

Study on the $a_2^- \rightarrow \pi^+ \pi^- \pi^-$ decay mode

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ABSTRACT:

Pile-up-effect associated with PMT(Photo Multiplier Tube) are undesirable as these would affect the detection of the particles passing through the scintillator of the counter. This effect arises due to the distortion of PCS (Photo Cathode Surface) of PMT as a result of high rate effect, background effect & accidentals resulting distorted out - put pulses. Keeping all these in mind we have analysed the $\pi^- p \rightarrow a_2^- p$ data near its production threshold incident pion beam momentum P_π . The background has been sufficiently reduced and the pile-up-effects have been avoided.

The results presented here on the analysis of $a_2^- \rightarrow \pi^+ \pi^- \pi^-$ decay mode are helpful in avoiding pile-up-effects. The a_2^- meson was produced in the interaction near its production threshold incident pion beam momentum. The production cross- section of the a_2^- meson produced in the $\pi^- p$ interaction is sufficiently high to be detected. Its mass and width have been estimated to be about 1320 MeV and 4 MeV respectively. These results are in good agreement with those of others as compiled by Groom *et al.*

Key words: Meson Branching Ratio, Yield curve, Gamma, Proton

INTRODUCTION:

Scintillation counters have been widely used in modern experiments. In its basic form it consists of a scintillator, a light guide, (LG) and a photo multiplier tube

(PMT). The PMT consists of a photo cathode surface (PCS) with a layer of CsI applied on its surface.

Many types of problems have been faced in experiments equipped with many scintillation counters. These include the presence of accidentals, high rate effects and background effects. As a result of these problems, the results obtained in the experiment are adversely affected. This would cause wrong conclusions as well as the non reproducibility of the data.

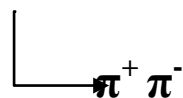
In many experiments pile-up-effects have been observed with the presence of high rate of the particles impinging on the scintillator. It has been found that this would cause an undesired effect for the detection of a particle. In such cases the response of a scintillation counter becomes unreliable.

Beside this we have found the non uniformity of the PCS of a PMT. It means that there is a certain variation in the response of the PMT depending upon the impact of the particles on different area of the PCS.

Keeping all these in mind we have analysed the $\pi^- p \rightarrow a_2^- p$ data near its production threshold incident pion beam momentum P_π . The background has been sufficiently reduced and the pile-up-effects have been avoided.

An investigation on the a_2^- (1320) meson constitute a topic of great interest. The mass and width of a_2^- meson have been estimated to be (1318.0 ± 0.6) MeV and (107 ± 5) MeV respectively. Its quantum numbers are given by $I^G J^{PC} = \rho^- 2^{++}$, its main decay modes are

(i) $a_2^- \rightarrow \rho^0 \pi^-$ with a branching ratio (BR) of $(70.1 \pm 2.2)\%$ and



(ii) $a_2^- \rightarrow \eta \pi^-$ with a B.R. of $(14.5 \pm 1.2)\%$.

Here we report some results on the $\pi^- p$ data analysis for the $a_2^- \rightarrow \pi^+ \pi^- \pi^-$

decay mode of the a_2^- meson. The a_2^- meson has been produced in the $\pi^- p \rightarrow a_2^- p$

(i) interaction near its production threshold incident pion beam momentum P_π .

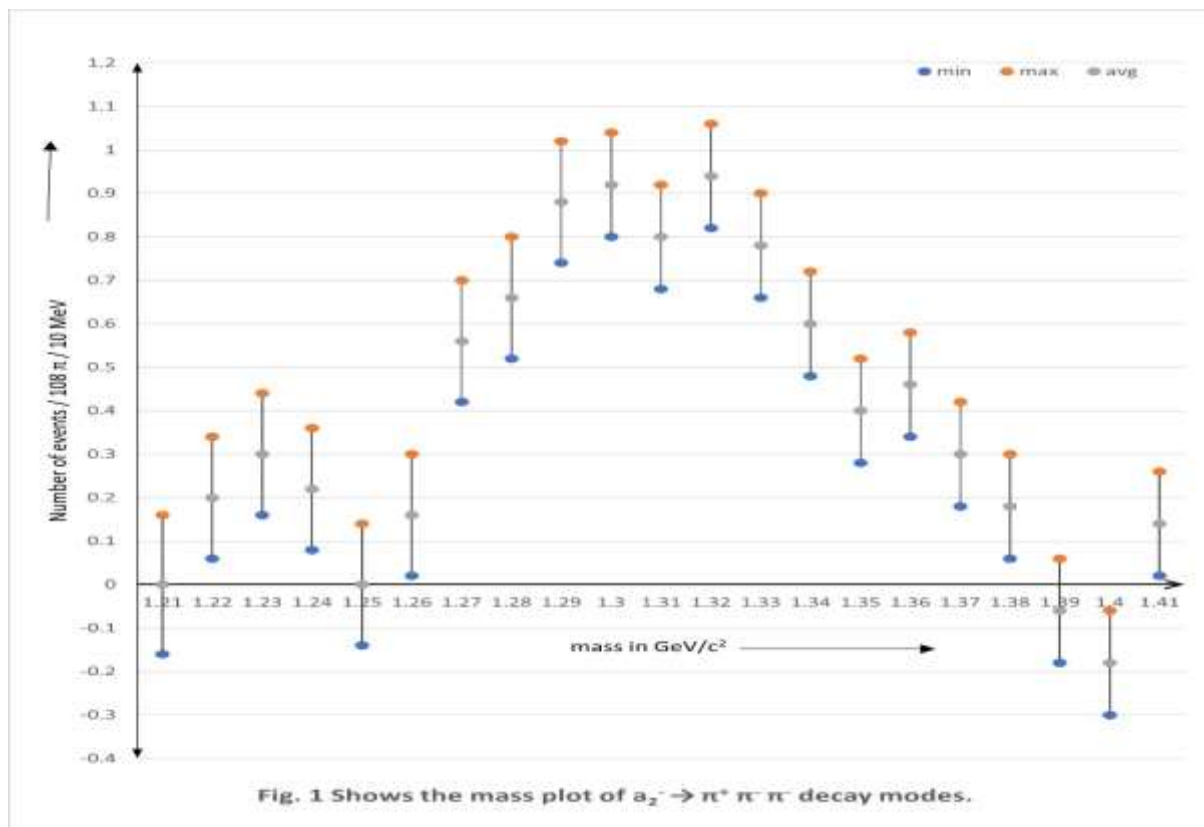
DISCUSSION:-

Here we report some results on the $\pi^- p$ data analysis for the $a_2^- \rightarrow \pi^+ \pi^- \pi^-$ decay mode of the a_2^- meson. The a_2^- meson has been produced in the

$$\pi^- p \rightarrow a_2^- p \quad (1)$$

interaction near its production threshold incident pion beam momentum P_π .

In this experiment, We measure only two quantities, viz (i) the time of flight (TOF) of the nucleons produced in the final state of the $\pi^- p$ interaction (1) and (ii) momentum of the pion beam incident on a liquid hydrogen target.



Fig(1) shows a mass plot for $\pi^+ \pi^- \pi^-$ events. It has been obtained by plotting the number of $\pi^+ \pi^- \pi^-$ events / 10^8 pions at different values of the masses near the a_2^- (1320) mass region over a specified TOF region, called gate.

A centre of mass (CM) gate has been selected for the purpose.

Number of observations	MASS GeV/c ²	Number of events/10 ⁸ π /10MeV
1	1.21	0.00 \pm 0.16
2	1.22	0.20 \pm 0.14
3	1.23	0.30 \pm 0.14
4	1.24	0.22 \pm 0.14
5	1.25	0.00 \pm 0.14
6	1.26	0.16 \pm 0.14
7	1.27	0.56 \pm 0.14
8	1.28	0.66 \pm 0.14
9	1.29	0.88 \pm 0.14
10	1.30	0.92 \pm 0.12
11	1.31	0.80 \pm 0.12
12	1.32	0.94 \pm 0.12
13	1.33	0.78 \pm 0.12
14	1.34	0.60 \pm 0.12
15	1.35	0.40 \pm 0.12
16	1.36	0.46 \pm 0.12
17	1.37	0.30 \pm 0.12
18	1.38	0.18 \pm 0.12
19	1.39	-0.06 \pm 0.12
20	1.40	-0.18 \pm 0.12
21	1.41	0.14 \pm 0.12

Table 1 Enlists the number of $\pi^+ \pi^- \pi^-$ events against the masses near the a_2^- mass region produced in the $\pi^- p \rightarrow a_2^- p$ interaction.

CONCLUSION:-

An inspection of this mass plot shows that:-

- (i) There is a statistically significant enhancement for the a_2^- (1320) meson.

- (ii) It means the a_2^- meson has been copiously produced in the π^-p interaction (1) near its production threshold, p_π .
- (iii) The a_2^- meson has its mass near 1320 MeV with an approximate width of 100 MeV.
- (iv) It decays into $\pi^+\pi^-\pi^-$ channel.

This result is in agreement with those of others as compiled by Groom et al.

So these results on the a_2^- meson are very encouraging.

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