the assumption that a constant power is being exerted during the stated period capable of developing, as at present, the stupendous energy of 240 millions of foot-pounds in a single minute, for each square foot of the surface of a sphere whose diameter exceeds 850,000 miles. This inconceivable amount of work cannot be performed with a less expenditure than the motive energy developed by the fall of a mass equal to the mass contained in the sun, the weight of which is nearly a thousand times greater than the weight of all the planets of the system. Obviously a *continuous* development of such an amount of energy is physically impossible, since there is a *limit* to the distance through which the weight can fall. Now the foregoing demonstration enables us to determine the said limit, with sufficient exactness to prove that although the efficiency of the great motor, during the past, may be measured by hundreds of millions of years, its future efficiency will be of comparatively brief duration.

Statements relating to the permanency of solar heat, based on the assumption that no diminution has been observed during historic times, have no weight in view of our demonstration showing that a shrinking of $\frac{1}{10}$ of the sun's diameter can only reduce the intensity from 81° to 67°·2, difference = 13°·8, in the course of two millions of years. This period being 500 times longer than "historic times" say 4,000 years, it will be seen that the diminution of the temperature produced by solar radiation, has not exceeded $\frac{13{\cdot}8}{500} = 0{\cdot}027$, or $\frac{1}{37}$ deg. Fah. since the erection of the Pyramids.

It will be proper to observe, before concluding our brief investigation of the source of solar energy, that, the development of heat by the shrinking of the sun, however fully demonstrated, leaves the important question unanswered: how is the heat generated by gravitation within the mass transmitted to the surface? If the matter within the sun is a perfect conductor of heat—a very improbable supposition—that fact alone furnishes a satisfactory answer. Imperfect conductivity, on the other hand, calls for other means of transmitting the energy from within, to make good the enormous loss caused by the external radiation. Besides, the falling of the crust at the rate of ten feet per month, attended by increase of internal pressure, and probably ejection of gaseous matter, together with the disturbance occasioned by contraction at the surface, disclose a mechanism of startling perplexity. But the parting with 312,000 thermal units for each square foot of the solar surface, involving an expenditure of kinetic energy fully 240,000,000 foot-pounds per minute, cannot be made good in that brief space of time, unless the sun shrinks at the rate ascertained by our calculations.

The development of solar energy in accordance with the combustion hypothesis (lately resuscitated by M. E. Vicaire) merits no consideration, while careful investigation has proved the meteoric hypothesis to be untenable. It must be admitted, however, that the mechanical difficulties alluded to, especially those relating to the means of transmitting the heat to the surface of the sun, any temporary local derangement of which must be productive of dark spots for a time, are of such a nature that the absolute certainty of solar radiation may be questioned; nor is evidence wanting to show that the solar mechanism is liable to derangement. History informs us that the great luminary has, during several seasons, partially failed to perform its functions. Herschel states, in his "Outlines of Astronomy," that "in the annals of the year A.D. 536 the sun is said to have suffered a great diminution of light, which continued fourteen months. From October A.D. 626 to the following June a defalcation of light to the extent of one-half is recorded; and in A.D. 1547, during three days, the sun is said to have been so darkened that stars were seen in the day-time." Again, the glacial periods, the ascertained abrupt termination and recurrence of which puzzles the geologist, point to periodical derangement of the solar mechanism in past ages.

J. ERICSSON

EXTRAORDINARY WHIRLWIND IN IRELAND

IN a letter to the *Belfast News-Letter*, Mr. C. J. Webb describes an extraordinary whirlwind which occurred in the district around Randalstown, about six miles N.W. of Antrim, near the shores of Lough Neagh, on the 25th of August last. The same phenomenon was witnessed about an hour and a half earlier the same evening at Banbridge, about seven miles S.W. of Dromore. It was first seen near Randalstown about 5 P.M., between that place and Toome, moving rapidly up Lough Neagh from the south, and presenting the appearance of a defined column of spray and clouds, whirling round and round, and not many yards in breadth, while at its base the water was lashed into a circle of white foam. It was next heard of in the neighbourhood of Staffordstown, about a mile from the lake, where it partially unroofed two houses, and damaged any trees or crops which happened to be in its course. From this point it travelled in a straight line for Randalstown, about three miles distant. It passed across a field close to Mr. Webb's house, levelling eight haystacks, and carried a considerable part of the hay up into the air out of sight. The breadth of the storm could be accurately ascertained at this point, and must have extended about thirty yards, as stacks remained unruffled at either side, while those between were thrown down and carried away or scattered about. Everything it lapped up was whirled round and round, and carried upwards in the centre, while dense clouds seemed to be sucked down on the outside, and came close to the earth. Both before and after there was lightning and incessant peals of thunder; but there was no rain till some time afterwards. Mr. Webb next observed its track in a hollow, some three hundred yards further on, where it knocked down a haystack, and then plunged into a wood of fine old Irish oaks. Here it tore numerous branches and limbs from the trees, carrying some along with it, and throwing others to the ground. One noble tree in the centre of the wood seems to have been a peculiar mark for its vengeance, although it would have been completely protected from any ordinary storm, owing to its position. It next passed across a corner of Shane's Castle demesne. Some who were at a short distance from this point describe its approach as causing considerable alarm. It was accompanied by a wild rushing noise, and the crashing of the trees and branches could be heard becoming louder and louder as it advanced. It crossed the valley over the railway viaduct, close to Randalstown, fortunately avoiding the village. It here presented the appearance of a vast whirling column of leaves and branches, mingled with clouds which looked like smoke.

The railway station next suffered, innumerable slates and two and a half cwt. of lead being torn from the roof in an instant. A great part of the railings surrounding the gardens was torn up, and an iron bar one inch thick, belonging to the gate, was bent to an angle of sixty degrees. A small shed at the rear of the station was unroofed, rafters and slates being hurled to the ground. What will give some idea of the excessive pressure of the wind, is the fact that three boards of the flooring of the waiting-room were forced up, owing to the wind finding an entrance to a cellar underneath, though the only aperture was a round hole about one foot in diameter. All this was the work of a few moments. The storm then passed away, leaving comparative calm behind. It next crossed an adjacent bog, scattering the turf in all directions. The last place Mr. Webb heard of its having visited was a farm house about three miles from Randalstown, between Antrim and Ballymena. It would be interesting to ascertain whether it travelled across to the sea-coast.

NOTES

THE British Association Committee on Mathematical Tables, of which Prof. Cayley is the chairman, has determined to tabulate the Elliptic Functions, or more accurately, the Jacobian Theta Functions, which are the numerators and denominators of the former, and their logarithms. The tables, which are of double entry, will therefore give eight tabular results for each