In consequence of the Coulomb attraction the capture probability will increase for negative mesons, while for positives it will be greatly reduced by the potential barrier. The competition between nuclear capture and spontaneous disintegration must in this way be different for mesons of different signs.

The effect of the Coulomb force on the capture of mesons in motion can roughly be taken into account by multiplying the capture probability, which was derived by various authors on the assumption of free mesons, by the factor

$$\frac{2\pi\alpha Zc/v}{1-e^{-2\pi\alpha Zc/v}} \quad \text{or} \quad \frac{2\pi\alpha Zc/v}{e^{2\pi\alpha Zc/v}-1} \tag{1}$$

for negative or positive mesons respectively, where Z is the atomic number of the material, and v is the velocity of the incident meson.

We have thus calculated the probability for a meson of an incident energy E, being captured along its path before it is brought to rest. The results for various values of E and Z are given in Table I.

TABLE I. *Capture probabilities along the path.*

	$E=10^8$	10^7	10^6	10^5 (VOLTS)	SIGN OF THE MESON
Pb	0.001	2×10^{-6}	5×10^{-15}	7×10^{-39}	+
	0.1	0.01	10^{-3}	10^{-4}	−
Al	0.017	6×10^{-4}	3×10^{-6}	4×10^{-11}	+
	0.032	2×10^{-3}	2×10^{-4}	2×10^{-5}	−
Air	0.013	5×10^{-4}	6×10^{-6}	6×10^{-9}	+
	0.019	10^{-3}	6×10^{-5}	6×10^{-6}	−

One sees from the table that this probability is, notwithstanding the Coulomb attraction, very small for slow negative mesons, and still less for positives. Consequently the capture in almost all cases does not take place before mesons come to rest. We have therefore calculated the probability per unit time for mesons being absorbed by nuclei after having come to rest. In this calculation one must realize that the factor (1) does not apply to such slow mesons as have their wave-length larger than the atomic radius. The capture cross section for mesons, the energy of which is smaller than about 1 volt, will show a very complicated dependence on v, because the screening of the nuclear Coulomb field begins now to come in (Ramsauer effect). The general feature, however, would roughly be given by assuming the cross section to vary in this energy range according to the $1/v$ law. The results obtained with this simplifying assumption are tabulated in Table II.

Since the probability for negative mesons being captured is seen always to be larger than the probability of disintegration, which is of the order of 10^6 sec.$^{-1}$, the negative mesons will be much more likely captured by nuclei than disintegrate spontaneously, not only in dense materials but also in gases. On the other hand, practically all positive mesons will disintegrate spontaneously because of the extremely small capture probability due to the existence of the potential barrier. Practically all positive mesons, which come to rest, should therefore be necessarily accompanied by a disintegration electron at the end of their range.

TABLE II. *Capture probabilities per sec. for negative and positive mesons.*

	NEGATIVE MESONS	POSITIVE MESONS
Pb	2.5×10^{12}	—
Al	1.2×10^{11}	—
Air	3×10^{7}	10^{-950}

Experimental materials are now rather scanty, but it does not seem to us merely accidental that all the Wilson tracks, which could so far be definitely identified as disintegration electrons, are positives,[2] and none of the photographs, in which a negative meson track terminates within the cloud chamber, shows such a disintegration electron.[3]

If our theory is right, the experiments of Montgomery and others,[4] who could not find disintegration electrons, seem hardly to be understood, unless we assume that slow mesons they observed are not identical with the ordinary cosmic-ray mesons and have much smaller lifetime.

The detailed calculation and discussions will shortly appear elsewhere.

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Radio-Isotopes of Ba and Cs

With the 37-inch Berkeley cyclotron as a neutron source for irradiating Ba, a chemically identified Ba isotope of half-life 30±1 hour was found.[1] The emitted radiations consisted of a "monochromatic" group of electrons at 250 KV, x-rays of approximately the characteristic energy for Ba K x-rays, and strong gamma-rays of about 250 KV, in addition to a soft complex spectrum of gamma-rays. This soft spectrum made it impossible to identify the x-rays definitely by using critical absorbers. Paraffin shielding decreased the yield of this activity, and Li was found to be a less effective source of neutrons than Be. This would seem to indicate that it is a neutron loss reaction, but that extremely high energy neutrons are not required. Deuteron bombardment of Ba metal did not give this period at all.

The 2.5-minute Ba period[2] was prepared by irradiating Ba with Li+H^2 neutrons and was proved to be chemically Ba.

The 87±1-minute Ba period[3] was strongly activated by deuteron bombardment of Ba and gave a β-ray upper limit of about 1 MV and a gamma-ray of about 0.6 MV according to absorption coefficients in lead and copper. There are no very strong soft "monochromatic" electrons with this period.

Cs bombarded with deuterons or neutrons consistently gave a 3-hour±10-minute period rather than the previously reported period[4,5,6] of 1.5 hours. The normal

β-ray absorption spectrum indicates an upper limit of about 1 MV. Little if any gamma-radiation is associated with this period. It is more strongly activated with slow than with fast neutrons, and was proved to be chemically Cs.

A long period (20±1 month) isotope,[7] chemically identified as Cs and apparently isomeric with the 3-hour Cs^{134}, was prepared by neutron or deuteron bombardment of Cs. Its normal β-ray spectrum has an upper limit of 0.9 MV, and there is fairly strong gamma-radiation.

Cs^{132} evidently has a very short period, a very long period, or one close to three hours, as nothing new appeared with fast neutron bombardment.

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Photo-Fission of Uranium and Thorium

We have observed fission recoils from uranium and thorium produced by γ-rays from CaF_2 and AlF_3 targets bombarded with protons. A rough estimate of the cross section, based on our data, gives 10^{-26} cm² for the photo-fission cross section in comparison with the theoretical estimate of 10^{-27} cm² given by Bohr and Wheeler.[1]

A beam of 0.5 microampere of analyzed protons of 2 to 3 Mev energy was used to bombard CaF_2 and AlF_3. With Ca and Al targets, no fissions were observed, indicating the absence of neutron fissions. Although a few neutrons are obtained when Ca is bombarded with protons, these were found to be too few to give fissions. Even fewer neutrons were found from proton bombardment of CaF_2 when a BF_3-filled ionization chamber was used to detect the neutrons. No appreciable decrease in the fission rate was observed with 4 cm of paraffin between the target (γ-ray source) and the ionization chamber containing uranium. This amount of paraffin was shown to cut down the fission rate by one-half when neutrons from $Li(p,n)$ were used instead of γ-rays. The fission rate was cut down by a lead absorber by roughly the right amount for high energy γ-rays. Further indication that the fissions are due to γ-rays is the observed proportionality of fission rate to high energy γ-ray intensity as this is increased by a factor of 5 on raising the proton beam energy from 2 to 3.2 Mev. Below 2 Mev the fission rate was too low for observation.

With 2.9-Mev protons, the observed fission rate in uranium was about one fission per 3×10^{13} protons hitting CaF_2. The γ-ray intensity measured by a Geiger counter 5 feet away and shielded with 1 inch of lead was about 150 counts per fission. Assuming the counter efficiency to be 2 percent[2] and allowing for scattering and absorption in the lead shield around the counter, we estimate a high energy γ-ray yield from CaF_2 of 10^8 γ-quanta per 3×10^{13} protons or per fission. It is to be noted that this estimate of 3 quanta per 10^6 protons at 2.9 Mev is higher than is obtained by taking the value of 1.2 γ-quanta per 10^9 protons[3] at 1.0 Mev and multiplying by 60, our observed factor of increase in intensity from 1 Mev to 2.9 Mev. This suggests that the above value for $F(p,\gamma)$ yield at 1.0 Mev and also the $Li(p,\gamma)$ cross section from which it was derived may be too low.

The fractional solid angle subtended by the uranium is 0.07, which gives about 7×10^6 γ-quanta passing through the uranium per fission. Assuming an effective thickness of 3 mg/cm² for the uranium whose fission recoils would be counted in the ionization chamber, we obtain about 2×10^{-26} cm² for the photo-fission cross section for fluorine γ-rays. The effect in thorium is roughly equal in intensity. Previous attempts[4] to observe photo-fission have not given positive results.

It has been suggested that photo-fission be referred to as "phission" to distinguish it from neutron fission.

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Accurate Solution of the Thomas-Fermi-Dirac Equation.

The Thomas-Fermi-Dirac equation

$$d^2\psi/dx^2=x[\beta+(\psi/x)^{\frac{1}{2}}]^3,$$

$\beta=(3/32\pi^2)^{\frac{1}{3}}Z^{-\frac{2}{3}}$ with the boundary condition $\psi(0)=1$, has been hitherto solved for $Li(Z=3)$, $Na(Z=11)$, $Ar(Z=18)$, $Cu(Z=29)$, $Kr(Z=36)$ and $Xe(Z=54)$,[1] expanding ψ in series for small values of x with an assumed value of the initial slope, and integrating numerically from there out. The most important case is that where ψ curve becomes tangent to the x axis. In this case, however, the numerical integration is very sensitive to small errors, as well as to small changes in the initial slope, so that it is very difficult to determine accurately the tangent point X_0 and consequently the value of the initial slope $-B_0$. By carrying out the calculation in the reversed direction to the above we were able to determine the relation of the tangent point X_0 to the atomic number Z as follows. We expanded for a chosen element whose atomic number is Z' in a series in the neighborhood of an assumed tangent point X_0', and integrated numerically from there out towards the ψ axis. This integration curve meets the ψ axis with a finite angle, not tangentially nor rectangularly, so that the