J-PARC activities in 2012

We report following progresses as highlights on J-PARC activities in 2012.

1. Experimental proposal of charmed baryon spectroscopy at the high momentum beam line was submitted [1].
2. Experimental study of $\Lambda(1405)$ via the d$((K^-, n))$ reaction (E31) [2] got ready to run.

1. Activity at the High-momentum Beam Line

We proposed a new joint-research project of RCNP at the high momentum beam line of J-PARC, which is based on the MOU on research collaboration between RCNP, the institute of Particle and Nuclear Studies, and the J-PARC center. Start up of this research project was approved by the P-PAC of RCNP.

We have submitted an experimental proposal on charmed baryon spectroscopy via the p(π^-, D^{*-}) reaction as a flagship experiment of the above mentioned research project. In a baryon with a heavy charmed quark, the motions of light quarks and a heavy quark are separated. Magnitude of the color-magnetic interaction between quarks is proportional to the inverse of the quark mass. It is expected that a correlation between two light quarks becomes stronger than that between the other pairs. A diquark correlation may be singled out. In this respect, charmed baryons provide a unique opportunity to investigate the diqaurk correlation. The nature of the diquark correlation is expected to appear in the level structure and decays of charmed baryons. If a light quark pair makes a collective system in the charmed baryons, a relative motion in the light quarks (ρ mode) and a collective motion of the pair to the heavy quark (λ mode) split in excited states. Due to the spin-dependent interactions between quarks, the levels split further, as illustrated in Fig. 1. In a λ mode excited state, a decay into a heavy meson and a light baryon, if it opens energetically, is expected to be favored rather than a decay into a heavy baryon and a light meson, where a quark-antiquark pair is created between the correlated light quark pair and the charm quark.

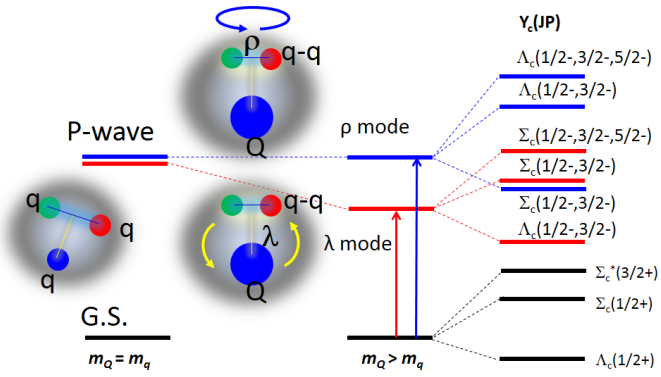

Figure 1: Schematic illustration of level structure of charmed baryons.

We will measure charmed baryons of a wide mass range from the ground state to the excitation energy of about 1 GeV in a missing mass spectrum of the p(π^-, D^{*-}) reaction. An excited charmed baryon decays into a low-lying heavy baryon emitting a light meson, or a heavy meson emitting a light baryon. We can identify such decay modes by detecting a decay light particle in coincidence with the parent charmed baryon reconstructing the other decay particle as a missing mass. Since the parent charmed baryon is identified independent of its decay final state, the decay partial widths can be measured rather easily. The proposed experiment is under discussion for stage-1 approval in the J-PARC PAC.

2. Activity at K1.8BR

The E31 experiment aims to study hyperon resonances below $\bar{K}N$ threshold via the d(K^-, n) reaction. The reaction is expected to enhance an S-wave $\bar{K}N$ scattering process to form $\Lambda(1405)$ [3], where an energetic neutron is kicked at a forward angle. We could reveal how $\Lambda(1405)$ is dynamically generated from $\bar{K}N$. In particular, it is of our interest if $\Lambda(1405)$ has two-pole structure [4] or not, which affects an argument on possible formations of deeply bound kaonic nuclei [5].

The experimental setup for E31 comprises an incident kaon beam spectrometer, particle detectors scattered at a forward angle, and a cylindrical detector system for emitted charged particles associated with a kaon-induced reaction. The setup is originally prepared for the E15 experiment aiming at searching for a deeply bound K^-pp system via the ^{3}He(K^-, n) reaction [6]. For E31, we developed backward proton detector system and the deuteron target system. The former comprises plastic scintillator hodoscopes and a drift chamber, which is located upstream of the target and necessary to identify the $\Lambda(1405) \rightarrow \pi^0\Sigma^0$ decay, as already reported in the past years [7, 8]. The latter has also been prepared as reported before [9], where we have demonstrated to liquify hydrogen in the target cell. Soon after that we have also succeeded to liquify dueterium. We presented that the experimental preparation was completed and received a stage-2 approval for E31 from the PAC for particle and nuclear studies at J-PARC. We are ready to run and waiting for beam time allocation.

References

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