We wish to thank O. Chamberlain, E. Segrè, R. Tripp, C. Wiegand, and T. Ypsilantis for discussions relating to their experiments.

A full account of the above material will soon be submitted to *The Physical Review* for publication.

* This work was performed under the auspices of the U. S. Atomic Energy Commission.

[1] E. Fermi, Nuova cimento **11**, 407 (1954); W. Heckrotte and J. V. Lepore, Phys. Rev. **94**, 500 (1954); B. J. Malenka, Phys. Rev. **95**, 521 (1954); Snow, Sternheimer, and Yang, Phys. Rev. **94**, 1073 (1954).

[2] De Carvalho, Marshall, and Marshall, Phys. Rev. (to be published); Chamberlain, Segrè, Tripp, Wiegand, and Ypsilantis, Phys. Rev. **93**, 1430 (1954).

[3] Suggested by E. Fermi and C. N. Yang. See also calculations of R. M. Sternheimer, Phys. Rev. **95**, 587 (1954).

[4] Parabolic and Gaussian well shapes were assumed for the central potential. The spin-orbit potential was taken to be proportional to the derivative of the central potential.

[5] Chamberlain, Segrè, Tripp, Wiegand, and Ypsilantis, Phys. Rev. (to be published).

[6] The nuclear potential was taken to be

$$V=-\{(18+i30)(1-r^2/R^2)+1.2\boldsymbol{\sigma}\cdot\mathbf{L}/\hbar\}\text{Mev},$$

for $r\leq R=4.8\times10^{-13}$ cm for Al. The calculation was done with W. K. B. approximation.

[7] It must be recognized, though, that the experimental difficulties for such large-angle scattering are quite pronounced and might make the resolution of a dip, if such existed, very difficult.

Magnetic Resonance Spectra of Beryl Crystals*

L. CARLTON BROWN AND DUDLEY WILLIAMS
Department of Physics, The Ohio State University, Columbus, Ohio

(Received July 1, 1954)

THE magnetic resonance absorption patterns of Be^9 and Al^{27} have been observed in single crystals of beryl, $Be_3Al_2Si_6O_{18}$. The Be^9 pattern consists of a strong central line with two weaker satellites as expected for a nucleus with $I=\frac{3}{2}$ and with a nonzero nuclear quadrupole coupling factor. The Al^{27} pattern consists of a strong central line with two pairs of satellites as expected for a nucleus with $I=5/2$ and with a nonzero quadrupole coupling factor.

The beryl crystal is hexagonal. From the structure deduced from x-ray studies,[1] it would appear that the Al^{27} nucleus is in an electric field of cylindrical symmetry with the unique electric direction parallel to the C axis or symmetry axis of the crystal. One of the principal directions of the gradient of the electric field at the site of the Be^9 nucleus is parallel to the C axis. It is probable that the largest electric gradient component is perpendicular to the C axis.

Two beryl crystals were employed in the present study. The first was a rather small crystal of optical quality. The second crystal was milky in appearance but was sufficiently large to provide a good oscillator coil filling factor. The spectrograph employed was of the superregenerative type; a constant magnetic field of 7800 gauss was provided by a large permanent magnet. The oscillator frequency was varied slowly by a clockdrive, and magnetic modulation of 40 cps was employed.

With the C axis of the crystal parallel to the magnetic field, the Al^{27} pattern was studied. The intense central line was relatively narrow; the inner satellites were broader and the weak outer satellites were extremely broad. The line frequencies predicted by theory[2] for the orientation in question are given by

$$\nu_{m\rightarrow m-1}=\mu H/Ih+(3e^2qQ/4Oh)(2m-1).$$

The observed frequencies lead to an effective value of 3.6401 ± 0.0003 nm for Al^{27} and a coupling constant $e^2qQ/h=3.070\pm0.015$ Mc/sec. The effective value of μ for Al^{27} in $AlCl_3$ solution is 3.6408 nm.

The Be^9 pattern with the C axis of the crystal parallel to the magnetic field has its central frequency $\nu_0=4.6674\pm0.0005$ Mc/sec, with a satellite separation of 116.3 ± 1 kc/sec.

The present study is being extended to include a detailed investigation of the Al^{27} and Be^9 patterns for various orientations of the crystal in the magnetic field.

The writers wish to express their appreciation to Professor Duncan McConnell and Professor Charles H. Shaw for supplying the crystals used in this study and for their advice on preparation of the crystals.

* This work was supported in part by a contract between the Office of Scientific Research of the Air Research and Development Command, Baltimore, Maryland, and The Ohio State University Research Foundation.

[1] R. W. G. Wyckoff, *Structure of Crystals* (Chemical Catalogue Company, New York, 1931).

[2] R. V. Pound, Phys. Rev. **79**, 685 (1950).

Nuclear Absorption of Negative *K* Particles*

HERBERT DESTAEBLER, JR.†
Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts

(Received July 1, 1954)

IN a preliminary scanning of 20 000 pictures obtained with the M.I.T. multiplate cloud chamber we have observed three events that we can interpret as the nuclear absorption of negative K particles. The chamber, operated at Echo Lake, Colorado, contained eleven 0.50-inch brass plates and was triggered by a detector of high-energy nuclear interactions located directly above the chamber.

In event 86407 (see Fig. 1) an L meson (π or μ meson) and a slow V^0 particle seem to come from the point of stopping of a K particle. The probability that this is a chance association between a V^0 particle and an S particle is about 10^{-5}. The L meson stops in the chamber. The limits of its range are (29.7 and 43.7) ±2.1 g cm^{-2} brass. The V^0 particle is coplanar with the point of intersection of the K-particle and L-meson

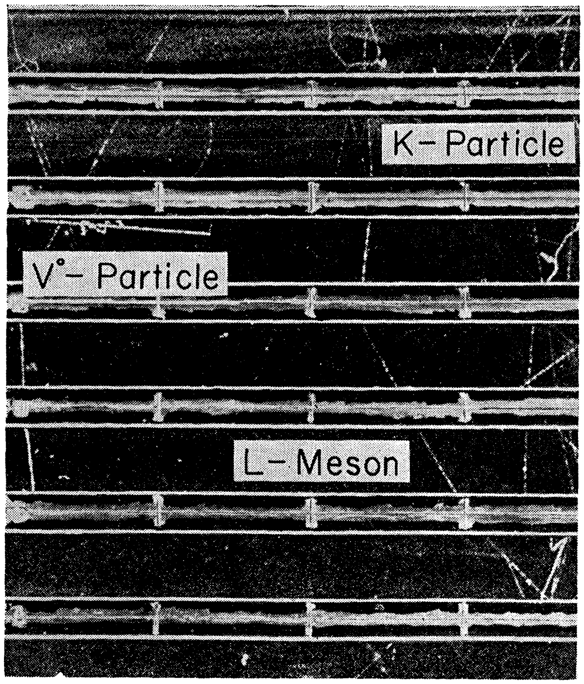

FIG. 1. Event 86407. A V^0 particle and an L meson seem to come from the point of stopping of a K particle.

tracks within the experimental error which is about 4°. The angle between the line of flight of the V^0 particle and the first section of track of the L meson is $(180°-38°)\pm2°$.

In events 91882 and 93243 a slow V^0 particle seems to come from a stopped K particle. In both events the V^0 particle travels upward and the plane of the V^0 particle intersects the line of flight of the K particle within the plate. In these two events there is no associated charged L meson as in event 86407. The probability that either of these events is a chance association between a V^0 particle and a stopped meson or proton is about $5\cdot10^{-3}$. These two events are similar to a cloud chamber event obtained by the Manchester group reported at the Duke Conference.[1]

We have calculated the limits for the Q values of the V^0 decays assuming the decay scheme $V^0\rightarrow p+\pi+Q$.[2] These values are listed in Table I. The data indicate that the V^0 particles are probably Λ^0 particles (for which Q is 37 Mev). Also listed in Table I are the kinetic energies of the V^0 particles, assumed to be Λ^0 particles, and the kinetic energy of the L meson in event 86407, assumed to be a π meson.

Although we cannot measure the mass of the primary particle in our three events accurately, our estimate of the mass, from range and ionization, suggests that the primary is a K particle.

One can interpret these events as the nuclear absorption of negative K particles according to the processes:[3]

$$K^-+n\rightarrow\Lambda^0+\pi^-, \tag{1a}$$

$$K^-+p\rightarrow\Lambda^0+\pi^0. \tag{1b}$$

This is the reciprical of the production process:

$$\pi^-+p\rightarrow\Lambda^0+\theta^0, \tag{2}$$

which has been tentatively identified at Brookhaven National Laboratory.[4] If the mass of the K particle in process (1a) is $965m_e$, the predicted kinetic energies of the Λ^0 particle and the π meson are 28 Mev and 148 Mev, respectively. If the K-particle mass is $1300m_e$ the kinetic energies of the Λ^0 particle and the π meson are 68 Mev and 280 Mev, respectively. One might expect that the motion of the nucleons in the nucleus would cause a distribution of these kinetic energies. In event 86407 the apparently low kinetic energy of the π meson and the noncolinearity of the line of flight of the Λ^0 particle and the line of flight of the π meson cannot be explained simply by the motion of the nucleon in the nucleus unless the mass of the K particle is between about 815 and $865m_e$. However, an inelastic nuclear scattering of the π meson within the nucleus could easily account for the observations. The fact that no charged π mesons were seen in events 91882 and 93243 could also be explained by a nuclear interaction of the π meson. If a neutral π meson had been ejected in either of these two events in a direction opposite to the direction of the V^0 particle, it is likely that the decay photons would not have produced any electrons in the illuminated volume of the cloud chamber.

TABLE I. Q-value and kinetic energy limits for the three events. The errors listed in the table are derived from an estimate of the uncertainties in the spatial reconstruction. The error in the kinetic energy of the π meson includes the effect of range straggling.

Event number	Limits for the Q value assuming $V_0\rightarrow p+\pi+Q$ (Mev)	Kinetic energy of Λ^0 particle (Mev)	Limits for kinetic energy of π meson (Mev)
86407	$34\pm3-43\pm1$	31 ± 3	$(81-106)\pm3.5$
91882	$32\pm4-60\pm8$	30 ± 8	...
93242	$33\pm14-41\pm5$	59 ± 15	...

It is a pleasure to thank Professor B. Rossi and Dr. H. S. Bridge for their help and Mr. R. A. Hewitt for his assistance in the operation of the cloud chamber.

* This research was supported in part by the joint program of the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.

† National Science Foundation Predoctoral Fellow.

[1] K. H. Barker, Proceedings of the Duke University Cosmic-Ray Conference, December, 1953 (unpublished), pp. II–20.

[2] We calculate the limiting values of Q by using transverse momentum balance and deriving momentum limits for the proton and π meson from measured range limits and estimated ionization limits.

[3] M. Goldhaber, Phys. Rev. **92**, 1279 (1953).

[4] Fowler, Shutt, Thorndike, and Whittemore, Phys. Rev. **93**, 861 (1954). An event also supporting process (2) was reported by R. W. Thompson at the 1954 Washington Meeting of the American Physical Society [Phys. Rev. **95**, 661 (1954)].

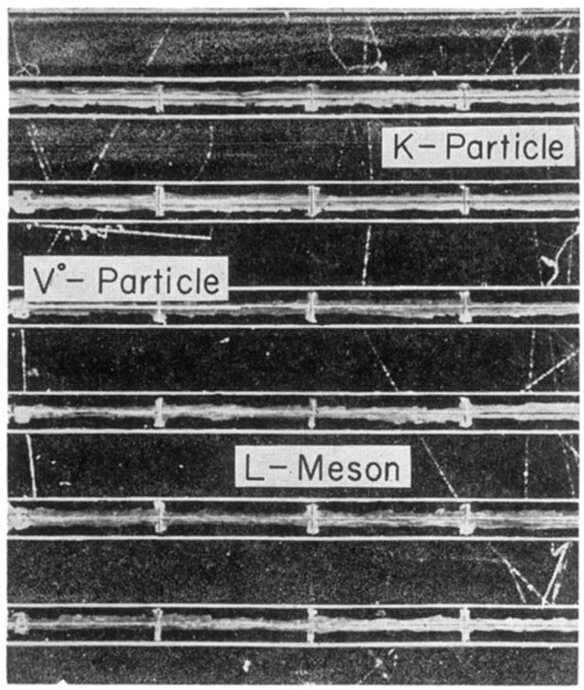

FIG. 1. Event 86407. A V^0 particle and an L meson seem to come from the point of stopping of a K particle.