CHALLENGES IN NUCLEAR STRUCTURE THEORY

Achim Schwenk
Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany
ExtreMe Matter Institute EMMI, GSI, 64291 Darmstadt, Germany
Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

The strong interaction described by quantum chromodynamics is responsible for binding neutrons and protons into nuclei and for the many facets of nuclear structure physics. Combined with the electroweak interaction, it determines the structure and properties of all nuclei in the nuclear chart in a similar way as quantum electrodynamics shapes the periodic table of elements. While the latter is well understood, it is still unclear how the nuclear chart emerges from the underlying forces.

During the last decades, nuclear structure theory has made great progress on many fronts and evolved into a field with a systematic theoretical foundation, with nuclear forces based on the underlying interactions and advanced methods to solve the nuclear many-body problem with controlled uncertainties. Effective field theories have played a guiding role in this process, as they reduce the complexity of the underlying theory to the relevant degrees of freedom in a systematic way.

In this talk, we will review the advances, status and challenges in understanding and predicting nuclei based on effective field theories of the strong interaction and complementary approaches. In addition, we will discuss new opportunities in the exploration of electroweak interactions in nuclei, which provides unique insights to nuclear structure and is key for tests of fundamental symmetries and for nuclear and particle astrophysics.