EXPERIMENTAL STUDY OF $\bar{p}n$ ANNIHILATIONS BETWEEN 1.0 AND 1.6 GeV/c

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$\bar{p}n$ annihilations into three and five charged mesons with or without neutrals have been studied, in order to measure the contributions of the various final states to the 5.5 mb enhancement discovered in the total I=1 $\bar{N}N$ cross section at 2190 MeV total CM energy. Fits have been performed to the cross sections as functions of the incident $\bar{p}$ momentum with background plus a resonant term. The fits show enhancement in several final states, the statistically most significant one being in the reaction $\bar{p}n \to \pi^+\pi^-\pi^-$ (0.51 ± 0.13 mb over a background of 1.4 mb). Less significant effects are also found in all other pionic annihilation final states regardless of their G-parity.

We have studied $\bar{p}n$ annihilations, in the 81 cm CERN bubble chamber, filled with deuterium. The final states analyzed were those with three or five charged mesons and zero, one or more neutrals. The analysis was carried out at seven different $\bar{p}$ momenta, from 1.0 to 1.6 GeV/c, in steps of 100 MeV/c. Aim of the experiment was the determination of the contribution to the various final states of the 5.5 mb enhancement found in the total I=1 $\bar{N}N$ cross section, at a CM energy of 2190 MeV, by Abrams et al. (1). To get an estimate of the size of the enhancement in the final states we analyzed, we fitted our data with an incoherent superposition of a Breit-Wigner term at 2190 MeV, with a width of 85 MeV and a smooth background. As the behaviour of the background in the 2190 MeV region is strongly influenced by the presence of a second bump at 2350 MeV, we performed two other fits including the data of Eastman et al. (2), who performed an experiment similar to ours at higher energy and added to the function used for the fit a second resonant term at 2350 MeV, 140 MeV wide. The results of the fits are shown in the table. Enhancements are present in various final states.

*) The results presented at the Conference were in a preliminary form. The present results differ from the preliminary ones only for the normalization.

The most significant appears in the reaction $\bar{p}n \to \pi^+\pi^-\pi^-$ (0.51 ± 0.13 mb over a background of 1.4 mb). Less significant effects are also found in all other pionic final states, regardless of their G-parity.

REFERENCES

1) R.J. Abrams et al., Phys. Rev. Lett. 18, 1209 (1967); Phys. Rev. D1 1917 (1970).

2) P.S. Eastman et al., Nucl. Phys. B51, 29 (1973).

FINAL STATE		BW(2190) mb	% of the cross section	b	scale factor	χ^2/ND	C.L. %	BW (2350) Fit	BW (2350) Ref.2
$\pi^+2\pi^-$	a	$0.59^{+0.17}_{-0.39}$	26	8.5 ± 2.1	—	1.1/3	77	$0.42^{+0.48}_{-0.42}$	
	b	0.33 ± 0.12	15	6.3 ± 0.5	—	15.3/12	22	0.34 ± 0.08	0.05 ± 0.16
	c	0.51 ± 0.13	22	7.0 ± 0.6	0.81 ± 0.07	8.3/11	69	0.20 ± 0.09	
$\pi^+2\pi^-\pi^o$	a	$2.14^{+0.72}_{-0.80}$	13	8.7 ± 2.6	—	2.4/3	49	$2.84^{+1.7}_{-2.8}$	
	b	NO ACCEPTABLE FIT							1.81 ± 0.51
	c	1.20 ± 0.58	11	6.0 ± 0.3	0.72 ± 0.04	13.7/11	25	1.26 ± 0.29	
$\pi^+2\pi^-$MM	a	1.81 ± 0.88	6	$5.6^{+2.0}_{-2.8}$	—	3.6/3	31	$0.0^{+5.0}_{-0.0}$	
	b								—
	c								
$2\pi^+3\pi^-$	a	$0.51^{+0.63}_{-0.51}$	11	$7.3^{+4.3}_{-2.3}$	—	1.7/3	63	$0.85^{+0.24}_{-0.70}$	NEGATIVE VALUE
	b	0.38 ± 0.20	8	6.5 ± 0.2	—	13.2/12	36	0.20 ± 0.13	
	c	0.37 ± 0.23	8	6.4 ± 0.3	1.01 0.03	13.1/11	28	0.21 ± 0.16	
$2\pi^+3\pi^-\pi^o$	a	$0.89^{+0.75}_{-0.82}$	9	$7.6^{+4.2}_{-1.2}$	—	1.0/3	81	$0.87^{+0.64}_{-0.87}$	
	b	1.28 ± 0.43	13	8.2 ± 0.2	—	14.7/12	26	0.84 ± 0.25	1.47 ± 0.73
	c	0.82 ± 0.48	9	7.8 ± 0.3	1.10 0.04	8.7/11	65	1.29 ± 0.31	
$2\pi^+3\pi^-$MM	a	0.74 ± 0.50	12	$12.9^{+7.3}_{-3.9}$	—	4.5/3	21		
	b								—
	c								
$K^+K^-\pi^-$	a	$0.04^{+0.09}_{-0.04}$	12	$10.6^{+7.4}_{-5.2}$	—	6.7/3	8	$0.10^{+0.05}_{-0.10}$	
	b	$0.0^{+0.01}_{-0.0}$	0	3.0 ± 0.5	—	26.0/12	1.1	0.03 ± 0.03	—
	c	$0.0^{+0.03}_{-0.0}$	0	5.0 ± 1.0	0.68 ± 0.12	18.9/11	6	$0.0^{+0.02}_{-0.0}$	
$K^+K^-\pi^+2\pi^-$	a	$0.05^{+0.08}_{-0.05}$	19	$5.6^{+14.4}_{-1.5}$	—	0.4/3	95	$0.09^{+0.12}_{-0.09}$	
	b	0.09 0.05	32	$5.9^{+1.2}_{-1.6}$	—	13.0/12	37	0.04 ± 0.04	—
	c	$0.04^{+0.06}_{-0.04}$	15	$5.3^{+1.3}_{-1.5}$	1.30 ± 0.23	11.3/11	42	0.06 ± 0.04	
SUMMED CROSS SECTION FITS									
$3\pi + 5\pi$	a	$0.97^{+0.63}_{-0.58}$	14	$7.3^{+4.1}_{-2.1}$	—	2.5/3	47	$1.07^{+0.37}_{-1.07}$	
	b	0.72 ± 0.24	10	6.5 ± 0.2	—	15.6/12	21	0.53 ± 0.15	
	c	0.81 ± 0.27	11	6.5 ± 0.3	—	13.9/11	24	0.36 ± 0.17	
$4\pi + 6\pi$	a	2.5 ± 2.5	12	$10.4^{+5.7}_{-2.1}$	—	2.5/3	47	$3.3^{+4.5}_{-3.3}$	
	b	NO ACCEPTABLE FIT							
	c	1.59 ± 0.76	8	9.4 ± 0.2	—	13.4/11	27	2.16 ± 0.44	
$3+4\pi + 5+6\pi$	a	$5.1^{+2.6}_{-5.1}$	18	$11.8^{+2.9}_{-3.4}$	—	2.6/3	46	$7.8^{+4.2}_{-7.8}$	
	b	NO ACCEPTABLE FIT							
	c	2.54 ± 0.81	9	9.2 ± 0.2	—	10.5/11	49	2.51 ± 0.48	
3πMM + 5πMM	a	$2.9^{+3.0}_{-2.9}$	8	6.0 ± 2.2	—	5.6/3	13	$3.4^{+7.3}_{-3.4}$	
	b								
	c								

* Fit a) Fit to our data only

Fit b) Fit to our data plus those of ref. 2

Fit c) Same as b) but with a variable scale factor for the data of ref. 2

D I S C U S S I O N

- *Rubinstein:*

Do you have any spin determination for the bumps?

- *Cresti:*

No, it is only the total cross-section. It is rather difficult to do, the signal-to-background ratio is about $\frac{1}{2}:\frac{1}{3}$. The number of events is insufficient for the spin analysis.

- *Fields:*

Can you assign a definite G-parity to the peak?

- *Cresti:*

No. If we look at the topological cross-sections the situation is not clear. Actually, we cannot say for sure whether the object is a resonance or not.

- *Kalogeropoulos:*

Are you saying that it is an I=1 object?

- *Cresti:*

The signal is present in $\bar{p}n$ interaction and it does not seem to be present with the same strength in even prongs in $\bar{p}p$.