

Decay in Flight of a Negative and a Positive τ Meson*

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Measurements made on two τ mesons, one positive and one negative, which decayed in flight in a cloud chamber in a magnetic field are given. The Q -value calculated for the positive event is 84 ± 6 Mev and for the negative event is 77 ± 9 Mev. The momentum, energy, and angles of the decay products in the center-of-mass system are also given.

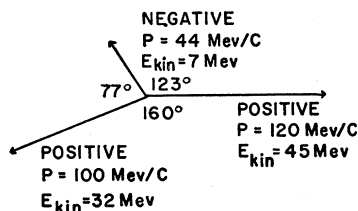
IN scanning approximately 30 000 photographs of a cloud chamber in a magnetic field,¹ we have observed two τ mesons that decayed in flight. One was positive and the other negative. Because of the importance of unbiased statistics regarding the mode of decay² and the ratio of positive to negative events, and in view of the small number of events that have been observed in magnetic cloud chambers, it seemed advisable to publish the data obtained from these two events.

Table I gives the measurements made on the two events. The direction cosines are given with respect to the cloud-chamber coordinates. The error in the direction cosines corresponds to plus or minus one degree in each of the three angles that define a direction.

TABLE I. Momentum, angle, and ionization measurements on the positive and negative τ mesons.

Particle	Sign	Momentum	Direction cosines (<i>l,m,n</i>)	Ionization <i>I/I</i> ₀
Event No. 29 701: Positive				
Primary	Positive	551 ± 31	(+0.188, -0.982, +0.016)	1.57 ± 0.12
2	Positive	262 ± 7	(-0.140, -0.985, -0.101)	1.10 ± 0.08
3	Negative	166 ± 4	(+0.313, -0.925, -0.213)	1.61 ± 0.13
4	Positive	155 ± 5	(+0.621, -0.611, +0.489)	1.93 ± 0.16
Event No. 43 000: Negative				
Primary	Negative	Not measurable	(+0.389, -0.920, +0.049)	Not measurable
2	Positive	389 ± 22	(+0.293, -0.932, -0.215)	1.00 ± 0.19
3	Negative	227 ± 10	(+0.309, -0.867, +0.391)	1.56 ± 0.21
4	Negative	216 ± 14	(+0.581, -0.799, +0.159)	1.20 ± 0.18

FIG. 1. Mode of decay of the positive τ meson in the center-of-mass system.



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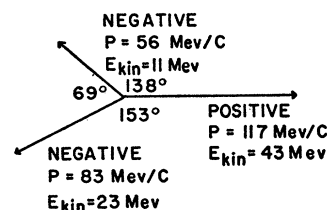
¹ W. B. Fretter and E. W. Friesen, Rev. Sci. Instr. 26, 703 (1955).

² R. H. Dalitz, Phys. Rev. 94, 1046 (1954).

Because of the large error in the momentum measurements of the primary in event number 29 701, and because the primary of event number 43 000 is too short for momentum measurements, both Q -calculations are based only on measurements on the secondary particles. For the positive event, event number 29 701, the total secondary momentum was 519 ± 9 Mev/ c and the angle between the total secondary momentum and the direction of the primary was 0 ± 3 degrees. The Q -value was 84 ± 6 Mev/ c which gives a mass of 980 ± 11 electron masses. For the negative event the total secondary momentum was 795 ± 27 Mev/ c and the angle between the total secondary momentum and the primary was 0 ± 4 degrees. The Q -value for the negative event was 77 ± 9 Mev and therefore the mass of the primary was 968 ± 18 electron masses.

Both events are therefore consistent with a τ decay. There is no unbalance in momentum and the calculated

FIG. 2. Mode of decay of the negative τ meson in the center-of-mass system.



Q -values are consistent with the well established Q -value of approximately 74.7 Mev. The identification is made even more definite by the ionization measurements. For the positive event the mass of the primary based on its ionization and momentum measurements is 1060 ± 115 electron masses. The masses calculated for the secondaries of both events are all consistent with the π meson mass. No ionization measurements were possible on the primary of the negative event.

Since the useful data for making a statistical study of possible spin and parity combinations are the data in the center-of-mass system, the measurements were transformed to this system. Figure 1 shows the configuration of the decay of the positive event in its center-of-mass system. Figure 2 shows the corresponding data for the negative event.