Letters to the Editor.

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Cosmical Theory and Radioactivity.

SIR ERNEST RUTHERFORD in his book "Radio-active Substances and their Radiations" has suggested the possibility that solar heat may be supplied from radioactive energy derived from elements which had become radioactive under the extreme thermal conditions prevailing.

As possibly having bearings on cosmical theory (formation of nebulae, planetary genesis, etc.) I would direct attention to the probability that such induced radioactivity would be attended with explosive phenomena on a very great scale and of extreme intensity.

Let it be assumed that in some deep-seated region of the sun the temperature has attained a potential critical for some element present—that is to say, adequate to disturb the atomic stability of this element. Now normal radioactivity results from internal atomic causes and the radioactive constant is statistical in origin, like a death-rate. But here instability is induced from without inwards. It seems, therefore, difficult to imagine that a normal radioactive constant can control the resultant effects. What will happen must resemble no mere death-rate based on statistics, but rather the mortality brought about by earthquake or flood. A large number of the specific atoms would be affected and a very great local rise in temperature would follow. There is, now, the further probability that this sudden rise will involve yet other elements in the catastrophe.

If this inference is justified, explosive phenomena in suns and nebulae so far from being unaccountable must be regarded as inevitable, as being associated with gravitative attraction and the internal properties of the atom.

It is to be expected that such explosive phenomena would diminish in frequency and intensity as time advanced and elements of higher atomic weight became degraded. Thus, in primeval times, our sun may have been many times rent by such explosions. There appears to be evidence that central explosions of great violence occasionally occur even to-day.

How would the principle of the conservation of moment of momentum fare under conditions involving the translation of internal atomic energy into molar forms?

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Trinity College, Dublin, July 9.

Gas Pressures and the Second Law of Thermodynamics.

IN the June *Philosophical Magazine* Mr. Fairbourn endeavours to prove that in certain easily attainable cases the second law of thermodynamics might be circumvented. He attempts to show that if an enclosure be divided by a partition, the chance that a molecule of a rarefied gas will pass the partition, from the space I to the space II, may be modified, by a funnel, without affecting the chance of passing from II to I, so that a pressure difference will arise. He considers the simple case, shown in Fig. 1, of a right-angled "funnel" in two dimensions only, truncated so that the diameter at the end BC is twice that at AD. Taking a point O on BC he shows

that, of the molecules passing through O, on the whole more than half will be reflected by AB or CD and less than half will pass through AD, since they can approach from an angle π while the angle between the limiting paths by which they can get through is in general less than $\pi/2$. He deduces that of $2N$ molecules striking BC in a given time less than N will pass through AD, while all of the N molecules reaching AD from the other side in the same time will cross it, so that on the whole more will come from II to I than *vice versa*.

The error in this argument lies in the fact that it is impossible to construct a line BC out of a number of points O; it is necessary to define the tolerance before one can say whether molecules have passed through O or not. As soon as this is done (by taking an element of length dl at O, and defining passage through O as passage through this length), it is clear that the chance of "passing through O" is not independent of the angle of incidence θ , but is proportional to $\cos \theta$, since dl is foreshortened for obliquely moving molecules. In any given case it will now be found that the total number of paths leading through AD is the same on both sides of the partition ZZ'. However, the following general proof of this equality should save the trouble of integrating particular cases. It applies to three dimensions and any shape of funnel.

It is clear that before the funnel (AB,DC) was added to the partition the chances of passing from

FIG. 1.

II to I and from I to II were equal, and that adding the funnel does not alter the chance of passing from II to I. If it is to have an effect then it must decrease the number of paths from I to II. But for every such path XY which it blocks it introduces a new path X'Y, and this is true of every point in any funnel. This result is of course well known in geometrical optics; if it were incorrect any temperature and energy density of radiation would be obtainable without work.

It may also be remarked that there is not only molecular roughness in even a polished wall, but thermal agitation of all the molecules of the wall; the argument that if the wall reflects light it should "reflect" a molecule is vitiated by the fact that the wave-length of visible light is about a thousand molecular diameters; and the argument that even if the direction of rebound is fortuitous the funnel should have an effect defies elementary hydrostatic theory.

Lastly, the mean free path of the molecules is irrelevant. Mr. Fairbourn assumes that his theory would not apply if there were a large proportion of encounters between gaseous molecules; but it is clear that if the effect of the funnel is to give on the whole a bias away from II to the average molecule striking it, it cannot matter whether that molecule retains the bias or hands it on to another in an encounter.