High statistics Σp scattering experiment using high intensity π beams at J-PARC

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In order to test theoretical frameworks of the baryon-baryon interactions and to confirm the "Pauli effect between quarks" for the first time, we have proposed an experiment (J-PARC E40 [1]) to measure low-energy hyperon proton scattering cross sections in the momentum range of $400 < p$ (MeV/c) < 700 in the following channels,

1. $\Sigma^- p$ elastic scattering,
2. $\Sigma^- p \to \Lambda n$ inelastic scattering,
3. $\Sigma^+ p$ elastic scattering.

We will measure these differential cross sections from 10,000 scattering events for each channel.

According to theoretical models based on quark-gluon picture the $\Sigma^+ p$ channel is expected to have an extremely repulsive core due to the Pauli effect between quarks, which leads a $\Sigma^+ p$ cross section twice as large as that predicted by conventional meson exchange models where short range core is treated phenomenologically. Especially we focus on the differential cross section at 90° in order to determine the strength of the quark Pauli repulsive force, that is the phase shift value, experimentally. Because the dominant contribution for $d\sigma/d\Omega(90^o)$ is the $^3S_1$ contribution which is the almost Pauli forbidden channel, this measurement is a key to determine the strength of the quark Pauli repulsive force. In addition, measurements of the $\Sigma^- p$ channels are also necessary to test the present theoretical models based on meson exchange picture with the flavor SU(3) symmetry. In order to reveal the nature of ΣN interaction, we aim to derive the differential cross sections of the three channels with an accuracy of 10% (typically 0.2 mb/sr) for a wide angular range of $-1 < \cos\theta < 0.6$, where θ is a scattering angle of Σ in the C.M. frame.

In the experiment, we detect two successive reactions of the Σ production and the Σp scattering with magnetic spectrometers and scattered proton detector (CATCH), respectively. CATCH is a key detector for E40 and consists of a cylindrical fiber tracker (CFT) and BGO calorimeter. The trajectory and kinetic energy of the scattered proton are measured by CFT and BGO calorimeter, respectively, to identify the Σp scattering event. Now we are intensively constructing CATCH and will complete the construction within this fiscal year.

In this contribution, we would like to introduce our experiment at J-PARC. We will present our expected results and how to derive the phase shift value of the almost quark Pauli forbidden channel. Then we also briefly mention about our development status of CATCH.

[1] K. Miwa *et al.*, J-PARC proposal, http://j-parc.jp/researcher/Hadron/en/pac_1101/pdf/KEK_J-PARC-PAC2010-12.pdf