

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

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

Now $a = 1.4 \times 10^{11}$ cm.; q , from Mr. Wilson's estimate = 3.6×10^{-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 1.53×10^{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 $\frac{1.5 \times 10^{19}}{(1.5)^2 \times 10^{24}}$, or 6.7×10^{-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

staff, partly, to supplement university lectures, but partly also to give more individual instruction to the duller or idler students. One of the results of this system can be easily seen—the average graduate quits his university with the greatest affection for his college, but with little or nothing of that broader *esprit de corps* towards his university as a whole.

In America, on the other hand, each university has only one college preparing him for the B.A. degree. Consequently, a single American college, *e.g.* Harvard College, Cambridge, contains several thousand students.¹ The centre of social life can no longer be in the college; it is transferred to the class, the class consisting of all students who are in the same year. Each class elects its own president and other officers, has its various rowing, football, and baseball teams, and holds meetings for the discussion of matters of common interest. A class in Cambridge, Massachusetts, knits the students together in somewhat the same way as does a college in Cambridge, England, although, of course, far less closely.

In the second place, there is a comparatively large number of students in American universities, who intend to lead, or finally do lead, a business life after they leave college. It is true that just now the question is being raised whether a college training is the right one for an American business man, but the only probable outcome of this discussion will be an improved adjustment of the college curriculum in the interests of those who intend to embark on a business career. Already at Harvard there is a proposal on the part of the president to make it possible for such students to complete their training in a shorter time than the usual four years.

In the end these two American features, the formation of class ties and the presence of students who are intended for a business career, combine to place a number of wealthy *alumni* at the beck and call of the universities. It is a common occurrence for the class of a certain year to defray, wholly or in part, the cost of a building of which their *alma mater* stands in need; at Cornell alone twenty-two class-gifts of this or similar kind are on record. Moreover, the *alumni* of the various universities form themselves into societies, both local and general. Every important city in America contains various associations of *alumni*, each association representing one of the more important universities. The *alumni* of various classes, dispersed throughout the States, are periodically invited to revisit their university. In some universities they directly elect a certain number of their body to serve on the board of trustees or corporation of the university. Such is the hold exercised by many American universities on their former students.

But it is not only from wealthy *alumni*, but also from citizens who have never been to college, that the universities of the United States derive their greatest benefactions. Now this would be impossible unless the American people were in full sympathy with American university work. Indeed, the university holds as warm a place in the heart of the American as the hospital holds in that of the Englishman. He feels that it is a living organisation, not an inert out-of-date machine, which is doing necessary work in the advancement of the civilisation of his country. Further, we come to understand the reason of this feeling when we contrast the undergraduate courses at the two Cambridges. At Harvard, the examination for admission consists of papers in English, history, algebra, geometry, and natural science, Latin or Greek, and French or German. After passing this, the student has to choose four courses of lectures per year in *more than one* of the following subjects:—English, German, French, Italian, Spanish, history, government, economics, philosophy, fine arts, music, mathematics, engineering, or some natural science. Apart from certain reasonable restrictions, which prevent him from acquiring a too superficial knowledge in too many subjects, the student is at liberty to select just those courses which will best suit him in after life; and, of course, he can readily obtain advice in any difficulties that may beset him when making his choice. In his second and later years he may specialise more deeply in these and other sub-

jects. He is examined twice a year, and shows thereby whether he is capable of proceeding to more advanced courses advantageously. He obtains his degree on the result of these bi-annual examinations. For an honours degree a thesis or special examination is required.

The undergraduate of our English Cambridge, on the other hand, having mastered at school the modicum of compulsory Greek required for the previous examination, has the choice of two distinct paths. He can straightway read for an honours degree in any *one* of the triposes which suits his requirements, the classical, mathematical, theological, natural sciences, mental and moral sciences, mechanical sciences, mediæval and modern languages, oriental languages, historical or other tripos—in which case he takes his degree almost always upon the results of a single examination in a single tripos at the end of his three years¹; or he may be content to take an ordinary degree, for which he must devote at least the whole of his first year to Greek, Latin, English, algebra, statics, hydrostatics and heat, and spend his later years preparing for examination in any *one* subject (*inter alia*) of the following:—theology, economics, law, history, logic, mathematics, classics, music, chemistry, physics, botany, physiology, zoology, or agriculture. This examination, qualifying him for the ordinary B.A. degree, is completed at the end of his third year.

Few graduates who have been educated on the basis of a Cambridge tripos would welcome changes in so admirably conceived a system of education. At one time it was believed that the student who devoted his three or four years in this manner to a single subject must suffer in general culture, whereas it is nearer the truth to believe that there is scarcely any branch of learning which cannot impart a very high degree of culture, provided only that it be taught from a sufficiently wide and liberal point of view. On the other hand, there are probably few who would not desire considerable changes in the regulations for the ordinary degree. The examination is hardly more than an advanced Little-go, ending in a feeble effort at specialisation. Instead of having to spend a year or more at Greek, hydrostatics, heat, &c., why should it not be possible for the undergraduate who is bent on an army career to qualify in modern or oriental languages, geography, surveying, and ethnology, or for him who intends to enter into finance to study mercantile law, economics, and modern languages, or for the future country squire to read straightway in history, literature, law, and agriculture? Is a university to confine herself solely to the encouragement of research and to the preparation of ministers, teachers, physicians, engineers, and musicians? Or is it impossible to prepare men for other walks of life without the sacrifice of culture in the interest of practical needs? Surely America gives us a useful lesson as to the unwisdom of driving away such embryo financiers and others elsewhere owing to the lack of attractive and useful courses of study which they could pursue after leaving school. The expenses of administration in our universities increase so enormously from year to year that, unless they are to receive State aid or to decay from sheer stagnation, they must be continually appealing to the public for support. And public interest can only be maintained when the universities are prepared to equip men appropriately for many more different walks in life than they are at present. Such changes, which involve merely the framing of new regulations, cannot fail to be followed by an increase in benefactions, whereby training in languages, archaeology, history, and economics may be improved, and the teaching and laboratories be alike brought to the requisite condition of efficiency for establishing a successful school of post-graduate research.

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An Ancient Lava Plug like that of Mont Pelée.

THE photograph of what is described as "a gigantic plug of solidified lava" in the centre of the new cone of Mont Pelée, which appears in NATURE of October 1 (p. 530),

¹ No mention is here made of the still more specialised second part of the triposes which corresponds in many respects to the training given in the post-graduate schools of the better American universities.

¹ The words college and university have thus acquired a significance in America which is unfamiliar to us. No college is regarded as a university unless, besides teaching, it encourages post-graduate research.