J-PARC Proposal Abstract

Systematic Study of Double Strangeness System with an Emulsion-Counter Hybrid Method

Beam-line : K1.8

Beam : 1.7GeV/c K^-;
$4x10^5$ $K^-/spill$ with K^-/π^- >9, Flat-top : 2.0 sec.

Detectors : Nuclear Emulsion, Double-sided Silicon Strip Detectors,
Hyperball-J(Ge detectors), Scintillating Fiber,
KURAMA Magnet, Drift Chambers, Plastic Counters

Beam time : 150 hours [tuning the beam line and detectors
630 hours [data taking]

Abstract

The purpose of the proposed experiment is a systematic study of double strangeness nuclei with 10 times higher statistics than the previous experiments and the first measurement of Ξ^- atomic X-ray. In this experiment, we expect to observe 10^4 stopping Ξ^- hyperons (Ξ^- atoms) in the emulsion via quasi-free (K^-, K^+) reactions on a diamond target.

Recently, we have reported Λ-Λ interaction energy showing weak attractive force by an uniquely identified event of ${}^{6}_{\Lambda\Lambda}$He double hypernucleus called "NAGARA event". However, it is quite important to measure masses of double hypernuclei for several nuclear species to determine the Λ-Λ interaction without uncertainty due to nuclear structure. We expect to find 100 events of double hypernuclei and make a mini-chart of them for the first time, and reveal the world of S=-2 nuclei. We have also observed an event showing a new weak decay of double hypernucleus, decaying to Σ^-. The branching ratio of this decay is expected to be large if the double strangeness exist as the H-dibaryon state in nuclei. This challenge leads us to the knowledge for the origin of nucler force, the exixtence of the H-dibaryon state and strange hadronic matter such as neutron stars.

The proposed experiment became possible due to the improved tagging detectors for the hybrid-emulsion method, high-speed automated emulsion analysis and a high purity K^- beam at the K1.8 beam-line. The measurement of Ξ^- atomic X-ray to study Ξ–nuclear potential is made for the first time. It becomes possible by large acceptance germanium (Ge) detector array called Hyperball which successfully observed many hypernucler γ transitions.

Thus, we request 630 hours for data taking with $4x10^5$ K^-/spill, although we will need 150 hours for tuning the detectors and beams which does not need high intensity beams.