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63 ( (Read May 28, 1938)

24 (§1. Introduction and Summary.

The theory of the heavy quantum with charge, mass and spin satisfying linear tensor equations of Dirac-Proca type was developed recently by several authors, 1) 2), 3), 4), 5) and was successful in explaining the exchange forces between the neutron and the proton. It was shown further that the introduction of the neutral quantum was necessary in order to account for approximate equality of the like particle and unlike particle forces. In §2 of the present paper, we deal with this problem by assuming the same equations for the neutral quanta as those for the charged quanta. It is assumed, moreover, that the interaction of the heavy particle with the former is the same as that with the latter, except that the factor of the form  $a + b\tau_3$  ( or  $\tilde{a} + \tilde{b}\tau_3$  ) appears in place of  $\tau_1 + i\tau_2$  ( or  $\tau_1 - i\tau_2$  ), where a and b are

- 1) Kemmer, Nature 141, 116, (1938); Proc. Roy. Soc. A 166, 127, (1938); Fröhlich, Heitler and Kemmer, ibid. 166, 154, (1938).
- 2) Bhabha, Nature 141, 117, (1938); Proc. Roy. Soc. A 166, 501, (1938).
- 3) Stueckelberg, Helv. Phys. 11, 299, (1938).
- 4) Yukawa, Sakata and Taketani, Proc. Phys.-Math. Soc. Japan 20, 319, (1938). This paper will be referred to as III.
- 5) Discussions of the scalar theory were made by Yukawa and Sakata, Proc. Phys.-Math. Soc. Japan 19, 1084, (1937), which will be referred to as II; Beck, Nature 141, 609, 832, (1938); Lamb and Schiff, Phys. Rev. 53, 551, (1938); Stueckelberg, Helv. Phys. 11, 225, (1938); Wentzel, Naturwiss. 26, 273, (1938).

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