

## OPENING SESSION

**Parity violation and nuclear forces**E. FISHBACH, *Purdue University, Lafayette*D. TADIĆ, *Institute »Ruder Boškovića, Zagreb*

Although weak parity violating  $\Delta S = 0^{*1}$  interactions among nucleons can provide us with many pieces of information which are unobtainable elsewhere, the study of this subject is a rather complicated undertaking. The accompanying box diagram intends to give a pictorial illustration of all theoretical steps, including doubts, uncertainties, and many-sided alternatives, which are necessary to produce results confrontable with experiments. The fact that only one box was allocated to the experiment, and that at the bottom of our scheme, reflects the fact that this paper intends to comment some aspects of the theory. Experimental papers reveal<sup>1)</sup> that experimenting with  $\Delta S = 0$  parity violating nuclear forces is no less intricate.

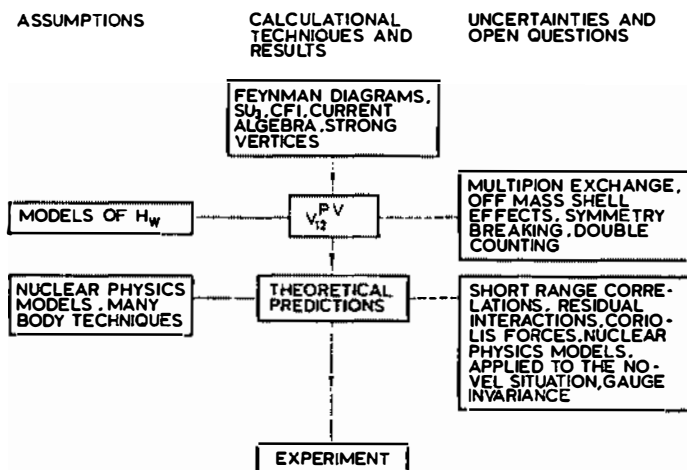
Even at the first step in the theoretical approach one is confronted with practically endless variety of possible models of weak interactions, which might, in fact, be just a first approximation to the »real« thing. Most of the common models, those of the »common type«<sup>2)</sup>, boil down to some or other current-current structure, and their consequences will be discussed at great length later on. For such models, the sign of the parity violating internucleon potential due to the  $\rho$ -exchange contribution can be predicted provided that the intermediate-vector-boson field of positive metric mediates the weak interaction. That is the sign, which seems to disagree with the existing experiments. In the case when no intermediate boson field is exchanged, the current-current product can, obviously, have any sign. However, there is a third possibility<sup>3)</sup>, namely that intermediate vector bosons are of negative metric. In that case the sign of the  $\rho$ -exchange contribution comes out to be opposite, so it would agree with experimental evidence. The investigation of other boxes in our diagram shows that such a statement, at this stage, cannot be taken too seriously. More has to be learned about two (or more) particle exchange contributions to the weak internucleon potentials, and nuclear physics problems have to be worked out in great detail. The experiments, which are still far from being perfected<sup>1,4)</sup>, will actually be testing theories involving both particle physics and nuclear physics hypotheses and assumptions. In order to make this somewhat

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\*S is the strangeness. We will denote the isospin by T.

easier, one has to strive to experimentally distinguish parts of the potential with different isospin selection rules (i. e.  $\Delta T = 1$  from  $\Delta T = 0, 2$ ). With some luck, in a few year time, the determination of the relative sign of the weak Fermi to electromagnetic coupling constant,<sup>3)</sup> might be a discussable item.

Not much can in general be said on the unconventional models of weak interactions<sup>2)</sup>, such as in Ref.<sup>5)</sup>, as their consequences have not always been completely worked out. One can mention that the models of the Kummer-Segré type<sup>6,7)</sup> attractive because being renormalizable, are already in trouble, as they allow, in a very natural way, for semiweak internucleon interactions, thus predicting for larger parity violating effects than observed experimentally. In order to forbid these semiweak contributions, they has to go into very inelegant contortions<sup>7)</sup>, predicting a whole array of new, yet unobserved, particles. The situation in weak interaction models is further complicated by some evidence originating from nuclear beta decay<sup>8)</sup> which suggests that second-class currents<sup>9)</sup> might be present.\*)



Such currents would naturally lead to the  $\Delta T = 1$  contribution to the weak internucleon potential<sup>13)</sup>, whose general form is similar to the pion exchange contribution, but whose magnitude can be estimated only with difficulty<sup>14)</sup>. In principle, such a contribution can either enhance the pion exchange effect, or destructively interfere with it.

In this communication we are first going to illustrate how the step from the weak Hamiltonian to the weak internucleon potential is made, discussing many of the difficulties involved. Once the potential is obtained, we have to discuss the problems connected with the gauge invariance, which are important when dealing with photon emitting processes. Some facets of nuclear physics calculations are investigated while going along the main line in our box diagram; others are only

\*See, however, a recent study<sup>10)</sup> (as well as papers<sup>11,12)</sup> where negative evidence is presented.

mentioned and referred to the other articles<sup>15,16</sup>). In the end some experimental evidence is explored attempting to draw some conclusions which can be based on the general features. In the above text, some of these possibilities have already been referred to.

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