Comment on "Three-Body Forces and Neutron-Neutron Effective Range Parameters"

Šlaus, Akaishi, and Tanaka[1] have suggested a reconciliation of the neutron-neutron scattering parameters extracted from the neutron-induced deuteron breakup reaction D(n, $2n$)p with those obtained from the reaction D(π^-, γ)$2n$ on the basis of three-body forces present in the final state of the former.

Unquestionably, three-body forces exist. There is also some evidence of effects in the nucleon-nucleon correlation from the reaction D(p, $2p$)n which may be due to the two-pion exchange three-body force,[2,3] pions being exchanged between two pairs of nucleons. Such effects are seen far from the nucleon-nucleon pole final-state enhancements in the correlation spectra and they would indeed, as they propagate into the pole-dominated kinematic regions, change the value of the scattering length. However, it is also well known that reactions involving the deuteron, with its long-tailed wave function, are complex and may involve charge-exchange processes that are difficult to differentiate from three-body force effects.[3] Such charge exchange is, of course, a genuine three-body effect, but it originates in the well-known n-p charge exchange described many years ago by the Serber force and potential.[4] The usual "exact" treatments of the deuteron breakup via Faddeev equations do not consider the charge-exchange processes *in a three-body system*, as usual input is simply two-body amplitudes (on- and off-shell). To summarize, there is real difficulty in disentangling charge-exchange processes in a three-nucleon system from genuine three-body forces. A definite test concerning the actual accuracy of "exact" treatments of the nucleon-induced deuteron breakup reaction may be forthcoming in the future, once the reaction D(p, $2p$)n is calculated incorporating the full electromagnetic dynamics,[3] as in this case the nucleon-nucleon interactions are known from *independent scattering experiments*. This brings once more into focus a basic criterion necessary to give confidence in any attempt to extract the neutron-neutron interaction from reactions involving three (or more) bodies: a test using pairs of charge-symmetric reactions, where in one all interactions are known and, in the other, the neutron-neutron interaction is the "unknown." Such a test has been known as "comparison procedure."[5] Just to show how uncertain the situation is concerning the origin of present-day discrepancies, it is worthwhile to mention the results of Gross *et al.*[6] using such a method in the reactions ^{3}He(^{3}He, ^{4}He)$2p$ and ^{3}H(^{3}H, ^{4}He)$2n$ which are, incidentally, far superior to the deuteron breakup reactions: $a_{nn} = -18.11 \pm 0.75$ fm, a value which is in excellent agreement with the (π^-, γ)$2n$ results cited in Ref. 1, -18.45 ± 0.46 fm. Here it may be argued that charge exchange is forbidden to reach the final state, and hence that the failure of the deuteron breakup reaction stems from charge exchange.[7] Perhaps the time is now ripe for a final attack via colliding neutron beams in order to provide totally unambiguous information. The effort seems worthwhile.

R. J. Slobodrian
Laboratoire de Physique Nucléaire
Département de Physique
Université Laval
Ste.-Foy, Québec G1K 7P4, Canada

Received 11 May 1982
PACS numbers: 21.30.+y, 25.10.+s

[1] I. Šlaus, Y. Akaishi, and H. Tanaka, Phys. Rev. Lett. 48, 993 (1982).
[2] R. J. Slobodrian, S. S. Dasgupta, C. Rioux, F. Lahlou, and R. Roy, J. Phys. (Paris) 42, 13 (1981).
[3] R. J. Slobodrian and P. Doleschall, Phys. Lett. 101B, 1 (1981).
[4] R. Serber, Phys. Rev. 72, 1114 (1947).
[5] W. T. H. van Oers and I. Šlaus, Phys. Rev. 160, 853 (1967); V. Hungerford, Nucl. Phys. A163, 523 (1971); R. J. Slobodrian, Rep. Prog. Phys. 34, 175 (1971), and references therein.
[6] E. E. Gross, E. V. Hungerford, J. J. Malanify, and R. W. Woods, Phys. Rev. C 1, 1365 (1970).
[7] The comparison procedure applied to D(n, p)$2n$ produced $a_{nn} = -16.7$ fm. R. J. Slobodrian, H. E. Conzett, and F. Resmini, Phys. Lett. 27B, 405 (1968).

