XVI. *Additional Observations tending to investigate the Symptoms of the variable Emission of the Light and Heat of the Sun; with Trials to set aside darkening Glasses, by transmitting the Solar Rays through Liquids; and a few Remarks to remove Objections that might be made against some of the Arguments contained in the former Paper.* *By* William Herschel, *LL. D. F. R. S.*

Read May 14, 1801.

HAVING brought up the solar observations, relating to the symptoms of a copious emission of the light and heat of the sun, to the 2d of March, I give them continued in this Paper to the 3d of May. It will be seen, that my expectations of the continuance of the symptoms which I supposed favourable to such emissions, have hitherto been sufficiently verified; and, by comparing the phænomena I have reported, with the corresponding mildness of the season, my arguments will receive a considerable support.

I have given the following observations without delay, as containing an outline of the method we ought to pursue, in order to establish the principles which have been pointed out in my former Paper. But we need not in future be at a loss how to come at the truth of the current temperature of this climate, as the thermometrical observations, which are now regularly published in the Philosophical Transactions, can furnish us with a proper standard, with which the solar phænomena may be compared. This leads me to remark, that, although I

have, in my first Paper, sufficiently noticed the want of a proper criterion for ascertaining the temperature of the early periods where the sun has been recorded to have been without spots, and have also referred to future observations for shewing whether a due distribution of dry and wet weather, with other circumstances which are known to favour the vegetation of corn, do or do not require a certain regular emission of the solar beams, yet, I might still have added, that the actual object we have in view, is perfectly independent of the result of any observations that may hereafter be made, on the favourable or defective vegetation of grain in this or in any other climate. For, if the thermometer, which will be our future criterion, should establish the symptoms we have assigned, of a defective or copious emission of the solar rays, or even help us to fix on different ones, as more likely to point out the end we have in view, we may leave it entirely to others, to determine the use to which a fore-knowledge of the probable temperature of an approaching summer, or winter, or perhaps of both, may be applied; but still it may be hoped that some advantage may be derived, even in agricultural economy, from an improved knowledge of the nature of the sun, and of the causes, or symptoms, of its emitting light and heat more or less copiously.

Before I proceed, I must hint to those who may be willing to attend to this subject, that I have a strong suspicion that one half of our sun is less favourable to a copious emission of rays than the other; and that its variable lustre may possibly appear to other solar systems, as irregular periodical stars are seen by us; but, whether this arises from some permanent construction of the solar surface, or is merely an accidental circumstance,

must be left to future investigation: it should, however, be carefully attended to.

OBSERVATIONS OF THE SUN.

March 4, 1801. I viewed the sun with a skeleton eye-piece, into the vacancy of which may be placed a moveable trough, shut up at the ends with well-polished plain glasses, so that the sun's rays may be made to pass through any liquid contained in the trough, before they come to the eye-glass.*

Through spirit of wine, I saw the sun very distinctly. There are 10 openings without shallows; and a pretty considerable one with a shallow. The opening is nearly round; and the shallow is concentric with it, and also round. The want of shallows about the small openings, and the roundness of that about the largest, indicate that the elastic empyreal gas which passes through them, is without side-bias in its motion.†

March 8. I viewed the sun through water. It keeps the heat off so well, that we may look for any length of time, without the least inconvenience. There are a few openings, many ridges and nodules.

March 9. The ridges near the preceding limb are more extensive than I have ever seen them; there is a broad zone of them.

March 12. There is a cluster of 20 small openings; none of them have any shallows.

March 13. There are 31 openings in the cluster of yesterday:

* See Plate XXVIII. Fig. 1 and 2.

† See page 281 of my last Paper, "*Probable Cause of Shallows*;" and page 301, "*The solar Atmosphere, like ours*," &c.

they are contained in a double row, nearly parallel to the sun's equatorial motion; the largest of them has now a shallow of a considerable size, on its north following side.

The number of small openings near each other, indicates a perpendicular ascent of the empyreal gas that breaks through the atmospheric clouds; and their want of shallows shews the same thing.

March 15. The set of openings which began to enter on the 8th, consists now of 29. There are 3 other small openings in different parts of the sun.

March 16. There is an opening lately entered. The cluster of yesterday has undergone considerable changes.

March 18. The opening of the 16th consists now of 8 different ones; none of them have any shallows.

The whole space about the cluster of the 8th, is surrounded with luminous ridges in many directions.

The corrugations all over the sun are beautiful, and coarse; resembling small nodules joined together like irregular honeycomb.

In a multitude of places, the corrugations are quite detached, like luminous wisps, or slender tufts, standing upright.

March 19. Another set of ridges has entered the disk; it contains one opening.

The corrugations are rich, and may be called luminous wisps, being much disjoined, except at their bottom; they are so rich, that they partake of the yellowish colour of the ridges.

The northern ridges extend a good way into the disk, like a zone.

March 21. There are five sets, containing 29 openings, none of which have any shallows.

At equal distances from the limb, the corrugations are equally coarse all over the disk of the sun.

March 22. An additional opening, with surrounding ridges, has lately entered the north-following limb. I counted 21 openings.

March 31. An opening very near the preceding limb is surrounded by a shallow, which is bordered by a luminous ridge all round it. The opening itself is also bordered by an elevated edge, which is nearly as high as the general surface of the corrugations; but not so high as that which borders the shallow, and stands above the general surface.

April 1, $11^h\ 30'$. I saw the opening of yesterday go out of the limb: it was the only one left.

$2^h\ 0'$. The sun is now without any openings; but the corrugations are very luminous and rich.

April 2. A considerable opening has entered the disk, accompanied with ridges. From its present situation, I conclude it must have entered not long after my last observation yesterday.

The sun is very rich in luminous corrugations, interspersed with bright nodules towards the south pole.

April 4. There are 4 considerable openings, and many ridges, as well as nodules, on the south and north preceding and following limbs.

The north-preceding ridges extend into the sun, till I can no longer distinguish them; and begin again at the north-following side, as far as they generally can be seen from the limb; so that there is probably a whole zone across the disk. Where I lose them, they are generally converted into tufted, rich, coarse corrugations, such as the sun is now every where covered with.

April 6. There are many ridges and rich corrugations; but I

can perceive no opening. The air is not clear enough to discover very small ones.

April 8. A cluster of 7 small openings is visible; and many ridges.

April 10. Five sets contain 32 openings. The sun is full of rich tufted corrugations.

April 17. Two sets of openings contain 20 of them.

April 19. I count 45 openings. The corrugations are extremely rich. The whole solar surface seems to be studded with nodules. There are probably two belts of ridges across the sun's disk; for, on the preceding side, as well as on the following, I see two ends of belts of ridges very plainly, extending over all the space where these phænomena can be seen.

April 20. The whole surface of the sun is rich: the corrugations are tufted. I count more than 50 openings; many of them have considerable shallows about them.

April 23, 6^h. There are above 60 openings in the sun. The last set is much towards the sun's north pole; very rich in ridges, and disturbed neighbouring surface.

April 24. I count above 50 openings. The corrugations seem to be closer than they were yesterday.

April 26. I viewed the sun through Port wine, and without smoke on the darkening glasses; but distinctness was much injured.

April 27. I count 39 openings. Many ridges and rich corrugations.

April 29. Six different sets contain 24 openings. There are many sets of ridges and rich corrugations.

4^h. I viewed the sun through a mixture of ink diluted with water, and filtred through paper. It gave an image of the sun

as white as snow; and I saw objects very distinctly, without darkening glasses.

As one of the largest openings had a considerable shallow, I found, in viewing it through this mixture, that the difference between what I suppose to be the light reflected from opaque, and the direct light of empyreal clouds, is now more striking than I ever had observed it before.

The ridges, through this composition, appear whiter than the rest of the sun.

The tops of the corrugations are whiter than their indentations, instead of approaching to a yellowish cast, as they do in my former way of seeing through green smoked glasses.

The corrugations are very small and contracted to day.

Suspecting that this new way of seeing might represent objects less than they appear, when I view them through an eye-piece that gives them in the manner I have been used to see them, I put on again the former composition; but found the corrugations as small and close then as they appeared before.

I count 36 openings.

When the ink mixture is more diluted, the sun's image will become tinged with purple.

A solution of green vitriol, with a sufficient number of drops of the tincture of galls to stop as much light as is required, gives a dark blue colour to the sun; and, by dilution with water, a light blue. It is considerably distinct.

With this composition, the corrugations look whiter at the top than in their indentations.

The tincture of galls, with as many drops of the solution of green vitriol as will turn it sufficiently black to stop light, makes

the sun look of a deep red colour; and, by dilution, the red will be paler. This composition is not so distinct as the former.

May 2. 5^h 20′. There are 36 openings, contained in six sets.

As I have remarked, March 19th, April 4th, and April 19th, that ridges are generally placed in equatorial zones, so I now may add, that the different sets of openings have also been generally arranged in the same directions.

May 3. 11^h 56′. Ink mixture. There are 37 openings, arranged in two zones. Four sets in the southern zone contain 27, and three sets in the northern have 10 openings. Through this mixture, I can observe the sun in the meridian, for any length of time, without danger to the eye or to the glasses, with a mirror of nine inches in diameter, and with the eye-pieces open, as they are used for night observations.

Slough, May 4, 1801.

EXPLANATION OF THE FIGURES. PLATE XXVIII.

A B, Fig. 1, is a square trough, closed at the two opposite ends C D, by well polished plain glasses. It will hold any liquid through which the sun's rays are to be transmitted. E is a small spout, and F a handle, so that any portion of the liquid may conveniently be poured out, when the rest is to be diluted.

The trough is made to fit into the open part of the skeleton eye-tube, Fig. 2, resting on the bottom G, and being held in its proper situation by the sides H and I. The end K, at the time of observation, is put into a short tube fixed to the NEWTONIAN telescope, and may be turned about, so as always to have the open part H I horizontal.

When the eye-piece Fig. 3, is screwed, by its end M, into the skeleton tube at L, Fig. 2, and the trough Fig. 1, with any liquid to be tried, is placed in the open part G H I, the sun's rays will come from the small mirror of the telescope to K, and, passing through the plain glasses C D, inclosing the liquid, will enter the eye-piece M, and, after the necessary refractions, come to the eye at N.

Any other, single or double, eye-pieces, of different magnifying powers, may be screwed into L, instead of the piece Fig. 3; and the liquid may easily be tempered so as to intercept a proper quantity of light to suit every eye-glass which is in use, and thus to render the inspection of the sun perfectly convenient.

Fig. 1.

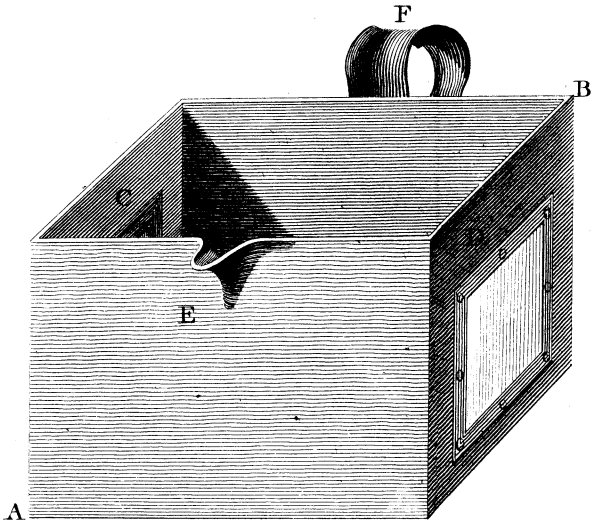

Fig. 2.

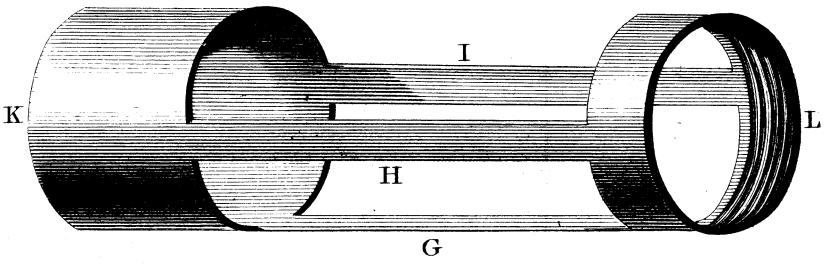

Fig. 3.