

# NOTE ON THE CORRESPONDENCE BETWEEN THE CLASSICAL AND QUANTUM THEORIES OF NEUTRAL MESONS

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Received April 4, 1941

WHEN one speaks of correspondence between the quantum and the classical theories of radiation, one means that the quantum theory of radiation passes over in the limit  $\hbar \rightarrow 0$  into the classical theory of radiation as embodied in the Maxwell equations. At the same time the formula for any physical process goes over into the corresponding classical formula. This is the strict mathematical sense in which one can speak of correspondence.

It is, however, common to speak of correspondence in another looser sense, thereby referring to the circumstance that the quantum formulæ for several physical processes go over into the corresponding classical formulæ when the energy of the light quantum concerned is small compared with some other constant of the dimension of energy occurring in the formulæ. A typical example of correspondence in this loose sense is afforded by the scattering of light by a free electron, where the quantum formula given by Klein Nishina goes over into the classical Thomson formula when the frequency of light is small.

In the quantum theory of radiation, the energy  $E$  of a light quantum of frequency  $\omega$  is given by

$$E = \hbar\omega. \quad (1)$$

The limit  $\hbar \rightarrow 0$  therefore corresponds to the limit  $E \rightarrow 0$ , if the frequency be kept constant. Thus the alteration in the quantum formula for any process introduced by going to the limit  $\hbar \rightarrow 0$  is the same as the alteration introduced by going to the limit of very low frequencies  $\omega \rightarrow 0$ . It is due to this cause that the looser meaning of the word correspondence coincides in most cases with the strict meaning given at the beginning.

The purpose of this note is to point out the interesting circumstance that whereas there is correspondence between the quantum and the classical theories of neutral mesons in the strict mathematical sense, meaning thereby that the former theory goes over into the latter if we pass to the limit  $\hbar \rightarrow 0$ , there is no correspondence between the two theories in the looser sense