PHYSICAL REVIEW D VOLUME 3, NUMBER 5 1 MARCH 1971

Comments and Addenda

The Comments and Addenda section is for short communications which are not of such urgency as to justify publication in Physical Review Letters *and are not appropriate for regular articles. It includes only the following types of communications: (1) comments on papers previously published in* The Physical Review *or* Physical Review Letters; *(2) addenda to papers previously published in* The Physical Review *or* Physical Review Letters, *in which the additional information can be presented without the need for writing a complete article. Manuscripts intended for this section may be accompanied by a brief abstract for information retrieval purposes. Accepted manuscripts will follow the same publication schedule as articles in this journal, and galleys will be sent to authors.*

Λp Resonance Observed in Nuclear Emulsion

D. P. GOYAL*

Department of Physics, Imperial College of Science and Technology, London SW7, England

(Received 7 July 1970)

It is found that the reported enhancement in the Λp mass distribution at 2110 MeV in an emulsion experiment of Jain is probably due to experimental biases in the data.

RECENTLY, an enhancement in the Λp mass distribution has been reported[1] from an analysis of K^- capture at rest with nuclear emulsions giving rise to Λ, p, and π^- final state particles. The enhancement is situated at 2110 MeV and has a full width at half-maximum of about 20 MeV. With these observations, a claim of a possible Λp resonance having $I=\frac{1}{2}$, $J=1$, $l=0$ has been made. Earlier several bubble-chamber experiments performed with K^- interactions in deuterium have been reported[2–6] in which an enhancement in the Λp mass distribution from $K^-d\rightarrow\Lambda p\pi^-$ reaction has been observed. The mass M and width Γ of the enhancement are observed as $M\approx 2126$ MeV, $\Gamma\sim 10$ MeV by Cline *et al.*[3]; $M\simeq 2130$ MeV, $\Gamma\sim 10$ MeV by Alexander *et al.*[4]; $M\approx 2129$ MeV, $\Gamma\sim 7$ MeV by Tan[5]; and $M\approx 2129$ MeV, $\Gamma\sim 10$ MeV by the BEGI collaboration.[6] The only positive claim of a resonance in these experiments is made by Cline *et al.*,[3] whose Λp mass peak is well below the $\Sigma^+ n$ threshold of ≈ 2129 MeV. The results of other experiments have been mostly explained as due to a kinematic effect.

The mass and width of the Λp enhancement, $M\simeq 2110$ MeV, $\Gamma\simeq 20$ MeV, as observed in emulsion[1] is clearly inconsistent with the values $M=2126$–2130 MeV and $\Gamma\leq 10$ MeV, quoted in deuterium experiments.[3–6] In what follows, we wish to point out that the emulsion result[1] could be subject to experimental biases, and therefore the observed result is of a doubtful nature.

It is well known that the scanning efficiency for two-prong stars (due to V^0 decays) in nuclear emulsions is very low. Further, once having found a V^0-decay event, its correlation with the parent star, which may be separated by distances $\gtrsim 1$ cm, cannot be found reliably. With the exception of mass measurements (which do not require any knowledge of the parent star), properties like spin, lifetime, decay modes, etc. for the Λ hyperon have for these reasons been studied almost exclusively using bubble-chamber or cloud-chamber techniques. Several years ago, we reported[7] our studies of the Λ hyperon in nuclear emulsion. We scanned Λ events by three different methods.

(i) Following back the tracks of π^- mesons from π^--capture stars: In this method, an area scan was first made for π^--capture stars in the region of stopping K^- mesons. The pion tracks from these stars were then traced back to their points of origin or 25 mm, whichever distance was less.

(ii) Area scan for V events: In this method a direct search was made under low magnification (10×15) for two-prong stars in which one of the secondary tracks may be due to a π meson and the other due to a proton.

(iii) Area scan for "hanging tracks": In this method an area scan was made under low magnification (10×15) for grey or black tracks which appear to have originated within the emulsion pellicle. The point of origin of the track was then scrutinized under higher magnification (100×15) to detect the presence of an associated track which may be otherwise missed under low magnification.

---

[*] Present address: Department of Physics and Astrophysics, University of Delhi, Delhi-7, India.

[1] P. L. Jain, Phys. Rev. **187**, 1816 (1969).

[2] O. I. Dahl, N. Horwitz, D. H. Miller, J. J. Murray, and P. G. White, Phys. Rev. Letters **6**, 142 (1961).

[3] D. Cline, R. Laumann, and J. Mapp, Phys. Rev. Letters **20**, 1452 (1968).

[4] G. Alexander, B. H. Hall, N. Jew, G. Kalmus, and A. Kernan, Phys. Rev. Letters **22**, 483 (1969).

[5] Tai Ho Tan, Phys. Rev. Letters **23**, 395 (1969).

[6] Birmingham-Edinburgh-Glasgow-Imperial College collaboration (unpublished).

[7] B. Bhowmik, D. P. Goyal, and N. K. Yamdagni, Nuovo Cimento **22**, 296 (1961); **21**, 1066 (1961); **23**, 108 (1962).

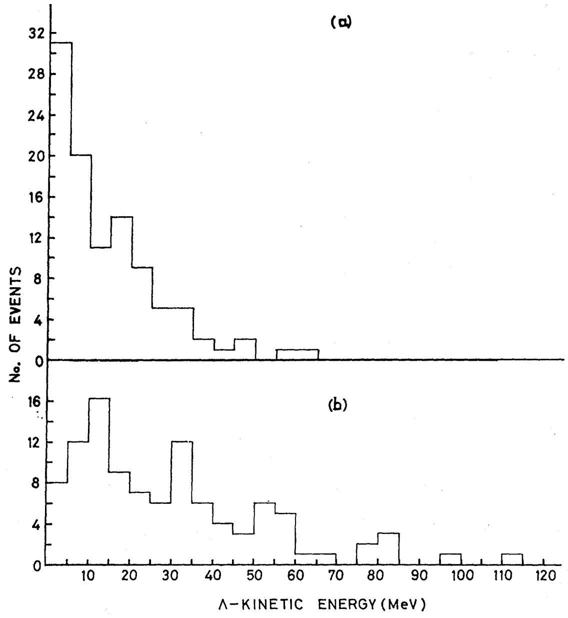

FIG. 1. Energy spectra of Λ events: (a) data of Ref. 1; (b) our data.

The first method gives events having a restricted range of the decay pion and thus the Λ sample obtained would be biased. Events found by method (ii) preferentially record those events in which both the decay π^- and p are rather slow, appearing as grey or black tracks, and having an opening angle fairly large, $\gtrsim 30°$. Most events missed by method (ii), however, could be recorded by method (iii), the decay proton always being expected to be "grey" for the highest energy of the Λ, ~150 MeV. Some events are, of course, still missed by both methods; in particular, those having a very short proton track and a rather fast pion track, either of which is difficult to observe under low magnification.

In Figs. 1(a) and 1(b) we reproduce the Λ-energy spectra for events reported in Ref. 1 and for 103 of our events found by scanning methods (ii) and (iii). A comparison of these figures reveals a general disagreement of shapes of the two distributions. The proportion of slow Λ's having, energy ≤ 20 MeV, is 75% in Fig. 1(a), which is considerably higher than the 45% found in Fig. 1 (b). The highest energy of a Λ in Fig. 1(a) is ~65 MeV, while in Fig. 1(b) it is ~115 MeV. The above disagreement is not surprising since events collected in Ref. 1 are those scanned by method (ii) only, which selects preferentially low-energy Λ's.

We next examine the question of correlation of an observed Λ with the parent K^- star. The actual production of an observed Λ in emulsion could be either from a K^--capture star, or from a $\Sigma^\pm$ interaction or capture star, or from a $\Sigma^0 \rightarrow \Lambda + \gamma$ decay. Further, a Λ after being produced could, in some cases, change its original direction because of nuclear scattering in the dense medium of the emulsion. A scan along the calculated direction of flight from the observed Λ decay could therefore lead to several choices of the parent stars. As reported in Ref. 1, in some cases more than one K^--capture star corresponding to a particular Λ is indeed found. The possibility of the Λ being produced from a $\Sigma^\pm$ interaction or Σ^0 decay, however, seems to have been ignored. A distribution of the measured proper lifetime of the Λ events could have thrown some light on the reliability of the sample collected in Ref. 1. However, no such estimate is reported.

It may be further remarked that a K^- capture in emulsion would take place on one of its constituent nuclei, which are mainly C, N, O, Ag, and Br. The assumption, then, that an observed final state of Λ, π^-, and p has arisen due to a K^- capture on two nucleons only, and the presence of other nucleons has not distorted the primary interaction, is not well substantiated in Ref. 1.

To conclude, the reported Λp enhancement in nuclear emulsion[1] is open to considerable doubt because of experimental difficulties and biases discussed above. The Λp enhancement probably occurs due to a preferential selection of low-energy Λ's.

I wish to express my sincere thanks to Professor C. C. Butler for his warm hospitality at the Imperial College. I am especially grateful to Dr. S. J. Goldsack for his continuous encouragement.