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Ryokichi Sagane

July, 1953

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We have preliminarily reported[1] the interpretation of our experimental results that the intensity of the spectrum at the maximum energy was zero. But, as has been reported in the second paper on page 17, UCRL-1261 (1951), we found that the results may also be fitted to a different spectrum with finite intensity at the maximum energy (for example, the spectrum given by Tiomno, Wheeler, and Rau[2] as tensor coupling with simple charge exchange), provided that we could admit the mass of μ-mesons was close to 206 m_o. The mass of μ-mesons was believed to be 210m_o at that time. Since the fit was a little better and the best value mass was 210m_o, for the first interpretation, we thought the agreement with the tensor coupling case (antisymmetric theory) was good.

Quite recently, however, the most probable value for the mass of the μ-meson has been revised by two independent groups[3] based on two different experiments to be 207.0 ± 0.4 m_o. This value is much closer to the value required by the second interpretation. It appears that the interpretation implying a finite intensity at the maximum energy is the more meaningful decision concerning the spectrum.

A careful computation based on a new extended calculation of the theory of the spiral orbit spectrometer gave the half widths of the resolution curves as ±2.5 percent for points less than 95 m_o c and ±3.5 percent for points close to the maximum energy.

Because of the absorption of energy through the target, some complications came in at the region close to the maximum energy. Electrons produced close to the center of the target were detected after losing energy

due to absorption. Only the outside part of the target became effective for the counts at the setting of the spectrometer close to the maximum energy. This fact resulted in (a) decrease of effective target volume, and (b) increase of mean radius of the effective target size.

Assuming the correction for (a) is made properly and the half width of the resolution curve is known, the corrections for the counts close to the maximum energy are still complicated. The situation may be more clearly understood in the following example. Corresponding to the assumption of the simplest type of resolution curves with the half widths of ± 1 percent, ± 2 percent, and ± 4 percent, as shown on the right side of Fig. 1, the expected measured values were illustrated here corresponding to the energy spectrum expected from the tensor coupling (simple charge exchange) and the maximum energy of the spectrum to be $105\ m_o c$. This corresponds to the mass of the μ-meson to be $206 m_o$. The curve for zero intensity at the maximum energy at $109\ m_o c$ is also given in Fig. 1 for comparison.

It is clear from Fig. 1 that if one has a resolution of better than 2 percent, one can possibly distinguish between the two different types of spectrum. But on the other hand, if the resolution is worse than 4 percent (as for all of the experiments so far made), and if the number of measurements with H_ρ as the variable were not ample, it would be almost impossible to decide the best fit between a number of possibilities. This is the situation with regard to our experiment. Our points are shown in the figure as circles. The two extreme cases are the spectrum with zero intensity at the energy maximum, assuming the mass of the μ-meson to be $212\ m_o$; the other is the spectrum with finite (about one-quarter of the maximum intensity) intensity with mass value of $206\ m_o$.

In other words, if the mass of the μ-meson is assumed, one can decide the shape of the spectrum; namely, one can determine the value of ρ, defined in the calculation of Michel[4], or vice versa.

The determination of both the μ-meson mass and the shape of the spectrum from the present type of measurement may be done with comparable accuracy to the mass measurements, if one can have a resolution curve of better than one percent for the half width and measure many points close to the maximum energy. An experiment is now in progress in an attempt to attain a resolution of two percent.

REFERENCES

1.   R. Sagane, W. L. Gardner, and H. W. Hubbard, Phys. Rev. 82, 557 (1951) and W. L. Gardner, (thesis) UCRL-1261 (1951).

2.   Tiomno, Wheeler, and Rau, Rev. Mod. Phys. 21, 144, (1949).

3.   F. M. Smith, W. Birnbaum, and W. H. Barkas, UCRL-2245 (1953); K. M. Crowe, (thesis) UCRL-2050 (1952).

4.   L. Michel, Proc. Phys. Soc. 63, 514 (1950).

○ EXAMPLES OF MEASURED POINTS

TENSOR (SIMPLE CHARGE EXCHANGE)

WITH ASSUMPTION THAT

$E_{MAX} = 105$ mc.

TENSOR

(ANTISYMMETRIC THEORY WITH

CHARGE EXCHANGE)

WITH ASSUMPTION THAT

$E_{MAX} = 109$ mc.

± 2% HALF WIDTH

± 1% HALF WIDTH

± 4% HALF WIDTH

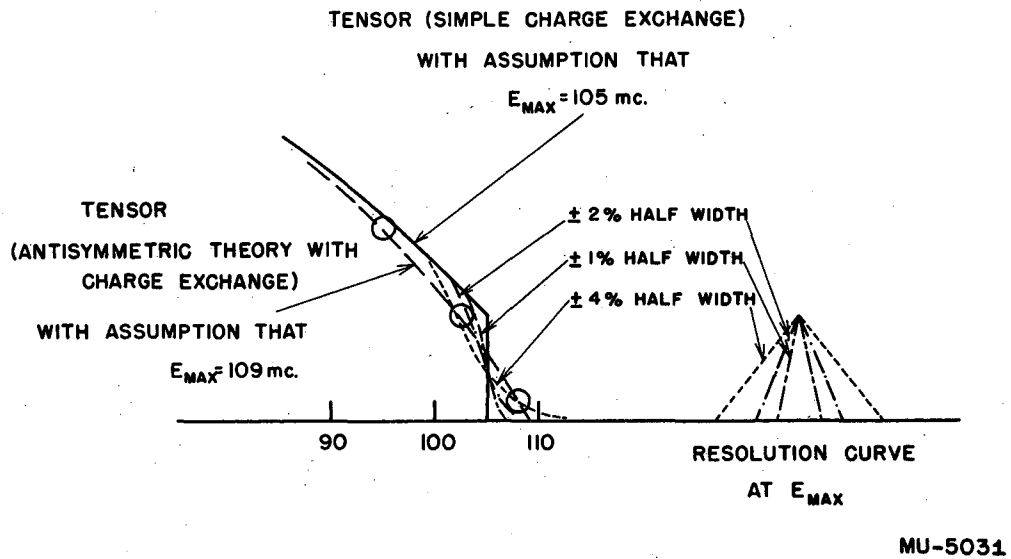90   100   110

RESOLUTION CURVE

AT E_{MAX}

MU-5031

Fig. 1 - Expected measured points of the spectrum close to the maximum
energy corresponding to 1 percent, 2 percent, and 4 percent
resolution curves