CORRESPONDENCE.

To the Editors of 'The Observatory.'

The Positive-on-Negative Method of measuring Spectra.

GENTLEMEN,—

May I add a few remarks to Prof. Turner's statement at the June meeting of the Royal Astronomical Society, when he kindly demonstrated my method of measuring the solar rotation by superposing positive on negative of East and West limb spectra? (*Observatory*, vol. xli. p. 275).

The method of superposing positive on negative and measuring the double displacement of spectrum-lines is not confined to solar rotation work, but has been used with great success at Kodaikanal for all measures of line-displacements requiring the highest attainable accuracy; only in special cases, however, in which solar rotation work is one, is it possible to measure the displacements

without reversing the positive on the negative end for end. I have had no experience in the measurement of star-images, but imagine that the same method might be usefully employed for determining proper-motions or parallax displacements. That the method is a practical success is shown by our record of work done this year, when at least 20,000 adjustments of coincidence of lines in Venus spectra alone have been made.

The ordinary form of Hilger micrometer with its microscope sliding in gun-metal ways has now been superseded, and the new micrometer built by Hilger to my specifications has more than justified my expectations of it. There is no sliding friction and no lost motion or "backlash" when reversing the movement, and it is adapted for either positive on negative or ordinary bisection methods of measurement, the latter being used only for measuring large intervals, scale-values, &c.

In the early stages of the work the new method and the instrument seemed to be beset with so many small troubles and difficulties that it was a question whether the advantages gained outweighed the time and labour involved. Now, having overcome all of these difficulties, the measurement of a plate proceeds with great ease and satisfaction, there is less strain to the eye than is experienced in bisecting with a thread in the ordinary way, but, of course, experience and practice are needed to get the best results. Attempts were made at first to avoid the possibility of actual contact between the positive and negative plates by superposing images of them by optical devices; these images could then be brought to an identical focal plane in the eye-piece. But it was found that the adjustment for coincidence was not nearly so delicate as is found when the films are actually superposed. This sensitiveness when the two films are almost in contact is remarkable, and in measuring well-defined solar lines in spectra having a dispersion of about 1 mm. to the angstrom unit, successive settings will differ usually by amounts under 0·002 mm., equivalent to 0·001 Å, so that in measuring one feels the need of estimating the next decimal or ten thousandths. For most of the emission-lines in the arc-spectrum of iron a still higher accuracy may be attained when the hand is trained equally with the eye. Such a degree of precision has never been approached by me or by any member of my staff here in the bisection method, notwithstanding an immense amount of practice, but I will allow that there may be prodigies that can do it!

The difficulty we now encounter (one which does not appear to have been a cause of trouble elsewhere) is that when quantities of the order of 0·001 mm. are involved, irregularities in the plates become obtrusive, and cause disappointment and disillusionment when plate is compared with plate. This is particularly evident when very fast plates are used and the negative is somewhat

under-exposed and over-developed : it is no doubt due to irregular distribution of the silver deposit or irregular growth of the images in development. Irregular shrinkage of the film when drying may also be concerned in all brands of plates, as when a drop of water hangs on the film and retards the drying in one particular spot.

Of course, these troubles are of an accidental nature, and may be eliminated by measuring a sufficient number of plates; and that is where the theory of errors helps, but it is tedious. Experience shows that, although it may be theoretically possible, we cannot by any amount of repetition get results that transcend the limits of perception ; intuition also says that it is not possible to measure an invisible quantity : I claim, however, for the positive-on-negative method that it extends our range of perception very appreciably.

The delicacy of the adjustment when the positive is made of the correct density reveals to the eye shifts of solar or arc lines which could not ordinarily be detected without long and laborious measurements. In some recent plates of the solar spectrum, where the Sun's image was accurately focussed on the slit and the definition good, I find that the spectrum-lines are far from being straight, little displacements of the order of ·002 Å to ·005 Å being at once perceived, whilst spectra similar in all respects but composed of generalized sunlight show no such shifts. These irregularities are doubtless due to movements of the solar gases, and will repay closer study : they explain many inconsistencies previously met with in Sun-arc and solar-rotation measures. It has also been found that the arc lines of iron are liable to very small displacements when more than one element is carrying the current in the arc ; but it has not hitherto been possible to trace out the precise combination of conditions necessary to produce these shifts, which are so clearly revealed when the positive and negative images are superposed in reversed positions.

I am, Gentlemen,

Yours faithfully,

J. EVERSHED.

Kodaikanal,
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