On the Nucleon-Antinucleon Interactions (*).

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1. – Introduction.

The experiments (1) on the nucleon-antinucleon cross-sections, although they are still in a preliminary stage, exhibit two striking features which deserve theoretical understanding:

1) For a given energy, the total cross-sections are much larger than in the nucleon-nucleon case: at 190 MeV in the laboratory system, the anti-

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proton-proton cross-section is of the order of 135 millibarns, in contrast with the 22 mb obtained with protons of the same energy.

2) The total cross-section seems to be essentially due to annihilation. If we choose to believe the experiments in their present state, there seems to be little room for elastic and exchange scattering, which contribute probably less than 20% of the total cross-section (2).

The large total cross-section has been explained by BALL and CHEW (3) using a model inspired by the success of the fixed source meson theory. This theory leads, in the nucleon-nucleon case, to the Gartenhaus potential (4); when a phenomenological spin-orbit term is added (5), it gives a good fit to the scattering and polarization data up to 150 MeV. A nucleon-antinucleon interaction can be obtained by reversing the sign of the second order term of the Gartenhaus potential, to take into account the charge conjugation between nucleon and antinucleon. BALL and CHEW make the two further assumptions:

1) The Signell-Marshak spin-orbit term remains unchanged when one goes to the nucleon-antinucleon case.

2) The inner region of the interaction \( r < 0.4(\hbar/\mu c) \), where \( \mu \) is the \( \pi \)-meson mass), of which little can be said from meson theory, is replaced by an absorbing core in which the annihilation takes place. The total cross-section at 140 MeV, computed in W.K.B. approximation with such an interaction is in good agreement with experiment. The reason why the total cross-section is larger for antinucleons than for nucleons seems to be that, in the latter case, there is a cancellation between 2nd and 4th order terms. This cancellation disappears in the antinucleon problem where the sign of the 2nd order term has been changed.

The small elastic and exchange cross-sections are much more difficult to explain. The absorption predicted by CHEW and BALL is quite small (69 mb). As we shall see later, an exact calculation with the same model leads to even smaller results. This is in definite contradiction with the experiments if we choose to believe them in their present state.

Similar results were obtained by KOBa and TAKEDA (6), who also considered a small black sphere, surrounded by a real square well.

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(2) O. Chamberlain: private communication.
(6) Z. Koba and G. Takeda: to be published.