

Hadrons in their simplest form called mesons are systems composed of a quark and an antiquark bound together by gluons (from the word *glue*). We know them for decades - they do agree very well with predictions of the fundamental theory of quarks and gluons - the Quantum Chromodynamics (QCD). However, it was clear from the early days of QCD [after discovery of first quarks (in 1969)] that QCD also predicts the existence of the other, more complex exotic mesons: diquark-antidiquark and meson-meson states, as well as glueballs (purely gluonic) and hybrids (quark-antiquark-gluon). Their final discovery in the low-energy domain has still to come.

Since several years the search for exotics is one of the most active topics of analyses performed by hadronic physicists around the world. A laboratory where in the coming years an intensified search of these states will be conducted is the Jefferson Laboratory (JLab) in the USA - one of the largest currently active labs worldwide. In order to find exotic mesons at JLab, a specially designed detector called GlueX was built. It started operations in year 2017. Collected data will require a thorough experimental and theoretical analysis. According to various theoretical models the signal from these states will be very weak, so to distinguish them from large background produced by already known standard (quark-antiquark) mesons, the measurements must be very accurate and the analyses of the data certain and unambiguous. This places very high demands on all groups which work for this experiment and therefore they must work together intensively.

The reason for such interest of physicists in searching for the exotic mesons is their role in QCD. Finding such mesons would be on the one hand a very strong confirmation of QCD and, on the other hand, it would give a unique opportunity to gain a better understanding of fundamental interactions of quarks - mainly confinement which forces quarks to be always in the company of other quarks. In case of mesons these are for example mentioned already pairs quark-antiquark.

Each meson has its own characteristic quantum numbers imposed by quarks and their interactions. Conventional quark-antiquark mesons have generally well-understood (standard) quantum numbers. However, exotic mesons can have either standard quantum numbers or, so called, exotic quantum numbers. So, if a new hadron with exotic quantum numbers is discovered, one can certainly conclude that an exotic meson has been experimentally discovered. It will be the smoking gun of the discovery of the first exotic meson in low-energy QCD. Some candidates do already exist, but a definitive confirmation is needed. Finding exotic mesons 'hidden' among mesons with standard quantum numbers will be more difficult because it requires separation of often very large backgrounds caused by standard mesons. Therefore, the emphasis in the search for exotic mesons is placed on accuracy and uniqueness of methods used in analyses of standard mesons.

In JLab mesons will be produced in a process called photoproduction, that is by means of collision of a photon with a proton. As a result of the interaction between them, a number of fast flying light mesons are produced, some of which can be the long searched exotic mesons. The main advantage of the photoproduction over other processes, in which the hadron (proton) collides with another hadron also composed of quarks, is the great simplicity of the process. This is due to the fact that the photon (in the first approximation) interacts directly with constituent quarks of proton, without mediation of other quarks and gluons. In hadron-hadron collisions the short-range strong interactions between quarks lead to the production of a much larger number of different mesons than in case of photoproduction. In this case isolating exotic mesons from the large background would be very difficult.

Yet, photoproduction involves electromagnetic interaction which is much weaker than the strong force alone. Hence, the accurate measurements of momenta and directions of the flying mesons and their subsequent analysis will enable the separation of weak signals of the searched mesons from large background created by standard ones. One has to keep in mind here that there will be millions of measured fast moving light mesons which will emerge in fractions of seconds. This requires the use of extremely advanced detector and high-speed computers with sophisticated software developed for this scope over many years.