

The Nature of the α Rays emitted by Radio-active Substances.

THE α rays emitted by radium and other radio-active substances have been shown by Rutherford ("Radio-activity," pp. 115-141) to consist of positively charged particles for which $e/m=6\times 10^8$. They are rapidly absorbed by gases and solids, the absorption coefficient being approximately proportional to the density of the absorbing medium. The value of the absorption coefficient in air divided by the density varies between 350 and 1300 for different types of α rays. The velocity of these rays is about $1/10$ th to $1/20$ th that of light.

It is interesting to compare the properties of these rays with those of kathode rays moving with about the same velocity; e/m for such rays is about 10^7 , and the value of their absorption coefficient in air at 1 mm. pressure is 0.85 (Lenard, *Ann. der Phys.*, Bd. 12, p. 714, 1903) when the velocity is $1/10$ th that of light and 3.9 when it is $1/20$ th.

The absorption coefficient for these rays is also proportional approximately to the density of the absorbing medium. Dividing 0.85 by the density of air at 1 mm. pressure we get 540,000, and in the same way 3.9 gives 2,500,000. The corresponding numbers for the α rays are about 350 and 1300. Thus we see that the α rays are nearly 2000 times as penetrating as kathode rays moving with the same velocity.

Assuming that $-e$ for the kathode rays is equal to e for the α rays, we have for the ratio of their masses $10^7/6\times 10^8=1/60$. It thus appears that the penetrating power of the α rays is to that of kathode rays, moving with the same velocity, approximately as the mass of the α rays is to the mass of the kathode rays. We may conclude from this that an α particle loses as much energy in colliding with an atom as a kathode-ray particle or corpuscle. If we regard the α particles as being of atomic dimensions (that is, as having a radius about 10^{-8} cm.), while an electron or corpuscle only has a radius of about 10^{-13} cm., it is very difficult to understand this result. On the view that all atoms are assemblies of electrons, the fact that the absorption of kathode rays depends only on the density of the absorbing medium is regarded as indicating that the electrons penetrate the atoms and are absorbed by colliding with the electrons which compose the atoms. Since α particles lose the same amount of energy as electrons in penetrating matter, it seems probable that they also penetrate the atoms and lose energy by colliding with the electrons in exactly the same way. If this view is taken, it becomes difficult to regard an α particle as of atomic dimensions, and we may look upon it as a positive electron exactly similar in character to an ordinary negative electron. The mass (m) of an electron is now regarded as being purely electromagnetic in character, and is given by the formula $m=2e^2/3a$, where a is its radius and e its charge. For a negative electron this gives $a=10^{-13}$ cm. Regarding an α particle as a positive electron, we get in the same way for its radius about $\frac{1}{2}\times 10^{-16}$ cm. On this view, therefore, the α particles are enormously smaller than the negative electrons.

The properties and modes of occurrence of the α particles are in agreement with the view that they are really positive electrons. For example, they are produced like kathode rays in electric discharges at low pressures (being then known as canalstrahlen), and have very similar properties to kathode rays. The writer therefore suggests the view that α particles may be positive electrons having a radius about 2000 times smaller than negative electrons.

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A Suggested Explanation of Radio-activity.

I AM venturing, in the present note, to add another to the already large number of suggestions as to the meaning of the phenomenon of radio-activity.

It seems to be well established that the apparent instability of the atoms of radio-active substances is not to any great extent dependent on the temperature of the mass; the instability, therefore, is not the outcome of intermolecular collisions. Neither does it seem to arise from

an excess of the internal energy of the molecule. For the internal agitation of the molecule, so far as is known, shows itself in the emission of light, and this is associated with high mass-temperature. There is, of course, the possibility, suggested by Prof. J. J. Thomson, that there are internal degrees of freedom not represented in the spectrum of the gas, and that it is the energy of these which forms the starting point of the radio-active process. On the other hand, it is possible that the atomic instability, not being the result of the agitation of the molecules or of the component material parts (ions or corpuscles) of which the molecules are composed, must be traced to the agitation of the ultimate constituents of these ions or corpuscles. If, for instance, we take a definite mechanical illustration, and imagine our universe constructed on the model suggested by Prof. Osborne Reynolds, the source of instability must be looked for in the agitation of the "grains" of which he supposes the ether to be constituted. The velocities of these grains follow Maxwell's law of distribution, so that very high velocities, although rare, are not impossible. It is at least thinkable that a grain moving with exceptionally high velocity may succeed in breaking down the normal piling in its immediate neighbourhood when this is possible (i.e., probably, when in the immediate proximity of matter), and may therefore effect a rearrangement of the adjacent ether structure. A process of this kind would be independent of the mass-temperature; it would, so to speak, depend solely on the ether temperature, which is supposed, on Prof. Reynolds's hypothesis, to be constant throughout space. It seems probable that the rearrangement would consist of the combination and mutual annihilation of two ether strains of opposite kinds, i.e., in the coalescence of a positive and negative ion, and would therefore result in the disappearance of a certain amount of mass. There would, therefore, be conservation neither of mass nor of material energy; the process of radio-activity would consist in an increase of material energy at the expense of the destruction of a certain amount of matter.

Apart, however, from this special mechanical model, it seems probable, on grounds of general dynamics, that the ether does not transmit waves in a perfectly unaltered form, and that there is therefore a continual degradation of the energy of regular waves into an energy of random agitation of the ultimate ether structure. This agitation would afford a sufficient cause for the beginnings of the process which results in the breaking up of the atom. Naturally this agitation would have the best chance of effecting a rearrangement when the strain is greatest, and therefore when the ions are most closely packed together. A larger energy of agitation would be necessary when the ions were less closely packed. We should, therefore, expect all matter to be radio-active to some extent, but should expect the greatest amount of radio-activity to be shown by the heavier atoms.

If the instability results from a rearrangement of an ether structure, and not solely of a material structure, we should, *a priori*, on general grounds of physical dimensions, expect the velocity of the ejection to be comparable with the velocity of waves in the ether, this being the only unit appropriate to the measurement of processes depending on the physical constants of the ether. [Just as, for instance, the velocity of a gas streaming into a vacuum might, *a priori*, be expected to be comparable with the velocity of sound in the gas.] The suggested cause of instability is therefore in agreement with the observed velocity of the α particles.

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The First Record of Glacial Action in Tasmania.

IN a recent paper on the Glacial geology of Tasmania (*Quart. Journ. Geol. Soc.*, vol. lx. p. 38), I referred to Gould's recognition of Glacial action in Tasmania as not having been directly published. This view I accepted on the strength of the statement by Mr. R. M. Johnston ("The Glacial Epoch of Australasia," *Proc. Roy. Soc. Tasmania*, vol. iv., 1893, 1894, pp. 92-3), than whom no one knows better the geological literature of Tasmania, that it was "through verbal communication to a personal friend of my

own, and one of his (*i.e.* Gould's) early associates, that I first, about 20 years ago, became aware of his discovery of many evidences of glaciation in Tasmania."

I have recently found a Parliamentary Paper, issued in 1860, in which Gould describes his recognition of Glacial action in some of the high valleys of central Tasmania. The passage is as follows ("A Report of the Exploration of the Western Country by Mr. Gould," Parl. Pap., Tasmania, 1860, No. 6):—

"In the Cuvier Valley I was struck, both in going and in returning, by the similarity to the terminal moraine of a glacier presented by an enormous accumulation of boulders which chokes the lower end of the valley, and, somewhat like a dam, extends completely across it, with the exception of the point where it is broken through by the river."

I am glad, therefore, to be able to give to Gould the credit of having published the discovery, which in my paper I could only quote as a verbal tradition.

The Cuvier Valley is one day's journey west of Lake St. Clair. A hut, five miles due west of the top of Mount Arrowsmith, occurs in it.

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The University, Melbourne, Victoria, April 25.

The Origin of the Horse.

In your issue of May 19 (p. 53) Prof. T. D. A. Cockerell refers to *Equus caballus celticus*, Ewart, as "still surviving in the pure state in Iceland." Prof. Ewart, in his paper on "The Multiple Origin of Horses and Ponies," says that "the few pure specimens of the Celtic pony survive" in the north of Iceland. I take it that Prof. Ewart does not mean that the northern Icelandic breed of ponies is a pure one, but only that certain individuals of this breed exhibit the "Celtic" characters in a very marked degree. In a recent paper (*Proc. Camb. Phil. Soc.*, vol. xii., part iv.) Mr. F. H. A. Marshall and I have brought forward both historical and zoological evidence for the mixed origin of the Icelandic pony. It is perhaps worth noting that the people of north Iceland still claim a social superiority over those of the south as being descended chiefly from the second body of colonists which reached the island. In considering the origin of different breeds of the domestic animals ethnological considerations are often important, and, conversely, the examination of local breeds may sometimes throw light on ethnological problems. For example, in the Malay Peninsula the breed of dogs owned by the majority of the jungle tribes usually classed as Sakais differs from that of the Malay pariah, which has recently been adopted in some cases by Semang tribes and also by those Sakais who live in close intercourse with the Malays. The pariah seems likely to oust the Sakai dog completely, and I am not aware that any zoologist has yet made a detailed examination of the latter, which shows certain resemblances to the local race of *Cyon rutilans*.

Of course, investigations into the ethnological distribution of animals must be made with the very greatest care, for not only may one breed oust or swamp another, but the characters of a single individual may prove so dominant that they may prevail in a great number of cross-bred descendants, and so change the character of a breed in a very short time. This has recently happened in the Færøe Isles. As we know from the statements of Landt ("Description of the Faroe Islands," 1798), there were at least two distinct breeds of dogs in these islands at the end of the eighteenth century, one resembling the modern Danish hound, but smaller; the other a short-legged, rough-haired terrier. The two breeds can still be traced on some of the islands, notably on Naalsole; but in the neighbourhood of Thorshavn, the capital, great alteration has taken place quite recently. Some ten or twelve years ago a Danish governor introduced a well-bred dachshund dog, which inter-bred with the native bitches. In 1903 I could hardly find a single dog in the town which did not show traces of dachshund ancestry—short, bent legs, long body, &c.—more or less marked. The in-bred highly specialised individual has proved prepotent when crossed with the more or less generalised types which, judging from the statements

of Lucas Debes (1623–1670) and Landt, have been somewhat cross-bred for at least two and a half centuries. We are apt to forget factors of the kind when discussing the breeds of domestic animals, and also when investigating the different races of men, but it should be remembered that they are of the very greatest importance in both lines of inquiry.

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Insular Races of Animals and Plants.

If we accept the view that species are such by virtue of segregation, and consider subspecies to be groups as yet imperfectly segregated, we seem logically bound to regard insular forms as valid species. According to this way of looking at the matter, a subspecies is in biology what a peninsula is in geography, while a species corresponds to an island. Hence it follows that many subspecies are far more widely distributed and for most purposes more important than many distinct species; just as many peninsulas are more important than the small islands off their coasts.

While it appears illogical to treat insular races as subspecies, there are difficulties in the way of regarding them all as distinct species. In former years, the most distinct were so recognised, and the others were simply ignored. This practice, while it smoothed the way for the systematist, deprived us of the use of a large body of facts of the greatest possible interest to the evolutionist, and the time has come when it must be given up. As a result of the new methods, the number of "species" recognised is increasing very rapidly, as shown, for example, by the description of seventy new Malayan mammals in a single paper by Mr. G. S. Miller, jun. Many of the "species" described in this paper are excessively similar, and yet distinguishable, and inhabit different islands. It is evident that one could take a map of the Malay Archipelago and prophesy with some degree of accuracy the number of insular species of *Mus* and some other genera awaiting discovery by simply counting the islands, eliminating those too closely adjacent. In mountain regions something of the same sort is found, the tops of the mountains or mountain ranges serving the same purpose as islands. For freshwater organisms, lakes and river systems afford similar phenomena, as shown, for example, by the races or species of *Salmonidæ*.

The objections to the recognition of all these isolated forms as valid species are two. First, their extreme similarity in many instances, and second, the specific name does not indicate the immediate relationships of the form. It has seemed to me that these difficulties might be overcome by the recognition of a new category, for which the name "idiomorph" suggested itself. This name may be objectionable on account of the term idiomorphic, used in crystallography, and it is probable that someone can think of a better. If it is accepted, it may be abbreviated to "id.," as "var." is written for variety, and "subsp." for subspecies.

To illustrate the different methods, we may take certain bats of the genus *Chilonycteris*, found in the Greater Antilles, using the facts recently published by Mr. Rehn.

C. macleayi group.

	i. (Species).	ii. (Sub-species.)	iii. (Idiomorphs).
Jamaica ...	<i>C. grisea</i> , Gosse.	<i>C. macleayi</i> <i>grisea</i> .	<i>C. (macleayi</i> id.) <i>grisea</i> .
Cuba ...	<i>C. macleayi</i> , Gray.	<i>C. macleayi</i> .	<i>C. macleayi</i> .
Haiti ...	<i>C. fuliginosa</i> , Gray.	<i>C. macleayi</i> <i>fuliginosa</i> .	<i>C. (macleayi</i> id.) <i>fuliginosa</i> .
Porto Rico	<i>C. inflata</i> , Rehn.	<i>C. macleayi</i> <i>inflata</i> .	<i>C. (macleayi</i> id.) <i>inflata</i> .

C. parnellii group.

Jamaica ...	<i>C. parnellii</i> , Gray.	<i>C. parnellii</i> .	<i>C. parnellii</i> .
Cuba ...	<i>C. boothii</i> , Gundlach.	<i>C. parnellii</i> <i>boothii</i> .	<i>C. (parnellii</i> id.) <i>boothii</i> .
Haiti ...	<i>C. ?</i> ¹	<i>C. parnellii</i> ?	<i>C. (parnellii</i> id.)?
Porto Rico	<i>C. portoricensis</i> , Miller.	<i>C. parnellii</i> <i>portoricensis</i> .	<i>C. (parnellii</i> id.) <i>portoricensis</i> .

¹ Doubtless exists, but not yet discovered.