

*Experiments on the Refrangibility of the invisible Rays of the Sun.*  
By William Herschel, LL.D. F.R.S. Read April 24, 1800.  
[*Phil. Trans.* 1800, p. 284.]

In a paper read to the Society at a former meeting, the Doctor announced some observations which seemed to indicate that there are two sorts of rays proceeding from the sun; the one the calorific rays, which are luminous and refrangible into a variegated spectrum; and the other the invisible rays, which produce no illumination, but create a sensible degree of heat, and appear to have a greater range of refrangibility than the colorific rays. To the latter he assigns the name of *radiant heat*. Having lately had some favourable opportunities to prosecute this investigation, he here delivers an account of the series of experiments he made on the subject, which seem to him to confirm the above conjecture. The mode of conducting these experiments was simply this:—

On a horizontal tablet covered with white paper, and divided into squares, for the conveniency of measurement, a part of the extreme colour of a prismatic spectrum was suffered to fall, the remainder of the coloured rays passing by the edge of the tablet, so as not to interfere with the experiment.

Three thermometers were placed on the tablet, at different distances from the termination of coloured rays. The general results of the ten experiments here described were as follows:—

From the four first it appears, that there actually are rays coming from the sun which are less refrangible than any of those which affect the sight; that they are invested with a high power of heating bodies, but with none of illuminating objects, which probably is the reason why they have hitherto escaped unnoticed.

The fifth and sixth experiments showed that the power of heating is extended, though in a feeble degree, to the utmost limits of the most refrangible or visible purple rays, but not beyond them; and that it is gradually increased as the coloured rays grow less refrangible. And from the four last experiments we gather that the maximum of the heating power resides among the invisible rays without the prismatic spectrum, and is probably about half an inch beyond the last visible one, or from the confines of the red ray. These likewise show that the sun's invisible rays, in their less refrangible state, still exert a heating power, considerably beyond this maximum, fully equal to that of the red-coloured light; and that consequently, if we may infer the quantity of the *efficient* from the *effect* produced, these invisible rays of the sun probably far exceed the visible ones in number.

The inferences deduced from these results are, that the range of refrangibility of radiant heat, or colorific rays, when dispersed by a prism, begins at the purple-coloured light, where they are most refracted, and have the least efficacy; and that their refrangibility lessens and their power increases as they approach the confines of the red-coloured light, but that these confines are not the limits of

their decreasing refrangibility and increasing power, these having been traced far beyond the prismatic spectrum in an invisible state; that as their density gradually decreases, their energy at last vanishes, till at length the thermometrical spectrum, as the Doctor is willing to call it, becomes wholly imperceptible. Hitherto the effects of these heating rays have been observed as far as one inch and a half from the confines of the red ray.

If this be a true account of solar heat, (says our author at the close of his paper,) it remains only for us to admit, that such of the rays of the sun as have the refrangibility of those which are contained in the prismatic spectrum, by the construction of the organs of sight, are admitted under the appearance of light and colours; and that the rest, being stopped in the coats and humours of the eye, act upon them, as they are known to do upon all the parts of our body, by occasioning a sensation of heat.

*Experiments on the solar, and on the terrestrial Rays that occasion Heat; with a comparative View of the Laws to which Light and Heat, or rather the Rays which occasion them, are subject, in order to determine whether they are the same, or different. By William Herschel, LL.D. F.R.S. Read May 15, 1800. [Phil. Trans. 1800, p. 293.]*

In the prefatory part of this paper, the author found it necessary to limit the sense he affixes to the word *heat*; and after excluding the late terminology of *latent*, *absolute*, *specific*, *sensible* heat, the *matter of heat*, *caloric*, and even *radiant heat*, which last, however, comes nearest to the expression he has adopted, he desires to be understood, that, in speaking of *rays which occasion heat*, he does not mean that those rays themselves are heat, but that he here considers heat merely as the effect of a cause, the nature of which is no part of his present inquiry.

Having thus determined the subject of his investigation, the Doctor distinguishes heat into six different kinds; whereof three are solar, and three terrestrial. These, however, are reducible into three general divisions, each of the solar and terrestrial kinds resembling each other respectively. The first is the heat produced by luminous bodies, whether by the sun or by terrestrial flames. The second comprehends the heat of coloured radiants, such as that of the sun separated by a prism, and that of culinary fires openly exposed. And the third relates to heat from radiants, where neither light nor colour can be perceived; such as the heat of invisible solar rays, refracted by a prism, which have been the subject of a former paper; and the terrestrial heat from fires inclosed in stoves, and from metals heated short of the lowest degree of incandescence.

The chief object of the present inquiry being to give a comparative view of the operations that may be performed on the rays that occasion heat, and of those which we know to have been effected on the rays that occasion light, a short detail is given of the principal facts