PRESENT STATUS OF THE $\omega\pi\pi$ DECAY OF THE A_2 FROM THE $\bar{p}p$ ANNIHILATIONS AT 700 MeV/c.

C. Defoix, L. Dobrzynski and P. Espigat
Collège de France, Paris, France

(Presented by C. Defoix)

Since the evidence for an $\omega^0\pi\pi$ decay mode of the A_2 from $\bar{p}p$ annihilations (Ref. 1) this effect has been observed in different final states (Ref. 2). If its existence seems well established now, discrepancies stand on two points between the different experimental evidences :

1) The first observation associates the existence of a new $\omega\pi$ effect, the B_1, with the decay in question;
2) The branching ratio $\frac{A_2 \to \omega\pi\pi}{A_2 \to \rho\pi}$ varies from 0.09 ± 0.03 to 0.29 ± 0.08.

Nevertheless, the mean branching ratio is about 0.15 ± 0.05 and if one takes account of the phase space factor and the centrifugal barrier, this leads to an $A_2 \to \omega\pi\pi$ coupling constant which has at least the same order of magnitude than the $A_2 \to \rho\pi$ one. Given the part taken by such a coupling constant in the reactions involving the A_2, it seems interesting to understand at best the properties of this $\omega^0\pi\pi$ decay mode.

We present here some partial results, limited to the A_2 question and issued from an increasing of the initial $\bar{p}p$ sample by a factor 2. 40,000 6-prong annihilations are now measured at Collège de France and among them 15,200 1C-events ($\bar{p}p \to \pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0$ at 725 MeV/c) are selected after kinematical fit. The pictures were taken in the 81 cm HBC at CERN.

METHOD OF ANALYSIS

The reaction $\bar{p}p \to \pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0$ at low energy is dominated by the ω^0 production (∿ 72. ± 2%). But the background of the non-ω^0 three pion combinations under this ω^0 is three times more important than the ω^0 signal itself. The preliminary approaches to the method used to study the effects produced in the final state $\omega^0\pi^+\pi^-\pi^+\pi^-$ are described in the refs. 1 and 3. This method consists in establishing the evolution of the size, N_{ω^0}, of the ω^0 signal in the $\pi^+\pi^-\pi^0$ distribution versus the quantity to be studied (mainly the effective mass distributions associated with the ω^0 4π final state). At present, this procedure is made systematic according to a "self consistant background" method:

- in a first step the height and the shape of the background under the successive ω^0 signal, a priori unknown, are approximated by a polynomial:

$$f(M) = (\alpha + \beta M + \gamma M^2 + ..) \times \left\{1 + \frac{N_{\omega^0}}{\sqrt{2\pi}\sigma} \exp\left(-\frac{1}{2}\left(\frac{M-M_{\omega^0}}{\sigma}\right)^2\right)\right\}$$

which is fitted on the experimental distributions. So, one deduces the first approximation of the effective mass distributions associated with the $\omega^0\ 4\pi$ final state, then from these last ones, one fits the rates of the different transition matrix elements taking into account all the effects observed in the final state in question.

- <u>in the next iterations</u>, the background under the ω^0 signals is defined by Monte-Carlo generation of the successive $(\pi^+\pi^-\pi^0)$ mass distributions according to the last matrix elements. From this new background, best approximations of the "$\omega^0\ 4\pi$" state distributions are deduced. And so on until the background stays stationary.

Generally one iteration is sufficient. For instance, the figure 1 shows the different $\pi^+\pi^-\pi^0$ distributions got for the determination of the $\omega^0\ \pi^\pm$ effective mass distribution*). The dotted curves are for polynomial first approximation, the full ones show the result of the iterative procedure by Monte-Carlo simulation. The B_1 effect (M = 1040 MeV; Γ = 45 MeV), whose the initial evidence comes from quite different methods (Ref. 3), is observed again by this procedure with the same value of mass and width.

This fact confirms that we are not in presence of an effect induced by the method.

<u>THE $\omega\pi\pi$ DECAY MODE OF THE A_2^0.</u>

The analysis of the second 6-prong sample leads to results compatible with the ones presented in the references cited above. For instance the fig. 2 shows the structure observed again on the general $\omega^0\pi^+\pi^-$ mass distribution at 1300 MeV (interpreted in terms of A_2^0 decay) and 1400 MeV (a possible new decay mode of the $X(I^G = 1^-)$ meson), respectively.

Now restricting the analysis to the $\omega^0\pi^+\pi^-$ combinations coming from the A_2^0 decay, one has drawn the 3 mass distributions of $\omega^0\pi^\pm$ combinations issued from 3 adjacent $\omega^0\pi\pi$ bands of mass, under, in and above the A_2 mass range (distributions 1, 2 and 3 respectively on the fig. 2a). These histograms are established from the whole 1-C event lot. The constatations are the following ones (figs. 3 and 4).

α) The Monte-Carlo generation of events taking account of a simple $\omega\pi\pi$ decay of the A_2^0 (for instance according to the phase space), describes the two lateral distributions 1 and 3 rather well, not the central one. (see also ref. 1, fig. 2);

β) For this central distribution, the background deduced by interpolation between the two lateral distributions agrees with the Monte-Carlo one;

γ) The signal observed above this estimated background in the distribution 2 is quite compatible with the B_1 one (agreement of size, central mass and width);

δ Reciprocally, the three $(\omega^0\pi^+\pi^-)$ mass histograms issued from the three corresponding $\omega^0\pi^\pm$ bands of mass (that is under, in and above the $\omega^0\pi^\pm$ effect respectively), show that no A_2 signal is observed in the lateral ones, whereas all this A_2 signal is restored in the $\omega\pi\pi$ distribution associated with the B_1 mass range.

---

* For more details, see the reference 1 cited above.

Such a behaviour is not foreseeable from a simple $\omega^{o}\pi^{+}\pi^{-}$ decay of the A_2. Indeed, the fig. 4 shows the two last central distributions we have isolated; the curves are for the predictions of the different decay modes one can suppose a <u>priori</u> for the A_2^{o}. Their Monte-Carlo generations take into account the Bose symmetrization and the angular momentum conservation; the non-A_2 background includes all the other final states interactions which are observed in the 1C-sample ($\omega^{o}\rho\pi\pi$, $\omega\rho\rho$ final states and $X(I^G = 1^-)$ production). Moreover:

1) through the simple $\omega^{o}\pi^{+}\pi^{-}$ mode, one has given chance to all the possible angular momenta up to $\ell = 2$ between the three particles, by assuming that we are in presence of the A_2^{o} with $J^P + 2^+$.

2) the $\omega^{o}\rho^{o}$ decay should take place under its threshold and one has assumed an S-wave between the ω^{o} the ρ^{o}.

3) finally the $B^{\pm}\ \pi^{\mp}$ decay mode is described according to the schema:

$$\begin{array}{lll} A_2 \longrightarrow & B^- & \pi \\ 2^+ & 1^+ & 0^- \\ & \multicolumn{2}{c}{\underbrace{\qquad\quad}_{\ell = 1}} \end{array}$$

In conclusion, these different possibilities are far from describing the experimental data which include now about 2,000 ($\omega\pi\pi$) decays of the A_2^{o}. At the present stage of the experiment (the initial sample has to be multiplied by a factor 4) only the hypothesis of a $B_1\pi$ decay is in a position to explain the behaviour of the $\omega^{o}\pi^{+}\pi^{-}$ combinations issued from the A_2.

<u>REFERENCES</u>

1) C. Defoix et al, Collège de France Paris - Physics Letters 43B, no. 2, p. 141.

2) Review of Particle Properties - Physics Letters 50B (1974), p. 92.

3) Analysis of narrow effects in $\bar{p}p$ annihilations - C. Defoix, Proceedings of the Chexbres Symposium on nucleon-antinucleon annihilations, p. 288.

FIGURE CAPTIONS

1. Successive $\pi^+\pi^-\pi^o$ effective mass histograms from which the $\omega^o\pi^\pm$ mass distribution is obtained.

   Each $\pi^+\pi^-\pi^o\pi^+$ (and c.c.) combination contains two $\pi^+\pi^-\pi^o$ combinations which are histogrammed. Thus, to each $(4\pi)^\pm$ mass interval (ΔM = 15 MeV) it corresponds a $(3\pi)^o$ mass distribution such that $(3\pi)^o$ C$(4\pi)^\pm$.

   The different curves are explained in the text.

2. $\omega^o\pi^+\pi^-$ effective mass distribution deduced by the method of "self consistant background" exposed in the text, and issued from the second and new sample of 6,100 (1C) events.

3. a) Distributions of $\omega^o\pi^\pm$ masses contained in $\omega^o\pi^+\pi^-$ combinations issued from the three successive mass intervals:

   1) [1.18 - 1.27] GeV; 2) [1.27 - 1.36] GeV; 3) [1.36 - 1.45] GeV

   The two lateral distributions are presented in the form of usual histograms to make easy their comparison with the central one which is associated with the A_2 region.
   The estimation of errors includes the fluctuation of the background under each ω^o signal.

   B) Distributions of $\omega^o\pi^+\pi^-$ masses containing at least one $\omega^o\pi^\pm$ combination in the three following mass intervals:

   1) [0.91 - 1.] GeV; 2) [1. , 1.09] GeV; 3) [1.09 - 1.18] GeV

   The second distribution is associated with the B_1 mass range.

4. Comparison of the different decay mode behaviours with the two central $\omega^o\pi^\pm$ and $\omega^o\pi^+\pi^-$ distributions shown on the fig. 3 [(B_1, A_2) region].

   The curves are explained in the text.

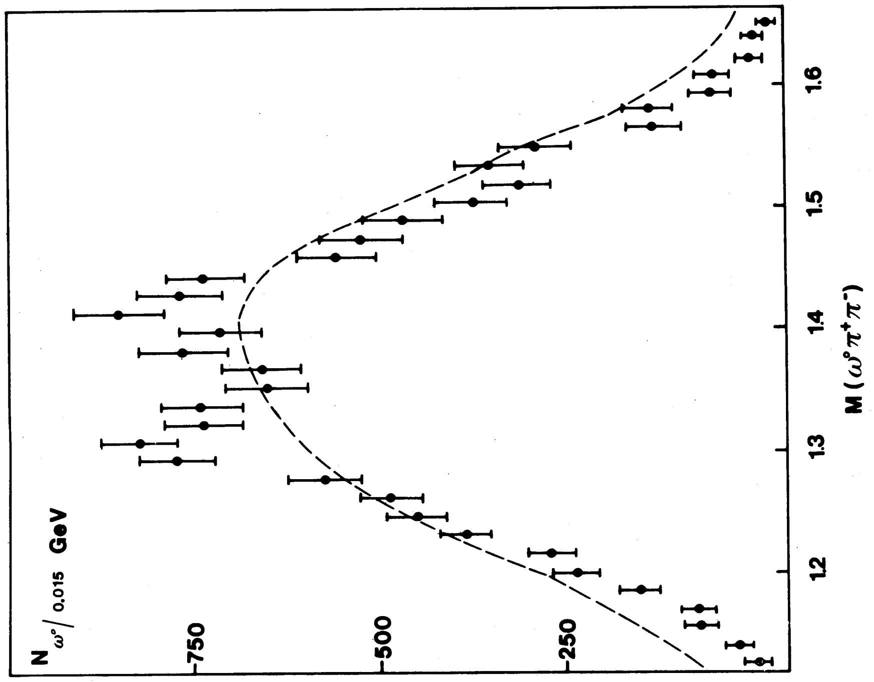
N ω°/0.015 GeV
750
500
250
1.2
1.3
1.4
1.5
1.6
M(ω°π+π−)

Fig. 2

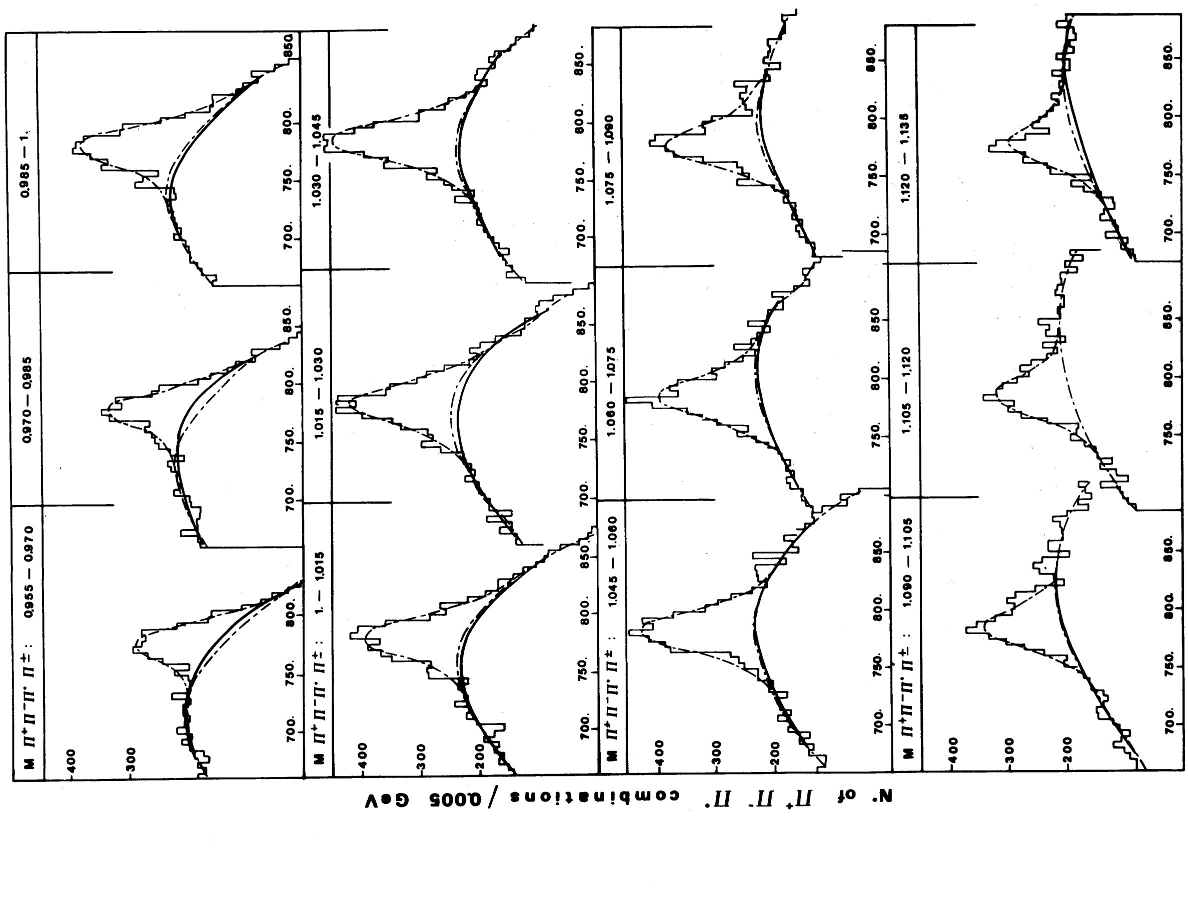
N° of π+ π− π° combinations / 0.005 GeV
0.955 – 0.970
0.970 – 0.985
0.985 – 1.
1. – 1.015
1.015 – 1.030
1.030 – 1.045
1.045 – 1.060
1.060 – 1.075
1.075 – 1.090
1.090 – 1.105
1.105 – 1.120
1.120 – 1.135
400
300
200
700.
750.
800.
850.

Fig. 1

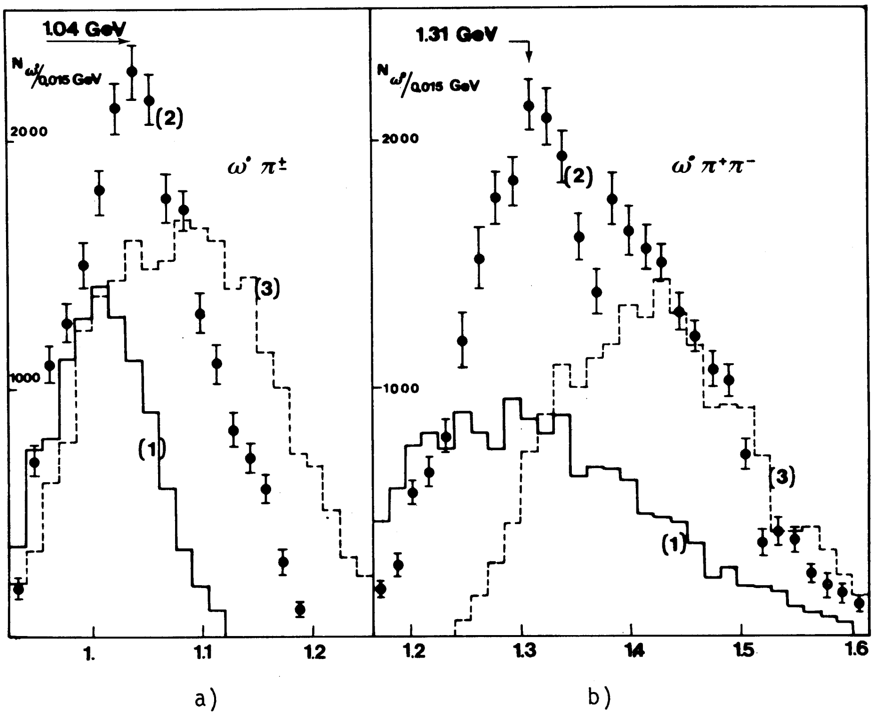
1.04 GeV
$N_{\omega^\circ}/0.015$ GeV
2000
1000
(1)
(2)
(3)
$\omega^\circ \pi^\pm$
1.
1.1
1.2
a)
1.31 GeV
$N_{\omega^\circ}/0.015$ GeV
2000
1000
(1)
(2)
(3)
$\omega^\circ \pi^+\pi^-$
1.2
1.3
1.4
1.5
1.6
b)

Fig. 3

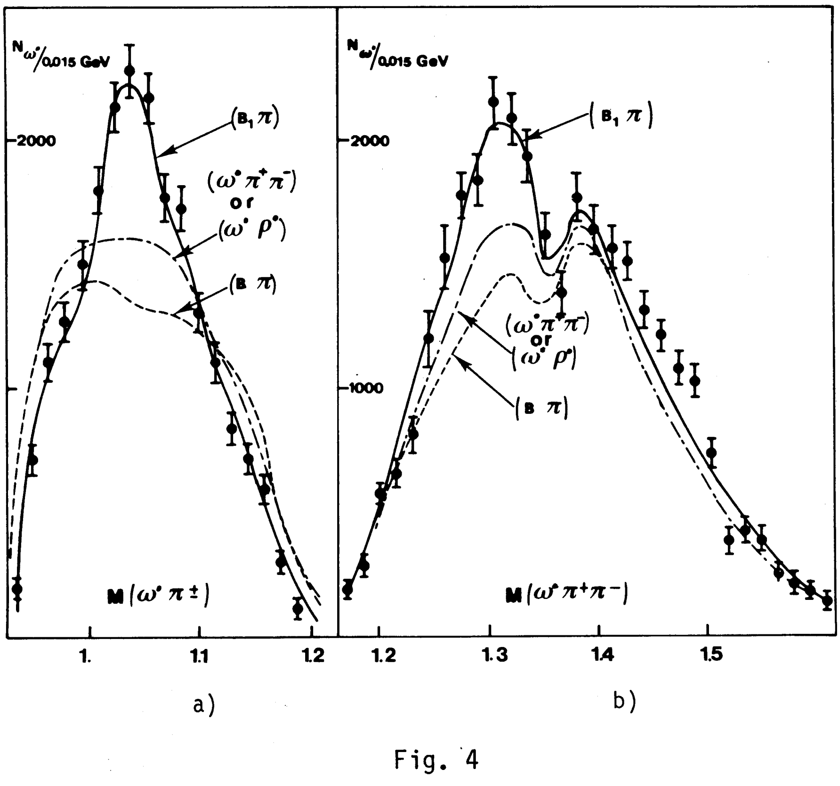
$N_{\omega^\circ}/0.015$ GeV
2000
$(B_1\pi)$
$(\omega^\circ\pi^+\pi^-)$
or
$(\omega^\circ\rho^\circ)$
$(B\ \pi)$
$M(\omega^\circ\pi^\pm)$
1.
1.1
1.2
a)
$N_{\omega^\circ}/0.015$ GeV
2000
1000
$(B_1\ \pi)$
$(\omega^\circ\pi^+\pi^-)$
or
$(\omega^\circ\rho^\circ)$
$(B\ \pi)$
$M(\omega^\circ\pi^+\pi^-)$
1.2
1.3
1.4
1.5
b)

Fig. 4