Nonlocality in the Quark-Model Induced Two-Baryon Potential

Sachiko Takeuchi[a] and Kiyotaka Shimizu[b]

[a] *Japan College of Social Work, Kiyose, Japan*
[b] *Department of Physics, Sophia University, Chiyoda-ku, Tokyo, Japan*

We investigate the short-range part of the two-baryon potential given by the quark cluster model employing an inverse scattering problem. We find that the local potential which reproduces the same phase shifts as those given by the quark cluster model (on-shell-equivalent local potential) has a strong repulsion at short distances in the NN$^1S_0$ channel. There, however, appears an attractive pocket at very short distances due to a rather weak repulsive behavior at very high energy region. This repulsion-attractive-pocket structure becomes more manifest in the channel which has an almost forbidden state, such as ΣN(T=3/2)$^3S_1$. In order to see what kinds of effects are important to reproduce the short-range repulsion in the quark cluster model, we investigate the contribution coming from the one-gluon-exchange potential (OGEP) and the normalization separately (figure 1). It is clarified that OGEP constructs the short-range repulsion in the NN$^1S_0$ while the quark Pauli-blocking effect governs the feature of the repulsion in the ΣN(T=3/2)$^3S_1$ channel.

We further investigate the Pauli-blocking effect on the kinetic term. This effect can be expressed as a two-baryon potential which is highly nonlocal. It is found that the Pauli-Blocking effect can be understood by the change of the degrees of the mixing between the incoming wave and the 0ℓ state of the inter-cluster wave function. Thus, the effect is not a simple repulsion or attraction; its sign changes at the energy which corresponds to the kinetic energy of the 0ℓ state. When the Pauli-blocking effect is large, this change of sign becomes a resonance, which can be seen in the ΣN(T=3/2)$^3S_1$ channel. The on-shell equivalent potential also changes its sign at short distances. When the effect is large, its off-shell behavior becomes very different from that of the original nonlocal one. The nonlocality concerning the $0s$ part, at least, can not be approximated by a local potential. On the other hand, when the effect is small, the on-shell equivalent potential seems to be able to simulate the off-shell behavior of the nonlocal potential well.

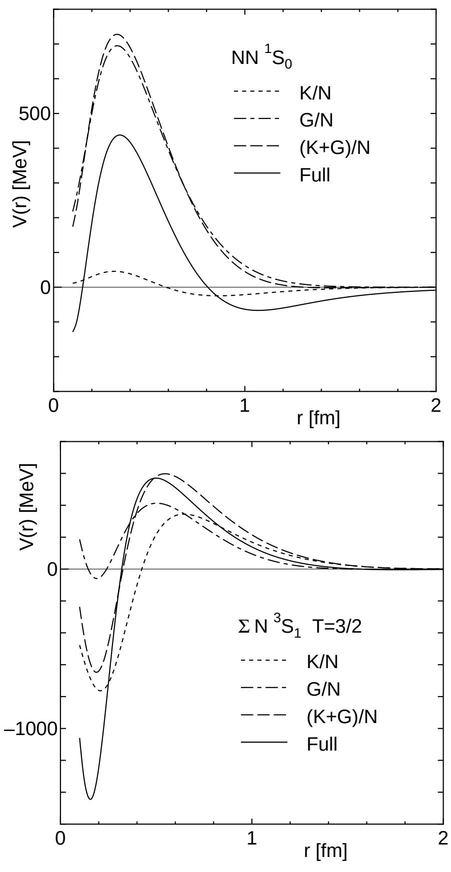

Figure 1: The on-shell-equivalent local potentials.

References

[1] S. Takeuchi and K. Shimizu, hep-ph/0201108 (to be published in Phys. Rev. **C**).