

was greater, or about 3·5, while the probable error was about the same. By using a telescope with a cross view, as he appears to have done lately, he has considerably reduced both quantities. But each person should determine the amount of retardation for himself, as depending upon his distance from the hill, peculiarity of observation, and other such causes. This done, and the quantity applied to one of the rises as a correction, will give a very near approximation to the error of the observer's watch, so that he will be fully prepared to observe the instant of the *drop* to the utmost exactness.

8. Has the accuracy of the drop of the ball been independently tested?

As to absolute time, not that I am aware of; but as to relative time, it has by the two very careful series of observations already mentioned, by Sir T. M. Brisbane and Mr Swan. The results of these are given below in the rates of their chronometers, for similar days. And it will be observed, that although one of them did alter its rate somewhat irregularly backwards and forwards, still as the other was going on in a uniform march at the selfsame time, the anomalous effect was all owing to the one chronometer, and nothing sensible was due to any error of the time-ball.

In conclusion, the author observed that the arrangements which were in the course of being made, would give uninterrupted facility to the public for ascending to the top of the monument.

3. On a Black Tertiary Deposit, containing the Exuviae of Diatomes, from Glen Shira. By Dr Gregory.
4. Additional Note to a Paper on the Structure of Coal, and the Torbanehill Mineral. By Dr Bennett.
5. On the Mechanical Energies of the Solar System. By Professor William Thomson.

In this paper it is shown, that by the sun's heat there is an emission of mechanical energy from the solar system, amounting in about 100 years to as much as the whole energy of the motions of all the planets. The principal object of the paper is to investigate the source from which this vast development of energy is drawn. It is argued, that either a store of primitive heat must be drawn upon,

or heat must be generated by chemical action (combustion), or heat must be generated by other forces than those of chemical action, that is, by forces of moving masses. Any store of primitive heat that can be drawn upon in solar radiation, must be entirely within the sun. It is shown that such a store would *almost certainly* be insufficient for the supply of the heat which has *certainly* been emitted during 6000 years, and it is also shown with about equally strong probability, that chemical action among elements of the sun's mass, would be insufficient to supply the actual emission for any such period of time. It is concluded that the source drawn upon in solar radiation cannot be primitive heat, nor heat of intrinsic combustion. If not heat of combustion at all, it must clearly be heat derived from the motion of bodies coming to the sun (the utter insufficiency, in point of duration, of ordinary motions of matter within the sun, being quite obvious); or if it be heat of combustion, fuel must be supplied from without. But no matter can come to the sun from external space, without generating, from its motion alone, thousands of times as much heat as it could possibly give rise to either by combustion among elements of its own, or by combination with substances primitively in the sun, unless it were possessed of incomparably greater chemical affinities than any known terrestrial or meteoric substance. It is inferred that the source of solar heat must be meteoric, and is *the motion of meteors coming to the sun*. The idea that solar heat is so produced, appears to have been first published by Mr Waterston, who brought it forward at the late meeting of the British Association at Hull.

But if (as was assumed by Mr Waterston) enough of meteors to generate heat at the actual rate of solar radiation, were falling in from extra-planetary space, the earth in crossing their path, would be struck much more copiously by meteors than there is any probability it is; and the increase of matter round the centre of the system, would within the last two or three thousand years, have caused an acceleration of the earth's motion, which history disproves. Hence the meteors which supply the sun with heat must, at least during historical periods, have been within the earth's orbit. We see them there in the sunshine (when the sun himself is below our horizon) a tornado of dust, called "the Zodiacal Light" whirling round the sun and carrying the inter-planetary atmosphere with them, probably to such an extent, as to cause centrifugal force

enough very nearly to balance solar gravitation upon it everywhere, except close to the sun's surface. The meteors themselves probably evaporate somewhere near the sun, merely on account of the high temperature of that part of space, but ultimately losing their rotatory motion by intense resistance in entering the sun's atmosphere, become condensed into a liquid state by solar gravitation, and come to rest in the sun. The quantity of heat thus generated in the region of intense resistance, by any quantity of matter falling in, will exceed half the equivalent of the work done by solar gravitation on an equal mass moving from an infinite distance by (what must probably be quite insensible in comparison) the latent heat evolved in condensation, together with the heat of any chemical combination that may take place. The other half of the work done by solar gravitation on every meteor which has come from an infinite distance (or from many times the sun's radius off), goes to generate heat in inter-planetary air by friction.

The meteoric matter thus added to the sun, to generate heat at the present rate of emission as determined by Pouillet, if settling at the surface with the same as his mean density, would cover it about sixty feet thick in a year, and would not increase his apparent dimensions by more than about 1" in 40,000 years; or in 2,000,000 years, by as much as he appears to grow from July to December. It must, therefore (whatever be the actual density of the deposit), be insensible from the earliest historical period of observation till the present time; and for thousands of years to come, if continued only at the same rate, it must remain neither demonstrated nor disproved by the most accurate measurements of the sun's apparent magnitude.

The approximate equality of solar heat in all regions of his surface is probably due to the distillation of the meteors, which if solid when entering the region of intense resistance, would probably give an immensely more copious supply in the equatorial than in the polar regions. The dark spots are probably whirlwinds, analogous to the hurricanes in the tropical regions of the earth's atmosphere, (although produced by a different cause,\*) which by centrifugal

\* The friction of the vortices of meteoric vapour close round the sun, upon the atmosphere between them, and his surface revolving at the comparatively slow rate of once in twenty-five days, probably gives rise to eddies sometimes

force diminish very much for a time the deposit of meteoric matter on limited portions of the sun's surface, and allow them to cool by radiation so much, as to become comparatively black.

The following Gentlemen were elected as Ordinary Fellows :—

1. Dr WILLIAM BIRD HERAPATH.
2. ROBERT HARKNESS, Esq., Professor of Mineralogy and Geology, Queen's College, Cork.
3. Dr THOMAS A. WISE, H.E.I.C.S.

*Monday, 1st May 1854.*

RIGHT REV. BISHOP TERROT, V.P., in the Chair.

The following Communications were read :—

1. Further Researches on the Crystalline Constituents of Opium. By Dr Thomas Anderson.
2. On the Action of the Halogen Compounds of Ethyl and Amyl on some Vegetable Alkaloids. By Mr Henry How, Assistant to Professor Anderson of Glasgow.

This paper contains some details of a continued investigation, of which the first results were communicated to the Chemical Society of London last year.\* It was then shown that new bases are produced by the action of iodide of methyl and of ethyl upon morphia and codeine, which are closely analogous with the ammonium bases of Hofmann, so that these alkaloids should rank among nitryle bases. The fact was also pointed out, that although one of the new salts produced had precisely the centesimal composition of the corresponding compound of codeine, the base of the artificial product was widely different from this alkaloid; and the conclusion was drawn that the primary molecules of these natural formations are of so peculiar a constitution, that chemists are not yet in the possession of means of imitating the process of their construction; for even the attempt

reaching down to the sun's surface, and constituting hurricanes, which would probably have a progressive motion northwards on one side, and southwards on the other side of his equator.

\* Quart. Jour. Chem. Soc., vol. vi.