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The Difference between Series Spectra of Isotopes.

I should like to add a few remarks to the interesting letter of Professor Ehrenfest about the contents of which he was so kind to inform me before publication. As pointed out in his letter, the effect of the mass of the nucleus on the spectrum of an atom, containing more than one electron, is a complex problem which depends on the electronic arrangement in the states of the atom, involved in the emission of the lines, in a way which has hitherto not received sufficient attention. Not only may the mass effect disappear completely in such cases, where several electrons move round the nucleus in equivalent orbits, but, as indicated by Professor Ehrenfest, this effect may also in case of the motions which we actually meet in the emission of the series spectra be different from that calculated for an atom with one electron. Although in the emission of these spectra we are concerned with motions, where a single electron moves in an orbit different in type from the orbits of the other electrons, the problem differs essentially from the problem of two bodies in celestial mechanics. Thus according to the picture of atomic constitution, outlined by the writer in two letters to Nature (March 24th 1921, October 13th 1921), we shall assume that the electron connected with the emission of the series spectra, although it during the larger part of the revolution remains outside the configuration of the electron in inner groups, will nevertheless in certain states during its revolution penetrate into the interior of the atom. The fact that the electron in the inner loop of its orbit is subject to large forces is of preponderant influence as regards the fixation of the energy in the corresponding stationary states of the atom. For such a motion the effect of the nuclear mass might differ essentially from that estimated from an examination of the mechanical properties of the motion in the outer loop only, and the question arises, whether the mass effect is sufficiently large to account for the discre-

pancies, observed by Merton, in the wavelengths of certain lines in the spectra of lead isotopes which although very small are yet much larger than those to be expected from the simple formula quoted in Professor Ehrenfest's letter. Although this question seems difficult to settle without a closer investigation, it would hardly appear probable, however, that the answer will be affirmative. On the other hand it is not excluded, that the discrepancies in question are due to a slight difference in the field of force surrounding the nucleus, arising from the difference in the internal nuclear structure of the lead isotopes. This possibility has been discussed from various sides. At first sight we meet with the difficulty, that the dimensions of the nucleus (ca. 3.10^{-12} cm.), estimated from experiments on the scattering of α-particles, are exceedingly small in comparison with the dimensions of the orbits of the electron responsible for the emission of the series spectra, which are of the order 10^{-8} cm. or larger. This difficulty may disappear, however, by considering the circumstance mentioned above, that in certain states the series electron during a short interval of its revolution penetrate deeply into the interior of the atom. In fact, we must assume, that this electron in the states corresponding to the S-terms of the series spectra during its revolution penetrate to even smaller distances from the nucleus than the electrons in the innermost group of the atom, the dimensions of which are in lead smaller than 10^{-10} cm. To the possible importance of this point in connection with the spectra of isotopes my attention was kindly drawn by Dr. Kramers in a discussion about Professor Ehrenfest's letter.

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