Systematic Research for Light Kaonic Nuclei

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Discovery Evening 2025
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- Self Introduction -

- Born in Aomori prefecture (青森県) “A lot of snow!” in fig.1
- My hobbies are playing baseball (fig.2), playing Shogi (fig.3) and going to sauna (fig.3).
- I belong to Nishina Center and I often work at J-PARC in Tokai village.
- I major in experimental physics, particle physics and high Energy physics.

fig.1 Winter in my hometown

fig.2 Baseball

fig.3 Shogi(将棋)

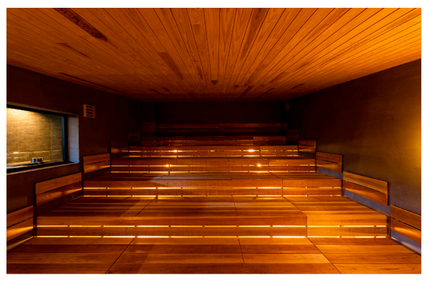
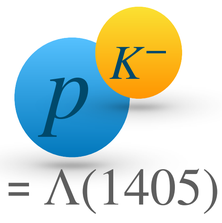


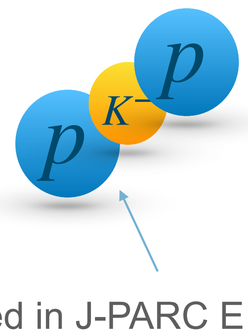
fig.4 Sauna!!!

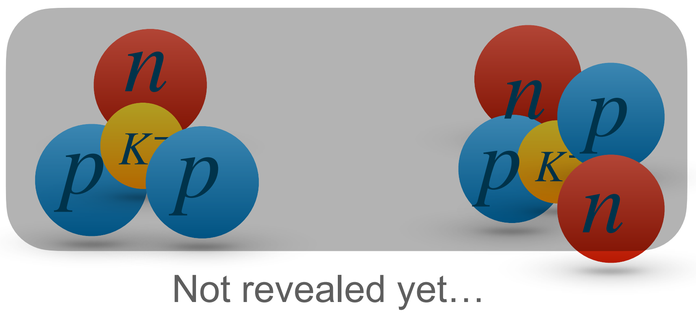
- What are “Kaonic Nuclei”? -

- Kaonic nuclei = anti-kaon($\bar{K}$) — nucleus(N) bound states
  - Predicted from attractive $\bar{K}N$ interaction in $I = 0$ channel and the existence of $\Lambda(1405)$



= $\Lambda(1405)$



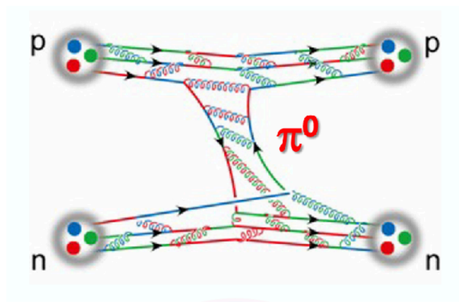


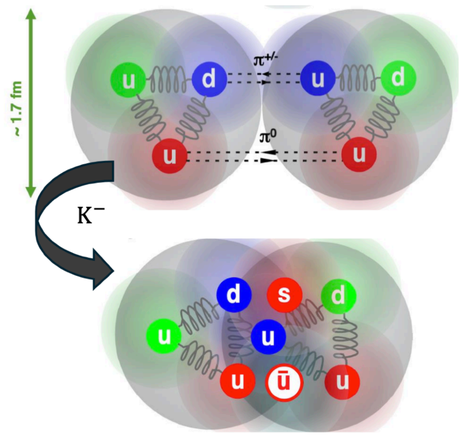
Not revealed yet…

Confirmed in J-PARC E15 experiment

- What is interesting? -

- “Real” meson in nuclei
  - Usualy, meson is “vertial particle” in nuclei (Yukawa theorem). Only in vacuum, real meson exists (cf. meson beam).
- High-density state may emerges
  - Predicted from its bigger binding energy and $\bar{K}N$ attractive force cf. $B.E.(K^-pp) = \sim 50$ MeV, pp -> unbound $B.E.(d = pn) = 2$ MeV
- A hint to understanding the unknown nature of exotic hadrons
  - If these are so dense that their components overlap each other, they could become quark matter, not molecule-like state, I think.

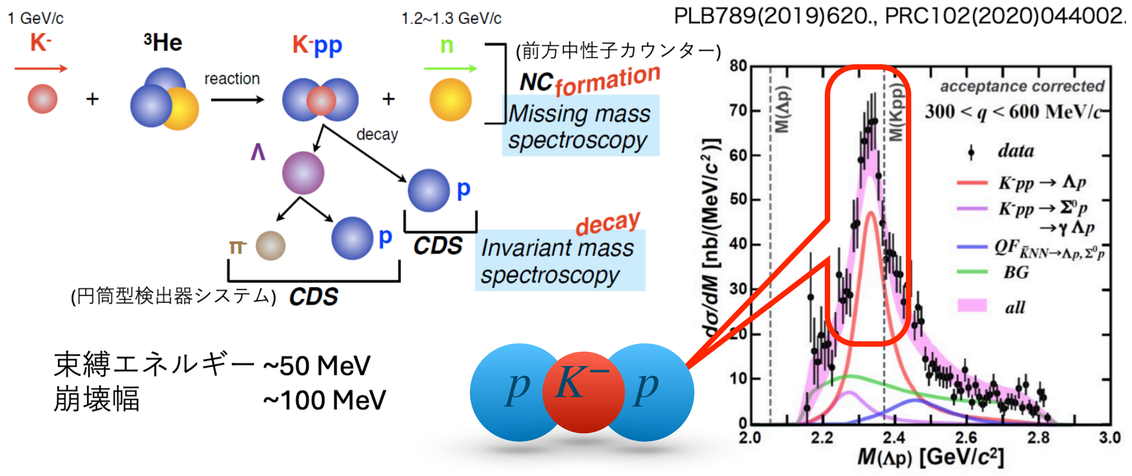




Molucle? Quark matter?

- To J-PAEC E80 From J-PARC E15 and the new Cylindrical Detector System -

J-PARC E15 experiment confirmed the existence of the simplest kaonic nuclei K^-pp.



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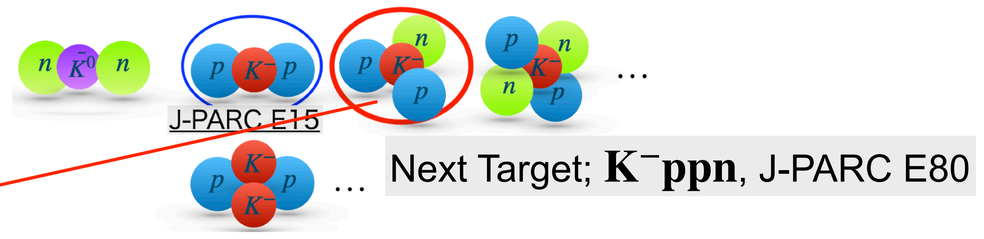
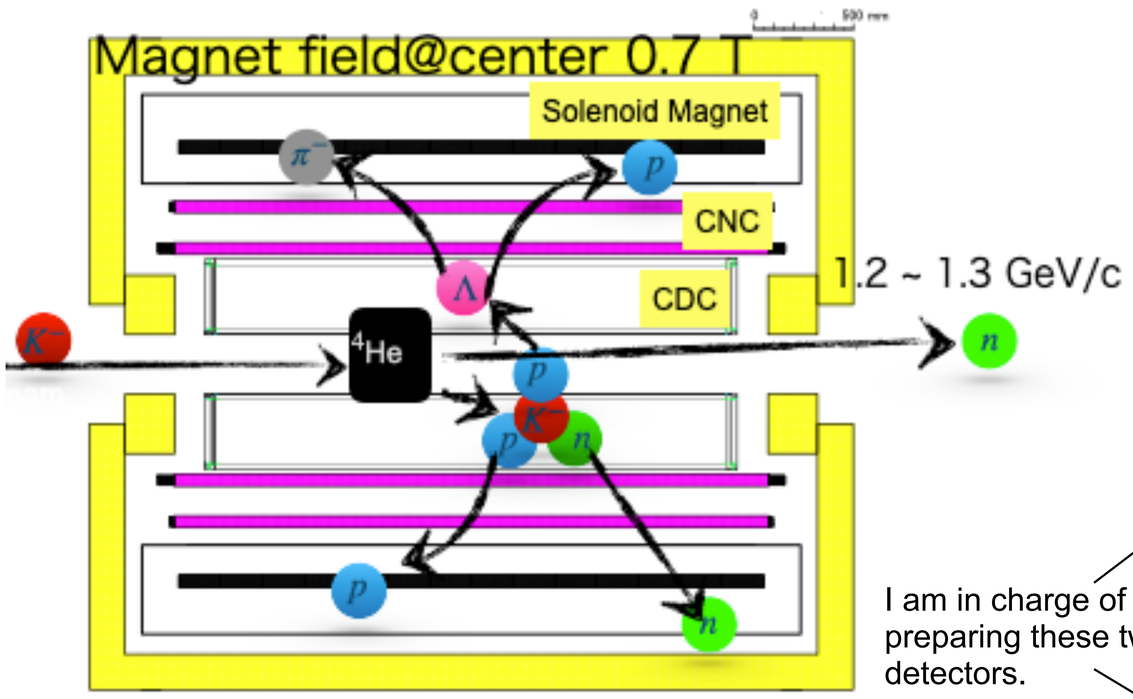
束縛エネルギー ~50 MeV
崩壊幅 ~100 MeV

- Kaonic nuclei are formed by the strongly attractive $\bar{K}N$ interaction
  —> The best probe to understand $\bar{K}N$ interaction in the subthreshold region.
- Deeper binding energy than normal nuclei
  —> Could this suggest high dense matter?
- The system includes a real boson.
  —> Potential to gain new insight into the composition of matter



J-PARC E80 We aim to obtain the **binding energy, decay width and branching ratio of the** K^-ppn.



- The neutrons to be detected are produced.
- The number of final-state particles increases compared to E15

Large solid angle and high neutron detection efficiency of the detector system is neccesary.

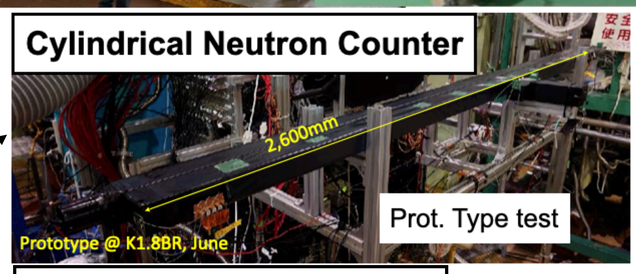
I am in charge of preparing these two detectors.

Solenoid York

Super-conducting coil

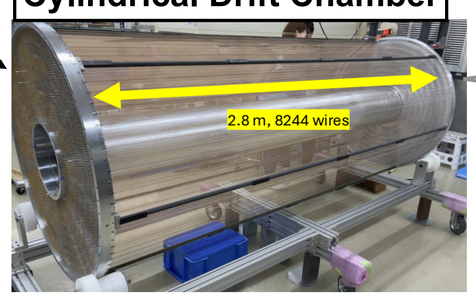
- 3.3m x 3.3m x 3.9m, ~108t in total
- Max. Field of 1.0T @ center
  - 189A - 10V
- NbTi/Cu SC wire, 98km in total
- Have been built in Feb. 2025
- Magnet field measurement -> no probrem

Cylindrical Neutron Counter



- Scintillator array: 2 layers, 12 cm thickness
- MPPC array
- Neutron detection efficiency of 12~36%
- Intrinsic time resolution of ~80ps

Cylindrical Drift Chamber



- The CDC consists of two aluminum end plates and a CFRP cylinder as the inner wall.
- 8,244 wires(The wire tension was applied so that the wire sag was less than 200 um.)
- 15 layers of hexagonal cells with a typical drift length of 9 mm
- Preamplifiers with ASAGI (developped by SPADI-A)

- Summary -

The J-PARC E80 experiment is planned for 2026. I will write my PhD thesis based on this data. Thank you for coming!