THE UNCERTAINTY PRINCIPLE

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We have seen that direct experimental evidence pointed to electrons being waves, in the sense that when we send a stream of them through two holes, we can only explain the result by supposing that, like a wave, each electron goes through both holes. We saw, moreover, that if a patch of wave-disturbance in a medium never encounters small obstacles it keeps together as it travels, and behaves in this way like an individual, which is what we think the characteristic of a particle. So we might at first sight be tempted to think that we had got a quite satisfactory and complete view of the character of an electron merely as being a wave of very short wave-length. But a little consideration shows that this will not do.

In the first place we have seen that though a patch of disturbance travels along as an individual with the definite group-velocity, there is always a region round its edges where the disturbance is slowly spreading. There is no way in which a wave can escape this gradual diffusion, and it means that ultimately it will become spread all over space. The rate of diffusion is smaller the larger the volume over which the waves are spread, so that it would be very slow for matter in bulk, and such waves would keep together a considerable time, but still they would not do so forever. Even if we regarded the world as originally created in well-defined “wave-packets,” they would certainly by now have spread indefinitely. We may say that the existence of fossils which have preserved their form unchanged for several hundred million years disproves the adequacy of the wave theory.

But the matter is worse than this, since we can do other experiments which seem immediately to disprove the validity of the wave-theory. There exist substances which have the property of scintillation...
Editor's Summary

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