

E06020U02

Letter to the Editor

A Consistent Theory of the Nuclear Force  
and the  $\beta$ -Disintegration

In spite of many attempts to develop the so-called " $\beta$ -  
hypothesis of the nuclear force<sup>1)</sup>", there still remains <sup>in the current theory</sup> the well  
known inconsistency between the small probability of  $\beta$ -

disintegration and the large interaction of the neutron and  
the proton. Hence, it will not be meaningless to show on this  
occasion <sup>a brief account of one possible more satisfactory</sup> a possible way of solving this difficulty  
which was proposed by the present ~~and~~ writer about two years  
ago. <sup>2) The fundamental departure from the ordinary current</sup>

First, we <sup>introduce</sup> consider the field which is responsible for  
the short range exchange force between the neutron and the  
~~neutron~~ <sup>proton</sup> just as the counterpart of the ordinary electromagnetic  
field which is responsible for the Coulomb force. The simplest  
<sup>conceivable</sup> possible one <sup>is perhaps</sup> ~~are~~ <sup>is perhaps</sup> such that can be derived from two  
scalar potentials  $U, U^*$  <sup>which are</sup> conjugate complex to each other, ~~which~~ <sup>and</sup>  
satisfy, in the presence of a heavy particle, the equations

*The fundamental departure of the present  
We <sup>assume</sup> consider this field <sup>to be</sup> something different from the  
electron-neutrino field in contradistinction to the  
current theory*

\* These results mean ~~the above theory differs essentially~~  
fundamental departure of the above theory ~~from the current theory~~ lies in the fact that  
~~the a heavy particle transition of the heavy particle~~  
from the neutron to the proton is accompanied

\* According to the above view, ~~the energy liberated by~~ the heavy transition  
of the heavy particle from the neutron to the proton state,  
for instance, is almost always taken up by another  
heavy particle, ~~without the aid of the intermediate transition~~  
which in turn make the reverse  
transition, ~~in contrast to the hypothesis assumption~~  
of the current theory. ~~that the energy is always~~  
transferred ~~always through the immediate transition~~  
of the light particle.

Further development of the theory  
The theory can be extended further so as to  
describe the interaction of the above field with  
the electromagnetic field. <sup>4)</sup> The formulae become  
rather complicated in this case, ~~although~~ <sup>can be predicted</sup> it follows immediately  
that the above field \* <sup>without lengthy calculation</sup>  
A noticeable result,

A Modification so as to fit the theory with  
The conclusion does not change essentially, if we modify  
mathematical formulation so as to be in accord with the  
result of Konopinski and Uhlenbeck



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and the  $\pi$ -meson

$$\frac{g}{r} \frac{e^{-\mu r}}{r}$$

potential

between the neutron and the proton. This force was found to be of Heisenberg type, but the major force can be included by a little more complicated assumption.

Next, we assume that this field interacts, on the other hand, with the light particle and leads to the transition of the latter between the neutron and the electron states. Thus, we add to the right hand side of (1) and (2) terms referring to the light particle with another constant  $g'$  instead of  $g$ , so that we can calculate the probability due to the interaction between the light and heavy particles by means of the U-field. The result is essentially the same as that of Fermi if we put  $g' = g$  equal to Fermi's  $g$ . Hence, three constants  $\lambda$ ,  $g$ , and  $g'$  can be adjusted so as to give correct magnitudes both for mass defects and the probability of  $\beta$ -decay.

If we take for example,  $\lambda = 2 \times 10^{10}$  and  $g = 10^6$ ,  $g'$  should be about 10 times smaller than  $g$ . The modification is necessary in order to be in accord with the result of  $\beta$ -decay.

A noticeable result which follows necessarily from the above field should be accompanied by quanta obeying Bose statistics with the elementary charge  $\pm e$  and the proper mass  $m = \frac{h\nu}{c}$ , which is about 200 times as large as the electron mass, if we take the above value for  $\lambda$ . This result seems to be in accord with the experimental results.

We can not expect, however, the creation of such quanta by ordinary nuclear process reactions, since it needed at least an energy of order  $10^8$  eV.

*in spite of this rather hardly be created (emitted)*

*conclusion which had no support at the time when the previous paper was written.*

On the contrary, if they ever exist, their tracks should be found in the cloud chamber photographs of cosmic ray, and it is not altogether impossible that the [anomalous] tracks with larger than that of the proton, are really due to such quanta, as the range energy curvature relation of these tracks being not in contradiction with such a hypothesis.

*Now to understand rays with the same*

*recently discovered by Anderson and Neddermeyer, which are likely to belong to the heavy particles.*

Further arguments will be given in the later issue of the Proc. Phys. Math. Soc. Japan. At least, this is not least as in fact, complete account of the theory.

Although it is desirable to make any further con-

*is not least as in fact, complete account of the theory. Further arguments will be given in the later issue of the Proc. Phys. Math. Soc. Japan. At least, this is not least as in fact, complete account of the theory.*

Osaka Imperial University,  
Osaka, Japan  
Jan. 15, 1937.

*The Whether should be premature owing to the meagreness of the experimental informations.*

- 1) See, for example, Bente and Bacher, Rev. Mod. Phys. 8, 82 1936 and further v. Weizsacker, Zeits. f. Phys. 102, 572, 1936; Iwanenko and Sokolow, ibid. 102, 119, 1936.

*At the same time, we can expect...*

- 2) Proc. Phys.-Math. Soc. Japan 17, 48, 1935.
- 3) Mathematical expressions becomes rather complicated on account of the interaction

*to have correctly order of magnitude at the same time. The correct order of magnitude will be given correctly at the same time.*

- 4) Mathematical development of the theory of the U-field in the presence of the electromagnetic field will follow on the similar line as that of Pauli and Weisskopf, Helv. Phys. Acta 7, 709, 1934.
- 5) Phys. Rev. 50, 263, 1936.

*although this situation is more complicated in our case, further complication is*

The mathematical development in this case follows on much the same line as that of Pauli and Weisskopf

Summary of the letter  
The current view of connecting directly the exchange force between the neutron and the proton was modified so as to give correct values both for mass defect and of  $\beta$ -decay and the small probability of  $\beta$ -decay, in the presence of a heavy particle, the equations satisfy, in the presence of a heavy particle, the equations scalar potentials  $U$ ,  $U$  conjugate complex to each other, which possible one are is perhaps such that can be derived from two field which is responsible for the Coulomb force. The simple neutron just as the counterpart of the ordinary electromagnet the short range exchange force between the neutron and the First, we consider the field which is responsible for ago.

which was proposed by the present author about two years ago. occasion a possible solution way of solving this difficulty the proton. Hence, it will not be meaningless to show on this disintegration and the large interaction of the neutron and well known inconsistency between the small probability of - hypothesis of the nuclear force, there still remains the we In spite of many attempts to develop the so-called " -

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