Σp scattering experiment in J-PARC (E40) and its development status

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We are planning to perform a Σ proton scattering experiment in J-PARC (J-PARC E40)[1] in order to investigate the Baryon-Baryon interaction and to confirm the "quark Pauli effect" which is considered as one of the origin of repulsive core. The Σ^+p channel ($\Sigma^+ : uus$, $p : uud$) is expected to have a large repulsive core due to the Pauli effect between quarks, which leads a Σ^+p cross section twice as large as that predicted by meson exchange models treating short range repulsive core phenomenologically. Therefore we can confirm the "quark Pauli effect" by measuring the cross section of the Σ^+p scattering.

Our detector system consists of spectrometer systems to identify the Σ production and detector system (CATCH) around a liquid hydrogen (LH_2) target to identify the Σp scattering events. The target is irradiated with a pion beam and a Σ particle is produced. The momentum of the produced Σ particle is reconstructed from those of π beam and scattered K measured by spectrometers placed at upstream and downstream of the target. As the downstream spectrometer, the KURAMA spectrometer will be used. A cylindrical tracking detector (Cylindrical Fiber Tracker, CFT) and bismuth germanate (BGO) calorimeters surround a LH_2 target. This detector system around the LH_2 target is called as CATCH (Cylindrical Active Tracker and Calorimeter system for Hyperon scattering). The trajectory and the kinetic energy of the recoiled proton are measured by CFT and BGO calorimeters, respectively. The scattering event is identified by reconstructing the kinematics from the scattering angle and the kinetic energy.

CFT consists of 4 straight layers and 4 spiral layers by using about 5000 scintillation fibers. The construction of 2 layers (1 straight and 1 spiral) of the actual type CFT was completed. The efficiencies were obtained to be 98% and 92% for straight layer and spiral layer, respectively. As for the angular resolution, the enough resolution of 1 degree (σ) was already obtained from the prototype detector. The size of BGO crystal is $30 \times 25 \times 400\text{mm}^3$ and 24 BGO calorimeters are used in order to surround CFT. The energy resolution of each BGO calorimeter was obtained to be less than 1% (σ) for 80MeV proton beam which is typical energy of proton for the Σp scattering, and this result satisfies our requirement of 3% (σ).

In this contribution, I will summarize the E40 detector system and the expected results of the cross section measurement. Then I will focus on the current preparation status of the E40 experiment, especially about the development of CATCH and the LH_2 target system.

[1] K. Miwa et al., Proposal for an experiment at J-PARC, http://j-parc.jp/NuclPart/pac_1101/pdf/KEK_J-PARCPAC2010-12.pdf