New developments in low-energy QCD

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Wednesday, September 15, 2021, 10:00 - 10:30

For almost 90 years we have built theories of the atomic nucleus based upon the solution of the many-body problem for protons and neutrons interacting through two- and three-body forces with no reference to the internal structure of the nucleons, which we now know is governed by QCD. Modern effective field theories of atomic nuclei are based on the idea that the energy scales associated with nuclear physics are too low for the internal quark and gluon structure of nuclei to be of concern. While that approach has a number of important successes it is quite unsatisfactory from a fundamental point of view. The EMC effect, for which there is no agreed explanation, strongly suggests that there is more to nuclear structure. Furthermore, we have known for almost 50 years that the relativistic mean-fields in nuclei are very large with the scalar potential as much as 40% of the mass of the nucleon. The effect on the internal structure of a nucleon caused by a scalar potential is fundamentally different from that of a vector potential and this undermines the energy scale argument noted above. We shall explain why the change of hadron structure in-medium is important, how it leads to a new paradigm for nuclear structure and how such an approach leads to a remarkably efficient description of many nuclear phenomena.