VELOCITY OF LIGHT AND MEASUREMENT OF DISTANCES BY HIGH-FREQUENCY LIGHT SIGNALLING*

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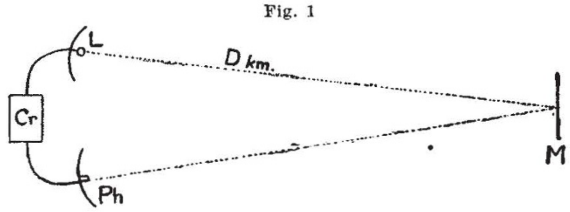
FIZEAU'S principle of determination of the velocity of light can be used for the measurements of lengths. In modern form an arrangement according to this principle is shown in Fig. 1.

L is the source of light, having a spherical mirror to collect the light in a beam. The source is influenced by high-frequency tension from the crystal-controlled oscillator *Cr*, and thus the intensity of the light emitted varies with the frequency of the oscillator. *M* is a plane mirror, which reflects back the light to the phototube *Ph*. The phototube gets its operating tension from the oscillator *Cr*. Accordingly, the sensitivity of the tube varies with the same frequency as the intensity of the emitted light. As the rapid blinks of light take a certain time to cover the distance to *M* and back again, the moments of high sensitivity of the tube will be more or less timed to the incoming blinks, depending on the distance *D*. Fig. 2 shows how the recording current directed by the phototube depends on the distance *D*.

Fig. 1



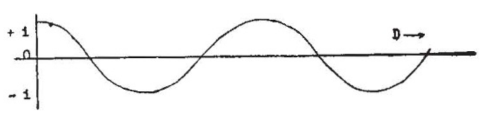


Fig. 2

A low-frequency alternating phase displacement of 180° of the high-frequency light variations makes the current exactly symmetrical with respect to the zero-line. By this means we get sharply marked positions of the mirror where the current is zero. The distance between the zero positions depends on the frequency of the oscillator *Cr*. In the actual apparatus, the frequency is 8·3 Mc./sec., corresponding to a wave-length λ of 36 metres. Thus the current becomes zero every ninth metre in accordance with the expression

$$D = K + \frac{2N - 1}{8} \cdot \lambda,$$

where D is the distance to be measured, K is a constant, depending on the apparatus used, λ is the wave-length, depending on the frequency and here being 36 metres, N is a whole number + 1, 2, 3, 4, ... Usually N is known from an approximate knowledge of D; if not, it may be determined by variation of λ. The values of D corresponding to $N = 1, 2, 3, \ldots$ are constant to the same degree as the frequency is constant, that is, to one part in ten millions; they depend also on the accuracy with which the atmospheric conditions are known. Thus the influence of temperature is 0·9 cm. per degree C. and 0·4 cm. per millibar air pressure, for a distance *D* of 10 kilometres.

In the field, the mirror *M* usually is not placed exactly at a zero-point. We then decrease the frequency slightly from its 'normal' value. The farthest zero-point glides out and passes the mirror. Just then the photo-current changes its direction and passes through zero. We now read off the change of frequency and get the distance of the mirror from the farthest 'normal' zero-point. In this way we get the extreme value of the distance to be determined. The other end is fixed in a similar way. Here we use the value of D for $N = 1$. This distance, about 1 metre, is very constant. By means of a variable loop of light, it can be determined or controlled. To get the main constant of the apparatus, the first determination is made on a known base-line.

At a value of *D* of 9 km., the sensibility of adjustment commonly was 0·4 cm. as a mean error of six determinations during a quarter of an hour. Measurements on different days showed a maximum divergence of 3 cm.

Knowing the frequency, we determined the velocity of light *in vacuo* to be 299·796 ± 2 km. per sec. We intend to make further measurements in March; therefore, the values given above should not be considered as definite.

A.G.A., Stockholm, intend to manufacture the 'geodimeter' for sale.

REFERENCES

Bergstrand, K. *Vetenskapsakad. Arkiv, M.A.F.*, Nr. 30 (Stockholm, 1943); Nr. 20 (Stockholm, 1949); *Acta Com. Geod. Baltique* (Helsinki, 1948).

* From a paper presented at the International Union of Geodesy and Geophysics, Oslo, 1948.

PHOTOMETRY OF THE CONTINUOUS SPECTRUM

PROF. W. M. H. GREAVES, president of the Royal Astronomical Society, delivered his presidential address on February 14, 1948, to the Society at Burlington House, selecting as his topic "The Photometry of the Continuous Spectrum". As Prof. Greaves pointed out at the beginning of his address, he was encouraged to make the attempt of presenting a survey of the subject by the consideration that it "can be used to illustrate the way in which Natural Knowledge is advanced by an interplay between observational and theoretical investigations". The address involves so many technical matters and is so comprehensive that no attempt can be made in this short notice to deal with it in detail; and those who are specially interested in the subject should study the paper itself (*Mon. Not. Roy. Astro. Soc.*, **108**, No. 1; 1948).

A general description is given of the kind of measurement which is undertaken in this comparatively new technique and also of the relation of this technique to that of classical photometry; after this there is a review of the theoretical work on spectral energy distribution which has taken place during the last two decades. The theory of the radiative equilibrium of stellar atmospheres had been independently developed by Lindblad and Milne, and, on the assumption that the stellar absorption coefficient did not vary with wave-length, Milne showed that the stars would radiate like black bodies. The calculated values for the sun's centre-limb contrast, which agreed well with the available data, seemed to substantiate this view, and the theory gave a definite set of temperatures—those of the Fowler–Milne scale—which were approximately identified with colour temperatures. The well-known work of Greaves, Davidson and Martin at Greenwich on the gradient difference between stars of spectral types $B0$ to $B3$ and stars of spectral type $A0$ showed a colour-temperature of 18,000° for $A0$-stars at a wave-length of 5000 A. as against the Fowler–Milne value of 10,000°; and it was necessary to discard Milne's provisional assumption that the stellar absorption coefficient did not vary with wave-length.

Reference is made to the advances which attended the work of McCrea, who calculated the emergent radiation for a model star composed entirely of atomic hydrogen, and of Pannekoek, who independently repeated McCrea's investigations, taking into account the contribution of metallic atoms in the stellar atmospheres. Also dealt with is the observational progress which was made during 1934–39 through the work of Barbier, Chalonge and their collaborators at Jungfraujoch, of Kienle and his colleagues at Göttingen, and R. C. Williams at Ann Arbor. Many others matters are included in the address, and towards the end Prof. Greaves expressed his personal opinion that, though the existence of intrinsic reddening in addition to space reddening has not been absolutely established, the balance of evidence favours the view that reddening by interstellar scattering is not the only process involved. Before attempting the task of interpretation, further measures are very desirable, and in particular the study of the variation of gradient excess with wave-length from the near infra-red to the near ultra-violet

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RUBBER RESEARCH INSTITUTE OF THE DUTCH EAST INDIES

THE Rubber Research Institute of the Dutch East Indies at Buitenzorg, Java, has recommenced publication after the delay of several years caused by the Japanese occupation, and a number of its recent reports contain points of interest.

Publication No. 38 shows that rubber obtained immediately after tapping the tree is readily soluble in petroleum ether, but on standing in the light it gradually becomes insoluble, especially if stored in the form of latex. These changes naturally complicate the supposed distinction between 'sol' and 'gel' rubber.

Publication No. 39 emphasizes the important bearing which the method of preparation of rubber has upon the physical properties of the final vulcanized article, especially in respect of water absorption and tension strength in the wet state; for example, whole-latex rubbers are much stronger when dry than when wet.

A study of the nature of the naturally occurring antioxidants in rubber latex (Publication No. 54) has shown that the amino-acids have a remarkably powerful antioxidant action. The spontaneous coagulation of *Hevea* latex has frequently been believed to result from progressive lowering of pH, but it still occurs even when the pH is kept constant, and work done in Java (Publication No. 58) suggests that the removal of magnesium ions, as a fatty soap, is the main cause of coagulation.

The vexed problem of the value of incorporating rubber powder in roadways receives a contribution in Publication No. 61, where it is shown that the durability of bituminous coatings in Java is much improved by the addition of rubber powder.

Some of those who use raw rubber have for long maintained that the 'fine hard Para', produced under primitive conditions in Brazil, is of superior quality to that produced on plantations. This controversy will presumably be revived by the report, given in Publication No. 62, that smoked sheets produced under primitive conditions in West Borneo may be of superior quality to those produced by native labour, following modern practice, in south Borneo.

The marked differences between fresh latex and old latex, some of which were commented on above, are responsible for an interesting development which is fully described in Publication No. 68. When old vulcanized latex is coagulated, a continuous coagulum is obtained; but if fresh latex is used for the vulcanizing process, and the product is then coagulated, the coagulum is not coherent and forms a powder, known as 'Mealorub', on drying. This very economical method of producing a powdered rubber will be watched with considerable interest, especially from the point of view of its use as a means of preventing the flow of road bitumens in hot weather, and as a means of binding certain types of road aggregates.

R. G. NEWTON

FORTHCOMING EVENTS

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*(Meetings marked with an asterisk * are open to the public)*

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UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. C. Rimington: "Haem Pigments in Nature".* (Further Lecture on March 7.)

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