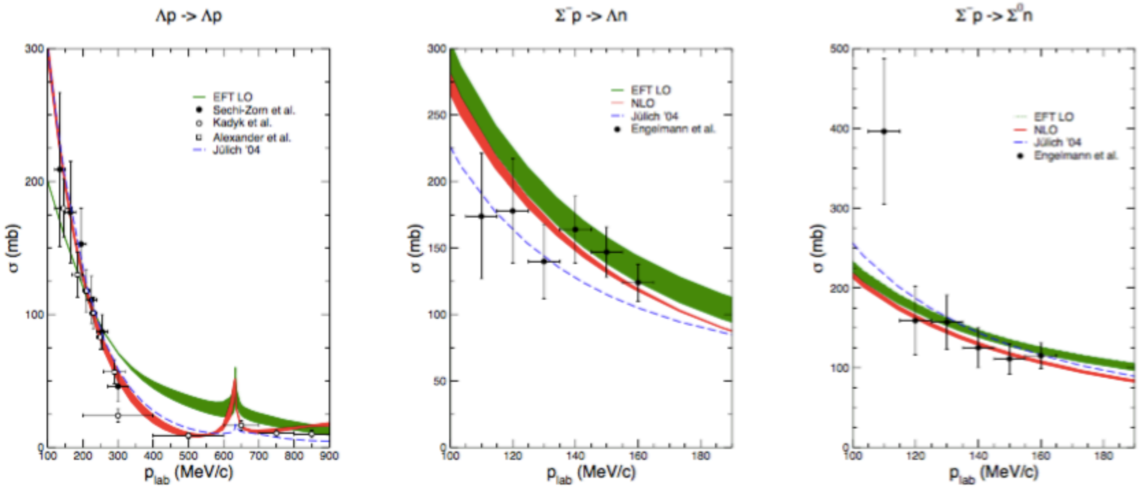
- Morning : results on BB interactions from different models
  - Chiral EFT + SU(3) breaking (Johann Haidenbauer)
  - HALQCD (
  - meson exchange and more (Th.A. Rijken)

- Afternoon : contribution on theoretical predictions and measurements on exotic states including heavy quark sector

Baryon-baryon interaction from chiral effective field theory, Johann Haidenbauer

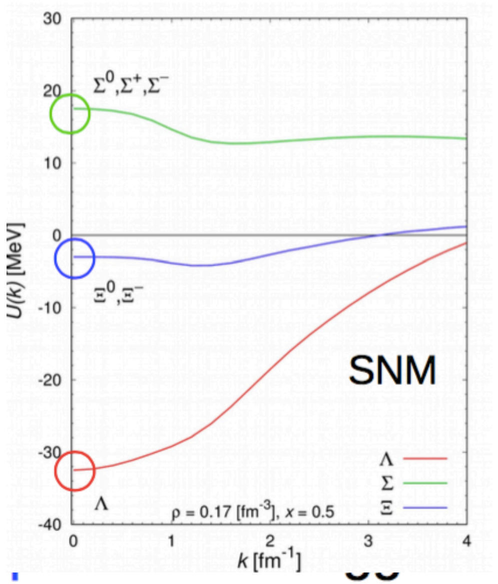
- BB within interaction Chiral EFT + SU(3) breaking
- YN results at NLO compatible with data
- Λ and Σ in nuclear matter
  - Λ single-particle potential at nuclear matter saturation density is in line with “empirical” results.
  - a repulsive Σ single-particle potential, weak Λ-nuclear spin-orbit potential is achieved
  - repulsive Λ potential at high density->hints for hyperon puzzle in NS



- *S* = −2: ΛΛ, Ξ*N* results are in agreement with empirical constraints -> need SU(3) symmetry breaking when going from *NN* to *YN* to *YY* !

Hyperons in infinite nuclear matter based on the hyperon-baryon interactions from the HALQCD method, Prof. Takashi INOE

- HALQCD approach : two step approach lattice + potentials to determine hyperon interactions
- Hyperon in nuclear matter : start from YN , YY as predicted from QCD, then use the single particle potential
  - nice agreement of single particle potential with data starting from QCD only
    - -> remarkable success



$U_\Lambda^{\mathrm{Exp}}(0) \simeq -30, \quad U_\Xi(0)^{\mathrm{Exp}} \simeq -10, \quad U_\Sigma^{\mathrm{Exp}}(0) \geq +20$ [MeV]

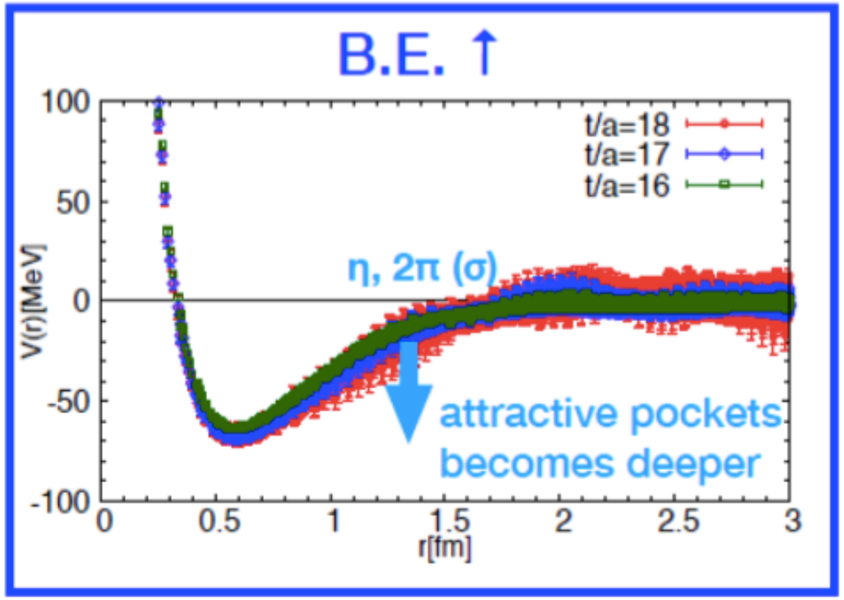
attraction   attraction small   repulsion

- Future plans : improve theoretical approach (SU(3)F , BBB, etc.) thanks to improved computing power in order make predictions on high density matter like NS and provide explanations on hypernuclei from QCD and solve hyperon puzzle of NS

Dibaryon candidates from Lattice QCD, Kenji Sasaki

- Within the HALQCD approach the BB interacions were studied in 4 cases : H-dibaryon, NΩ, ΔΔ and ΩΩ

- H-dybarion : difficult to conclude the fate, strong attraction in NΞ J=0 with I=0
- NΩ state with $J^p=2^+$: interaction is strongly attractive, no short range repulsion. It forms a bound state with about 20MeV B.E. Physical point result will be open for ΩN channel.
- DD(I=0) have strongly attractive potential, DD(I=3) and WW potential have repulsive core and attractive pocket. Physical WW system in J=0 strangest dibaryon



Baryon-baryon interactions from Meson-exchange, Th. A. Rijken

Conclusions and Perspectives

1. High-quality Simultaneous Fit/Description $NN \oplus YN$,
   OBE, TME, MPE meson-exchange dynamics.
   $SU_f(3)$-symmetry, (Non-linear) chiral-symmetry.
2. NN,YN,YY: Couplings $SU_f(3)$-symmetry, $^3P_0$-dominance QPC
   Quark-core effect: $^3S_1(\Sigma N, I = 3/2)$ is more repulsive.
3. Scalar-meson nonet structure ⇔ Nagara $\Delta B_{\Lambda\Lambda}$ values.
4. NO S=-1 Bound-States, NO $\Lambda\Lambda$-Bound-State.
5. NO S=-2,-3,-4 Bound-States.

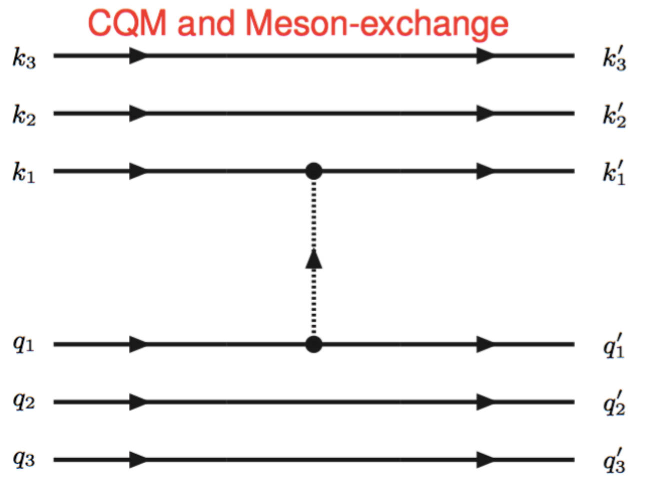
Meson-exchange description of the YN/YY-interactions:

a. Well-depths $U_\Lambda, U_\Sigma, U_\Xi$ significant contributions 3-body forces.
c. Hyperons: NStar mass $M/M_\odot = (1.44 - 2.2)$ ⇔ Multi-Pomeron.

Application: Three-body forces !

Application: QPC educated guesses !?

Application: soft Q-Q and Q-Baryon interactions !?



BB-interactions ⇒ Quark-interactions :

Via Quark Pair Creation model (QPC), quark momenta meson exchange and Strong Coupling Lattice QCD
Possibility to extract parameters at the quark level from the parameters extracted at the baryon level.

Afternoon sessions

Recent results on light (hyper-)nuclei structure from NPLQCD, *Assumpta PARREÑO*

Nuclear Physics with Lattice Quantum Chromo Dynamics (**NPLQCD**)
no e.m. interactions, SU(3) (J=0, J=1)

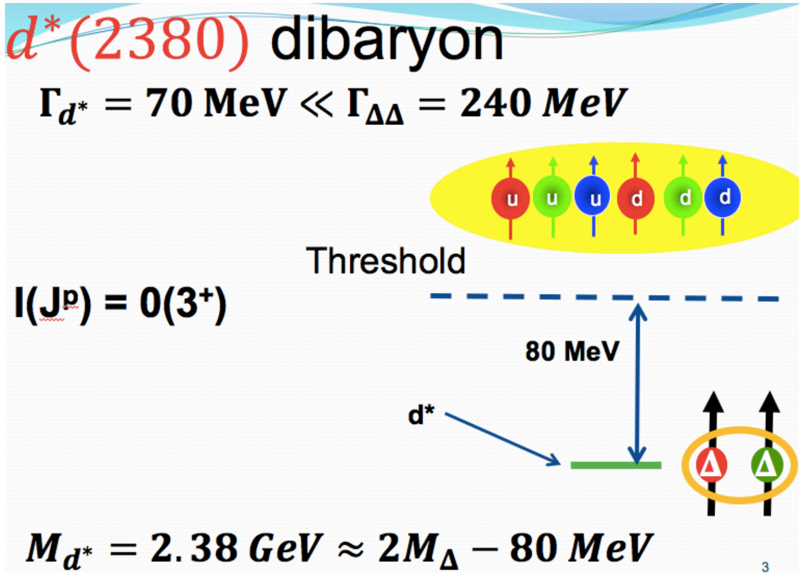
Description of the Lattice (->compromise with computational cost)

➢ Analysis on YN and YY states

- predictions on energy levels and shifts from two body interactions and bound states
- calculations of magnetic moments of baryonic systems
- continue production at lighter pion mass (~300 MeV)

Dibaryon production and structure, Mikhail Bashkanov

- Discussed items :
  - d*(2380) internal structure : hexaquark, molecule, diquark dominate, meson assisted, σ-dressed
  - d* in nuclear medium (-> neutron stars)



- Conclusions :
  - $d\uparrow*$ dibaryon is likely to be a very compact object
  - The first hexaquark – 6q benchmark state
    - Mass, Width, Branching Ratios
    - 9 decay channels studied
  - $d\uparrow*$ in photo/electroproduction
    - Size & structure
  - $d\downarrow s\uparrow*$ is the next in queue (9 SU(3) $d\uparrow*$ members to be discovered)
  - Other hexaquarks and baryon-baryon molecules…

Structure of exotic compounds, Melahat Bayar

- Fixed Center Approximation approach to the Faddeev equations computation for multi hadron interaction

- Promising tool to describe composite objects made of hadrons:
  - ρ(1700) appears as resonance of ρ*K* *K*bar
  - Multi ρ states could be identified with meson states of increasing spin : *f*2(1270ρ), ρ3(1690), *f*4(2050), ρ5(2350) and *f*6(2510)
  - *K* ∗ -multi r states can also be identified with *K* ∗ states of increasing spin : *K*2∗(1430), *K*3∗(1780), *K*4∗(2045), *K*5∗(2380) and *K*6∗
  - In the charm sector the method is repeated and new charmed resonances, *D*3∗, *D*4∗, *D*5∗ and *D*6∗ are predicted
  - The method is expanded to the beauty sector ...

Overview on exotica production with CMS, *Nazar BARTOSIK*

- CMS is perfectly suitable for heavy-flavor physics
- Important contributions to studies of exotic states made by CMS:
  - observation of Y(4140)
  - measurement of X(3872) differential cross section
  - search for Xb partner of X(3872)
  - search for X(5568)

- Not all searches resulted in observed particles, but Run-II data is bringing a lot of opportunities

Exotica structure from Bethe-Salpeter approach, *Gernot EICHMANN*

- Exotic particles : composite objects
- Bethe –Sapleter approach initially described for mesons and baryons
- compute mesons, baryons, tetraquarks, . . . **from same dynamics**
  - Meson masses
  - Baryon masses (including strange baryons)
  - Tetraquark : Four-quark bound-state equation can be considered as two-body interactions and permutations -> meson molecule
  - Interestung system : rare π^0 -> e^+e^-
  - Towards 6 q objects….

Exotica production in heavy-ion experiments, *Suhoung LEE*

- Compact multiquark states can be understood from color spin flavor wave function
- A strong attractive short range interaction is needed in the SU(3) broken limit
  - Heavy quarks are needed to reduce extra kinetic energy
    - Tcc could be strongly bound
- Measurements from Heavy Ion can discriminate the structures