The photographic instruments are placed in an underground chamber with a view of exposing them as little as possible to change of temperature. As in the instrument used for direct reading, each instrument has attached to it a small mirror and immediately below a fixed mirror is attached to the slate bed on which the instruments are placed. The light from a gas jet passes through a slit into a collimating tube the image of the slit passes then through a lense and is thrown on to the two mirrors and by them reflected through a semi cylindrical lense which focusses the light into two bright points which are projected on cylinders carrying sensitised paper and fed forward by clock work. The spot from the fixed mirror gives a straight or base line, and that from the mirror attached to the magnet exhibiting the direction and amount of the movements of the needle. It is to the continuous record thus obtained by photography that we must look to obtain the information necessary to establish the laws of change in the magnetic elements, and on the occasion of violent magnetic storms they give us the means of comparing the most minute changes as well as the greatest, which on these occasions seem to take place at the same instant of absolute time.

Professor Grylls Adams has in this way investigated the great magnetic storm of the 11, 12, 13 and 14 August, 1880. This storm began at 10 hours 20 min. a. m. G.M.T. The traces showing the same instant in Europe, Asia, and America in high northern and southern latitudes, and also near the equator at Bombay, and everywhere precisely in the same way. A full report of the examinations of the records of this storm will be found in the report of the British association for 1881, being a paper on magnetic disturbances and earth currents by Professor W. Grylls Adams, F. R. S.

Professor Adams says in closing his paper on magnetic disturbances: "We know so little as yet of the causes of the changes of the sun, and this connection with terrestrial phenomena that we can hardly do more than ask what possible causes there are that could account for the effects which are observed. Can we suppose that the sun is a very powerful magnet, and that a great alteration in his magnetism accompanies the production of the bright faculæ, and the spots in his atmosphere? such a change of magnetism would affect the magnetism of the earth, although the effect would not be large unless the sun is magnetized to an intensity much greater than the earth, even allowing for the difference in the mass of the sun and earth."

As I have already mentioned, Professor Balfour Stewart has pointed out that there are similar periods of short range in the solar spots and in the fluctuations of temperature at Toronto and other stations where results have been worked up.

The conclusion which he drew from these investigations was that the sun emitted more heat at times of maximum number of spots than at minimum. In order to test directly whether this was the case he devised an instrument called an actinometer. One of these instruments of a most improved pattern has been purchased for use at the Toronto observatory.

The instrument itself consists of a large mercurial thermometer, with its bulb in the middle of a cubical chamber of brass, the chamber being so massive that its temperature will remain sensibly constant for some time. This massive chamber is lined outside with felt, and this again surrounded by polished brass plates.

A lense is attached by means of a rod to the cubical chamber, and in taking the observation the sun's rays are focussed by this lense, and projected directly on the bulb of the thermometer. In taking an observation the aperture in the cubical chamber through which the sun's rays are projected is first kept closed, and say that the time of exposure has been selected as two minutes, the thermometer is first read exactly two minutes before exposure begins. It is again read at the expiration of the two minutes, and the exposure at once made by drawing out the slide which covers the aperture. Exactly two minutes after it is again read and the exposure discontinued. Again, at the expiration of another two minutes, the thermometer is read. The comparative heating power of the sun is deduced from the formula

$$R + \frac{r \times}{s}$$

where R is the amount of heat gained during exposure, and r and r' the difference between the 1st and 2d, and 3d and 4th readings respectively, which indicate the heat which the instrument is losing by radiation from itself.

The great difficulty in the way of making these direct observations is the variability of the condition of the earth's atmosphere, which forms a medium of ever varying opacity, through which we are forced to view the sun. This source of uncertainty might be reduced to a minimum if these observations were made at some great altitude, as on the top of a high mountain where the lower or grosser strata of the atmosphere would be left behind.