tions that exhibit a lambda and a nucleon in the final state.[8,9] It should be noted, however, that the reaction $\Sigma^- + \mathrm{He}$ is particularly suited to reveal such a resonance. The lambda is directly produced, and the nucleon in the final state cannot be considered a spectator to the initial interaction; nor does the reaction involve a pion that can distort the spectrum through Y^* formation.

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EXAMPLE OF DECAY $\Omega^- \to \Xi^- + \pi^0$†

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The existence[1] of the Ω^-, a baryon of mass[2] 1676 MeV and strangeness -3, has been predicted from SU(3) invariance of the strong interactions. This prediction was beautifully confirmed by three examples[3] found in the 80-in. hydrogen bubble chamber in a separated 5.0-BeV/c K^- beam at the AGS accelerator at Brookhaven National Laboratory. We have found another example of an Ω^-, which decays into a Ξ^- and π^0. The three previous examples have exhibited the decay modes $\Omega^- \to \Xi^0 + \pi^-$ and $\Omega^- \to \Lambda + K^-$ (two examples).

The exposure for this experiment was carried out at Brookhaven National Laboratory using the 80-in. hydrogen bubble chamber. A mass-separated beam of 4.2-BeV/c K^- mesons from the AGS was incident on the bubble chamber. We have scanned 25 000 pictures for events initiated by an incident-beam track and containing at least two (charged or neutral) V particles.

Figure 1 shows the complete event reported on here. This event is interpreted to be

$$K^- + p \to \Omega^- + K^+ + K^0 \quad (1a)$$
$$K^0 \to \pi^+ + \pi^- \quad (1b)$$
$$\Omega^- \to \Xi^- + \pi^0 \quad (1c)$$
$$\Xi^- \to \Lambda + \pi^- \quad (1d)$$
$$\Lambda \to p + \pi^-. \quad (1e)$$

Both the Λ decay (1e) and the K_1^0 decay (1b) give excellent fits to the reactions indicated. All alternative hypotheses, such as alternate origins or mass assignments, fail to fit. For the Ξ^- decay (1d) we also obtain a good fit.

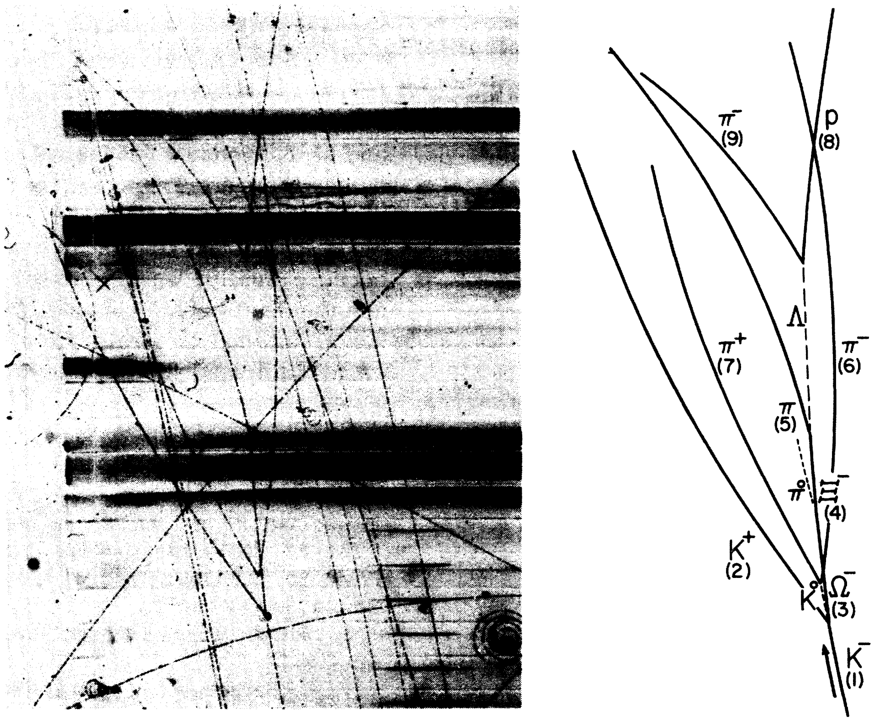

FIG. 1. Photograph and line diagram of event showing Ω^- production and decay.

The transverse momentum in this decay is 96 ± 2 MeV/c, which is large enough to exclude the alternative interpretations $\Sigma^- \to \Lambda + e^- + \nu$ or $\pi^- \to (e^-, \mu^-) + \nu$ for this vertex. The (K^-, p) production reaction hypothesis (1a) gives a very good fit, assuming that the mass of the Ω^- is 1675 MeV, as reported by Barnes et al.[3] Using the fitted Ω^- momentum from Reaction (1a) and the fitted Ξ^- momentum from the decay (1d), one obtains a good fit to the hypothesis $\Omega^- \to \Xi^- + \pi^0$, (1c).

As a further check on this interpretation, we have determined the bubble density of each charged track from measurements of their gap-length distributions. All of these measurements agree with the bubble density predicted by the fit to Reactions (1a)-(1e). Table I lists the predicted and measured bubble densities for the K^+, Ω^-, and Ξ^- tracks. Note that the measured bubble density of track (2) is incompatible with the assignment of a π^+ mass to this track.

We have tried to find other interpretations of this event. We accept the assignment of track (4) as a Ξ^- because of the excellent fit of the Λ and the π^- [track (5)] to this decay hypothesis. The small-angle deflection at the $\Omega^- \to \Xi^-$ vertex cannot be interpreted as a (Ξ^-, p) elastic scatter since no proton recoil is visible. The recoil proton would have a momentum of 102.5 ± 4.2 MeV/c, corresponding to a range of 3.0 mm. The possibility that the Ξ^- scatters on a deuteron still remains, although the bubble-density measurements do not favor this hypothesis. This possibility would allow the following alternative interpretation of the event:

$$\pi^- + p \to \Xi^- + K^+ + K^0 + \pi^0, \qquad (2)$$

followed by

$$\Xi^- + n \to \Xi^- + n.$$

Besides requiring the incidence of a π^- rather than a K^-, this interpretation requires that the

Table I. Bubble-density measurements.

Track	Momentum (MeV/c)	Predicted bubble density	Measured bubble density
(2) K^+	571 ± 10	1.8	1.7 ± 0.1
(3) Ω^-	2547 ± 12	1.4	1.46 ± 0.15
(4) Ξ^-	1580 ± 37	1.7	1.94 ± 0.24

π^0 be emitted along the direction of track (3), in order to conserve momentum at the production vertex. A conservative estimate[4] of the relative probability of this interpretation to the Ω^- interpretation is $<10^{-7}$.

Another interpretation that is allowed by the kinematical fits is the sequence

$$K^- + p \to K^- + K^+ + \bar{K}^0 + n, \quad (3)$$

followed by

$$K^- + n \to \Xi^- + K^0.$$

The interpretation of track (3) as a K^- would predict a bubble density of 1.1, which is 2.4 standard deviations below the measured value as given in Table I. In addition, the arguments presented against Reaction (2) can be repeated here, and yield a probability for Reaction (3) relative to Reaction (1a) of 10^{-7}. We conclude that this event is an example of Ω^- production, as described by Eqs. (1a)-(1e).

In this event, the Ω^- traveled 7.45 cm, corresponding to a proper time of 1.63×10^{-10} sec. The three Brookhaven Ω^- events[3] exhibited proper times before decay of 0.7, 1.4, and 1.43×10^{-10} sec, respectively. Combining these four values, one obtains for the best estimate of the Ω^- lifetime

$$\tau_{\Omega^-} = (1.3 \pm 0.7) \times 10^{-10} \text{ sec.}$$

In the sample of film in which this Ω^- was found, there were ~400 τ^- events. This corresponds to a K^- path length equal to 1.2 μb equivalents (i.e., a process with a cross section of 1.2 μb would on the average give rise to one event in this length of K^- track).

Finally, we consider the value of the Ω^- mass. For this event, the best information for the Ω^- mass comes from fitting the K^--p production vertex. The principal error arises from the uncertainty in the incident K^- momentum, p_{K^-}. Using the measured value for track (1), $p_{K^-} = 4140 \pm 41$ MeV/c, as input, we obtain $M_{\Omega^-} = 1652 \pm 13$ MeV. A more accurate estimate of p_{K^-} can be obtained from 18 fitted τ events $p_\tau(\text{av}) = 4208 \pm 25$ MeV/c. Using this value for the incident K^- momentum, one obtains $M_{\Omega^-} = 1673 \pm 8$ MeV, which is in excellent agreement with the previous measurement of Barnes et al.[3]

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[4]The relative probability that this event is due to Reaction (2) is given by the product of the following factors: $\pi^-:K^-$ ratio $= \frac{1}{10}$, deuterium contamination 1/6000, σ[Reaction (2)]/σ[Reaction (1a)] $\lesssim 50$, probability that the π^0 is emitted along the direction of track (3) $\sim 10^{-3}$, probability of a small-angle (Ξ^-, p) elastic scatter $\sim 10^{-2}$. The product is 1×10^{-8}.

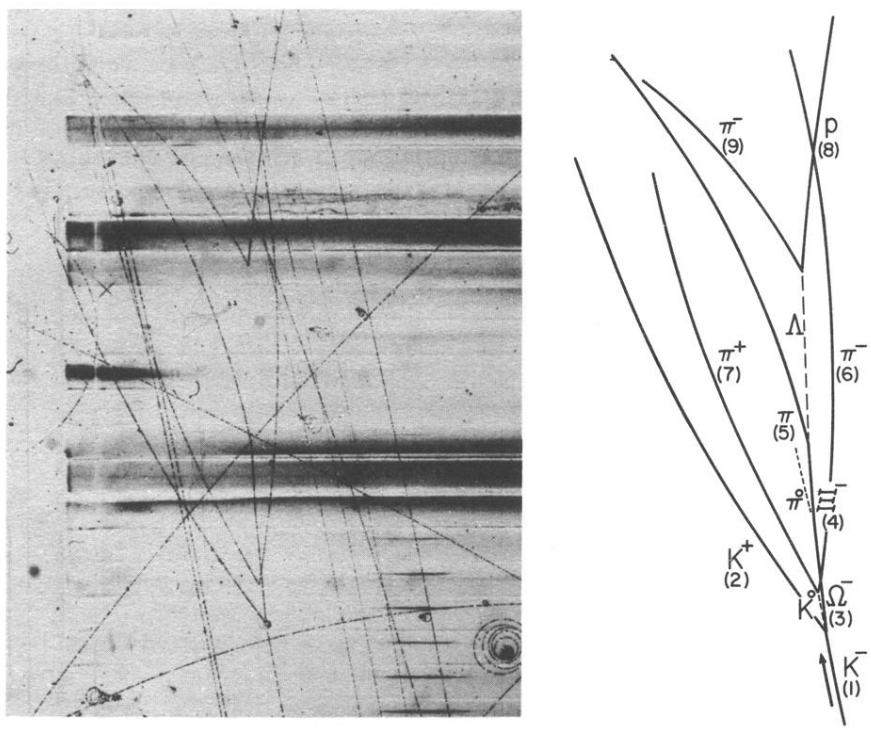

FIG. 1. Photograph and line diagram of event showing Ω^- production and decay.