TABLE I. *Values of Hρ at different points along the tracks.*

Long Track			
Distance from origin*	1.28	2.56	3.84 cm
$H\rho(\alpha=90°)$	3.55	3.50	3.46×10^{-5}
$H\rho(\alpha=75°)$	3.65	3.60	3.56×10^{-5}
Short Track			
Distance from origin*	0.77	1.28 cm	
$H\rho(\alpha=90°)$	2.48	2.40×10^{-5}	
$H\rho(\alpha=55°)$	3.15	3.06×10^{-5}	

* Values at NTP.

vapor and which results in an emission of protons or deuterons so highly energetic, demands an initial energy of 35–40 Mev. If we suppose that, simultaneously with observable charged particles the same reactions give birth to one or several neutrons,[5] invisible in a cloud chamber, the incident ray must possess an energy of 60–70 Mev. According to these estimations, the reactions observed must be induced chiefly by the soft component of the cosmic radiation—a conclusion already deduced from the very rapid increase of the discussed phenomena with the altitude.

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* We were able to ascertain the absolute inactivity of the interior of the chamber.

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The Beta-Radiation of As^{76} *

The problem of beta-emission is complicated by the possibility that the transition takes place to more than one level in the final nucleus.[1] We have therefore considered it of interest to study rather extensively a spectrum in which other observers have found indications of complexity.

Previous measurements[2, 3] on As^{76} agree that there are two groups of beta-rays, but the estimates of their relative populations are in serious disaccord. No attempt has been made to study the low energy region carefully, although the high energy end of the spectrum seems to have been well analyzed.[3]

The work reported here was done with a hydrogen-filled expansion chamber placed in a magnetic field uniform to ±2.5 percent over the useful volume of the chamber. During a run the field was maintained constant to ±1 percent. Data were obtained for magnetic field strengths of 800 and 342 oersteds. Only those tracks were measured which (1) were not visibly scattered, (2) were at least 10 cm long, (3) initially lay within the same solid angle for each radius of curvature. The radioactive arsenic was chemically separated from cacodylic acid which had been irradiated by slow neutrons from the cyclotron or a $D-D$ source.

Recent experiments[4–6] have shown the distortion of the momentum distribution in a beta-ray spectrum which is caused by "back scattering" due to a finite mass of material behind the source. In our work this effect, which arises essentially from a "forward" and "backward" asymmetry in the scattering of low energy electrons in the source, has been partially compensated for by folding the filter paper on which the active precipitate was deposited so that the source was contained between two equal thicknesses of paper. The total surface density of the source amounted to 29 mg/cm^2. The maximum thickness of material a beta-particle would have to traverse was 21 mg/cm^2, corresponding to a momentum loss of about 180 oersted-cm for a beta-particle of $H\rho=2000$. It therefore seems that the finite source thickness could not seriously affect our observations above this value of $H\rho$.

Figure 1 shows the experimental momentum distribution of the beta-particles. The observed upper limit occurs at $H\rho=10{,}600\pm500$ corresponding to 2.71 ± 0.14 Mev. This energy limit agrees closely with that obtained by Harteck, Knauer and Schaeffer.[3] The average energy of the beta-particles is 0.93 Mev.

The decomposition of the experimental curve into components each having a Fermi distribution is only possible by assuming that at least three groups are present, the highest energy group fitting over a region covering 40 percent of the energy spread of the spectrum. The extrapolated end-point of the Fermi plot is 2.78 Mev. If, on the other hand, we assume as the basis for analysis the K-U modification of the Fermi theory, we find that the spectrum may be resolved uniquely into two groups having extrapolated end-points of 0.97 and 3.32 Mev, the low energy group containing 20 percent of the particles. At the high energy end of the spectrum the usual[4–7] divergence from the distribution given by the K-U theory is found. That the number of particles in the low energy group is small was confirmed by an absorption experiment. Gamma-radiation was observed to produce about one percent of the total ionization.

The decay of chemically separated As^{76} was followed for five half-lives and found to have a single period $T=26.75$

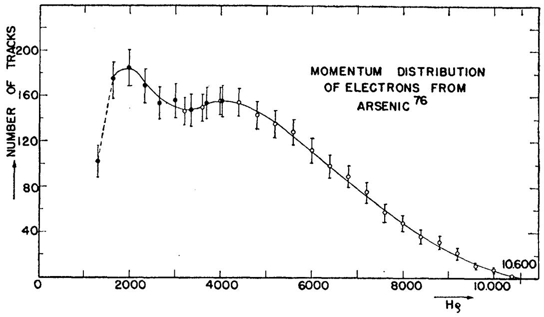

FIG. 1. The momentum distribution of the electrons from As^{76}. The complexity of the spectrum is indicated by the resolution of the two peaks. The observations taken at 342 oersteds are indicated by filled circles, those at 800 oersteds by open circles. The length of the vertical line through a point is the uncertainty estimated by taking the square root of the number of observed tracks corresponding to the point.

±0.15 hours. Assuming the existence of the two groups suggested by the K-U analysis, the partial disintegration constants may be computed, and these figures taken with the extrapolated energies place the low and high energy groups, respectively, on the second and between the second and third Sargent curves.

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The Structure of Electric Particles and the Number 137

In a recent letter to the editor[1] I reported the purely empirical result that the uncertainty product of the ranges in space and in momentum space of an electric particle, $\Delta p\cdot\Delta r=h=137\cdot 2\pi e^2/c$, is reduced to a product $\Delta p^0\cdot\Delta r^0\approx 2\pi e^2/c$ without the factor 137 if Δp^0 and Δr^0 are the *proper* ranges as measured by an observer on the particle itself. The result was based on Einstein's energy-momentum relation ($E^2=1+P^2$ in reduced units) and on a similar space-time relation ($T^2=1+R^2$ in reduced units). The latter equation (postulate A), established in (I) for the first time, was to characterize the particle in a fashion "reciprocal" to Einstein's relation in the sense of *Born's principle of reciprocity.*[2] The physical meaning of $T^2=1+R^2$ is that a signal sent across the particle travels at a velocity larger than c, in agreement with an earlier result of Dirac's.[3] If, according to Dirac, the time saved by such a signal from infinity to the center of the particle, is $2e^2/3m_0c^3$, then our reduced coordinates are to be

$$R=r\cdot(m_0c^2/e^2\gamma),\qquad T=ct\cdot(m_0c^2/e^2\gamma)$$

with $\gamma=\frac{2}{3}$. However, the question of the magnitude of the factor γ is not quite settled; it is a question of the *classical* theory of the electron.

Starting from the classical equation $T^2=1+R^2$ and from the empirical result of (I) we have tried to work out a more consistent quantum theory of the particle with the aim of having the Sommerfeld fine structure constant $\alpha=1/137$ appear as the eigenvalue of a linear integral equation whose eigenfunction under an additional condition is the density amplitude $\psi(r)$ of the electric particle (irrespective of its mass). With $\alpha=e^2/\hbar c$ and with $\alpha'=\alpha/\gamma$ the Fourier expansion of quantum theory reads

$$\psi(R)=(\alpha'/2\pi)^{\frac{3}{2}}\int\int\int\chi(P)\exp\left[i\alpha'(P\cdot R)\right]dV_P$$

and its inversion. We introduce a similar equation for the *proper* reduced coordinates and momenta (compare with (I)) $P^0=\sinh^{-1}P$ and $R^0=\sinh^{-1}R$, namely (Postulate B):

$$\chi^0(P^0)=(\alpha_0'/2\pi)^{\frac{3}{2}}\int\int\int\psi^0(R^0)\exp\left[-i\alpha_0'(P^0\cdot R^0)\right]dV^0$$

and its inversion. Here we have used $\alpha_0'=\alpha_0/\gamma$ where α_0 is a "proper" fine structure constant to be determined later. Identifying ψ^2dV with $(\psi^0)^2dV^0$ and χ^2dV_P with $(\chi^0)^2dV_P{}^0$ we obtain a closed chain of equations expressing ψ by χ, χ^0, ψ^0, ψ, and resulting in a *linear integral equation*[4] for $\psi(R)$ whose unsymmetrical kernel K depends on the two parameters α and α_0 since γ is known classically:

$$\psi(R)=\int K(R,R',\alpha_0,\alpha)\cdot\psi(R')\cdot dR'.$$

On the suggestion of L. H. Thomas we add the condition that the electrostatic self-energy equals the rest energy m_0c^2. In our reduced coordinates this condition reads

$$\int\int(1/R_{12})\cdot\psi^2(R_1)\cdot\psi^2(R_2)\cdot dVdV_2=\gamma.$$

The integral equation is solved, according to a very rough approximative consideration,[4] by an eigenvalue α_0 of order *unity* if we assume α to be 1/137, and by an eigenvalue α of order 1/137 if we assume α_0 to be unity. The latter value would amount to a "proper quantum" $\hbar_0=e^2/c$ applying to the proper space, as against $\hbar=e^2/\alpha c$.

There is the objection to (B) that *two* quantum theories, one with $\hbar$ and one with $\hbar_0$ cannot hold simultaneously on the ground of the transformation theory. This is true in general. But the point is that if we *require* them to coexist then we are led automatically to special ψ-functions, those representing a *particle.*

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