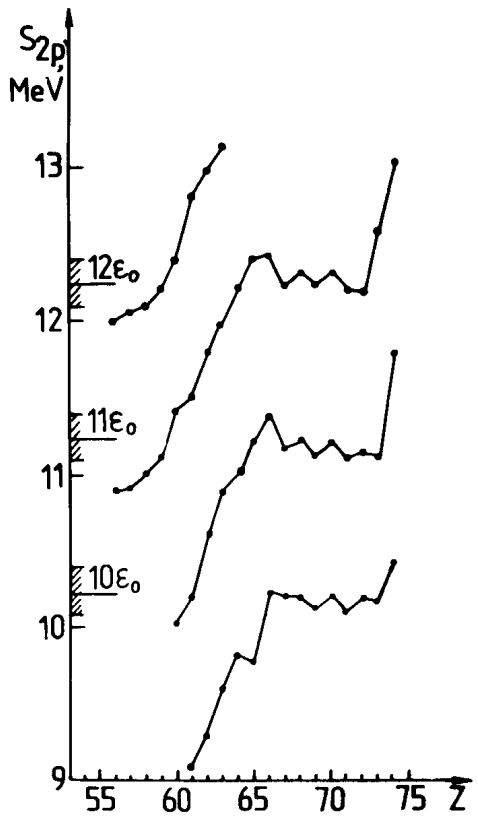

Fig. 2. Dependence of S_{2p} on Z for N-even nuclei with Z=56—74

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