



Contribution ID: 111

Type: not specified

Status and perspectives of the search for eta-mesic nuclei

Friday 11 March 2016 08:30 (30 minutes)

The negatively charged pions and kaons can be trapped in the Coulomb potential of atomic nucleus forming so called mesonic atoms. Observations of such atoms allows for studies of strong interaction of pions and kaons with atomic nuclei on the basis of shifts and widths of the energy levels. It is also conceivable that a neutral meson could be bound to a nucleus. In this case the binding is exclusively due to the strong interaction and hence such object can be referred to as a mesic nucleus. Here the most promising candidate is the η -mesic nucleus since the η -N interaction is strongly attractive.

The η -mesic nucleus was predicted about 30 years ago. Many promising indications of the existence of such an object were reported, but so far none was independently confirmed. Initially the η -mesic nuclei were considered to exist for $A \geq 12$ only due to the relatively small value of the η N scattering length estimated in eighties. A decade later, large values of the η -nucleon scattering length (up to 1 fm) were extracted in some analyses. Such large value does not exclude the formation of bound η -nucleus states for such light nuclei as helium or even for deuteron. However so far there is no direct experimental confirmation of its existence. The search of the η -mesic nucleus was conducted in many inclusive experiments via reactions induced by pions, protons, deuterons and photons. In the case of the eta-mesic helium the determined upper limits are close to the newly predicted values of total cross sections.

The status and perspectives of the search for the eta-mesic nuclei will be reviewed emphasizing the high statistics and exclusive measurements conducted with the WASA detector at COSY.

For references see the reviews:

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Session Classification: Friday Morning