It can be shown that the second condition is also satisfied for the indicated point groups. The selection rules and the formulas for the intensities of the transitions can be easily obtained from expression (2) by known methods, and are therefore not given here.

The quantities $a_n^{\beta\gamma}$ in (2) can be calculated from the matrix formula $a^{\beta\gamma} = L^{-1}A^{\beta\gamma}$, where L is the matrix of the forms of the oscillations, the elements of the column matrix $A^{\beta\gamma}$ depend on the structural parameters of the molecule [2], and the quantities $(\partial\mu/\partial q_n)_e$ can be obtained from the intensities of the infrared absorption ground bands.

The estimates in [1] for methane and our estimates for the boron trichloride molecule show that the spectra considered here can be observed in the microwave and the long-wave infrared regions of the spectrum.

A detailed description of the investigation with the results of the numerical calculations, and also questions pertaining to induced centrifugal distortions by rotational spectra of nonpolar molecules in excited vibrational states will be published separately.

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A NOTE ON THE ASYMPTOTIC CONDITION OF NUCLEAR-FORCE SATURATION

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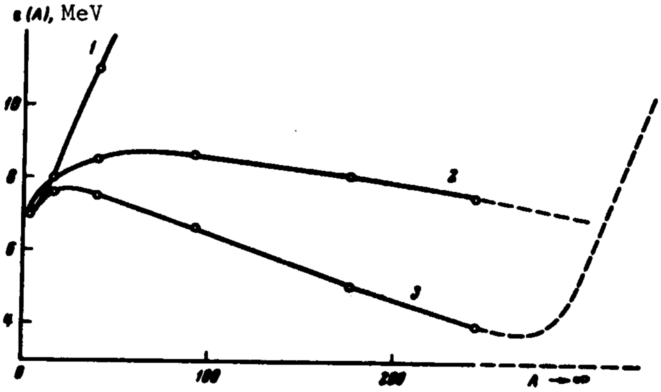
Simonov and Calogero (see, e.g., [1]) have recently derived the necessary asymptotic conditions for the saturation of nuclear forces and have shown that they impose rather stringent limitations on the nuclear forces. In any case, practically none of the presently known NN potentials satisfy these conditions. This means that when a number of nucleons A is sufficiently large, the system collapses and the binding energy per nucleon increases with increasing A.

In this article we wish to call attention to the fact that the asymptotic saturation conditions need not always be related to saturation in real nuclei.

The figure shows three possible plots of the binding energy per nucleon ε against A. Curve 1 corresponds to the case when the asymptotic behavior with respect to A sets in already in the region of real nuclei. It was obtained for the well-known Volkov potential [2]: for He^4 and O^{16} it gives more or less good results, and collapse takes place already starting with Ca^{40} (see [3]). If the NN potential leads to an ε(A) plot of type 1, then one can state quite definitely that it is not



realistic. Curve 2 corresponds to the case when the NN potential satisfies all the saturation conditions and the binding energy per nucleon in the region of large A can even decrease with increasing A, owing to the Coulomb interaction of the protons, as is observed for heavy nuclei.

We now stop to discuss curve 3. It corresponds to NN potentials that do not satisfy the asymptotic saturation conditions, and the asymptotic behavior with respect to A sets in far beyond the limits of the region of real nuclei, and a dip due to the Coulomb forces is present in the interval.

How frequently can a relation of type 3 occur? For example, always when the absence of saturation is attributed to the presence in the NN potential of a static LS interaction that gives a relation of the type $A^{7/3}$ for the total energy in the collapsed state, which is higher than that given by central static potentials (see [1]).

In view of its smallness compared with the central forces, the rise of curve 3 begins somewhere beyond the limits of the region of real nuclei. The structures of the nuclei are significantly different in the region of real A and in the region of the start of the rise of curve 3 and beyond. In the former case the average orbital and spin momenta are small, if not equal to zero, whereas in the latter case they are large (see [1]).

A similar dependence can be obtained also for central static forces. Apparently, it will be obtained when the potentials do not satisfy the saturation conditions, but the collapse sets in at large A - beyond the limits of the region of real nuclei. The dip on the curve is due to the Coulomb repulsion. We note that the relative role of the Coulomb forces in the collapsed state is very small, owing to the smallness in comparison with the nuclear forces, but in the non-collapsed state the Coulomb interaction at sufficiently large A influences strongly the state of the nucleus. This change in the role of the Coulomb forces is connected with their long-range character.

For concreteness curve 3 in the region of real nuclei was drawn through the points obtained in [3] for one such potential (in the approximation of the minimal K of the K-harmonics method). Its rise to the asymptotic value, shown by the dashed line, follows quite obviously from the results of [4], where an asymptotic value ($A \to \infty$) was obtained for the binding energy in this approximation.

We note that such a behavior of the binding energy (curve 3), as can be readily understood, is not the result of the approximation made (minimal K), but is due to the Coulomb forces. An exact calculation will change the quantitative results, but the qualitative course of curve 3 should remain unchanged.

It now remains to ascertain whether the NN potential should be regarded as nonrealistic if it gives a dependence of the type 3. There are two possibilities here: 1) the rise of curve 3 begins at densities much higher than those of real nuclei; at these densities, relativistic effects become important and we have no right to assign any physical meaning to this part of curve 3, because the potential formulation of the problem is no longer valid; in this case such a potential should unconditionally be regarded as realistic; 2) the rise of the curve 3 begins at densities that are higher than the usual density, but are insufficiently large to make the relativistic effects predominant. In this case, too, one can hardly regard such a potential as nonrealistic. To be sure, this raises the question of the feasible existence of such exotic nuclei, as already discussed by the authors of [1].

The following should be noted here: even if such nuclei do exist, they are separated from the region of real nuclei by a giant barrier, which excludes under ordinary conditions transitions between these states, and if they are formed at all, this occurs somewhere in "singular points" of the universe, for example in galactic nuclei or in the case of gravitational collapse of stars.

It follows from all the foregoing that the asymptotic saturation conditions are not always an unconditional test in the search for NN potentials.

In conclusion, I am grateful to A.I. Baz' for discussions.

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SOFT-PION THEOREMS AND DIRECT NUCLEAR PROCESSES

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We have obtained the spectra of soft pions emitted in direct stripping and pickup nuclear reactions. It is shown that the pion spectra are not sensitive to the mechanism of the direct nuclear reactions.

We investigate here the applicability of the so-called soft-pion theorems (see [1, 2]) against direct nuclear stripping and pickup reactions. In this connection, we consider two processes: the possibility of extrapolating nuclear amplitudes with respect to the momentum transfer q^2 to a point corresponding to the mass of the physical pion, and the possibility of obtaining information concerning the mechanism of the direct nuclear processes by investigating reactions with emission of soft pions.

Of greatest importance in the question of the feasibility of the extrapolation procedure is a determination of the rate of change of the nuclear amplitudes with respect to the momentum transfer q^2 when $q^2 \lesssim \mu^2$ (μ is the pion mass).

To this end we have considered a broad class of diagrams with pion emission by one of the nucleons of the nucleus. This class of diagrams has a singularity in the momentum transfer to the nucleus at $q^2 = M\varepsilon$ (M is the nucleon mass and ε its binding energy in the nucleus). In the particular case of a deuteron, this singularity corresponds numerically to $q^2 \simeq 1.2\mu^2$. It follows therefore intuitively that extrapolation of the amplitude to the physical pion over a distance on the order of $q^2 \lesssim \mu^2$ may turn out, generally speaking, not valid. This situation differs significantly from that in elementary-particle theory where one can hope the ratio of the pion mass to the characteristic mass of the process to be $\mu/m_{char} < 1$ [2]. For this reason, the extrapolation procedure turns out to be valid here. On the other hand, in the case of direct nuclear processes, the characteristic-mass is of the order of $m_{char} \sim \sqrt{M\varepsilon}$ [3]. Taking this result into account, we can conclude that the process of the validity of the extrapolation procedure in nuclear processes should be considered separately in each concrete case. In this connection, it is apparently necessary to approach the results obtained without such a special investigation with some caution (see, e.g., [4]).