

In connection with that portion touching upon the Meridian Circle, Professor Keeler states that during the year ending last September, and upon 106 nights, 6000 observations were made with the Meridian Circle.

Now the question I would submit, and upon which I would request information, does Professor Keeler wish it understood that 6000 star places were observed in that time, or are these numbers of observations made up of the determination of the right ascension, declination, nadir point, collimation, level and azimuth, each individual determination of these quantities to be counted as one observation?

The above figures give as a nightly average 57 observations, and from my experience four or five observations per hour—I mean a complete determination in both right ascension and declination, when one is not working with an assistant and not in zone work—is about the limit.

When it is taken into consideration that one observer sets his circle, reads four microscopes, observes nine or eleven transits, makes two or more bisections in zenith distance, and records all these, reads his level at least once every hour, observes his collimation twice in an evening's work, an average of 57 observations per night is almost, if not quite, unrivaled.

But, as I said before, perhaps what Professor Keeler wished to convey by the word 'observations' is not what I have construed it, a complete determination of the two coördinates of the star place, but may contain two, three or four quantities, which he calls observations.

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NOTE ON THE FOREGOING LETTER BY PROFESSOR HILL.

IN the part of my report to which Professor Hill refers in his letter, one observation means one complete determination of both coördinates of a star. A complete observation of the nadir (zenith) point and level is also, in accordance with the usual custom, counted as one observation. Collimation and flexure determinations and *mire* readings have not been included.

A reference to our records for the year covered by my report shows that the average number of stars, completely observed in both coörd-

minates during this period by Professor Tucker, was fifty per night. With an assistant reading the microscopes the average number was sixty-two per night of from four to five working hours. The observations, as shown by their probable errors on complete reduction, are of the highest order of precision.

Doubtless this is quick work, but I believe that it is by no means of unprecedented rapidity. It is moreover obvious that a comparison of the work of different instruments, on the basis of such figures as those given by Professor Hill, may be quite misleading, since the rapidity with which observations can be made depends largely on the character of the work which is being done. With a full list like that of Mr. Tucker's during the past year, the stars culminate more rapidly than they can be observed, so that the list has to be gone over several times. The rate of observation then depends upon the observer's quickness and skill. With a list which contains many gaps, stars have to be waited for, and the rate depends upon the list alone.

JAMES E. KEELER.

DARK LIGHTNING.

TO THE EDITOR OF SCIENCE: My attention was drawn to Mr. Clayden's work by an article in *Nature* in which reference was made to a communication in one of the photographic journals. The note in the *Philosophical Magazine* I had somehow overlooked.

Mr. Clayden in his letter states that he was unable to obtain any results with the calcium light or with sunlight, and suggests that there may exist some difference between light from such a source and a source whose excitement is electrical, and that it is not safe to assume that the time factor is the only one, until the image of some non-electrical source has been reversed. I cannot see much difference between the calcium light and the arc, for in both we are dealing with an incandescent solid. To settle the matter definitely I have repeated the experiment with the revolving disc, using a calcium light, and obtained perfect reversed images of the slit on the first trial. Mr. Clayden's failure to get reversal with sources other than the spark was due, I imagine, to a too long exposure. The duration must be something less than  $1/15000$