before its radio-activity dies out. We would expect that the more impervious mineral substances would show the least amount. Quartz is without radium, as the Hon. R. J. Strutt shows by his determinations.

There appears to be no improbability that matter in minute quantities might reach us from the sun. Here we are observing the most minute traces. If the observations are correct as to the velocities of solar ejections, it would take but a few days to bring solar matter into the orbit of the earth. The sun-spot-weather connection may possibly be involved, as well as the phenomena of atmospheric radio-activity, although doubtless emanation from radium already accumulated on the surface and in the soils is mainly responsible for these latter effects. Whatever may be said as to the value of such subsidiary evidence, it appears as if only by looking to such an extra-terrestrial origin of radium can we evade the difficulties connected with the associated uranium. We are evidently not compelled to assume that the radium received upon the earth carries with it the equilibrium amount of uranium, although doubtless we may expect that some uranium is also received.

It is possible to arrive at a rough estimate of the amount of radium reaching the earth if we assume the annual oceanic supply of radium is mainly extra-terrestrial, and that a state of radio-active equilibrium with the average rate of supply has been attained. In effecting this estimate we deduct the annual river supply from the supply required for maintenance of the radium concentration of the ocean. The result is an annual supply to the ocean of $1{\cdot}77\times10^{6}$ grams. If this supply is received uniformly over the oceanic area, about 12·5 milligrams enter over each square mile per annum. This result is probably excessive, as it assumes no uranium to be in the ocean or received from extra-terrestrial source.

If it is permissible to apply to the land area the mean figure deduced for the ocean, we can ascertain the depth to which the observed radium content of the sedimentary rocks would be maintained at its present value. It is but trifling—about ten metres. As I have indicated above, however, the received radium will be washed from the surface soils and carried into the denser and more retentive rocks. The due proportion is doubtless carried to the sea on the break-up of the rocks or by percolating waters. We are no longer in difficulties on this score. J. JOLY.

Trinity College, Dublin, January 6.

P.S.—A small quantity of radium will almost certainly be carried to the land along with wind-borne sea-salts. From Pierre's measurements of the latter on a coastal rainfall of 60 cm., I find that about three thousandths of a milligram per square mile ($1{\cdot}2\times10^{-16}$ grams per sq. cm.) per annum will in this way reach coastal countries. This small quantity will not complicate the problem unless there is associated uranium, and unless, further, this latter substance accumulates in the rocks. In this case the rocks of coastal countries might in course of time come to have a higher content of radium than interior continental rocks. But, I repeat, the supposition that uranium will continually gather in the rocks and never follow the usual channels of escape seems very improbable.

Much remains for investigation, naturally arising out of Mr. Strutt's fertile work. Rain-water should be systematically examined, due allowance being made for wind-borne radium carried from the sea. I have begun such observations, but they will necessarily demand time and care if they are to be of value. In the hope of getting further light on some of the points at issue, I have the rocks of the Simplon Tunnel and certain of the deep-sea oozes under examination. J. JOLY.

January 16.

Green Sunset Colours.

THE green sky described by Mr. Collins in NATURE of January 3 (p. 224) was evidently an unusually brilliant example of the green tints often seen in a sunset sky. As I have not seen any explanation of the phenomenon, it may possibly be of some interest to give the following attempt at one.

The colour of the sky at any time is made up of two components: A, the light from the upper regions; B, that reflected from the small particles in the lower air. The A component is always blue, and its spectrum shows a deficiency in red and yellow rays. Its light passes between the particles, and therefore forms a background upon which they are projected. The spectrum of the B component is variable. When the sun is well above the horizon the light is white, and the variations in the deepness of the blue of a clear sky are due to differences in the relative proportions of A and B. As the sun nears the horizon the B light begins to lose its more refrangible rays, and the absorption extends towards the green and yellow as the sun goes down.

Now if we take two equally brilliant spectra, cut out the red, orange, and yellow from one, and the violet and blue from the other, and then mix the residues, we shall obviously have all the colours necessary to make white light with a double allowance of green. An eye receiving the whole will see pale green. This, I take it, is the origin of the green colours of the sky. The A component is deficient in the less refrangible rays, which are supplied by the B component, and the two spectra overlap in the green, showing an excess of that colour.

Occasionally, but rarely, the two are exactly complementary over a limited stretch of sky, and then white patches are seen amid the colours of the sunset which are easily distinguished from clouds. They shade off on one side into tints of green where the spectra overlap, into yellow where the B component is in excess, and into blue where the A light preponderates.

When the sky is clear it is no uncommon thing to see a considerable expanse of green, shading on the one side into pale lemon-yellow where the overlap of the spectra is considerable, while on the other side it shades through a narrow border of silvery tint where the balance is exact into a delicate rosy hue where there is a general deficiency in the central rays.

Green tints are by no means always to be seen, and I think the foregoing explanation shows why—their production depends upon such an adjustment between the brightness of the two components that they shall be approximately equal. The white patches are rarer still, as they require exact equality in brightness and correct apportionment of colour. ARTHUR W. CLAYDEN.

5 The Crescent, Exeter.

Ultra violet Fluorescence of Benzene.

FROM my observations on the emission of light by canal rays (*Ann. d. Phys.*, 21, 401, 1906; *Physik. Zeitschr.*, 7, 355, 1906), I have concluded that absorption of light in a band spectrum (running towards the red) produces fluorescence. Hartley and others have stated that benzene has a banded absorption spectrum in the ultra-violet; adopting that principle, I conjectured that benzene had an ultra-violet fluorescence. I have confirmed this by the following method:—The ultra-violet rays from a mercury lamp by W. C. Heraeus (Hanau, Germany) fell vertically upon a diluted solution (0·25 per cent.) of benzene in alcohol, and the fluorescence light emitted by it horizontally was analysed by a quartz spectrograph. In the spectrograms obtained there appeared, besides the mercury lines, a group of four strong continuous bands situated in the ultra-violet between λλ 271 and 314 $\mu\mu$; these bands run towards the red end of the spectrum, and the heads have the wave-lengths 272, 280, 283, 292 $\mu\mu$.

As Hartley has shown, the absorption spectra of the benzene derivatives are produced by an alteration (both in intensity and spectral position) of the simple benzene spectrum; such an alteration is produced by condensation and substitution. According to our principle, the same is true for the fluorescence spectra of the benzene derivatives. The question as to the relations between chemical constitution and fluorescence is thus reduced to the question of the relations between chemical constitution and absorption, and banded absorption must be explained with regard to the fact that it is coupled with fluorescence. There may also be drawn from the above result some conclusions about the constitution of the benzene ring.

J. STARK.

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