Along the same lines as I have just indicated, with the high-speed β particles in the interior of the nucleus, it seems natural to concede that highly penetrating γ rays originate in the very interior of the nucleus when one of these high-speed β particles passes, without leaving the nucleus, from one stable trajectory to another. The absence of penetrating rays in the transformation of radium E doesn't seem to me to contradict this hypothesis. In this case, the β particles would leave the nucleus, but wouldn't undergo the changes in orbit associated with the emission of penetrating γ rays. I would like to ask Sir Ernest Rutherford if he sees any real problem with the supposition that γ rays originate in the interior of the nucleus.

MR. RUTHERFORD: No. I believe that high-frequency γ rays must have their origin in the nucleus.

MR. PERRIN: What difference do you see between the electrons that are near the nucleus and those that are in the interior?

MR. RUTHERFORD: I believe that there is a no man's land between the electrons in the nucleus and those that surround it.

MR. DE BROGLIE: Do the electrons Sir Ernest Rutherford is speaking of, which are so close to the nucleus, figure in the total charge of the latter?

It is striking how the γ rays seem to give way to regular series of X-rays in a continuous manner, so to speak, as Sir Ernest Rutherford has measured γ rays in which the wavelength is approximately half that of the most penetrating X-rays.

The absolute character of the discontinuity created by the nucleus thus seems to fade a bit; the total exterior charge equal to + N*e* which, in an atom with an atomic number N, is exerted on the exterior electrons, is nothing but the difference between the charge of a central nucleus with a positive charge much higher than N*e*, partially masked by the peripheral nuclear electrons. As a result, one could apply equations similar to the Bohr equation to these, but with higher N values.

In short, one could say that what defines an electron as belonging to the nucleus is the fact that its negative charge weighs in the valuation of the total algebraic charge, in such a way that it has an effect on the exterior, for example, on an electron in the K-ring.

MR. LANGEVIN: There doesn't seem to be any great difficulty in assuming that in the nucleus, electrons behave at least approximately in accordance with their usual properties, as the ray attributed to them by the electromagnetic theory (10^{-13} for the negative ones, and probably much less for the positive ones) is much lower than the valuations indicated by Mr. Rutherford for the ray from the nucleus.

MR. PERRIN: I believe that upon learning of the wonderful discoveries of Sir Ernest Rutherford regarding the displacement of atomic nuclei by α rays, we have all been struck by the fact that the hydrogen atoms extracted from the nucleus can be shot in any direction with greater kinetic energy than that of the projectile (notably in aluminum and phosphorus).

The surprise stems from the fact that one likens the phenomenon to the action of a projectile whose impact tears off part of a construct, throwing it more or less in the direction of the impact with an amount of energy that is inevitably lesser than that of the projectile.

Mr. Rutherford's experiments seem to prove that we must reject that notion of a simple impact. The α projectile, due to its high velocity, and despite a very strong electric repulsion, can reach the immediate vicinity of the nucleus with its speed significantly reduced. At that moment, a "transmutation" takes place, probably consisting of an intranuclear rearrangement with the nucleus' possible capture of the incident α (as we don't know what becomes of it), emission of the hydrogen nucleus forming the observed H-ray and perhaps with further, less significant projections. Looking at it this way, there is no reason why the emitted H projectile would "remember" the direction of the initial impact or why its energy (partly borrowed from the intranuclear electric energy) should be lesser than that of the incident projectile.

If, for example, the impacted aluminum nucleus captures the α projectile and doesn't emit any electrons, after emission of the H projectile, there would remain an atom with a mass of (27 + 4 - 1) – or 30 – and an atomic order of (13 + 2 - 1) – or 14 – therefore, a silicon isotope. Other hypothesis would be easy, incidentally.

MR. RUTHERFORD: It could very well be that the α particle enters into some sort of temporary combination with the nucleus.

MR. EHRENFEST: What is the range of the H particles from aluminum?

MR. RUTHERFORD: The range of the H particles in the direction of the α particles is around 80 cm. In the opposite direction, it is from 50 to 60 cm.

MR. EHRENFEST: Is chlorine split?

MR. RUTHERFORD: No proof of the decomposition of chlorine has been obtained.

MR. MILLIKAN: It's interesting to recall that our experiments in which we passed sparks through an ultra-high vacuum demonstrate the development of hydrogen when the power is at 300,000 volts. Thus, disintegration of the nucleus occurs when it is penetrated by an electron at high velocity. We concluded that all the other elements whose presence had been detected through a spectroscopic examination could be attributed to impurities, with the exception of hydrogen. This continues to come from the electrodes. There doesn't appear to be any formation of helium. Hydrogen comes from carbon, but that may be due to the traces of aluminum and other elements in the carbon electrodes, consistent with Mr. Rutherford's results.

MR. RUTHERFORD: I'm not as optimistic as Mr. Millikan when it comes to the possibility of discarding hydrogen as an impurity. Hydrogen is everywhere and it is very difficult to eliminate. It's doubtful that the energy or amount of movement of the electron in Mr. Millikan's experiments was sufficient to release an H particle. In the case of bombarding an element with high-velocity α particles, I...