LOUIS DE BROGLIE

INTRODUCTION TO THE VIGIER THEORY OF ELEMENTARY PARTICLES

ELSEVIER

and especially at the time of the great successes in the quantum theory of fields, many indications of the existence of an even deeper level seemed to crop up — for example, the appearance and disappearance of particles on the microphysical level, which led, in the case of the electron-positon pairs, to the conception, due to Dirac, of an 'ocean' of electrons with negative energy which remain hidden even at the microphysical level; or again, interactions expressed in terms of emissions and absorptions of particles referred to as 'virtual' — a notion that has no clear or concrete meaning and which, up to the present time, is simply the expression of a certain mathematical formalism; or again, the necessity, when attempts are made to account for certain experimental phenomena such as the Lamb-Retherford effect and the slightly abnormal value of the electron's magnetic moment, of having recourse to the constant interaction of the particles with the vacuum that surrounds them — in which case this 'vacuum' quite paradoxically appears endowed with very important physical properties, appears, indeed, susceptible to polarization and even, according to a calculation by Bohm, containing a formidable hidden quantity of energy per unit volume.

In view of this state of affairs, it seems very likely that the phenomena we can detect more or less directly at the microphysical level can be explained only by having recourse to a deeper level acting upon them. Along with Bohm and Vigier, we shall call this medium the 'subquantic medium'. One can say, metaphorically, that the indirectly observable microphysical level forms a kind of 'surface' of the hidden subquantic level.

Bohm and Vigier have used this hypothesis of a subquantic medium to justify more completely the fact that the square of the modulus of the wave function $|\Psi|^2 = a^2$ must give the probability of presence of the particle (*Phys. Rev.*, 96 (1954) 208). They have, to this end, introduced the idea that the particle is constantly subjected to entirely random perturbations that make it constantly shift from one of the trajectories in the absence of perturbations predicted by means of the guidance formula to another of these trajectories. In this way they have been able to show that, taking the continuity equation into account, this continual random jumping of the particle must have as its effect the physical realization, in a very rapid way, of the probability of presence in $|\Psi|^2$. And they have suggested that these constant random perturbations are due to the permanent interaction of the particle with a subquantic medium, which many other aspects of experimental phenomena seem to lead us to suspect, as we have said above.

If we admit the existence of this subquantic medium, how can we visualize it? Without concealing what such conceptions have about them that is in-