LETTERS TO THE EDITORS

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Filamentous Carbon

P. AND L. SCHÜTZENBERGER[1] reported that when cyanogen was passed down a porcelain tube containing gas carbon with powdered cryolite on its surface, heated to a cherry-red heat, decomposition occurred and elementary carbon separated in a bulky mass of very slender filaments. The filaments had some elasticity, were friable and marked paper. When aluminium was mixed with the gas carbon, non-elastic filaments separated round it which, on gentle compression, resembled graphite.

FIG. 1.

This filamentous or woolly form of carbon is sometimes found in beehive and recuperative coke-ovens, particularly near the ascension pipe. C. and H. Pélabon[2] found that the wool consisted chiefly of grey cylindrical threads with a glazed surface and occasional bundles of much finer threads. The average length of the threads was 5 cm. and the diameter varied between 0·03 and 0·15 mm., the finer threads being only about 0·002 mm.

A similar filamentous form of carbon has been obtained by cracking methane, diluted with nitrogen, hydrogen and carbon monoxide on an iron surface at 1,000° C. The bulk of the carbon was deposited in the form of a hard, brittle, grey mass, on the surface of which was a large number of slender carbon filaments all running more or less parallel to each other (Fig. 1). These filaments are very fragile, but we succeeded in mounting a small bundle of them and taking an X-ray photograph. Unfiltered cobalt K-radiation was used with a specimen to film distance of 48 mm. The photograph (Fig. 2) indicates that the carbon present is the ordinary 'amorphous' variety ($\theta_{002} = 14 \cdot 8°$, inter-layer plane spacing about 3·5 A.) with the c axis perpendicular to the fibre axis, that is, the hexagon layer planes more or less parallel to the fibre axis, with a maximum deviation of about 30°.

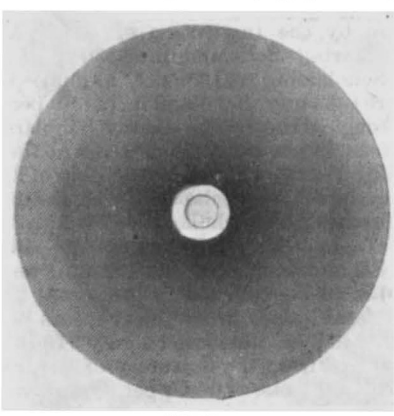

FIG. 2.

So far as we know, this is the first example of a fibre built up from lamellar units.

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[1] *C.R. Acad. Sci.*, **111**, 774 (1890).
[2] *C.R. Acad. Sci.*, **137**, 706 (1903).

The Divergence Difficulty of Quantized Field Theories

IN the theory of interaction of particles like photons and electrons or mesons and nucleons, etc., the experiments are always made in such a way that the different kinds of particles are observed in different parts of space with different instruments. In these parts of space one can speak of pure kinds of particles and describe them by pure quantized fields—Maxwell's field, Dirac's field, etc. However, in the part of space where the collisions really take place, the pure fields are not simply additive but have to be supplemented by an interaction field. All effects due to the interaction can be obtained by considering the stationary states of the whole system.

Because of the complication of the problem, one has to use a method of successive approximation called the perturbation method in which the interaction is regarded as small. It is well known that then special care must be taken to remove the degeneracy of the states of the unperturbed system in a way so as to anticipate the eigenstates of the perturbed system. This preliminary step has, however, been ignored in the usual practice for the interaction of fields; and consequently divergent expressions appear as soon as the next higher order of the perturbation method is attempted.

The results obtained by the usual practice were in good agreement with observations in the case of the photon-electron interaction, although the divergence of the higher approximation indicates that some mistake must have been made, which might be physical or mathematical. No such agreement with observation has been found in the case of the meson field. Some time ago an improved method[1] based on physical reasoning was developed which takes account, to the first approximation only, of what is classically known as the 'radiation reaction'. This method is well confirmed by its applications, especially to the meson field, but hitherto its theoretical basis was not satisfactorily established.

It has now been found that this provisional method can be rigorously established by a systematic application of the ordinary perturbation theory for degenerate systems adapted to the case of the continuous