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Nuclear matter and hypernuclear states calculated with the new SU_6 Quark Model Kyoto-Niigata potential*

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Abstract. Nuclear matter saturation curves and hyperon single-particle (s.p.) properties in nuclear matter are presented, using the new version of the SU_6 quark model Kyoto-Niigata potential. The Σ s.p. potential is turned out to be repulsive. The s.p. spin-orbit strength for the Λ becomes small due to the $LS^{(-)}$ component. With these favorable results in view of the experimental data, the extension of the quark model predictions to the strangeness -2 sector is in progress.

The spin-flavor SU_6 quark model provides a unified framework to describe the NN and YN interactions. Because of the scarcity of the experimental information in the strangeness sector it is interesting and valuable to discuss quantitative predictions of the quark model potential. In refs. [1,2] we presented G-matrix calculations for the NN, ΛN and ΣN interactions in nuclear matter, using the Kyoto-Niigata potential FSS [3,4]. As Fujiwara explained in his talk in this workshop, we upgraded the FSS to the new version fss2 to remedy the insufficient description at higher energies by incorporating the momentum dependent Bryan-Scott terms and vector mesons.

Since the quark model potential is defined in a form of RGM kernel, we first define partial wave Born amplitudes in momentum space by numerical angle integration. This amplitude is applied to solve the Bethe-Goldstone equation. Nuclear matter saturation curves with the QTQ and the continuous choices for intermediate spectra are shown in Fig. 1, compared with the results from the Paris [5] and the Bonn-B [6] potentials. The result demonstrates that the quark model potential works as well as the sophisticated OBEP in spite of the different description of the short-ranged repulsive interaction.

The s.p. potentials $U(k)$ of N, Λ and Σ calculated by the G-matrices with the continuous choice for intermediate spectra are shown in Fig. 2. It is noted that the Σ s.p. potential turns out to be repulsive, reflecting the characteristic repulsion in the ${}^3S_1 + {}^3D_1$ channel of the isospin $3/2$, which is in line with the recent analysis [7] of the $(K^-, \pi^\pm)$ experimental spectra.

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* Talk delivered by Michio Kohno
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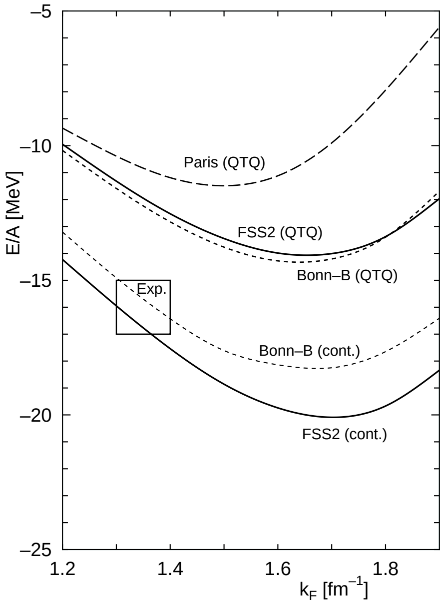

Fig. 1. Nuclear matter saturation curves

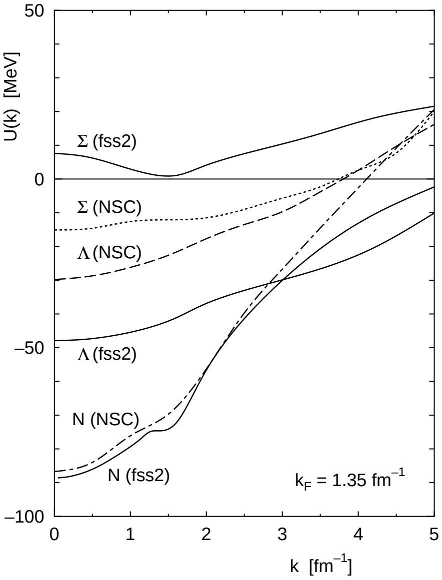

Fig. 2. Nucleon, Λ and Σ s.p. potentials $U(k)$ in nuclear matter with $k_F = 1.35$ fm^{-1}, using the quark model potential fss2. Results by Schulze *et al.* [8] with the Nijmegen NSC potential [9] are also shown.

Another interesting quantity is the strength of the s.p. spin-orbit potential, which is characterized by the strength S_B in the Thomas form:

$$U_B^{\ell s}(r) = -\frac{\pi}{2} S_B \frac{1}{r} \frac{d\rho(r)}{dr} \boldsymbol{\ell} \cdot \boldsymbol{\sigma} \,.$$

The quark model description of the YN interaction contains the antisymmetric spin-orbit ($LS^{(-)}$) component which originates from the Fermi-Breit LS interaction. The large cancellation between the LS and $LS^{(-)}$ contributions in the isospin $I = 1/2$ channel leads to a small s.p. spin-orbit potential for the Λ, $S_\Lambda/S_N \sim 0.26$, which is favourably compared with recent experimental data. The short-range correlation is also found to reduce the S_Λ/S_N. On the other hand $S_\Sigma/S_N \sim 0.54$. Detailed accounts of the s.p. spin-orbit strengths are reported in ref. [2].

Encouraged by these successful predictions of the quark model NN and YN interactions, we are now preparing the studies of the effective interactions in the $\Lambda\Lambda$-$\Sigma\Sigma$-ΞN channel and the multi Λ hyperonic nuclear matter.

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