A SIGNIFICANT EXCEPTION TO THE PRINCIPLE OF SELECTION.

BY PAUL D. FOOTE, F. L. MOHLER AND W. F. MEGGERS.

THE pair $1s-3d$ of sodium and potassium, in Sommerfeld's theory, necessitates an interorbital transition where the change in azimuthal quantum number is two units. The presence of this pair has been always attributed to the incipient Stark effect of the exciting field. In the present paper an experimental arrangement is described wherein the radiation is completely shielded from the applied field—itsself only 7 volts. The pair may then be produced at will by increasing the exciting current until it is one of the strongest lines of the spectrum. It therefore is an exception to the selection principle which can not be explained away by a Stark effect. Its explanation is of deeper origin, possibly requiring a reconsideration of the method whereby single azimuthal quantum numbers have been assigned to each of the s , p , d and b terms.

BUREAU OF STANDARDS.

THE CHARGE ON THE ALPHA PARTICLE.

BY J. E. SHRADER.

THE charge on the alpha particle which is known to consist of two units of electricity has been redetermined by Rutherford and Geiger's method, using the sensitive point and photographic recording apparatus of Geiger.

This method consists essentially of two parts:

1. Measurement of the current due to positive charges from the alpha particles from a given radioactive source.
2. The counting of the alpha particles given off from the same radioactive source.

From the results of these two operations, the charge on the alpha particle and hence the elementary electrical charge has been determined.

Polonium which emits only alpha particles was used as the radioactive source.

The current was determined by the null method with a sensitive quadrant electrometer with an accuracy of about .2 of one per cent.

The counting operation did not give results of comparable accuracy, the error being as great as 4 or 5 per cent. This error is believed to be inherent in the sensitive point method. In operation the sensitive point loses its sensitivity with time and even failure to record is clearly observed. By removal of absorbed gases by electrical heating or by operation of the sensitive point in vacuum, the loss of sensitivity and failure to record are more marked. A failure to record is clearly shown from the fact that the number of particles recorded does not agree with the inverse ratio of the distance and that the number recorded varies with time disproportionate with the rate of decay of the radioactive source.

From observed results, it is believed that the entrance of an alpha particle produces a minute current by ionization by collision and that this stimulates

the release of ionized gas molecules from the point and that this source of ions rather than ionization by collision is responsible for the greater part of the current. Hence the irregularity of counting is due to instability of the gas film.

The value obtained for e by this method taken from an average of several determinations of currents due to positive charges of alpha particles and the number of particles given off from the same source at different rates of counting is 4.78×10^{-10} E.S. units.

The difficulties encountered with the sensitive point method where conditions are hard to control necessarily indicates that this is not a precision method for the determination of e .

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RADIATION FROM A GROUP OF ELECTRONS.

BY LEIGH PAGE.

THE most serious contradiction between Bohr's theory of the atom and classical electrodynamics is in connection with the question of radiationless orbits. Bohr's theory requires the existence of such orbits; electrodynamics seems to deny the possibility of them. To be sure, radiation of the first order can be eliminated by assuming that two electrons revolve in a circular orbit at opposite ends of a diameter, but even in the K ring of an atom of atomic number greater than two (helium) the second order radiation from such a pair is greater than the first order radiation from hydrogen. The object of this paper is to investigate the conditions requisite to the annulment of radiation of all orders. That it is possible to devise an atomic structure involving a finite number of electrons which satisfies all of these conditions is extremely doubtful.

Take some point in the atom (the nucleus) as origin. Let $\mathbf{r}$ be the position vector of an electron relative to this origin. Then, by expanding the retarded expression for the electric intensity due to a point charge, the field strength at a great distance R from the origin is found to have the very simple form (in Heaviside-Lorentz rational units),

$$\mathbf{E}_\infty = \frac{1}{4\pi R c^2} \left\{ \left[\frac{d}{dt} (\Sigma e \mathbf{v}) + \frac{1}{c} \frac{d^2}{dt^2} (\Sigma e \mathbf{r} \cdot \mathbf{M} \mathbf{v}) + \frac{1}{2c^2} \frac{d^3}{dt^3} (\Sigma e \mathbf{r} \cdot \mathbf{M}^2 \mathbf{v}) \right. \right. \\ \left. \left. + \frac{1}{6c^3} \frac{d^4}{dt^4} (\Sigma e \mathbf{r} \cdot \mathbf{M}^3 \mathbf{v}) + \cdots \right] \times \mathbf{M} \right\} \times \mathbf{M},$$

where $\mathbf{M}$ is a unit vector having the direction of R , and c is the velocity of light. Hence the conditions for radiationless orbits are

1st order:	$\Sigma e \dot{x}_j = \text{const.}$	3 equations,
2d order:	$\Sigma e x_m \dot{x}_j = \text{const.}$	9 equations,
3d order:	$\Sigma e x_m x_n \dot{x}_j = \text{const.}$	18 equations,
4th order:	$\Sigma e x_m x_n x_o \dot{x}_j = \text{const.}$	30 equations.

where $x_1 \equiv x$, $x_2 \equiv y$, $x_3 \equiv z$, and the subscripts assume the values 1, 2, 3.