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THE OBSERVATION OF $^{4}_{\Lambda}$H RELATIVISTIC HYPERNUCLEI PRODUCED IN ^{4}He COLLISIONS WITH LIGHT NUCLEI AT 18 GeV/c

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There is hitherto only one experimental result on cross sections for hypernuclei production and their mean life-time obtained by means of projectile relativistic ions /1/. In this paper we present our preliminary results on the cross section for ${}^4_\Lambda H$ hypernuclei production in a ${}^4He$ beam (3.7 GeV/nucleon), the estimate of ${}^4_\Lambda H$ mean life-time and the upper limit of the cross section for ${}^7_\Lambda Li$ production in a ${}^7Li$ beam (3.0 GeV/nucleon).

The data have been obtained with the spectrometer GIBS exposed to extracted beams of nuclei accelerated in the Dubna synchrophasotron. The registering part of the spectrometer is a streamer chamber ($2 \times 1 \times 0.6$ m^3) filled with a pure neon gas under atmospheric pressure and placed in a magnetic field of 0.9 T. During the run with the ${}^7Li$ beam the scintillation counters of A, B and C groups (Fig.1) were tuned to select ions with charges 3,3 and 4, respectively, what suggested the ${}^7_\Lambda Li$ production in a target with a consequent decay ${}^7_\Lambda Li \to \pi^- + {}^7Be$. Analogously, during the run with the ${}^4He$ beam the counters of A, B and C groups were tuned to select ions with charges 2,1 and 2, respectively. This suggested the ${}^4_\Lambda H$ hypernuclei production in a target with a consequent decay ${}^4_\Lambda H \to \pi^- + {}^4He$ within the sensitive volume of the chamber.

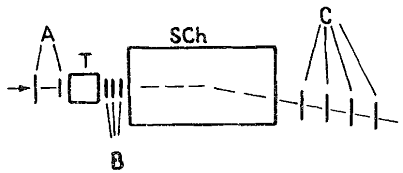

Fig.1. Experimental set-up. A,B,C - the groups of scintillation counters, T-target, SCh-streamer chamber.

As a result of analysis of the obtained pictures, we have found five registered ${}^4_\Lambda H \to \pi^- + {}^4He$ decays. One event has been registered, which can be interpreted as a ${}^7_\Lambda Li \to \pi^- + {}^7Be$ decay. The characteristics of the five ${}^4_\Lambda H$ decays are given in a table. As is seen from the table, the effective masses of a (${}^4He + \pi^-$) system are in good agreement with the mass of the ${}^4_\Lambda H$ hypernucleus which is equal to 3922.5 MeV /2/. There is also an additional argument for proper identification of these events, namely the difference in the ionization of primary (${}^4H$) and secondary (${}^4He$) tracks which is distinctly observable in the pictures. By means of momentum measurements in the two-prong events including ${}^4_\Lambda H$ decays, we were able to separate secondary ${}^4He$ and ${}^3He$ nuclei (see Fig.2), which usually have almost the same veloci-

Table 1

M_{eff} (GeV/c^2)	P_{He} (GeV/c)	P_{π} (GeV/c)	l (cm)
3.9254±0.0034	15.82±0.98	0.5939±0.0058	61.5
3.9267±0.0042	16.38±1.12	0.5805±0.0071	61.4
3.9205±0.0018	15.90±0.48	0.8090±0.0120	4.9
3.9220±0.0018	16.18±0.47	0.8250±0.0120	4.5
3.9143±0.0094	16.71±1.34	1.411 ±0.029	83.2
3.9098±0.0097	17.30±1.54	1,398 ±0.031	83.2
3.9226±0.0041	15.77±0.60	1.2799±0.0170	47.8
3.9220±0.0044	15.78±0.62	1.2779±0.0250	47.8
3.9195±0.0027	15.97±0.43	0.4430±0.0027	18.5
3.9216±0.0027	16.27±0.42	0.4410±0.0027	18.4

M_{eff} - effective mass of a ($\pi^- + {}^4He$) system,

P_{He} - momentum of ${}^4He$,

P_{π} - momentum of π^- meson,

l - ${}^4H$ range in the chamber fiducial volume.

Two results of measurements are given for each of five events.

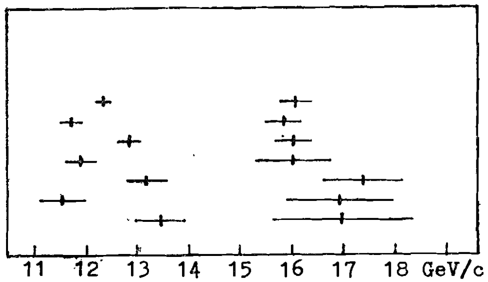

Fig.2. Momentum distribution of He nuclei.

ty. It should be noted that the hypernucleus decays ${}^4_\Lambda H \to \pi^- + {}^4He$ cannot be imitated by charge exchange reaction ${}^4H + Ne \to {}^4He + \pi^- + ...$ because the ${}^4H$ isotope decays within nuclear time /3/.

The number of the registered ${}^4_\Lambda H$ decays allows us to estimate the cross section for production with a polyethylene target $\sigma({}^4_\Lambda H) \simeq 0.1/R_1$ microbarns, where

$$R_1 = \frac{\Gamma({}^4_\Lambda H \to \pi^- + {}^4He)}{\Gamma({}^4_\Lambda H \to \text{all channels})} .$$

According to Refs. /4-6/, $R_1 \sim 0.5$ and therefore $\sigma({}^4_\Lambda H) \sim 0.2$ mcb (~ 0.02 mcb per target nucleon). If for

$$R_2 = \frac{\Gamma({}^7_\Lambda Li \to \pi^- + {}^7Be)}{\Gamma({}^7_\Lambda Li \to \text{all channels})}$$

we use $R_2 \sim 0.1$ (according to data in /5-7/), then the upper limit of the cross section for ${}^7_\Lambda Li$ production is about 1 mcb (0.1 mcb per target nucleon).

Our cross section data essentially differ from those for ${}^{16}_\Lambda O$ hypernuclei production in a ${}^{16}O$ beam at an energy of 2.1 GeV/nucleon /1/ ($\sim$ 2 mcb per target nucleon) and are in qualitative agreement with theoretical estimations /8,9/ of the cross section for hypernuclei production in peripheral collisions.

The estimation of the ${}^4_\Lambda H$ hypernucleus mean lifetime yields $\tau = (3.3 {}^{+2.3}_{-1.2}) \cdot 10^{-10}$ s.

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