

Nuclear physics: the ISOLDE facility

The lecture is aimed at both physics and non-physics students. It deals with the physics of the CERN-ISOLDE facility, which is devoted to the production and studies of radioactive nuclei. The ISOLDE research covers classical nuclear physics, nuclear astrophysics, fundamental studies and applications in material science, biology and medicine.

In this lecture I will give a comprehensive introduction to the questions and challenges in modern nuclear physics, followed by a description of the ISOLDE facility and several examples of ISOLDE experiments and their recent results, covering a wide variety of topics.

Nuclear physics deals with the interaction of nucleons inside atomic nuclei and their resulting properties, such as mass, half-life, or energy levels. Although it is a field which started in the first half of XX century, it has flourished in the last few decades due to the advent of radioactive-beam facilities, such as ISOLDE at CERN.

Out of 3000 atomic nuclei identified until now, only the 300 stable nuclei formed the basis for the first nuclear-structure models, such as the nuclear shell model, crowned with the Nobel Prize in 1960's. It turns out that with much different proton-to-neutron ratio the radioactive nuclei exhibit new properties which the models have a hard time predicting. Formation of halo-like structures, neutron and proton emission, or "migration" of closed shells are a few examples.

Thus, the topics of modern nuclear physics are connected to improving our description of atomic nuclei, searching for the limits of their existence, and connecting the existing models to the underlying theory of quantum chromodynamics. Radioactive nuclei at facilities like ISOLDE are also used for astrophysics and the understanding of element formation in the stars, as well as applications in condensed matter, bio- and medical physics.