will not be affected by any temperature, or other external set of physical conditions, which can be possibly attained in the existing universe. If the process occurs at all accordingly, it should occur on the earth and hence be accessible to our direct experience.

As a matter of fact, the data quoted by Sir James Jeans himself *re* the observed energy flow from the earth's surface, enable us at once to place a minor limit to the average life of the existing terrestrial atoms. The heat flow from the earth's interior at present is about $1{\cdot}9 \times 10^6$ calorie per cm.^{2} per sec., or $2{\cdot}6 \times 10^9$ ergs per cm.^{2} per year. The total surface area of the earth$=5{\cdot}1 \times 10^{18}$ cm.^{2}, hence the total loss of energy of the earth per year is $13{\cdot}3 \times 10^{27}$ ergs, equivalent to a loss of mass of $1{\cdot}5 \times 10^7$ grams. Now the mass of the earth itself is 6×10^{27} grams, hence if the earth is cooling, the average life of a terrestrial atom must be at least 4×10^{20} years, or about 10^8 times the probable age of the existing universe.

It is to be observed that in the above calculation we have neglected the fact that a large portion of the energy loss is supplied by the known amount of radioactive elements present in the earth's crust. In fact, the surface materials are so rich that a layer about 13 km. thick would supply the whole loss, and it is only by assuming a rather arbitrary diminution of radioactivity with depth that we can ensure that the earth as a whole is cooling. If we accept Jeffreys' estimate that 87 per cent of the loss is due to the breakdown of the known radio-active elements, we can only attribute the remaining 13 per cent to the apparently stable elements, and this would lead to an average life for these elements of about 5×10^{21} years.

There is, of course, another possibility, that is, that the earth as a whole is not at present cooling, but that heat energy is steadily accumulating. This view is favoured by geological history, but the increase of energy production which it involves seems to be amply explained by the measured radio-activity of eclogites and other presumably deep-seated materials. It seems improbable, therefore, that there could be any large accumulation of heat energy due to the breakdown of ordinary elements at present taking place in the earth, and we are probably correct in concluding that the complete life of a terrestrial atom must be at least 10^{21} years. This age is so enormous compared with the estimated age of the universe, that we would seem to be justified in treating our terrestrial atoms as eternal.

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I QUITE agree with Dr. Poole. I had previously discussed the question he raises in a lecture, "Recent Developments of Cosmical Physics," published as a supplement to NATURE of Dec. 4, 1926; there is a similar discussion on p. 131 of my "Astronomy and Cosmogony": "Our terrestrial atoms have so little capacity for spontaneous transformation that they may properly be described as 'permanent.' . . . If the terrestrial elements underwent any appreciable transformation in periods comparable with 10^{17} years, the resulting generation of heat by the earth's mass would make the earth too hot for human habitation."

J. H. JEANS.

Radio Communication and Magnetic Disturbances.

LOOKING through the wireless data of Sir Douglas Mawson's Australasian Antarctic Expedition which has come into my hands through the untimely death of Dr. Chree, I have found a copy of the *Australian Monthly Weather Report*, vol. 4, No. 9. This contains Mr. F. J. Henderson's analysis of the working of the Macquarie Island station during 1914 and 1915 in the form of a statement of the dates on which the receipt of wireless signals was difficult or impossible, apparently excluding the days on which atmospherics were serious enough to cause the trouble. The stations with which Macquarie Island was generally in communication were Hobart, Wellington, and The Bluff.

In order to obtain confirmation of certain results from the first rough analysis of the logs of communication between Macquarie Island and the Antarctic base station, the international magnetic character numbers for each day of bad communication at Macquarie Island were tabulated from the lists printed in *Terrestrial Magnetism*. The mean character number for these days gave the surprisingly high figure of 1·1 for 1914, and 1·0 for 1915, compared with the mean values for all days of the months in question, namely, 0·55 for 1914 and 0·64 for 1915. This close relation between bad wireless communication and magnetic disturbance is the more surprising because the international character numbers are awarded mainly on the results from the more numerous magnetic observatories of the northern hemisphere. It would be interesting to compare these results with the magnetograms from the Christchurch Magnetic Observatory, which might be expected to show an even higher degree of correlation with wireless communication.

Communication appears to have been mainly carried out on wave-lengths less than 2000 metres, and the results refer to the era of crystal reception. In general, communication was not simultaneously bad from all three stations, but the days when communication was impossible from all of the three stations mentioned were, on the average, more disturbed magnetically than days when communication was less restricted.

The polar regions contain the auroral belts which are highly disturbed magnetically, and world-wide communication along great circle paths will often cross these belts. It becomes, therefore, a matter of practical interest that important magnetic storms are of world-wide occurrence, and that a disturbed day (or year) is likely to be followed immediately by another disturbed day (or year). It may be that close study will enable rules to be laid down as to the best means of roundabout communication by relay stations on bad days, analogous to the mariner's rule for avoiding the centre of a hurricane.

It may be mentioned that the apparent relation between bad wireless communication from New Zealand and neighbouring parts to Macquarie Island, and magnetic disturbance defined by the international character number, is closer than the relation between this character number and exceptional aurora observed at Macquarie Island.

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The Raman Effect in X-ray Scattering.

THAT a quantum of radiation can be absorbed in part by an atomic system, and the remaining part scattered by it giving rise to a radiation of increased wave-length, has been demonstrated by recent work on the scattering of light in material media. In his address on "A New Radiation" (*Ind. Jour. Phys.*, vol. 2, p. 398, Mar. 31, 1928) Raman pointed out that precisely similar effects should also be observable in the case of X-ray scattering. In other words, in addition to the Compton type, we should also have other modified X-radiations scattered by the atom, in which the scattering electrons alter their positions