Quark Nuclear Physics with a Photon Beam at Elphs Lab

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Abstract

Quark nuclear physics (QNP) is a research field where several aspects of non-perturbative QCD are studied. Hadron structure is a subject to be investigated in detail in QNP, where the nucleon, for example, has other configurations than 3 valence quarks as a fraction, such as 5 quark states, 7 quark states, and so on. From this point of view, we have been working on exotic hadrons like penta-quark baryons experimentally. The QCD vacuum is another subject to be discussed in non-perturbative QCD, where chiral symmetry plays a very important role. It is a widely accepted understanding that chiral symmetry is one of the most fundamental properties of QCD and is spontaneously broken in our real world. The pions are thought to be the NG-bosons associated with dynamical breaking of $SU(2)_L \otimes SU(2)_R$ chiral symmetry down to $SU(2)_V$ symmetry in the simplest case of flavor $SU(2)$. In this scenario, the low mass scalar meson giving the state-independent attractive nuclear force gets a new role in QCD similar to the standard model Higgs remnant in the electroweak interaction. In this regard, experimentally we search for precursory phenomena of a phase transition of the QCD vacuum in nuclei where chiral symmetry is expected to be partially restored. We employ for this purpose a GeV photon beam that is capable of going inside the nucleus in contrast to a hadron beam.

Research Center for Electron Photon Science (ELPH), Tohoku University, operates a 300 MeV electron LINAC and a 1.2 GeV electron synchrotron and provides several photon beams of the energy up to 1.15GeV. The photon beams are generated by the electron accelerators. ELPH is a university-based laboratory and is open not only for users in Tohoku University but for everybody. The talk will provide a glance of research activities at ELPH and cover on-going research projects in QNP.