Three-Nucleon Bound State in the SU_6 Quark Model for the Baryon-Baryon Interaction

Y. Fujiwara,[a] K. Miyagawa,[b] Y. Suzuki,[c] M. Kohno[d] and H. Nemura[e]

[a] *Department of Physics, Kyoto University, Kyoto 606-8502, Japan*
[b] *Department of Applied Physics, Okayama Science University, Okayama 700-0005, Japan*
[c] *Department of Physics, Niigata University, Niigata 950-2181, Japan*
[d] *Physics Division, Kyushu Dental College, Kitakyushu 803-8580, Japan*
[e] *Institute of Particle and Nuclear Physics, KEK, Tsukuba 305-0801, Japan*

Properties of the three-nucleon bound state are studied in the Faddeev formalism, in which the quark-model NN interactions fss2 [1] and FSS [2] are explicitly incorporated to calculate the off-shell T-matrix. Here, fss2 is the most recent Kyoto-Niigata quark-model interaction, which reproduces the deuteron properties and the NN phase shifts very accurately. It also reproduces low-energy hyperon-nucleon cross section data, and is consistent with the recent events of the double-Λ hypernuclei. This is achieved by extending the model to any arbitrary combinations of the complete baryon octets. [3] The model fss2 yields the ground-state energies $E(^3\mathrm{H}) = -8.51$ MeV (see Table 1) in the 34 channel calculation, when the np interaction is employed for any NN pairs. Since the charge-dependence correction in the two-body force (especially, in the $^1S_0$ state) is estimated to be 190 keV, the difference from the experimental value $E^{\mathrm{exp}}(^3\mathrm{H}) = -8.48$ MeV is $150 \sim 160$ keV. This difference is less than half the standard value of OBEP's, which is usually attributed to the effect of the three-body force and the medium effect on the two-body force. Preliminary results of the charge rms radii for ^{3}H and ^{3}He are listed in Table 2. The Coulomb force and the relativistic corrections of the charge current operator are not included. The excellent agreement with the empirical values is obtained. A characteristic description of the short range correlations in the quark model is essential to reproduce the large binding energy and the correct size of the three-nucleon bound state without reducing the D-sate probability P_D of the deuteron.

Table 1: ^{3}H binding energies in MeV.

model	FSS	fss2	Bonn A
P_D (%)	5.88	5.49	4.4
5 ch ($J \le 1^+$)	8.03	8.19	8.38
18 ch ($J \le 2$)	8.34	8.44	8.30
34 ch ($J \le 4$)	8.39	8.51	8.32

Table 2: Charge rms radii of ^{3}H and ^{3}He.

	R_C (point)		$\sqrt{< r^2 >_{\mathrm{C}}}$		Exp't
	FSS	fss2	FSS	fss2	(fm)
^{3}H	1.60	1.57	1.74	1.72	1.70 ± 0.05
					1.81 ± 0.05
^{3}He	1.75	1.72	1.93	1.90	1.87 ± 0.05
					1.93 ± 0.03

References

[1] Y. Fujiwara, T. Fujita, M. Kohno, C. Nakamoto and Y. Suzuki, Phys. Rev. C **65** (2002) 014002.
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[3] Y. Fujiwara, M. Kohno, C. Nakamoto and Y. Suzuki, Phys. Rev. C **64** (2001) 054001.