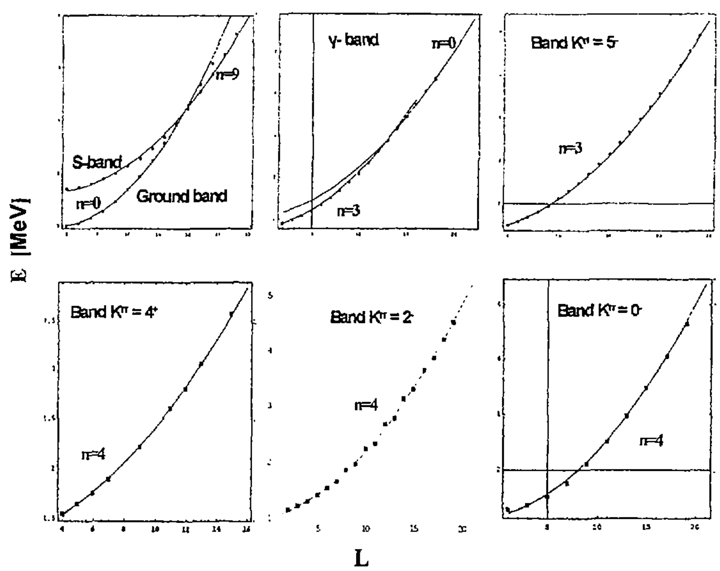
Comparison of IVBM calculations with experiment in ^{162}Dy



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ON THE DETERMINATION OF THE VERTEX CONSTANTS AND ASYMPTOTIC NORMALIZATION COEFFICIENTS

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The nuclear vertex constant (VC) G_{abc} is the on-shell matrix element of the virtual decay (or synthesis) of a composite system into fragments b and c: $a \leftrightarrow b+c$. It is proportional to the asymptotic normalization coefficient (ANC) of the wave function of the system a in the $b+c$ channel. VC's and ANC's are important nuclear characteristics. They determine the cross sections of low-energy nuclear reactions with charged particles, in particular, of the peripheral astrophysical nuclear reactions [1]. There are different methods to obtain information on the values of VC's and ANC's, either from the analysis of experimental data or by calculating them using approaches of nuclear structure theory. Some of these methods are described in the review article [2]. In the given work, the new method of determining VC's is suggested, which makes use both of the experimental information and of the analytical properties of the scattering amplitudes. We consider two integrals over k of the partial wave amplitude $f_l(k)$ of the elastic $b+c$ scattering in the complex k plane, k being the relative momentum of b and c. In the first integral (I_1) $f_l(k)$ is integrated along the real k axis where its values could be in principle taken from the phase-shift analysis of the corresponding data. The integration path of the second integral (I_2) is chosen along the dynamical cut of $f_l(k)$, which is situated on the positive imaginary k semi-axis. The integrand of I_2 is the discontinuity of $f_l(k)$ on this cut. Its explicit form follows from the analytical properties of $f_l(k)$. If there exists the bound state a with the angular momentum l in the $b+c$ system, then, according to the Cauchy theorem, the sum I_1+I_2 is equal to $2\pi i$ res $f_l(k)$, where res $f_l(k)$ is the residue of $f_l(k)$ at the pole corresponding to the binding energy of a in the $b+c$ channel. This residue is expressed directly in terms of the sought-for VC G_{abc} [2]. The integration limits of I_1 and I_2 are infinite and practically one knows the integrands in the limited intervals only. To improve the convergence of the integrals, one may multiply the integrand $f_l(k)$ by exp(ikR) where R is an arbitrary parameter, the value of which does not influence the value of the extracted G_{abc}.

To test the suggested method, a model example was considered. The amplitude $f_0(k)$ was constructed in the explicit form, which satisfied the unitarity conditions and displayed the correct behavior at $k \to 0$ and $k \to \infty$. In the upper half-plane of k, $f_0(k)$ possesses a dynamical cut beginning at $k = i\gamma$ and a pole at $k = i\kappa$ corresponding to the single bound state. The parameters of $f_0(k)$ were fitted to the low-energy parameters of the neutron-proton scattering in the triplet S state. In the example under consideration, the integrands of I_1 and I_2 are written in the explicit form and the integration could easily be done. Using the method described above resulted in the determination with a high accuracy of the VC G_{dnp} corresponding to the $d \to n+p$ vertex. It was corroborated that including the exp(ikR) factor considerably improved the convergence of the values of the VC.

It is worth noting that VC's are more fundamental quantities than ANC's. Indeed, VC's are related in the model-independent way to scattering amplitudes whereas the formula relating the ANC to the corresponding VC contains the combinatorial factor depending on the model of the wave function used, namely, on the way of its antisymmetrization.

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