Letters to the Editor.

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Determination of the Yard in Terms of the Wave-length of Light.

IN the issue of NATURE for May 9, p. 726, a short account is given of an investigation by Dr. A. E. H. Tutton of the length of the yard in terms of the wave-length of light. This being the first occasion on which the value of the yard in wave-lengths has been directly determined, considerable interest naturally attaches to the result.

In the complete account of his work which has now been published,¹ Dr. Tutton arrives by calculation, from the means of several determinations made in the red line of hydrogen and in the strong yellow line of neon, at a value for the length of the yard in terms of the standard cadmium red line which is in good agreement with that derived from the accepted value of the metre in terms of this line, taken in conjunction with the known ratio of the yard to the metre.² Unfortunately, however, he gives no adequate investigation of the probable error of his result, which the internal evidence of his paper clearly shows is very large. In fact, from the nature of the procedure adopted it could not be otherwise.

The method consists in actually counting, to the nearest tenth of a band, the number of interference bands corresponding to three intervals each $\frac{1}{16}$ in. in length—that is, a potential accuracy of the order of 1 part in 50,000—and then stepping up to the yard by a process which, apart from any further errors which may be involved, is one of sheer multiplication. Actually the various individual counts of the separate sixteenths of inches in H_α exhibited differences between themselves amounting to as much as 1.6 bands, with an average difference from the mean in each group of 0.44 band, or nearly 1 part in 10,000. Only two counts were made in Ne_β , the average difference between corresponding pairs being 0.5 band.

As a test on the accuracy of the building-up process, the following comparison is informative. On pp. 312, 316, Dr. Tutton gives the final values he obtained for the length of the yard as—

$$1 \text{ yard} = 1,393,290.5 H_\alpha$$

$$1 \text{ yard} = 1,562,408.6 Ne_\beta$$

respectively. From the ratio of these two figures, taking the value of Ne_β as 5852.488 Å., the value of H_α can be calculated as

$$H_\alpha = 6562.865 \text{ Å.},$$

a result which, though somewhat high, is in tolerable agreement with expectation. The building-up process can, however, add nothing to the accuracy of the original counts, and if we take from pp. 301 and 303 the aggregate mean counts of the three separate $\frac{1}{16}$ in. lengths in the two radiations, we get 16,266.5 $Ne_\beta = 14,504.3 H_\alpha$, from which, using the same value of Ne_β , as above, we find

$$H_\alpha = 6563.536 \text{ Å.},$$

showing a difference of 1 part in 10,000 as compared with the result derived from the same data after building up to the yard length.

Incidentally, this more direct calculation gives a value for H_α too far removed from the range of values found for this line by other observers to be acceptable, and it is thus clear that the agreement of Tutton's results with expectation, both as regards the wave-

length value of the yard in Ne_β and as regards the derived value of H_α , must be entirely fortuitous, both the original counts and the building-up process being liable to errors of the order of 1 part in 10,000. There are other points in Dr. Tutton's paper which might be criticised, but in these circumstances there is no necessity to enter into details.

At the conclusion of his paper, Dr. Tutton generously records his acknowledgments in respect of certain facilities which I was happy to be able to afford him; and having been to this small extent associated with the work, I the more regret having thus to direct attention to the uncertainty of the results. Had they differed from expectation as much as these remarks show that they easily might have done, the necessity would scarcely have arisen, but their chance agreement with expectation involves a risk that they may be accepted at their face value without sufficient scrutiny. It is very important that the wave-length value of the yard should be determined with all attainable precision. Preparations for such a determination at the National Physical Laboratory are well advanced, and it is expected that the results will become available for publication during the course of next year.

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¹ Tutton, *Phil. Trans.*, A, 230, 293; 1931.

² Sears, Johnson and Jolly, *Phil. Trans.*, A, 227, 281; 1928.

IN rendering due thanks to Mr. Sears, at the conclusion of my paper, for the facilities granted to me for the use of the interferential comparator, which I had the honour to devise and see constructed and installed at the Standards Department of the Board of Trade, in the time of the late Deputy-Warden of the Standards, Major P. A. MacMahon, nothing was further from my intention than to imply any responsibility on the part of Mr. Sears for the results communicated to the Royal Society in my paper. Indeed, he was from the first unsympathetic towards my interferential method. While in Major MacMahon's time the statutory periodic comparisons of the Imperial Standard Yard with its official copies were carried out with my interferential comparator, the interferometric portion was afterwards dismantled, and the instrument used for purely mechanical and microscopic comparisons. Much valuable time had to be spent at the outset of my work in cleaning, re-fitting, and readjusting the interferometric part, and by the Office of Works electricians in replacing perished electrical fittings, especially those of the thermostat, which maintains the whole comparator room at the official temperature of 62° F. and which had become positively dangerous from disuse. Fortunately, all the base-line work, the actual counting, band by band, of the interference bands (10,846 in yellow neon Ne_β light) in the one-eighth of an inch, was able to be carried out on my own interferometer, an improved copy of that at the Standards Department, in my private laboratory at Cambridge.

The specific criticisms of Mr. Sears are all fully dealt with in the paper. It is unfair to assume an error of one in ten thousand, the true facts being stated on page 318, where it is shown to be less than 0.03 of an interference band, corresponding to about four wave-lengths in the final result. Not two but six counts in yellow neon light are recorded, two on each of three separate sets of Grayson-ruling (half wave-length) fiducial marks, and double this number of counts were actually made with identical results.