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A DETERMINATION OF THE RELATIVE $\Sigma - \Lambda$ PARITY *

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To determine the relative Σ-Λ parity, we have measured the invariant mass spectrum of Dalitz pairs from the decay of unpolarized Σ^0 hyperons, $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$. This method has been suggested by Feinberg[1], Feldman and Fulton[2]. We have already published the results of the analysis of 353 events[3]. This report gives the results for a total of 597 events. Again, the mass spectrum strongly favours even Σ-Λ parity.

Under the assumptions:

$$f_2(x) = f_2(0) \quad \text{and} \quad |f_1| \lesssim |f_2| \tag{1}$$

(where $f_1(x)$, $f_2(x)$ are respectively the electric and magnetic form factors of the Σ-Λ electromagnetic transition) the differential invariant mass distribution of the Dalitz pairs has the approximate form

$$w(x) = C(x)(1 - x) \qquad \text{for even parity} \tag{2}$$

$$w(x) = C(x)(1 + 1/2x) \qquad \text{for odd parity} \tag{3}$$

where $x = \left[(E_+ + E_-)^2 - (\vec{p}_+ + \vec{p}_-)^2 \right] / \Delta^2$

is the square of the invariant mass in units of Δ^2, and

$$\Delta = (M_\Sigma - M_\Lambda) = 76.1 \text{ MeV}.$$

The quantities $E_\pm$ and $P_\pm$ are the electron energy and momentum, and

$$C(x) = \frac{1}{x} (1-x)^{1/2} \left(1-\frac{x_o}{x}\right)^{1/2} \left(1 + \frac{x_o}{2x}\right) \tag{4}$$

with

$$x_o = \frac{4m_e^2}{\Delta^2} = 1.80 \times 10^{-4}$$

Fig. 1 shows the measured distribution of the invariant mass divided by C(x). It also shows the mass distributions calculated using equations (2) and (3), normalized to the number of measured events. The measurements agree very well with the even parity spectrum.

A single parameter test of the parity can be made by comparing the average value of the invariant mass with that predicted by the theoretical function. We find experimentally

$$\langle x^{1/2} \rangle = 0.1625 \pm 0.0068$$

For $(f_1/f_2) = 0$, the predicted values of the invariant mass are

$$\text{for even } \langle x^{1/2} \rangle = 0.162$$

$$\text{for odd } \langle x^{1/2} \rangle = 0.215$$

Our experimental value is in excellent agreement with the predicted one for even parity.

The full expression [3] for the invariant mass spectrum has a dependence of $\langle x^{1/2} \rangle$ on the electric and magnetic form factors f_1 and f_2.

Fig. 2 shows the values predicted for even and odd parity as a function of (f_1/f_2). (f_1/f_2) is taken to be a real number, independent of x. It can be seen that this test eliminates odd parity unless $(f_1/f_2) = +10 {}^{+1.5}_{-2}$.

A perturbation theory estimate[2] of (f_1/f_2) gives 1/4.

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References

1) G. Feinberg, Phys. Rev. 109, 1019 (1958).

2) G. Feldman and T. Fulton, Nucl. Phys. 8, 106 (1958).

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Figure Captions

Fig. 1 The ratio of the number of events to the function C (x) plotted against x, the square of the invariant mass. The theoretical predictions for odd and even parity are shown, assuming $|f_1| \lesssim |f_2|$ and $f_2(x) = f_2(0)$. Spectra are normalized to the same number of events.

Fig. 2 The theoretical average invariant mass of Σ^0 Dalitz pairs as a fucntion of the ratio of factors f_1/f_2. The shaded area is the experimental value.

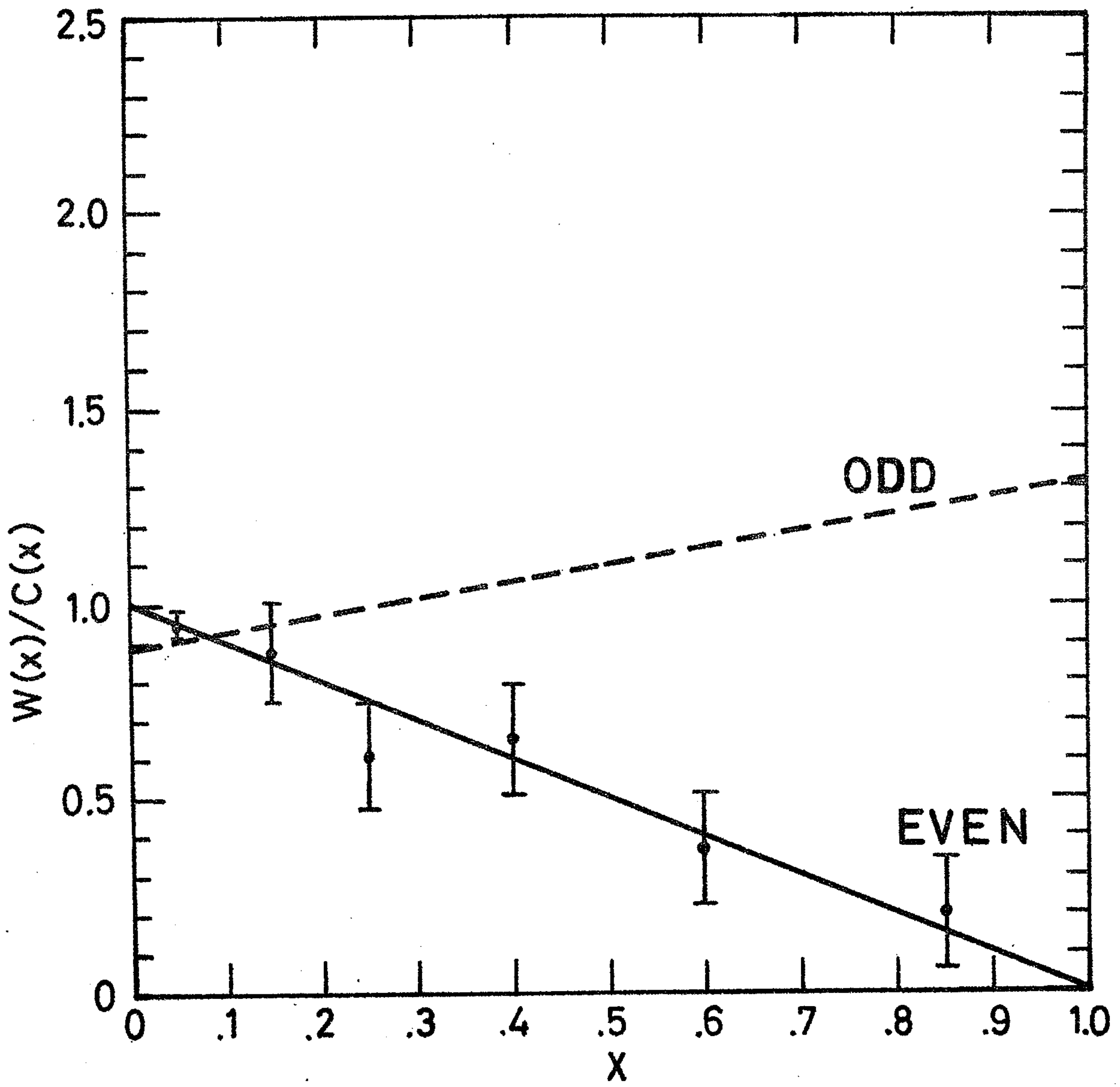

FIG. 1

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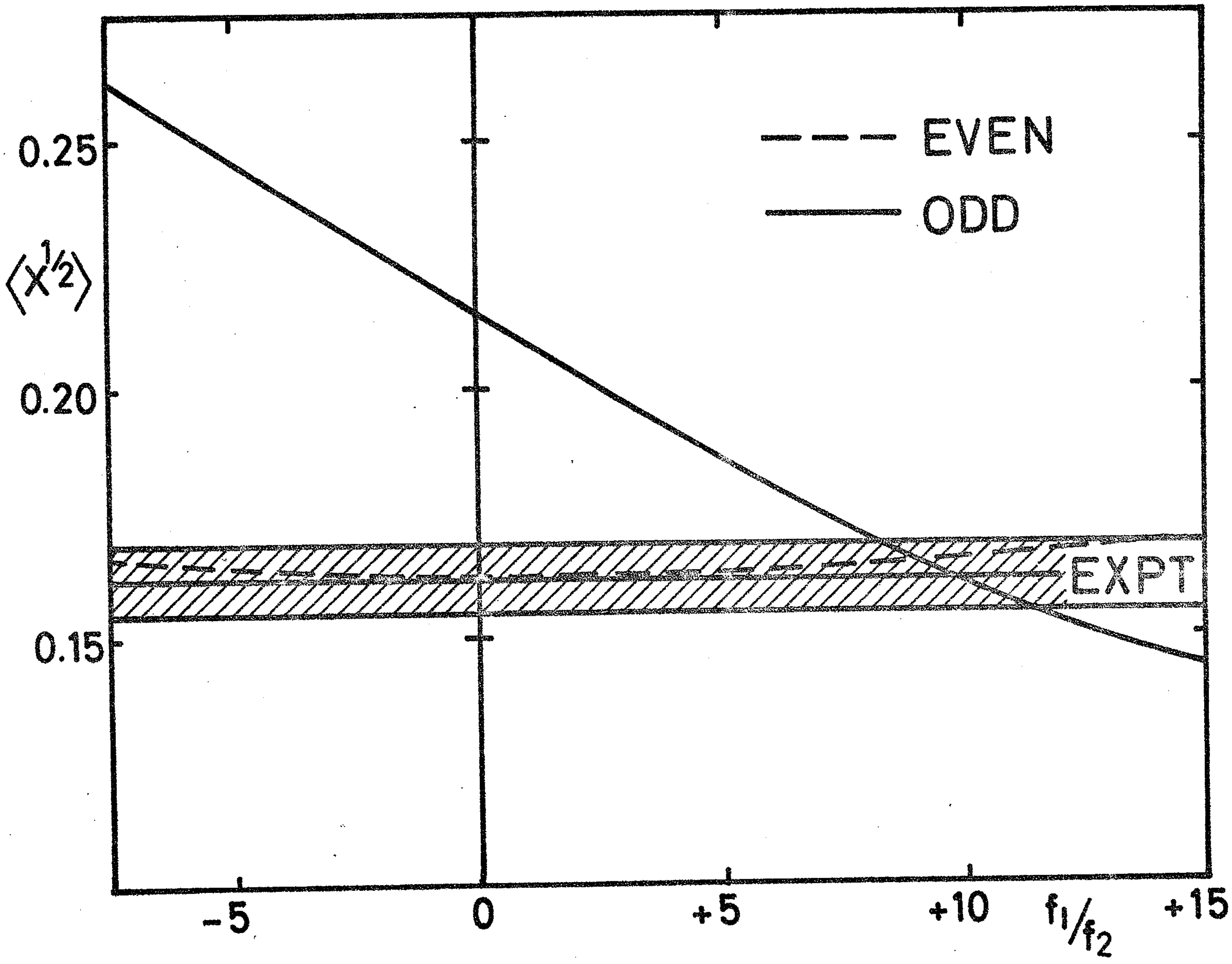

FIG_ 2

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