the actual charge density arising from a smeared-out electron, but the probability of finding the corpuscular electron in the different parts of space. This view has been the basis of the developments due to Dirac and Jordan which have given a much more general form to the mathematics of quantum mechanics.

This interplay of wave and particle concepts which makes the wave field serve as giving the probability of different positions of the particle or particles governed by the wave field implies a fundamental limitation on the precision of certain physical quantities, a point which has been emphasized by Heisenberg and by Bohr. (See especially Bohr's article in *Nature* for April 14, 1928.) A plane wave of infinite extent is to be associated with a particle of which the momentum is exactly known. The infinite extent of the wave in turn means that the particle is equally likely to be anywhere in space. That is, exact knowledge of the momentum implies absolute ignorance concerning the position of the particle. By superposing waves of different wave-lengths, it is possible to have the different waves interfere everywhere except in a certain small region of space. Such a group of waves is taken as the wave representative of a particle *of which it is known* that the particle is in this region of space. It follows from the laws of wave interference that the smaller the region in which the waves do not destructively interfere, the greater the range of wave-lengths which must be represented in the different plane wave constituents which are superposed to make up the group. Recalling the connection between wave-length or wave number and momentum, it is seen that such a group of waves, which represents a particle known to be in a certain region, implies a range of values of the momentum or a lack of precision in the knowledge of the momentum. The size of the region in which the particle is known to be located may be thought of as the uncertainty of our knowledge of the position of the particle. The range of wave-numbers in the constituent waves of the group measures the associated uncertainty in the momentum of the particle. Calling Δx, Δy, Δz the uncertainties in positional coordinates and Δp_x, Δp_y, Δp_z the uncertainties in the momentum components, the laws of wave interference, together with the quantum law of association between the concepts of wave number and momentum, give the equations:

$$\Delta x\, \Delta p_x \gtrsim \frac{h}{2\pi}, \quad \Delta y\, \Delta p_y \gtrsim \frac{h}{2\pi}, \quad \Delta z\, \Delta p_z \gtrsim \frac{h}{2\pi}$$

If the laws of wave interference really do govern the motion of particles this implies that our simultaneous knowledge of the position and momentum of a particle may never be so precise that the product of the uncertainty in a coordinate multiplied by that in the associated momentum component that the product of the two uncertainties is less in order of magnitude than Planck's constant, h. A consideration of various methods of measuring simultaneously the position and momentum of a particle has indicated that all physical measurements are really subject to this fundamental limitation. This point is likely to prove of considerable interest to philosophers. It appears that in the concepts of position and momentum we are confronted with two quantities, either of which may be given a precise definition when considered alone, but when considered together there is a correlated vagueness about their magnitudes which appears as a fundamental law of nature.

In conclusion, it may be well to point out that the reason that the classical laws of mechanics prove to be so satisfactory for macroscopic things is that the wave-lengths of the wave phenomena for them are so small that diffraction effects are negligible, just as in many problems concerning light it is admissible to ignore the wave nature of light, as is done in geometrical optics. The laws of classical mechanics bear the same relation to those of quantum mechanics as the laws of geometrical optics bear to the wave theory of light.

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SCIENTIFIC EVENTS

CONFERENCE OF THE BRITISH ASSOCIATION ON THE PRESERVATION OF SCENERY

THE London *Times* says that the detailed work of the British Association is carried out in 13 sections, lettered from A to M, and one "conference," a gathering of delegates from 160 societies in correspondence with the association. Partly owing to the accident that this gathering is not named and lettered as a section, its proceedings have hitherto received something less than their due share of publicity. On the occasion of the Glasgow Meeting of the British Association the conference will constitute itself in fact, if not in name, a section dealing with the Science of Scenery.

Dr. Vaughan Cornish in his presidential address pointed out that the special responsibility of learned societies in regard to the preservation of scenery is to discover and define the combinations which result in scenic beauty, and thus provide a secure foundation for an esthetic of scenery.

Mr. C. R. Gibson, representing the Royal Philosophical Society of Glasgow, will move that it is

desirable that the British Association should urge his Majesty's Government to stimulate the employment by local authorities of the powers already conferred upon them by Parliament for the preservation of scenic amenity in town and country. The motion will be seconded by Mr. T. Sheppard, representing the Museums Association, and Miss R. M. Fleming, of the Cardiganshire Antiquarian Society, who will deal especially with the concern of Wales in this matter. Lord Crawford and Balcarres, chairman of the Council for the Preservation of Rural England, will speak in support of the resolution.

The second and concluding session of the Conference of Corresponding Societies, to be held on Tuesday, September 11, will be devoted to the scenery of the English Lake District and its preservation. The subject has been chosen for treatment on this occasion because the Lake District is the most significant scenic region in Great Britain, not only on account of its unusual combination of fine natural features and of certain advantages for rambling which result from the social and economic conditions of the district, but also because it is inseparably connected with the prophetic inspiration of one whose interpretation of nature is of unique importance to readers of English poetry.

Dr. Hugh Mill, vice-president of the Royal Geographical Society, will describe the geography of this well-defined scenic region. The next speaker will deal with "Wordsworth's Interpretation of Nature," after which Mr. Ewart James, of St. Bees, Cumberland, will give a detailed account of the elaborate scheme of regional planning for the preservation of scenic amenity in the Lake District and its environs which is now under the consideration of numerous local bodies.

RESEARCH ON AIR NAVIGATION

DR. GEORGE WILLIAM LEWIS, director of aeronautical research under the National Advisory Council, in proposing the formation of the subcommittee on problems of air navigation, as announced in last week's issue of SCIENCE, presented the following outline for its work:

1. It has been brought to my attention that there is need at the present time for the coordination of scientific research being conducted on the problems of instruments for air navigation, aerial communications and meteorological problems of air navigation, especially landing in fog.

2. The importance of coordinating these activities has been called to my attention particularly by representatives of the Daniel Guggenheim Fund for the Promotion of Aeronautics and the American Telephone and Telegraph Company. To provide aids to air navigation is a function of the Department of Commerce.

The coordination of scientific research for the providing of such aids is considered to be properly a function of the National Advisory Committee for Aeronautics, and can be so interpreted from the act establishing the committee, which states it shall be the duty of the committee "to supervise and direct the scientific study of the problems of flight, with a view to their practical solution, and to determine the problems which should be experimentally attacked, and to discuss their solution and their application to practical questions."

3. Commander Hunsaker, of the American Telephone and Telegraph Company, has advised me that his company is conducting research on aerial communications, especially in connection with the navigation of aircraft and the communication of weather reports. He has found that the researches being conducted along lines in which he is particularly interested are rather wide-spread and varied, and that there is no organization at present that is coordinating this work in a manner similar to the functions of the Aerodynamics Committee and other subcommittees in other fields of aeronautical activity. Among the organizations at present conducting research along the lines of aerial communications are the American Telephone and Telegraph Company, the Bureau of Standards, the War Department, the Navy Department and the Radio Corporation of America.

4. The Guggenheim Fund organized, under the direction of Admiral H. I. Cone, a committee to study the problem of fog landing. The committee included in its membership representatives of the various government organizations concerned with the problem, the purpose being to coordinate the efforts of the various investigators along this line with a view to the making of definite recommendations as to what the Guggenheim Fund could do to aid in the solution of this particular problem.

5. Admiral Cone also brought to my attention the importance of coordinating the work of government organizations and manufacturers in fundamental investigations leading to the development of better and more accurate aerial navigation instruments.

6. There is a feeling on the part of every one connected with aeronautics, both in the government services and in outside organizations, including the manufacturers, that the committee has discharged its function of coordinating fundamental research in a very praiseworthy manner with reference to aerodynamics, power plants and materials for aircraft.

The time has now come when the problems of air navigation, particularly meteorological problems, aerial communications and navigational instruments, are of the utmost importance, and the coordination of fundamental research in connection with these projects is properly a function of the National Advisory Committee. It is, therefore, recommended that a Subcommittee on the Problems of Air Navigation be organized, to include in its membership representatives of those agencies particularly interested in these problems, both in the government services and outside the government.