The effect is to compress H in one half and expand it in the other half of a period, with corresponding strengthening and weakening of periodicity, and also with a shifting of the nodes towards the compressed part. When \( u/v \) is made large, there is a great concentration at \( \phi = \phi_0 = 2\pi, \ 3\pi, \ 4\pi, \ ... \), with only a weak disturbance of opposite sign between them. That is, there is a tendency to turn the original simply periodic vibration into periodic pulses, which become very marked as \( u \) increases towards \( v \). The radiation of energy is very rapid. It involves (\( u/v \) the factor \( (1-u^2/v^2)^{-1} \). This becomes so great as to seem to shut out the possibility of anything more than momentary persistence of revolution. But there might be a partial revolution, or nearly complete, in cometary fashion, which would generate a single pulse, if there cannot be a sequence of several at speeds nearly equal to that of light.

Three suggestions have been made about the X-rays. Röntgen suggested a longitudinal ether disturbance. This has not found favor, because it requires a new theory of electricity. Schuster suggested very rapid vibrations. This is tenable, because in the inside of an atom rudimentary calculations show that vibrations much more frequent than light are easily possible with revolving electrons. Stokes suggested simple oscillations. This is tenable, too, for the collisions must produce electromagnetic pulses. I think X-rays are mixed Stokes pulses and Schuster vibrations, the latter arising from the atoms of the body struck. Now a pulse is not the same as a continued vibration, though it may be analysed into the sum of various sorts of continued vibrations, just as the distorted simply periodic vibration in (5) above may be. There ought, then, to be a physical difference between the effects of collisional pulses and continued very rapid vibrations. Apart from the emission of electrons and matter, there might be six sorts of radiation at least, say, light vibrations, below light, above light, collisional pulses, cometary periods, and possibly periodic pulses. The last may have to be excluded for the reason mentioned. The cometary pulses would resemble the collisional ones, though less dense. The above light vibrations need not require \( u/v \) to be more than the small fraction, though even then their maintenance is a difficulty. They require renewal again and again, perhaps in a collisional manner. There is a good deal to be found out yet in the relations of electricity to matter. There is also sometimes a good deal of misconception as to the relation of theory to fact. A purely dynamical theory of electricity, like Maxwell’s, can give no information about the connection between electricity and matter. For example, Zeeman’s experiment, as interpreted by Lorentz, brought out the striking fact that it was the negative electron that revolution, not seemingly the positive, and the fact harmonises with J. J. Thomson’s negative corpuscles. Theory could never predict such a fact, because it is not in the theory. It could not be there, because it has no dependence upon the dynamics of electricity in the theory. The same may be said of various other new facts much discussed of late. Now, though the theory cannot predict such facts, it is useful, of course, as a guide in framing hypotheses to account for the new facts, for it is no use flying in the face of solid theory. Whether the solid theory itself (not meaning that the ether is solid) will need to be altered remains to be seen. There is no sign of it yet, though I cannot believe the ethereal theory is complete.

To analyze the dopplerised vibrations expressed by (1), (2) into simply periodic vibrations seemed to involve very complicated work at first, save just for two or three terms. But there is a trick in it, which, when found, allows the complete expansions to be developed in a few lines. First show that (this is the trick)

\[
a^2 \cos \phi_1 = \frac{d^2}{d\phi_0^2} \cos \phi_1, \quad a^2 \sin (\phi_1 - \phi_2) = \frac{d^2}{d\phi_0^2} \sin \phi_1 \quad (6)
\]

Next, by the theorem known as Lagrange’s, \( \sin \phi \), can be at once put in the form of a series involving the derivatives of various powers of \( \cos \phi \). Do not find the derivatives from them, but put \( \cos \phi \) in terms of the sum of first powers of \( \cos \phi \) by the well known circular formula. The
line, as follows:—Some marked peculiarity is determined on to be made the subject of study. It may be an excess or deficiency of some normal character, or it may be a trait, a feature, a disease, or a monster, the process being the same in all these cases. The inquirer then endeavours to trace its hereditary distribution. He fixes upon some individual who possesses the peculiarity in a highly marked degree, and traces the frequency and intensity with which it occurs among his kinsmen. He tries to do so exhaustively by compiling the facts relative to those kinsmen in each and every degree to as great a distance of kinship as he is able, or cares, to go. He follows a similar course in respect to many other individuals belonging to as many different families, and finally he obtains average results by well-known methods. I am speaking solely of inquiries of the table, are supposed to be entered in a corresponding number of paragraphs on a separate sheet. After more trials and failures than would be easily credited, I think I have at last succeeded fairly well. Still, as I began by saying, I should be very grateful for useful suggestions. The table admits of indefinite extension with no alteration of method. It will, of course, be understood that each successive step in the line of descent introduces a new element that may seriously affect the previous influences. Much might be added, but I think that with the aid of a little reflection the arrangement of the table will explain and justify itself.  

FRANCIS GALTON.

The Source of the Energy of Radium Compounds.

If I understand Prof. Rutherford’s communication right (NATURE, January 7, p. 222), he concludes from the constancy of radio-active results with a solid radium salt and the same dilution that the energy of radium compounds cannot be derived from external sources. The matter is of such wide scientific interest that I ask your permission to present concisely the contra argument.

(1) When a coloured solid is dissolved the amount of absorption of light effected by the solid is equal to the amount of light absorbed by its solution. Thus I have shown that a plate of solid bichromate of potash of 0.711 millimetre in thickness effects the same absorption of light as 6 centimetres of solution containing 0.0306 gram of the salt per cubic centimetre, as in each case the same number of bichromate molecules or molecular aggregates is acting on the light. To be perfectly clear, taking the specific gravity of bichromate of potash as 2.947, we have in the former case a rectangular bundle of rays 1 square centimetre section passing through 0.711 x 2.947 = 2.018 gram of solid, while the bundle of rays in the latter case passes through 6 x 0.0306 = 0.1834 gram of dissolved bichromate (see Chem. News, October 5, 1877).

(2) It has been amply demonstrated that the absorption of X-rays follows the same general laws as the absorption of light; thus the amount of both kinds of radiation absorbed increases (1) with the thickness of the body passed through, and (2) with the molecular weight in a comparable series of bodies (‘The Old Light and the New’), 1890, pp. 73-80).

Therefore if it be postulated that the energy of radium is due to the absorption of “an unknown external radiation” “similar in character to the radiations which are emitted,” viz. the γ rays, then the mere act of dilution of a milligram of radium bismut will not affect its constancy of absorption, and therefore also will not materially influence its radio-activity.

WILLIAM ACKROYD.

Borough Laboratory, Halifax, Yorkshire.

γ-Rays from Radium.

From the letter of Prof. Rutherford in NATURE of January 7 it is improbable that γ rays from radium are Röntgen rays generated by self-bombardment. The γ rays must therefore arise from radium directly, and not as a secondary effect of bombardment. It may be useful here to recall a remark made by Sir George Stokes at a meeting of the physical collation of the Owens College, Manchester, shortly before his death. Commenting on Becquerel’s rays, he likened the discharge of cathode rays to the discharge of a gun, the impact of cathode rays to the discharge of a gun, the impact of cathode rays on a target creating an ethereal disturbance, analogous to the Röntgen rays. But, he said, in the same way as there is an explosive disturbance in the gun where the bullets issue, so there must also be a violent ethereal disturbance, not only where cathode rays strike, but also where they issue.

Is it not just this disturbance where α rays issue which is now being detected in γ rays, and is it not quite consistent with this view that the explosive disturbance of the atom which produces α and β rays should at the same time generate something akin to Röntgen rays?

J. R. ASHWORTH.

105 Freehold Street, Rochdale, January 10.