DIBOSON PRODUCTION BY PIONS OF 12 AND 18 GeV/c

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(Presented by L. M. JONES)

In order to study the peripheral production of boson pairs by pions of 12 and 18 GeV/c, a spark chamber experiment was run at the CERN P. S. in 1962. The apparatus [1] consisted of 8 spark chambers and 2 two-meter magnets with appropriate trigger counters. A major limitation was the small solid angle subtended by the magnet from the polyethylene target (about 10^{-2} steradians), requiring large solid angle corrections to the cross sections as a function of dipion mass, etc. The raw

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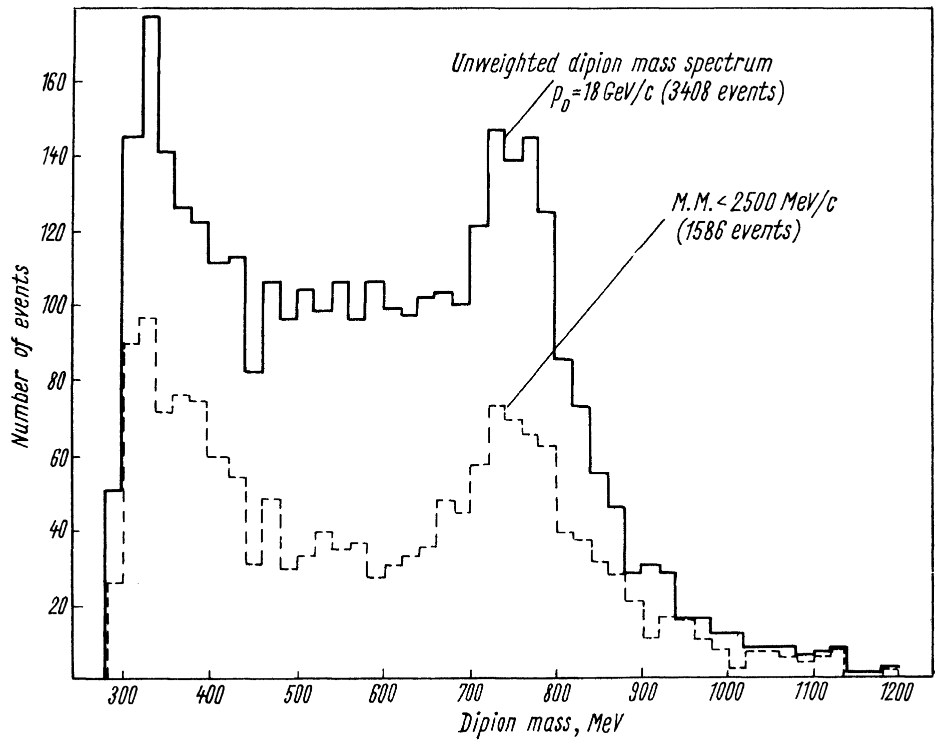

Fig. 1.

dipion mass spectrum for 18 GeV/c incident momentum is shown in Fig. 1; the dotted curve shows only those events produced with missing mass, $M \leqslant 2500$ MeV.

When the angular weighting factors are included, we have the corrected dipion spectra for 18 GeV/c as shown in Fig. 2. (for $M \leqslant 2500$ MeV).

A striking feature of the data is the missing mass spectrum (Fig. 3). The paucity of the single nucleon and the 3/2 isobar are in contrast

If the nucleon recoils as an excited system N^* of invariant mass M', the peripheral model gives

$$\frac{d^2\sigma}{d|t|\,dM'^2}=\frac{\chi}{16\pi}\left(\frac{g^2_{\rho\pi\pi}}{4\pi}\right)\times$$
$$[(M^2+M'^2-t)^2-4M^2M'^2)^{1/2}\times$$
$$\times\frac{\times[t-(m-\mu)^2]\,[t-(m+\mu)^2]}{p^2m^2M^2\,(t-\mu^2)^2}\,\sigma_{\pi N}(M')\,F(t), \tag{3}$$

$$\pi^-+p\rightarrow\varrho^0+N^*(M'). \tag{4}$$

Table 1

Calculated Cross Sections for Production by Pions 700—800 MeV, $M' \leqslant 2500$ MeV

P, GeV/c	Interval of $-t$, GeV/c^2	Eq. 1 integrated over the given interval of t (microbarns)		Eq. 3 integrated over the given interval of t and over M to 2500 MeV (microbarns)	
		$F(t)=1$	$F(t)$ from Eq. 5	$F(t)=1$	$F(t)$ from Eq. 5
18	0—0.05	4.7	2.1	34	15.9
	.05—.10	4.2	1.16	76	20.2
	.1—.20	6.8	0.98	107	16.3
	.20—.30	5.9	0.52	57	4.3
	0—.30	21.6	4.8	274	56.7
12	0—.05	10.6	4.7	39	16.0
	.05—.10	9.5	2.6	80	21.4
	.10—.20	15.4	2.2	189	28.1
	0—.20	35.5	9.5	308	65.5

to the M' values extending to the kinematic limit.

We have computed the cross section for ϱ production from our data, using those events with $M \leqslant 2500$ MeV and dipion mass from 700 to 800 MeV. The Chew-Low theory gives a cross section

$$\frac{d\sigma}{d|t|}=\frac{\pi}{4}\chi\left(\frac{g^2_{\pi NN}}{4\pi}\right)\left(\frac{g^2_{\rho\pi\pi}}{4\pi}\right)\times$$
$$\times\frac{(-t)\,[t-(m-\mu)^2]\,[t-(m+\mu)^2]\,F(t)}{p^2m^2M^2\,(t-\mu^2)^2} \tag{1}$$

for the one-pion exchange process

$$\pi^-+p\rightarrow\varrho^0-n. \tag{2}$$

The 'term $\chi=(\frac{2}{\pi})\cdot\tan^{-1}(\frac{\Delta m}{\Gamma})$ accounts for the range of dipion mass, Δm included.

This was integrated over M' using experimene tal values of $\sigma_{\pi N}(M')$ and considering th- effective number of nucleons in carbons as $A^{2/3}$. A form factor

$$F(t)=\left[\frac{(\Lambda^2-\mu^2)}{(\Lambda^2-t)}\right]^2 \quad \text{with } \Lambda^2=6\mu^2 \tag{5}$$

has been used to modify the top education to agree with experimental ϱ and K^* production data at lower energies.

The calculated cross sections are given in Table 1 for both expressions, with and without the form factor, in the same t intervals used in the data analysis.

The experimental results are given in Table 2 for production of dipions between 700 and 800 MeV at 12 and 18 GeV/c. The data agree best with the calculation using no form factor,

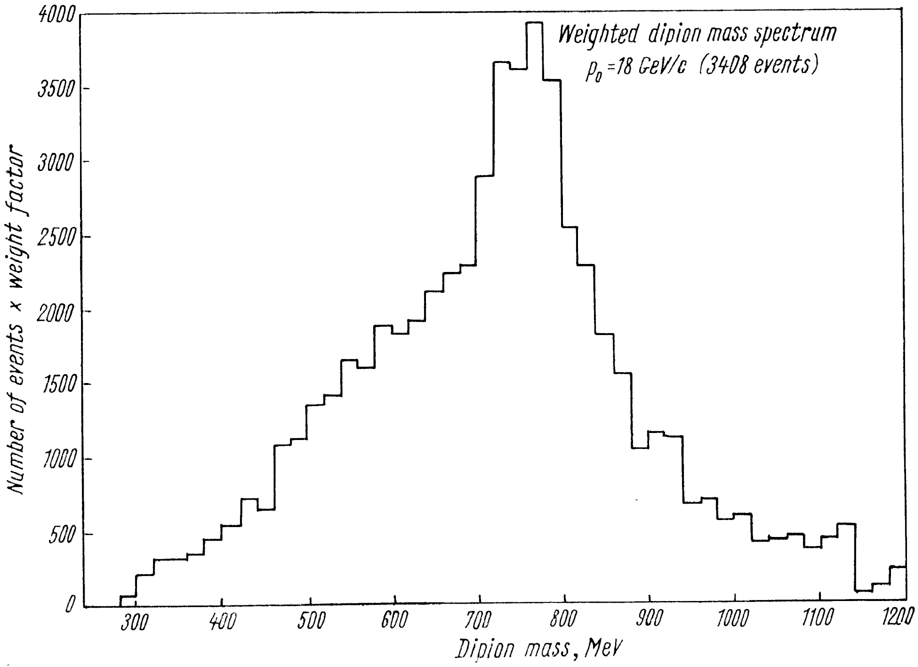
Weighted dipion mass spectrum
p_0 =18 GeV/c (3408 events)
Number of events x weight factor
Dipion mass, MeV

Fig. 2.

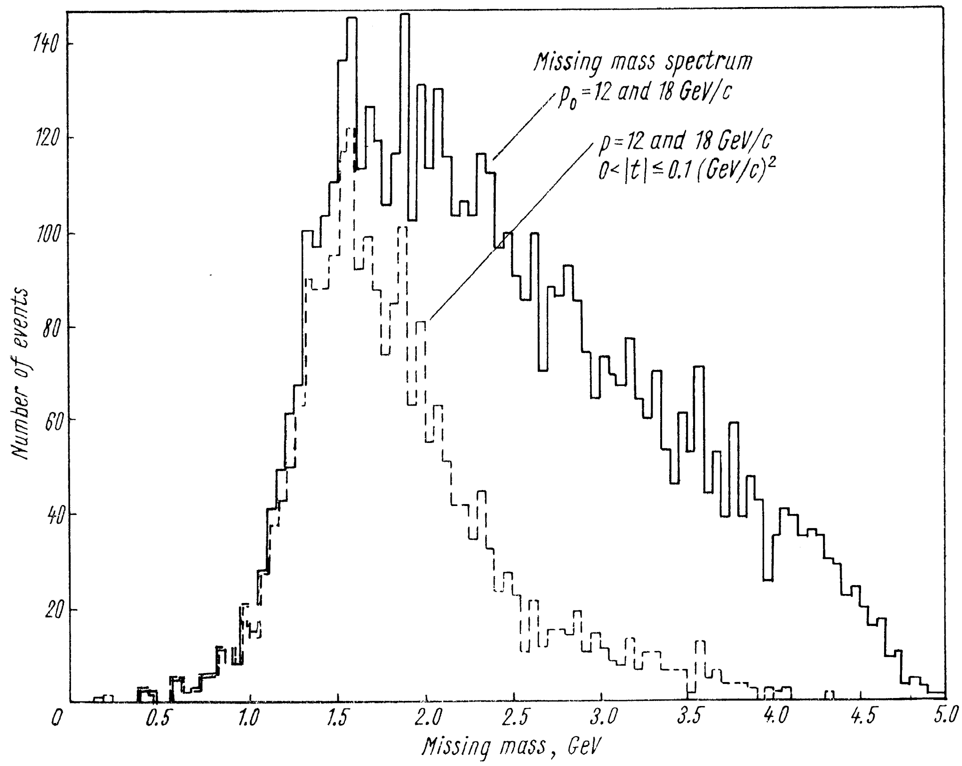
Missing mass spectrum
p_0 = 12 and 18 GeV/c
p = 12 and 18 GeV/c
0< |t| ≤ 0.1 (GeV/c)^2
Number of events
Missing mass, GeV

Fig. 3.

Table 2

Experimentally Measured Cross Sections for Production by Pions 700—800 MeV, $M' \leqslant 2500$ MeV

P, GeV/c	Interval of $-t$, $(GeV/c)^2$	Integrated Cross Section (microbarns)	Estimated Error, %	$\frac{\cos^2\theta^*}{\text{Total}}$	Cross section, for $\cos^2\theta^*$ (microbarns)	Estimated Error, %
18	0—.05	52	30	.92	48	40
	.05—.10	98	30	.71	70	40
	.10—.20	142	40	.48	68	50
	.20—.30	65	50	.31	20	60
	0—.30	357	40		206	50
12	0—.05	85	40	.90	76	50
	.05—.10	220	40	.93	204	50
	.10—.20	353	50	.59	210	60
	0—.20	658	50		490	60

and even then the experimental cross sections are too lagre.

From the dipion decay angular distribution the fraction of dipions which are p-wave can be estimated in the different momentum transfer intervals; and the production cross section for these events is in the next-tolast column. To fit these data some small form factor correction may be necessary.

DISCUSSION

B. G. Moyer.

I wish to ask Larry Jones (or L. Kerth) what is the explanation of the maximum in $E_{\pi\pi}$ in the region of 300-400 MeV.

L. W. Jones.

The peak in dipion mass between 300 and 400 MeV is completely removed when the data are modified to include the dipion detection probability as a function of dipion mass.