LETTERS TO THE EDITOR.

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Radium and its Disintegration Products.

IN NATURE of December 6, 1906, Mr. H. S. Allen has suggested that the difficulty encountered in introducing actinium with its four α-ray products between uranium and radium can be removed by assuming that the α particle is one-half of the helium atom, and he has applied this suggestion in a table showing six α-ray changes between uranium and radium. There would appear to be two serious and insurmountable objections to this view, however, viz., (1) the continuation of the same line of reasoning would lead to the assumption of no less than seven α-ray changes between radium and its final disintegration product, lead, while but four are known; and (2) the activity of the actinium in equilibrium with radium in minerals is entirely too low to permit any such conclusion.

That lead is the final disintegration product of uranium is, I believe, conclusively shown by the fact that in unaltered *primary* minerals from the same locality the amount of lead is proportional to the amount of uranium in the mineral, and that in unaltered primary minerals from different localities the amount of lead relative to uranium is greatest in the minerals from the locality which, on the basis of geological data, is the oldest.

In the case of a non-emanating, radio-active mineral containing no thorium, in which there is reason for assuming that the elements of the uranium-radium series have reached a state of equilibrium, the activity of the mineral in extremely thin films measured in an electroscope with a large ionisation chamber is about 5·3 times as great as the activity of the uranium present in the mineral. The activity of the radium itself is about 0·52 of the activity of the uranium, and the activity of the radium products of rapid change together about 2·4 times that of the uranium. The activity of the radium F (polonium) is probably about 0·55 uranium, and is certainly not less than 0·5. The combined activity of the uranium, the radium, and the radium products is therefore about 4·5 times the activity of the uranium alone. This leaves an activity of only 0·8 that of the uranium which can be attributed to the activity of the four α-ray products of actinium. It was the knowledge of the approximate value of this factor which led Prof. Rutherford and the writer to conclude (*Amer. Jour. Sci.*, xx., 56, 1905) that actinium was not a direct product of uranium in the same sense as is radium.

The ranges of the four α particles expelled by the actinium products have been determined by Hahn, and the average range of the four is 5·6 cm. The range of the α particle from radium itself is 3·5 cm. according to Bragg and Kleeman. If the particles are similar we would expect that the average particle from the actinium products would produce about 1·6 times the ionisation of the particle from radium. Since the activity of radium itself is 0·52 times that of the uranium in the mineral, the activity of the four actinium products might be expected to be $0{\cdot}52 \times 1{\cdot}6 \times 4 = 3{\cdot}32$ uranium. The number actually found, as has been stated above, is only 0·8 uranium, or one-fourth of this number.

It will be noted in the above that the activity of the uranium is about twice that of the radium present, which is in good agreement with the conclusion of Moore and Schlundt that there are two α-ray changes in uranium, if it is assumed that the average range of the two uranium particles is about 3·5 cm.

Although speculations of this sort are of doubtful value, the following suggestion may be sufficiently interesting to warrant its intrusion:—if the two changes in uranium and the five changes in radium are each assumed to take place with the expulsion of *four* α particles, and the four changes in actinium with the expulsion of only *one* α particle each, the conditions required by the relative activities of the various substances would appear to be fulfilled, and if, moreover, the mass of each α particle be taken as 1, then the indicated atomic weights of the successive elements are in fairly good agreement with the accepted values. We have then uranium = 238·5, actinium = 230·5, radium = 226·5, and radium F (lead) = 206·5. In making this suggestion I fully appreciate that I am taking liberties with the accepted value of e/m for the α particle.

It is of further interest to note that the activity of pure radium, calculated from the relative activity of the uranium and radium in minerals and the relative quantities present (Rutherford and Boltwood, *Amer. Jour. Sci.*, xxii., 1), is indicated as about $1{\cdot}4 \times 10^6$ times that of uranium, and the activity of pure radium bromide containing the equilibrium amounts of emanation and products of rapid change as about 3×10^6 times uranium.

BERTRAM B. BOLTWOOD.

Sloane Laboratory of Yale College, New Haven, Conn., December 17, 1906.

The α Rays.

THE α rays from radium appear to start life without electric charge, and subsequently become charged owing to collisions with the gas molecules they strike in their path. It seems, therefore, worth while inquiring what their behaviour would be if they were liable to become discharged again at a later collision, and to go on repeating this cycle during the ionising portion of their path. Very possibly the α particle is capable of losing more than one electron, in which case it would seem certain that it will have a greater charge at some portions of its path than at others. Looked at in this way the problem is a statistical one of considerable complexity, but my point of view will be sufficiently well illustrated by considering the average α particle to behave as if it had the following constitution. For a distance x of its path it possesses an electric charge e. This is succeeded by a distance x', during which its electric charge is e'. This is followed by a distance x with charge e, then a distance x' with charge e', and so on, repeating indefinitely. Let the particle have a mass m and initial velocity v_0, then, confining our attention to a portion of the path so small that v_0 is not appreciably diminished by the collisions which occur, it is easy to show that the quantity measured by the electrostatic deflection as mv_0^2/e would really be $\frac{mv_0^2(x+x')}{ex+e'x'}$, whilst the quantity measured by the electromagnetic deflection as mv_0/e would be $\frac{mv_0(x+x')}{ex+e'x'}$. Thus the measurements would give v_0 correctly, but the quantity denoted by e/m would be $\frac{ex+e'x'}{m(x+x')}$. It is evident that the apparent value of e/m would be independent of the pressure at which the measurements were made, since change of pressure changes both x and x' in the same ratio.

It is interesting to see what would happen if the α particle were *uncharged* during one series of portions of its path, and carried the ordinary electrolytic unit of charge e during the alternating portions. If the alternate stretches were equal, this is what would be obtained if it were an even chance whether the α particle escaped with or without a charge after each encounter. In this case we should have $x = x'$ and $e' = 0$, and the measured e/m would really be $e/2m$. On this view Rutherford's measurements would indicate that the α particles are hydrogen atoms with the normal charge instead of helium atoms with twice that charge.

It may well be that it is a matter of chance whether the atom struck or the α particle retains the positive charge after an ionising encounter, but I do not wish to imply that this warrants the conclusion that the α particle is a hydrogen atom. If we accept this conclusion we find ourselves face to face with serious difficulty in finding a place for helium in the story of radio-active change; but even if the α particle turns out to be a helium atom it is possible that its charge might vary periodically in something like the manner indicated. In this case the average charge would have to be twice the electrolytic unit.

This kind of view has the advantage of affording a reasonable explanation of why the α particle ceases to produce ionising and other effects at a stage when it possesses a much greater amount of energy than that which is known to be required by a positive ion to produce other ions by collision. These effects would cease when the uncharged particle was no longer able to become ionised by colliding with a neutral atom. The energy (about 10^{-6} ergs) which it then possessed would represent the minimum energy which an uncharged particle must possess in order to shake out an electron on collision with a neutral atom.

Even if these speculations are ultimately disproved by the facts, it is interesting to note that, with such a constitution for the α ray, the experiments would measure the velocity correctly, whereas the mass, and therefore the kinetic energy, would be erroneous to the extent indicated.

Princeton, N.J., U.S.A. O. W. RICHARDSON.

The Effect of Radium on the Strength of Threads.

WE have carried out some experiments with cotton threads in continuation of those described by Miss Martin and one of us in NATURE of August 17, 1905. The following is a summary of the results obtained :—

No difference in the effect was found when the emanation was continuously removed during the exposure by a current of air. The same negative result followed an experiment in which it was sought to remove oxygen and moisture from the neighbourhood of the threads by enclosing radium and threads along with phosphoric anhydride in a tube from which the air was exhausted, some metallic sodium being afterwards heated to fusion in a side tube.

When threads or a piece of filter paper, after exposure to radium, are dyed with methylene blue, the exposed part is found to take a deeper colour than the rest. This is given as a test for the presence of oxycellulose.

A series of three-day exposures was made at increasing distances from the radium. The effect was found to become inappreciable at 18 mm. distance. When the weakening produced was plotted against distance, the curve showed a corner at 9 mm., suggesting the similar feature found by Prof. Bragg and others on the ionisation curves of α rays to mark the end of the effective range of one set of rays.

A comparison under the microscope of the broken ends of exposed and unexposed threads showed that the fibres in the former case were straight up to their ends, while the unexposed fibres were curled back on themselves. This would indicate a loss of elastic quality through the action of the radium.

J. L. MCKEE.
W. B. MORTON.

Queen's College, Belfast, December 27, 1906.

The Upheaval of the Sea Coast by Earthquakes.

THE question so long discussed by geologists concerning the upheaval of the land by earthquakes has been impressively revived by recent events. In the San Francisco *Argonaut* of November 3, 1906, Prof. H. D. Curtis, of the D. O. Mills Expedition of the Lick Observatory at Santiago, Chile, reports that the harbour at Valparaiso is now 10 feet shallower than before the earthquake of August 16, 1906, and he concludes that the movement was mainly vertical. In the Bulletin of the Geological Society of America for May, 1906, Messrs. Tarr and Martin give a memoir on the changes of level at Yakutat Bay, Alaska, produced by the great earthquake of September 3–20, 1899, two of the most terrible shocks of which occurred on September 10 and 15. The investigators prove conclusively that an uplift occurred extending along the whole Yakutat coast for more than a hundred miles, the maximum movement in Disenchantment Bay being 47 feet 4 inches. Uplifts of 7 feet to 20 feet were common, while slight subsidences also occurred in a few places.

In view of these facts, how can anyone claim that the earth is entirely solid and deny the vertical movement of the land under earthquake forces, as is done by Prof. Suess in his great work on "The Face of the Earth"?

T. J. J. SEE.

U.S. Naval Observatory, Mare Island, California, December 8, 1906.

THE observations of Messrs. Tarr and Martin in Yakutat Bay undoubtedly form a valuable addition to the knowledge we possess respecting sudden adjustments in the earth's crust.

In September, 1899, a portion of the west coast of Alaska was shattered. Fault lines were created or extended, and the displacements along these lines have been measured. On January 31, 1906, off the coast of Columbia, and on April 18 of the same year in Central California, rock movements similar to those at Yakutat were recorded. Every world-shaking earthquake—and there are about sixty of these per year—is an announcement of a molar movement. We do not know the magnitude of the masses involved, but from measurements like those made by Messrs. Tarr and Martin we may estimate them as being represented by one or two million cubic miles of rocky material.

J. M.

Emerald Green Sky Colour.

THE account of the colour of the sky on December 10, 1906, sent by your correspondent from St. Moritz closely resembles an experience of a friend and myself on December 27.

We were returning from a geological ramble to the west of Crediton, in Devonshire, and were walking eastward, while behind us and gradually overtaking us there had been for several hours a thick snowstorm which later on was to envelop us. Between three and four o'clock in the afternoon we remarked the peculiar appearance of the sky; in your correspondent's phrase, there was "instead of the usual blue, a fairly large expanse of vivid emerald green." I may add that the ground was everywhere white from previous snow.

It will be seen that the conditions in Devonshire on December 27 correspond as regards time of day, point of compass, and state of atmosphere with those observed at St. Moritz on December 10.

With J. W. Noble I shall await with much interest the explanation. F. G. COLLINS.

Exeter.

Perception of Relief by Monocular Vision.

THE following fact seems to show that the aperture of the pupil plays an important part in the perception of relief by monocular vision.

When a polyhedron made of wire is looked at through a small pin-hole pierced on a piece of card, and the pin-hole is moved about slightly, the polyhedron seems to rotate a little about an axis perpendicular to the direction of motion of the pin-hole. The effect is most remarkable by lamplight, when the pupil is more dilated than it is in broad daylight. T. TERADA.

Science College, Imperial University, Tokyo, November 15.

THE GEOLOGY OF THE GERMAN ANTARCTIC EXPEDITION.[1]

THE most striking geographical achievement of the German Antarctic Expedition was its determination that Antarctica occurs farther north in western Wilkes Land than had been inferred by some authorities from the work of the *Challenger*. Prof. von Drygalski and his comrades have re-established faith in Wilkes's Termination Land; as from their Kaiser Wilhelm Land they saw high land to the north-east, only about one hundred miles from the site assigned by Wilkes to his Termination Land. The most fully investigated locality in the newly discovered Kaiser Wilhelm's Land is the Gaussberg, a basalt mountain on the southern shore of the bay in which the *Gauss* reached its farthest south.

1 "Deutsche Südpolar-Expedition, 1901–1903." Edited by Erich von Drygalski. II. Band, Kartographie, Geologie, Heft i. Pp. 87, 1 map, 8 plates. (1) E. von Drygalski: Der Gaussberg, seine Kartierung und seine Formen. (2) E. Philippi: Geologische Beschreibung des Gaussberges. (3) R. Reinisch: Petrographische Beschreibung der Gaussberg-Gesteine. (Berlin: G. Reimer, 1906.) Price 18 marks.