however, for first order processes: for second order processes it must be modified by an appropriate generalisation of the Bethe and Fermi method[4]. If we introduce this correction, which is equivalent to computing the reaction of the process on the incident electron, we obtain as cross-section

$$d\sigma_1 = \frac{14}{9\pi}\,\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^2 \frac{2\varepsilon}{mc^2}\,\frac{d\varepsilon}{\varepsilon} \quad . \quad . \quad . \quad (2)$$

Even this cross-section is incorrect, because it neglects the action of the nuclear field on the incident electron, while on the other hand we may suppose that the excess impulse is given to the nucleus by this electron rather than by the rising one. If we calculate the process only with this last nuclear action, we obtain as cross-section

$$d\sigma_2 = \frac{8}{9\pi}\,\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^2 \frac{2\varepsilon}{mc^2}\,\frac{d\varepsilon}{\varepsilon} . \quad . \quad . \quad . \quad (3)$$

(If we assume Møller's primitive interaction without modifications, $d\sigma_2$ would be small in comparison to $d\sigma_0$ and $d\sigma_1$.)

To obtain the right expression for the cross-section, it suffices to sum $d\sigma_1$ and $d\sigma_2$, because the product of the matrix elements due to the two nuclear actions is antisymmetrical as regards the electron and positron, and vanishes with the integration. We have then

$$d\sigma = \frac{22}{9\pi}\,\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^2 \frac{2\varepsilon}{mc^2}\,\frac{d\varepsilon}{\varepsilon} , \quad . \quad . \quad . \quad (4)$$

and integrating,

$$\sigma = \frac{22}{27\pi}\,\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^3 \frac{2w_0}{mc^2} . \quad . \quad . \quad . \quad . \quad (5)$$

We see then that even in this approximation, we must neither neglect the reaction of the process on the incident electron, nor the interaction between this electron and the nucleus.

A fuller calculation and discussion of this problem will shortly be published.

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July 27.

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[3] E. J. Williams, NATURE, **135**, 66; 1935.
[4] H. Bethe und E. Fermi, *Z. Phys.*, **77**, 296; 1932. See also W. Heitler et L. Nordheim, *J. Phys.*, **5**, 449; 1934.

Registration of the Ionisation Curve of a Single α-Particle

IN a recent letter[1], Dr. Alfvén of Uppsala has described a method for measuring the ionisation along the track of individual α-particles. Some years ago, an almost identical method was developed in this laboratory[2] (Fig. 1) and has been used for the investigation of the α-rays from radium and polonium[3]. The main difference between this method and that developed in Uppsala appears to be that, thanks to the oblique direction of the α-rays to the field, with the former method complications from different saturation are largely eliminated. Also the loss of ions to the grid is avoided by the application of a suitable potential. We have, however, of late abandoned this method for others giving more accurate results; namely, for the counting of α-particles and H-particles the "Doppel Röhrenelektrometer"[4], and for exact measurements of the

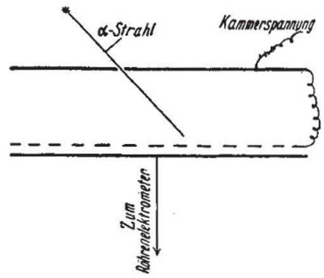

FIG. 1. From *Phys. Z.*, **33**, 294; 1932.

specific ionisation along individual α-tracks the method recently published by G. Stetter and W. Jentschke[5], also using a twofold registration.

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[1] NATURE, **136**, 60, July 13, 1935.
[2] G. Stetter, *Phys. Z.*, **33**, 294; 1932.
[3] H. Dannbauer, Dissertation, Universität Wien.
[4] G. Stetter u. J. Schintlmeister, *Wien. Ber.*, **142**, 427; 1933. *Mitt. Rad.-Inst.*, No. 322.
[5] G. Stetter u. W. Jentschke, *Phys. Z.*, **36**, 441; 1935.

I AM sorry that I overlooked the papers cited by Prof. Stetter. In excuse I may state that the first paper is published under the title "Eine neue Methode zur Messung der Ionenbeweglichkeit", the second is unobtainable here, the third is published in a journal not very much read, and the fourth was published after my letter was sent to NATURE.

In any event, I do not agree with Prof. Stetter, that my experiment is a copy of his. The main features of the former are:

(1) The ions move with *constant* velocity to a special chamber where they cause a current which is amplified. In some experiments in 1929 I tried to move the ions by a slow air current, but with bad results. In the experiment described in my letter, it is made with a *homogeneous* electrical field. As the grid and the chamber have the same potential in Prof. Stetter's experiment, the field (deriving from the "Durchgriff" only) is not homogeneous. Then the ions do *not* move with a constant velocity and there is no possibility of constructing the ionisation curve from the current to the amplifier.

(2) The amplifier is constructed in such a way that the *current* to the first grid (not its integral) is registered by the oscillograph. Then the ionisation curve is *directly* registered on the oscillogram. In Prof. Stetter's experiment, the registered curve must be differentiated to give the current to the amplifier. In the registrations he has published it seems to be impossible to differentiate the curve with any degree of accuracy.

As regards complications from different saturation and the loss of ions to the grid, I do not think that these are of much importance in an experiment which in any event gives only an approximate picture of the ionisation curve.

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