A Simple Method for Testing Homogeneity of Wood

SOME time ago[1] we found that there seems to be a characteristic difference in the structure of the wood used for the building of string instruments: X-ray investigations have shown that the top always exhibits a very marked fibre structure, whereas the back in instruments of good tone quality is nearly homogeneous.

The question arises whether it is possible to find these differences by methods which might have been available to the Italian makers of the classical period? I found that it is possible to obtain this information by using heat conductivity in the different directions of the wood as an indicator of its homogeneity. It is well known that a thin layer of wax applied to a crystal face will melt into a figure of definite contour (isotherm) if the crystal is touched at one point with a hot wire. The same method can be easily applied to wood, and one finds that the isotherm on a piece of wood cut vertical to the fibre is always a circle, except where a knot produces an inhomogeneous region. The isotherm on a cut parallel to the grain varies in its outline for different materials. The ratio of the axes for pine used for the top of violins has been found as high as 1·95, and for nearly homogeneous maple used for the back 1·15. We have obtained recently, through the courtesy of Dr. A. Koehler, director of the U.S.A. Forest Products Laboratory, Wisconsin, some samples of white ash which range, as revealed by X-ray investigations, from very marked fibre structure to almost complete homogeneity. The same variation and exactly the same order has been found by using the isotherm method.

It is possible that such a method, discovered accidentally, may have been used by the instrument makers, since many of the old instruments exhibit branding marks even if the maker did not use a brand for the identification of his instruments.

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[1] NATURE, **134**, 23 (1934).

The Structure of Light Waves

I WAS very much interested in Sir J. J. Thomson's letter[1] in which he suggests that light waves are axially symmetrical systems of electro-magnetic waves propagating *along* the axis of symmetry, as I made the same suggestion in 1929[2] and then repeated it in my recent papers in the *Philosophical Magazine*[3] where this kind of Maxwell waves was discussed in detail; on the basis of this discussion a theory of elementary "material" particles (like electrons and protons) and of the photons was developed, according to which these entities were regarded as certain axially symmetrical systems of Maxwell electro-magnetic waves.

Similarly to Sir J. J. Thomson, I used the Maxwell equations in *cylindrical* co-ordinates, and I have transformed these equations practically into the same form as Sir J. J. Thomson does[4], only a little more generally, and correspondingly obtained a solution[5] of which Sir J. J. Thomson's solution $Q = A\rho + B/\rho$ represents a particular case[6].

This particular case is, however, *unsuitable* for *free* electromagnetic waves, for Q becomes infinity, either at $\rho = 0$ or $\rho = \infty$, or both. Sir J. J. Thomson tries to avoid this by putting $A = 0$ when $\rho > a$, and $B = 0$ when $\rho < a$. But then we shall obviously obtain not *free* electromagnetic waves, but electromagnetic waves propagating along a cylinder of radius a, co-axial with the axis of symmetry of the waves, made either of conductive material with infinite conductivity or an insulator with infinite dielectric constant (when the magnetic lines of force are circular while the electric lines of force are situated in axial planes) or alternatively, of ferro-magnetic material of infinite permeability (when the electric and magnetic lines of force are situated vice versa)[7]. Otherwise the Maxwell equations would be no longer valid at the surface of this cylinder, owing to the discontinuity of the axial component of the vector situated in axial planes and, as is not difficult to find, proportional to A.

For this reason I have not considered in detail the particular case which was used by Sir J. J. Thomson, but discussed a more general solution in which the *phase along the radius was variable*[8].

However, later I found that even this more general solution was not satisfactory for various reasons, and, therefore, I based my further discussion on solutions in the form of Bessel functions, in which no such discontinuity exists[9]. This discussion led eventually to the above-mentioned theory of elementary particles, including photons, which explained their fundamental properties, classical as well as wave mechanical and relativistic, and also the actual numerical value of the mass ratio between the proton and the electron, on the basis of Maxwell electrodynamics.

In conclusion, I would like to express the hope that Sir J. J. Thomson's letter will increase the interest in the axially symmetrical electromagnetic waves, for I am convinced that this study must contribute essentially to the solution of various problems of physics. The fact that Sir J. J. Thomson arrived at the conclusion as to the importance of this kind of waves without being aware of my previous results makes his opinion still more valuable as a stimulus. The value of this stimulus is not affected by the unsuitability for the free electromagnetic waves (and hence for light waves) of the particular solution which Sir J. J. Thomson tries to apply.

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[1] NATURE, **137**, 232 (Feb. 8, 1936).

[2] *Z. Phys.*, **54**, 1 and 2, 121 (1929).

[3] *Phil. Mag.*, **19**, 954 (1935); *ibid.*, **20**, 441, 646, 695 and 702.

[4] See equation (24) in *Z. Phys.*, *loc. cit.*, from which Sir J. J. Thomson's equation $\frac{d}{d\varrho}\left(\frac{1}{\varrho}(\varrho Q)\right) = 0$ is obtained as a particular case by equating the constants $l = 1$ and $k = 0$.

[5] See formula (27) in *Z. Phys.*, *loc. cit.*, Sir J. J. Thomson's solution is obtained as a particular case by putting $l = 1$ and $k = 0$.

[6] The notation used in my paper differs from the notation in Sir J. J. Thomson's letter. His Q, ϱ, A and B correspond to my Y, r, $\sqrt{C_1}$ and $C_2\sqrt{C_1}$ respectively.

[7] The solution suitable for *free* axially symmetrical waves of this kind requires that the radial component of the electro-magnetic vector at $\varrho = 0$ should not only be finite, but also equal to zero (see *Z. Phys.*, *loc. cit.*, 116).

[8] *Z. Phys.*, *loc. cit.*

[9] *Phil. Mag.*, *loc. cit.*

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