Journal notes

Quantum Electrodynamics

In quantum theory, the interpretation of the mathematical formalism raises problems of a far more delicate kind than in classical theory. This is due to the fact that when dealing with quantum phenomena it is no longer permissible to disregard the interaction of the observer and his measuring instruments with the atomic objects under observation. In fact, while all account of experience must necessarily be formulated with the help of the concepts of classical physics, the existence of the quantum of action sets a limit to the possibility of analyzing atomic phenomena in terms of such concepts. Thus, in quantum mechaincs, which deals with systems of particles treated as material points, the limitation in question is embodied in Heisenberg's indeterminacy relations for pairs of conjugate space-time and energy-momentum variables. In this case, the consistency of the interpretation of the formalism can be demonstrated by a careful discussion of the idealized measuring procedures by which the concepts underlying the theory receive a well defined meaning. It appears, in fact, that the limitations imposed on the accuracy of such measurements by the existence of the quantum of action correspond exactly to the predictions derived from the indeterminacy relations.

Similar problems arise in the quantum theory of electromagnetic fields, with the additional complication that we have here to do with a continuous distribution of field quantities in space and time. It appears that only averages of such field quantities over finite space-time regions have a well defined meaning; no absolute scale of spatio-temporal dimensions, however, is involved in the theory. It is then possible to set up idealized measuring procedures for field averages, by means of which the consistency of all theoretical predictions, including the reciprocal limitations of measurability of field averages due to their noncommutation, and the occurrence of statistical fluctuations arising from their quantization, can be tested in every detail.

The next stage is the theory of quantum electrodynamics, in which not only the electromagnetic field, but also the wave-functions describing space-time distributions of electric charge and current are subjected to relations of noncommutation, with resulting reciprocal limitations in the measurability of the space-time averages of these quantities. The situation in this case is to a large extent parallel to that in the quantum theory of fields. A characteristic difference is the occurrence of an absolute scale of spatio-temporal dimensions, fixed by the Compton wavelength associated with the charged particles.

It can be shown, however, that the test of the consistency of the formalism by idealized measurements of charge-current averages can be carried out down to space-time regions of much smaller dimensions than the Compton wavelength of the electron. The difficulties of present quantum electrodynamics must therefore be traced, not to any formal inconsistency, but rather to a failure to deal adequately with the close interactions between the various kinds of elementary particles. L. R.

Field and Charge Measurements in Quantum Electrodynamics. By L. Rosenfeld and N. Bohr. *Phys. Rev. 78: 794, June 15, 1950.*

Tester for Photographic Lenses

Testing lenses, particularly photographic lenses, for performance in a simple, fast, and accurate manner is a very difficult problem. Conventionally different lens aberrations for different field angles and apertures are measured in order to judge lens performance. The determination of these lens aberrations by conventional means is very complicated. One method, the Hartman method, requires exposure and processing of photographic film, which is then measured microscopically. Another, the bench method, requires accurate determination of preliminary data before the actual measurements can be made. In both methods extensive mathematical processing is required before the results may be evaluated and each measurement has to be repeated a great number of times because of observational and other random errors to which both methods are subject. The elimination of these errors requires further statistical treatment of the computed data.

It stands to reason that these methods, though indispensable for experimental design, are not suited for inspection or quality control purposes. So, instead of breaking up the lens performance into different aberrations and then synthesizing these aberrational components again into a measure of lens resolution, an instrument has been built which measures the combined effect of all aberrations on the image quality and which allows direct reading without further computation of the image displacement caused by these aberrations. It is therefore possible, even for an unskilled operator, to determine whether or not a lens conforms to stipulated specifications.

The tester is basically an autocollimator in which a suitable target is imaged by a well corrected lens at infinity. The lens to be tested forms an image of the infinity target on a special screen and this screen image in turn is examined through the collimator lens and the lens to be tested by means of an eyepiece. The image screen can be moved by a micrometer; thus the tester permits reading immediately how far the image for each aperture and each angle of field falls out of the ideal image plane. F. G. B.

Lens Tester for Photographic Lenses. By F. G. Back. *Rev. Sci. Inst. 21: 722, August, 1950.*

Soap on Rye

Soaps are metal salts of long chain fatty acids. The metal ions are small, spherical, and bear one or more positive charges. The fatty acid ion is a long, zig zag, hydrocarbon chain bearing a negatively charged carboxyl group at one end. In their packing in the solid these negative ions can be regarded as nearly cylindrical rods. The forces which lead to the formation of a solid arise from the electrostatic interaction of the charges on the ions, and from the van der Waals type of forces between the long fatty acid ions. The solids which result can be pictured as a close packing of bundles of parallel rods,