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MEASUREMENTS OF MESON MASSES AND RELATED QUANTITIES

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MEASUREMENTS OF MESON MASSES AND RELATED QUANTITIES

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This paper has been submitted to Physical Review for publication.

Measurements of Meson Masses and Related Quantities

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A meson mass measurement program has been completed. The method has been partially described[1,2] and preliminary results[2,3,4] have been reported at earlier stages of the work. As noted previously[2], it was discovered that stray mesons coming from points other than the target were interfering with the measurements. Attempts to reduce this effect have been successful, and little evidence of stray mesons remains.

To determine the pion masses, meson and proton ranges and momenta were measured in the same velocity interval. To measure the pion to muon mass ratio, similar comparisons were made between pions and muons. In one of the methods employed to find the momentum, p_o, of the muon which is emitted when the pion decays at rest, the muon range is compared with the ranges of pions of known momentum and of nearly the same velocity. The decay muons were also compared directly with muons coming from the target in a second type of experiment.

For each particle the quantity studied statistically is that function of the mass in which the range appears linearly. The dominant term in the variance of this quantity is the range straggling; consequently, it as well as other sources of variance has been examined closely, and the shapes of the measured distribution functions are now understood theoretically.

The stray mesons mentioned above introduced a systematic error of about one percent in the mass values quoted previously. The known systematic effects are now believed to be eliminated, and the statistical errors also

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have been considerably reduced. Our final results are contained in Table I.

Complete reports of the theoretical and experimental details are being prepared for publication.

The generous assistance of many individuals in the Radiation Laboratory is acknowledged with appreciation.

References

1. W. H. Barkas, Proceedings of the Echo Lake Cosmic Ray Symposium, page 47, June 23-28, 1949.

2. W. H. Barkas, Amer. Jour. of Physics 20, 5 (1952).

3. W. H. Barkas, F. M. Smith, and E. Gardner, Phys. Rev. 82, 102 (1951).

4. W. Birnbaum, F. M. Smith, and W. H. Barkas, Phys. Rev. 83, 895 (1951).

TABLE I

Values for Meson Masses and Related Quantities

The errors quoted are statistical probable errors. The uncertainties in the various quantities are not independent.

The mass assumed for the proton is 1836.1 electron masses.

The bracketted numbers are absolute mass determinations in the derivation of which no use is made of information obtained from the direct comparison of masses with that of the proton, but it is assumed that a neutrino of zero rest mass is emitted in a two body decay of the pion.

Fundamental Mass Ratios

π^+/Proton	π^-/Proton	π^+/μ^+
0.14888 ± 0.00011	0.14840 ± 0.00017	1.321 ± 0.002

Absolute Decay Momentum of Positive Muon

p_o = 29.80 ± 0.04 Mev/c

Derived Masses in Units of the Electron Mass

π^+	π^-	μ^+
273.4 ± 0.2	272.5 ± 0.3	207.0 ± 0.4

Absolute Mass Measurements in Units of the Electron Mass

π^+	μ^+	$\pi^+ - \mu^+$
(273.5 ± 1.2)	(207.1 ± 1.1)	(66.41 ± 0.07)