LETTERS TO THE EDITOR.

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Radium and the Sun's Heat.

IN your last week's issue Mr. Hardy directs attention to the fact that no Becquerel rays can be detected from the sun, and regards this as an objection to the view that the solar heat may be accounted for by the presence of radium.

Let us attempt to calculate the effect to be expected if the sun's heat were due to this cause.

In doing this, we may assume that the sun contains 3·6 grams of radium per cubic metre. This was the amount which Mr. W. E. Wilson gave in NATURE of July 9 as required to emit the observed amount of heat. Experiment shows that when the Becquerel radiation has to pass through lead screens of thickness 1 cm. or more, the radiation transmitted is practically all of the γ variety. This is cut down to half its value by 8 cm. of aluminium, and in the case of other substances by strata of equal mass per unit area. Now the earth's atmosphere constitutes a stratum far more absorbent than 1 cm. of lead. We need, therefore, only consider the γ rays, for if these cannot be detected, it is certain that the α and β rays cannot.

For the sake of simplicity of calculation, we shall treat the sun as a cube, with its side equal to the diameter of the real sun, and so placed that the normal to one face, which passes through the centre, shall also pass through the earth. This will be for all practical purposes near enough to the truth.

Let a be the side of the cube, q the quantity of radium per c.c., and λ the coefficient of absorption of the radiation. Then, from an elementary slice, thickness dx, and distance x from the face, the intensity of radiation at a distant point will be

$$a^2 q e^{-\lambda x} dx$$

if the radiation due to 1 gram of pure radium at the same (great) distance be taken as unity.

The radiation due to the entire mass will be

$$a^2 q \int_0^a e^{-\lambda x}\, dx = a^2 q \left[\frac{-e^{-\lambda x}}{\lambda}\right]_0^a = \frac{a^2 q}{\lambda}\left(1 - e^{-\lambda a}\right)$$

Now $a = 1{\cdot}4 \times 10^{11}$ cm.; q, from Mr. Wilson's estimate $= 3{\cdot}6 \times 10^{-6}$.

Assuming that the coefficient of absorption is proportional to the density, and taking the sun's density as 1/7, and the value of λ for aluminium as 0·086, the value of λ for the sun comes out 0·0046. Substituting these values, we find that the effect of the sun is equivalent to that of $1{\cdot}53 \times 10^{19}$ grs. of radium at the same distance, assuming this radium to be spread out into a thin layer, so that all the radiation can escape without undergoing absorption in the mass.

Now I have found that the γ radiation from 10 milligrams of radium bromide can barely be detected by the electrical method, where 10 cm. of lead intervene between it and the testing vessel. To decide whether the solar rays would be detectable, we must compare their expected effect after enfeeblement by distance, and by the absorption of the atmosphere, with this.

The distance of the sun is 1.5×10^{12} times greater than the distance of the radium from the testing apparatus, so that, apart from the atmospheric absorption, the effect of the sun would be equivalent to that of $\frac{1.5 \times 10^{19}}{(1{\cdot}5)^2 \times 10^{24}}$, or $6{\cdot}7 \times 10^{-6}$ grams of radium, 10 cm. from the apparatus. This is less than one-thousandth part of the radium used in the experiment cited, and the solar radiation, instead of passing through only 10 cm. of lead, would have to pass through the atmosphere, equal in mass to 32 feet of water, or about 89 cm. of lead. This would, of course, reduce it many million times further. So that, even if all the sun's heat were due to radium, there does not appear to be the smallest possibility that the Becquerel radiation from it could ever be detected at the earth's surface.

R. J. STRUTT.

REFERRING to Mr. Hardy's experiment described in his letter in NATURE, October 8, it is easy to show that whatever the intensity of radio-activity might be at the surface of the sun, by mere surface ratios and assuming no absorption its activity per unit area at the distance of the earth must fall to about one forty-thousandth part. Now, if the sun were composed of solid radium bromide, the radiation reaching Mr. Hardy's indicator from the sun will be only about one-thousandth part of that derived from a sphere of radium bromide three millimetres in diameter and twenty millimetres distant from the indicator: the probable conditions of Mr. Hardy's experiment.

In the experiment one centimetre thickness of lead is interposed. The earth's atmosphere is equivalent in mass to 76 cm. of mercury. This supposes no absorption from, possibly, some thousands of miles of solar atmosphere. Moreover, we assume in the comparison a sun of solid radium bromide. It would appear, however, that a very small percentage of this body in the materials of the sun would suffice to account for many millions of years of solar heat.

The absence of β and γ radiations at the earth's surface is, therefore, not a weighty argument against the presence of radium in the sun.

The arguments in favour of supposing that this element exists in the sun are:—(1) The presence of radium on the earth; (2) the high atomic weight of radium; (3) the presence of helium in the sun; (4) Arrhenius's theory of the Aurora Borealis; (5) the fact that the estimate of the duration of solar heat from the dynamical source appears to run counter to geological data.

J. JOLY.

Trinity College, Dublin, October 10.

Cambridge in the Old World and in the New.

ONE of the most striking features of the universities of the United States is the wealth of their endowment. During the writer's visit to Cambridge, Massachusetts, for example, Harvard University was successfully collecting large sums towards a new building for philosophy in memory of Emerson, and within the last few months has been promised two million dollars by two millionaires towards her new medical school.

Reasons for such well-known munificence of Americans towards their universities are not hard to find. Pauperism is an almost negligible quantity in America, so that the money, which drains away on this side in charity, finds an outlet there in the advancement of education and research. Primogeniture, again, is contrary to American ideals. While the newly-made English millionaire thinks it his duty to sink a considerable part of his fortune in buying and maintaining a family estate for his son and heir, the American more often divides his property equally between his children, and feels at greater liberty to dispose of much of it in his lifetime as he pleases, for he is willing that the uphill life he has lived himself shall be lived again by his descendants. The absence of inherited titles in America tends, of course, towards the same end. Many of the younger universities, too, are in districts where huge fortunes have been rapidly made and civic pride runs high, producing numerous benefactions in the cause of local institutions. But although all these are reasons, none of them is sufficient to explain the situation satisfactorily. To find the true cause, we must enter into the differences in life and education between the older English and American universities.

The average English youth, passing from public school to Oxford or Cambridge, intends to make his living by some profession, perhaps as minister, teacher, barrister, or physician; relatively seldom has he sufficient to live upon without further exertion. He spends his three or four years in one of the seventeen or more colleges from which he has to choose, and his college becomes the centre of his social life. Probably there he makes his greatest friendships; certainly the number of men he knows outside his own college is comparatively small. In eights, elevens, or fifteens, the various colleges are pitted against one another. Nor, indeed, is inter-collegiate competition confined to athletics. Each college is continually struggling against the rest to secure the most promising boys from the public schools, and to acquire the greatest number of university distinctions. Each has to maintain a more or less separate

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