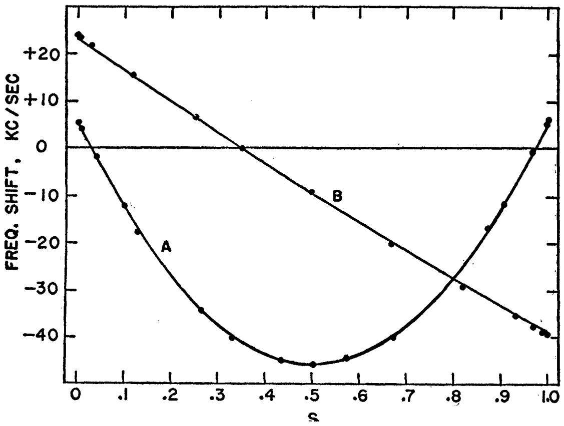

FIG. 1. The dependence of the frequency shift of the central component of the Al^{27} line in spodumene on crystal orientation. (A) X rotation about b axis of spodumene. (B) Y rotation about c axis of spodumene. $s=\cos^2(\theta_X-55.5°)$ for X rotation. $\theta_X=0$ when c axis of spodumene coincides with magnetic field H_0. $s=\cos^2\theta_Y$ for Y rotation. $\theta_Y=0$ when c axis of spodumene is at 90° to H_0. Each dot represents average of four observations. Solid curves are given by: (A) $(\nu-\nu_0)_X=1.46(3.610-139.8s+140.4s^2)$ kc/sec; (B) $(\nu-\nu_0)_Y=1.46(15.60-45.79s+3.606s^2)$ kc/sec. $\nu_0=7.453$ Mc/sec.

$\eta=0.95$ in Eq. (2). As a check on the experimental accuracy, the above values of $|C|$, η and δ, were inserted into Eqs. (1) and (3), and gave without any further adjustment the solid curve B for the Y rotation. The agreement obtained suggests the following results together with their estimated limits of error: $|C|=2960 \pm 10$ kv/sec, $\eta=0.95\pm0.01$, and $\delta=-55.5°\pm1°$ for Al^{27} in spodumene. The y principal axis of φ_{ij} [corresponding to the eigenvalue $-(1+\eta)\varphi_{zz}/2$] lies between the a and c axes of spodumene at an angle of $55.5°\pm1°$ with the c axis. The x axis [corresponding to $-(1-\eta)\varphi_{zz}/2$] lies along the b axis. The z axis (corresponding to φ_{zz}) is mutually orthogonal to these two.

In connection with theories of chemical binding, it seems suggestive that a principal axis of φ_{ij} at *both* the Li and the Al sites in spodumene appears to point directly at the projection of the nearest oxygen atom on the *ac* plane.

* Work supported by a grant from the National Research Council of Canada.
† Holders of Ontario Research Council Scholarships.
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τ-Meson Decay in Flight*

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IN a series of cloud-chamber pictures taken at Berthoud Pass, Colorado[1] (680 g cm^{-2}), we have observed a probable example of the decay in flight of a τ-meson. These particles have been observed in nuclear emulsions,[2,3] and Leighton and Wanlass[4] recently observed two τ-meson decays in flight in the gas of a cloud chamber in a magnetic field, these latter examples being the only two decays in flight reported up to this time.

The cloud chamber (illuminated region approx 50 cm×50 cm ×12 cm) contains 11 silver-plated Pb plates 0.63 cm thick, separated by about 3.8 cm. The chamber is triggered by a penetrating shower detector placed above the chamber. Four photographs are taken of each event, the extreme cameras being mounted at 17° on either side of the center line.

The event is shown in Fig. 1. A particle enters the chamber at *a*, penetrates 7 Pb plates (about 8 radiation lengths) without appreciable deviation, and at *b* near the center of the illuminated region, splits into three charged particles. Each of the three secondary particles penetrates 4 Pb plates without interacting. They leave the chamber at *c*, *d*, and *e*. The low energy δ-ray observed near *b* originates below the point where the splitting occurs. Likewise, the horizontal electron which seems to go through *b* is actually not space coincident. A small blob of ionization can be seen at *b*. This blob is no larger than other blobs observed along minimum ionization tracks in the picture, and it should also be pointed out that the τ-meson decay in flight differs from, say, the V decay in that the τ-meson decay involves 4 ionizing particles meeting at a point instead of 2 in the case of the V.

FIG. 1. A τ-meson decay in flight.

Of course, there is always the possibility that this event is a nuclear collision in the gas of the chamber. However, we feel that this is an unlikely possibility. First, no recoil nucleus of more than several hundred kev energy is observed. Hence, if this were a nuclear event, it would be one of those rare events classified as a peripheral collision, involving, as we shall see later, multiple meson production. Second, and most important, we show below that momentum is conserved by the visible ionizing prongs.

The primary particle *ab* and the three secondary particles lie roughly in a plane. Table I summarizes the relevant information

TABLE I. Summary of data on particles in Fig. 1.

Particle	Angle of deviation from primary in deg	Rms[a] angle of multiple scattering in deg	$pc\beta$ in Mev	pc in Mev[b]
ab	...	0.9±0.3	1000±270	1100±310
bc	13	1.9±0.7	480±170	490±170
bd	5	2.4±0.9	380±130	400±140
be	7	3.3±1.2	270±100	300±110

[a] The errors shown are the approximate standard deviations $1/(2n)^{\frac{1}{2}}$(n = No. of plates). [See N. Arley and K. R. Buch, *Introduction to the Theory of Probability and Statistics* (John Wiley and Sons, Inc., New York, 1950), pp. 139 ff.]
[b] Assuming the primary to be a $\tau(m_\tau=970m_e)$, and the secondaries to be π-mesons.

about the event. Using the projected angles of multiple coulomb scattering,[5] one finds the values of $pc\beta$ given in the table (p = momentum, βc = velocity). The "noise level" scattering correction[5] is estimated to be small (less than 25 percent) in all cases, although we do not yet have enough data to evaluate this correction exactly.

Since each of the three secondaries penetrates 4 Pb plates without appreciable scattering or multiplication, these particles are all heavy compared to an electron. If these particles were protons, one can see from the values of $pc\beta$ given in Table I that their ionization would be between twice and three times the minimum. From Fig. 1, it is probably that these particles do not ionize this strongly.

Assuming the primary particle to be a τ-meson and the three secondaries to be π-mesons, we obtain the momenta given in the fifth column of Table I. It is evident that momentum is conserved in the direction of the primary particle; it is also conserved in the transverse direction, by the observed ionizing particles.

Following a suggestion of Wilson and Butler,[6] we quote the lifetime data as follows: In the rest frame of the τ-meson, the τ-meson lived $(3.31\pm0.56)\times10^{-10}$ sec in the chamber. In the same frame, the τ-meson decay would have been observed if it had lived as long as $(5.02\pm0.85)\times10^{-10}$ sec.

In the center-of-mass system, the π-meson were emitted at rather wide angles with respect to each other.

* Supported by the joint program of the ONR and AEC and by the Research Corporation.
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The Average Electric Charge of Daughter Atoms from β-Decay and Isomeric Transition*

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HIGH positive charges are predicted for the products of nuclear isomeric transition by internal conversion.[1,2] Positive bromine ions from the decay of 4.4-hr Br^{80m} in gaseous ethyl bromide have been observed.[3] Neither the average charge following transition by internal conversion nor the charge spectrum has been reported. However, the average charge of Cl^{37} from the similar process of electron capture by A^{37} has been recently determined.[4]

The charge carried by products of β-decay has been measured for the single case of Kr^{88} decay to Rb^{88}.[5] The extent to which change in nuclear charge should induce additional ionization in β-decay has been discussed by several authors.[6–8]

This communication will report the average charge found on the products of β-decay of H^3 present as molecular hydrogen, of C^{14} as CO_2, and of a mixture of Kr and Xe fission gases. Results with 18-min Br^{80} from the transition of 4.4-hr Br^{80m} present as C_2H_5Br will also be given.

The experiments were performed in spherical and cylindrical ion chambers of copper (Figs. 1 and 2) in which a small central electrode was held at 1000 to 1500 volts negative to the outer shell. A grid was placed about the central collector and held at 100 to 200 volts negative potential relative to the ion collector, in order to return secondary electrons produced by impact of positive ions with the central electrode to that electrode. The vessels were filled with the radioactive gases to known pressures of from 5×10^{-5} to 1.5×10^{-3} mm. Ion currents across the chamber were then measured in an attached dynamic condenser electrometer and

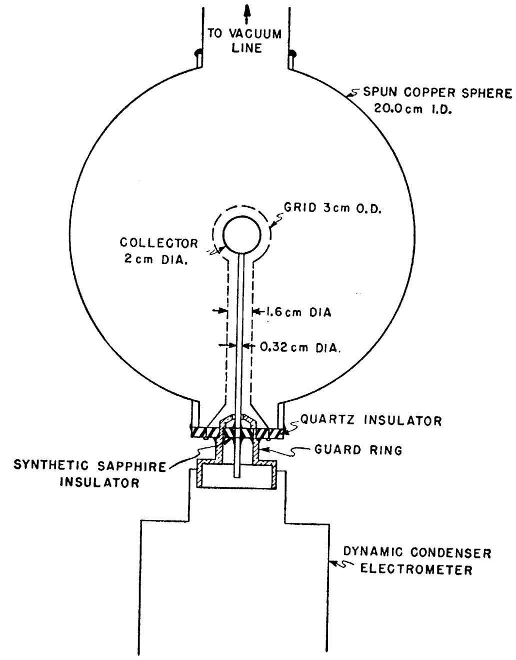

FIG. 1. Spherical ion collection chamber.

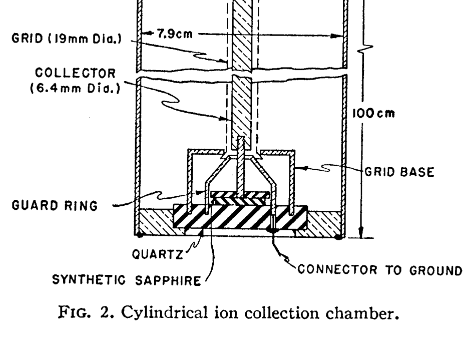

FIG. 2. Cylindrical ion collection chamber.

FIG. 1. A τ-meson decay in flight.