

FIG. 1. Spontaneous fission half-life of Fm^{256} .

*French Atomic Energy Commission - C. E. N. Fontenay-aux-Roses, Frances.

¹Jones, Shuman, Butler, Cowper, Eastwood, and Jackson, Phys. Rev. **102**, 203 (1956).

²Harvey, Chetham-Strode, Ghiorso, Choppin, and Thompson, Phys. Rev. **104**, 1315 (1956).

³S. G. Thompson and M. L. Muga, Proceedings of the Geneva Conference on Peaceful Uses of Atomic Energy, 1958 (to be published).

⁴A. Chetham-Strode, Jr., University of California Radiation Laboratory Report, UCRL-3322, 1956 (unpublished).

⁵Ghiorso, Harvey, Choppin, Thompson, and Seaborg, Phys. Rev. **98**, 1518 (1955).

DECAY OF A NEGATIVE τ' MESON*

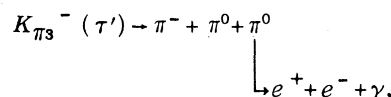
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In a systematic study of negative K -meson decays and interactions in flight, an example of the τ' mode of decay has been observed. A photomicrograph of this decay, event 1320, is shown

in Fig. 1. From the known momenta of the incident particles and the position of the decay point in the stack the energy of the K^- meson at decay was determined to be 105 ± 10 Mev. Ionization measurements on the K^- meson track at the decay point are in agreement with this value. Track A is a π^- or μ^- meson as determined from ionization versus range and from its characteristic scattering along the track. However, the three-prong star at its end strongly favors identification as a π^- meson. The energy of this meson, if a π , as determined from its range, is 19.5 Mev. The laboratory angle between the incident K^- -meson direction and the outgoing light meson is 42 deg. If this event were a $K^-_{\pi_2}$ decay, the π^- meson emitted at 42 deg would have an energy of 190 Mev. Thus the $K^-_{\pi_2}$ decay mode is ruled out.

Prongs B and C have ionizations of 0.97 ± 0.10 and 0.93 ± 0.10 times plateau, respectively. Multiple scattering versus ionization identifies these as electrons with $p\beta$ equal to 102 ± 20 and 52 ± 13 Mev/c, respectively. The opening angle of the electron pair is 17 deg. The total momentum vector of the electron pair makes an angle of 65 deg with the K^- -meson direction.

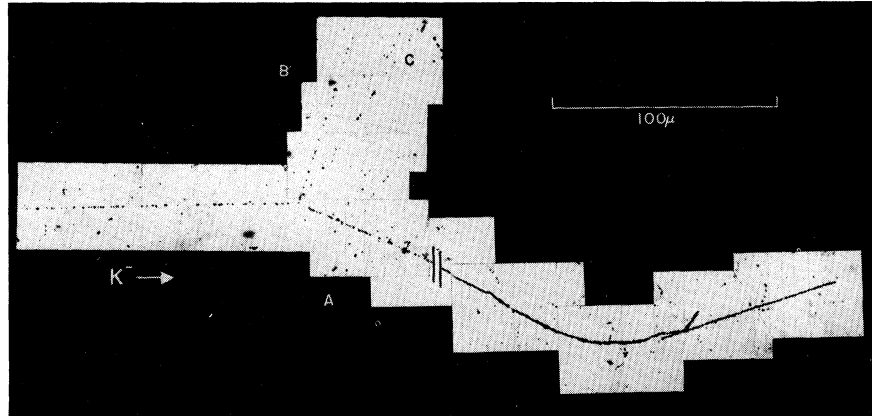
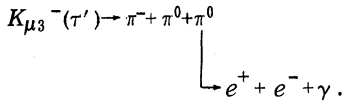
In order to establish this event as an example of the τ' decay mode of the K^- meson,



it is necessary to rule out other decay modes as well as a K^- capture in flight. The kinematics and the presence of the charged π (μ) meson and the π^0 meson, as evidenced by the high-energy electron pair, immediately rule out all decays except the τ' and $K_{\mu_3}^-$.

The permitted processes and the ratios of their expected frequencies are listed in column 1 of Table I. The expected numbers of events having a single π^- (μ^-) meson with no accompanying blobs, slow electrons or recoils are given in column 2. For the decay processes these numbers are the branching ratios of K^+ mesons¹ times the number of K^- decays in flight which we have observed. For the K^- captures in flight the number has been obtained in the following way. We have seen 2 nondecay-like π^- meson events (π meson plus blob, slow electron, or recoil but no other prongs) in 250 K^- interactions in flight. About 75% of the single- π events from K^- captures at rest are nondecay-like. Taking the same ratio of decay-like to nondecay-like single- π events among the inter-

FIG. 1. Photomicrograph of the decay of a negative τ' meson (event 1320).



actions in flight yields about one decay-like π event. The probability of seeing a three-prong star at the ending of a π^- (μ^-) meson ^{2,3} appears in column 3. In column 4 are the probabilities of seeing a high-energy electron pair in combination with a π^- (μ^-) meson.⁴ The number listed for K^- interactions in flight comes from the fact that we have not seen a high-energy electron pair in combination with a π in over 3000 K^- captures at rest although three examples of such pairs where no π was emitted have been observed. The expected numbers of τ' decays, K^- interactions in flight, and $K_{\mu_3}^-$ decays which have the characteristics of this event are listed in column 5. It can be seen that the identification of event 1320 as the τ' mode of decay of the K^- meson is favored over the K^- interaction in flight by a factor of at least 40, and is favored over the $K_{\mu_3}^-$ mode by a factor of at least 190.

Previous examples of the τ' mode of decay of the K^- meson have been reported⁵; however, due to the absence of electron pairs it is evident from Table I that those events have about equal

probabilities of being K^- interactions in flight. Similar decays of positive τ' mesons each yielding a π^+ meson and an electron pair have also been observed.⁶

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¹M. Gell-Mann and A. Rosenfeld, Annual Review of Nuclear Science (Annual Reviews, Inc., Palo Alto, 1957), Vol. 7, p. 457.

²H. Morinaga and W. F. Fry, Nuovo cimento **10**, 308 (1953).

³G. Brown and I. S. Hughes, Phil. Mag. **2**, 777 (1957).

⁴R. H. Dalitz, Proc. Phys. Soc. (London) **A64**, 667 (1951); Lindenfeld, Sachs, and Steinberger, Phys. Rev. **89**, 531 (1953).

⁵W. H. Barkas, Proceedings of the Seventh Annual Rochester Conference on High-Energy Nuclear Physics, 1957 (Interscience Publishers, Inc., New York, 1957), Chap. VIII, p. 30; S. Nilsson, Nuclear Phys. **3**, 364 (1957).

⁶R. Levi-Setti and W. Slater, Nuovo cimento **5**, 1784 (1957); Harris, Orear, and Taylor, Phys. Rev. **106**, 327 (1957).

Table I. Expected numbers for K^- decays and K^- captures in flights.

Process	Expected numbers of decay-like events	Probability of 3-prong star from $\pi^-(\mu^-)$	Probability of electron pair in combination with $\pi^-(\mu^-)$	Expected numbers of events of this type
τ' decay	0.5	0.15	0.025	1.9×10^{-3}
K^- capture in flight	1	0.15	$<3 \times 10^{-4}$	$<4.5 \times 10^{-5}$
$K_{\mu_3}^-$ decay	1	$<8 \times 10^{-4}$	0.012	$<9.6 \times 10^{-6}$
Ratio $\frac{\tau' \text{ decay}}{K^- \text{ capture in flight}}$	0.5	1	>80	>40
Ratio $\frac{\tau' \text{ decay}}{K_{\mu_3}^- \text{ decay}}$	0.5	>190	2	>190

FIG. 1. Photomicrograph of the decay of a negative τ' meson (event 1320).

