Photo-production of the $f_0(980)$ scalar meson

Most of ordinary matter is made of hadrons, i.e. baryons, made of three quarks, and mesons, made of a quark and an anti-quark pair. Since the discovery of the pion, a number of different mesons has been identified and studied. However many open questions about these particles still remain.

There are indications that some of the mesonic states that have been observed in experiments may be made by different quark configurations than $q\bar{q}$. In particular light scalar mesons as the σ, κ, *f_0(980)* and *a_0 (980)* have been suggested as candidates for tetraquarks or meson molecules, because of the peculiar ordering of their mass spectrum that disfavors the naïve $q\bar{q}$ picture. Information about their internal structure can also be inferred by the production mechanisms. For example, some authors suggest that a compact $q\bar{q}$ system is expected to be observed as a peak in the invariant mass distribution of its decay products, while a diffuse state, e.g. a meson molecule, would more likely appear as a dip.

A very clean way to excite scalar mesons is the photo-production process. The study of observables such as the cross section or the mass distribution of the decay products as a function of the excitation energy might shed light on the internal structure of these mesons.

Due to the small probability to be produced with electromagnetic probes, only sparse data were available so far. The situation changed radically with the new generation of photo-production experiments running in the Hall-B of Jefferson Lab. The high photon flux together with the excellent performance of the 4π CLAS detector allowed us to measure for the first time the *f_0*(980) meson in a photo-production experiment. The meson was observed in the decay to $\pi^+\pi^-$, when the angular distribution of the two pions corresponds to an S-wave, which identifies scalar mesons.

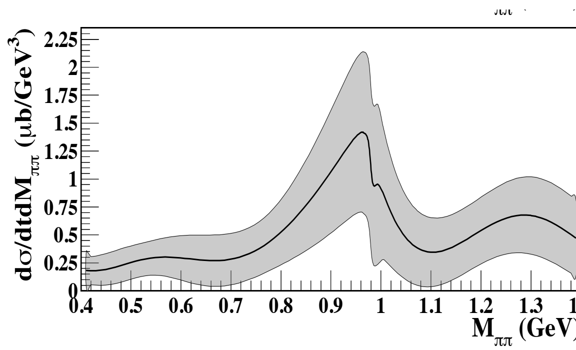

Figure 1: S-wave differential cross as a function of the di-pion invariant mass.

The probability to produce this meson state was found to be 50 times smaller than for other well established resonances, as the ρ meson.

The CLAS results show that photo-production can really be used as a powerful tool to study the meson spectrum, opening a wide experimental program that will be continued with the 12 GeV upgrade of Jefferson Lab and the newly designed CLAS12 detector.

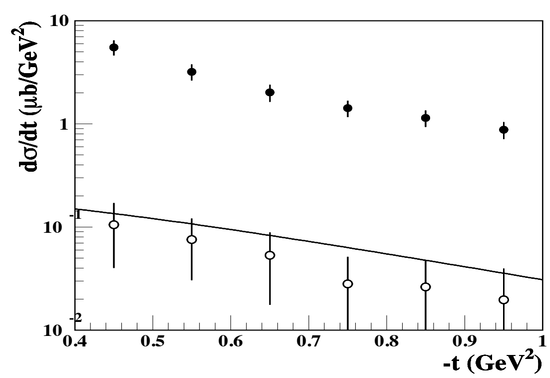

Figure 2: S-wave differential cross section in the mass region of the *f_0*(980) (red) is about 50 times smaller than the p-wave differential cross section in the mass region of the ρ meson (black).