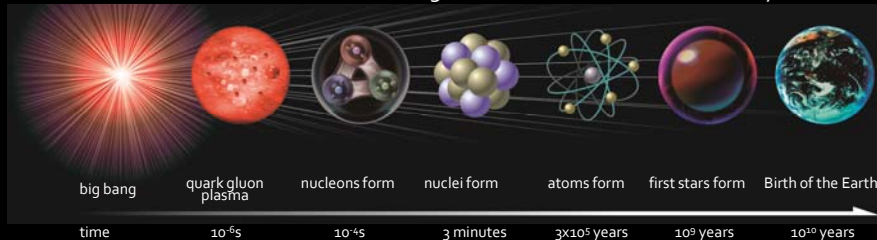


# PARTICLE & NUCLEAR PHYSICS AT J-PARC

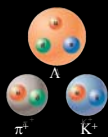
## Explore History of the Universe and Formation of Matter

Megumi Naruki for the Hadron Facility Team



### Matter-Antimatter Asymmetry

Why matter dominates over antimatter?



Hadrons

- Meson ( $\pi$ ,  $K$ , ...)
- Baryon (proton, neutron, strange baryon;  $\Lambda$ ,  $\Xi$ , ...)

### Structure of Hadron

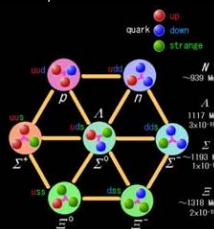
How strong is the strong force, especially between quarks inside a hadron?

### Origin of Mass

By what mechanism is hadron mass generated?

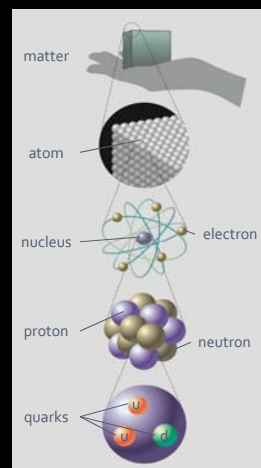
### Origin of Nuclear Force

Can be described with the words of QCD?



Quark Model

Hadron can be described as bound states of quarks.  
**QCD (Quantum Chromodynamics)** describe strong interaction between quarks.



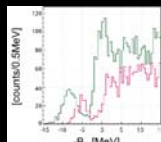
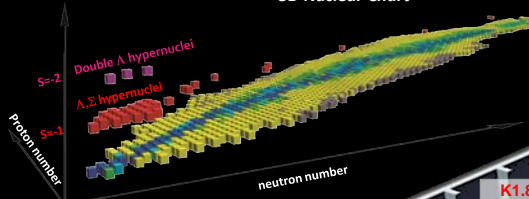
## NEW VIEW OF MATTER PROBED BY KAONS

### Strangeness Nuclear Physics

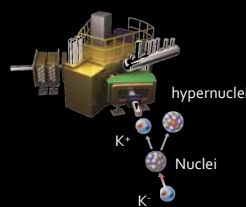
New type of hadron/nuclei that has new quantum number : Strangeness

With the high intensity kaon beam, various physics programs are planned to research new hadron/nuclei which has strangeness at the Hadron Experimental Hall.

### 3D Nuclear Chart



E05 experiment : observe  $\Xi$  hyper nuclei for the first time with high resolution and high statistics, determine the binding energy and life.

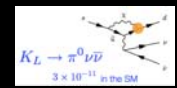


### Inner Structure of the Neutron Star



### Broken Symmetry

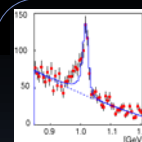
CP violation & T violation  
 The universe is composed of matter, rather than anti-matter. The study of CP violation may explain the asymmetry.



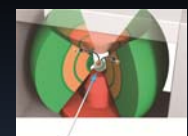
E14 : search for  $K_L \rightarrow \pi^0 \nu \bar{\nu}$  to study CP violation in neutral Kaons. New physics?

### Origin of Mass

if the hadron mass is generated by the spontaneous breaking of the chiral symmetry, it would be decreased at high temperature/high density.

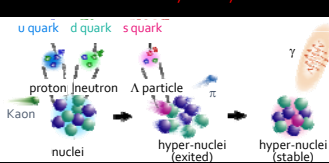


E16 : measure the mass of  $\phi$  meson in nuclear medium. velocity /size dependence of mass modification.

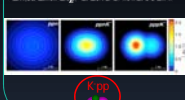


E325 Result: observe mass modification of  $\phi$  meson.

How strong is the Y-N interaction? from nuclear force to baryon-baryon interaction



E15: search for the strange tri-baryon system ( $ppK$ ), which could be extremely dense matter.



E19 : Search for Pentaquark  $\Theta^+$ . approach the QCD at non-perturbative regime.

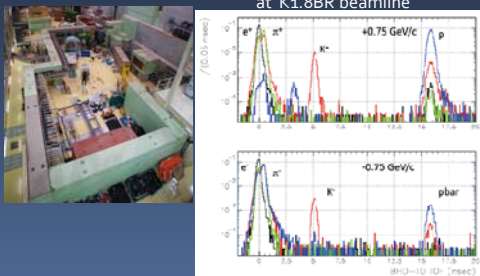
### New Hadrons

search for new hadrons beyond the conventional baryons to

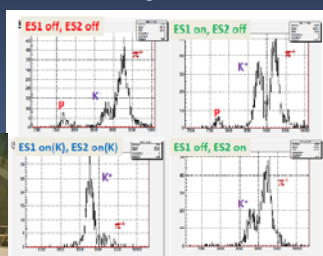
## Recent Results

Successfully confirm the Kaon production at all secondary beamlines. The tuning for the beamlines is now ongoing!

Secondary particle production at K1.8BR beamline



Kaon Enhancement at double-staged K1.8 beam line



$K_L^0$  production at KL beam line

