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Prospects of theoretical nuclear spectroscopy of light nuclei

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The modern theory of the structure of light nuclei is dynamically developing due to the introduction of ab initio (from first principles) methods of describing nuclear systems. An essential place among such methods is occupied by various versions of No-Core Shell Model (NCSM) (see, for example, [1]) that uses realistic NN potentials to describe the interaction of nucleons. Usually, these potentials are derived from Chiral Effective Field Theory. The discussed approach makes it possible to successfully describe the spectra of nuclei up to masses A ˜ 16 in a wide range of energies. The radii and electromagnetic moments of the low-lying states of nuclei and, in part, the electromagnetic M1 and E2 transitions are also described satisfactorily.
In the literature, there are also several successful attempts to describe the total widths of the nucleon and cluster decay of nuclear states [2,3]. In our works [4, 5], we developed a method that makes it possible to solve the problem of multichannel decay of nuclei and calculate the partial widths of decay into a variety of channels. The talk demonstrates the capabilities of the developed approach: a wide range of studied levels, the quality of description of level energies, total and partial widths known from experiment. The decay characteristics of the known and not yet discovered states, as well as the energies of the latter, are predicted. The most striking prediction seems to be the prediction of a new previously not observed rotational band of strongly clustered states 0+, 2+, 4+ in the 8Be nucleus.
As a result, it is demonstrated that the complex of NCSM-based approaches developed to date by various theoretical groups has great predictive power and, in the near future, will become the basis of the direction that can be called theoretical nuclear spectroscopy of light nuclei.

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