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OBSERVATION OF NARROW BARYONIUMS IN THE EXPERIMENT BIS-2.

2. Baryoniums with Hidden Strangeness

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Prague — Sofia — Tbilisi

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In the experiments WA-62 [1,2] and BIS-2 [2,3,4] performed at the CERN SPS and at the Serpukhov accelerator respectively, narrow resonances U/M_s with a mass of ~3100 MeV/c^2 - candidates into the strange baryonium were observed. Their main characteristics do not fit into the standard quark-antiquark scheme of mesons, but can be described within the assumption of their multiquark structure with one strange quark/antiquark ($sq\bar{q}\bar{q}/\bar{s}\bar{q}qq$). Corresponding hadron multiplets might also include the baryonium with hidden strangeness, i.e. containing strange quark and antiquark. The mass of such resonance must be greater than the mass of U/M_s, and it might decay with the production of strange particles.

In the given paper the results of the search for baryoniums with hidden strangeness are presented. They are obtained in the analysis of the same data which is analysed in Section 1 of the given paper [4]. Preliminary data obtained in part of the statistic are presented in [5].

The baryoniums with hidden strangeness were searched for in the decays containing baryon, antibaryon and the strange particles:

$$\Lambda\bar{p}K^+, \qquad (1a)$$

$$\bar{\Lambda}pK^-, \qquad (1b)$$

$$\Lambda\bar{p}K^+\pi^+, \qquad (2a)$$

$$\bar{\Lambda}pK^-\pi^+, \qquad (2b)$$

$$K^0_s\bar{p}pK^+, \qquad (2c)$$

$$\Lambda\bar{p}K^+\pi^-, \qquad (2d)$$

$$\bar{\Lambda}pK^-\pi^-, \qquad (2e)$$

and

$$K^0_s\bar{p}pK^-. \qquad (2f)$$

The eight states listed above are the most acceptable for searching for such baryoniums in our experiment.

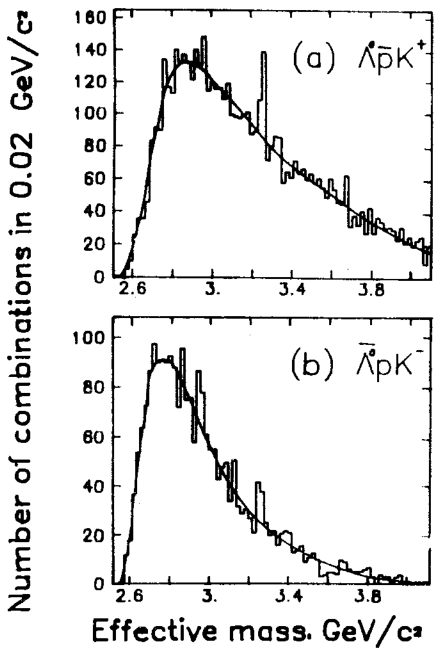

Fig. 1. Invariant mass spectra of the systems: *a)* $\Lambda\bar{p}K^{+}$, *b)* $\bar{\Lambda}pK^{-}$.

In the experiment $\sim 2.2\cdot 10^{5}$ events containing Λ, $\sim 1.5\cdot 10^{5}$ events containing K°_{s}, and $\sim 2.7\cdot 10^{4}$, containing $\bar{\Lambda}$ were detected. The K°_{s} decays were identified by the decays $K^{\circ}_{s} \to \pi^{+}\pi^{-}$, for which the V°'s were accepted, if their invariant mass did not differ from the mass of K°_{s} more than 10 MeV/c². The Λ, $\bar{\Lambda}$ selection criteria are presented in section 1 of the given paper [4] .

For histogramming the invariant mass spectra of the systems (1a)-(2f) the events containing Λ, $\bar{\Lambda}$, or K°_{s}, and at least two charged hadrons h+ and h- emitted from the interaction point were selected. Taking into account the conditions mentioned above, 62345, 8241 and 54211 events of this type, containing Λ, $\bar{\Lambda}$ and K°_{s} respectively were selected.

For identification of the charged hadrons [4] the information from multichannel threshold gas Cherenkov counters C1/2 [6] was used. The majority of the particles, candidates into p/p̄ or K+/-, have momenta lower than 11 GeV/c, which is below the kaon thresholds in C1/2. Therefore, in the analysis of each of the combinations the particle - candidate into p/p̄ or K+/-, has not to be identified as a pion. All the possible combinations satisfying these conditions were remained for further analysis.

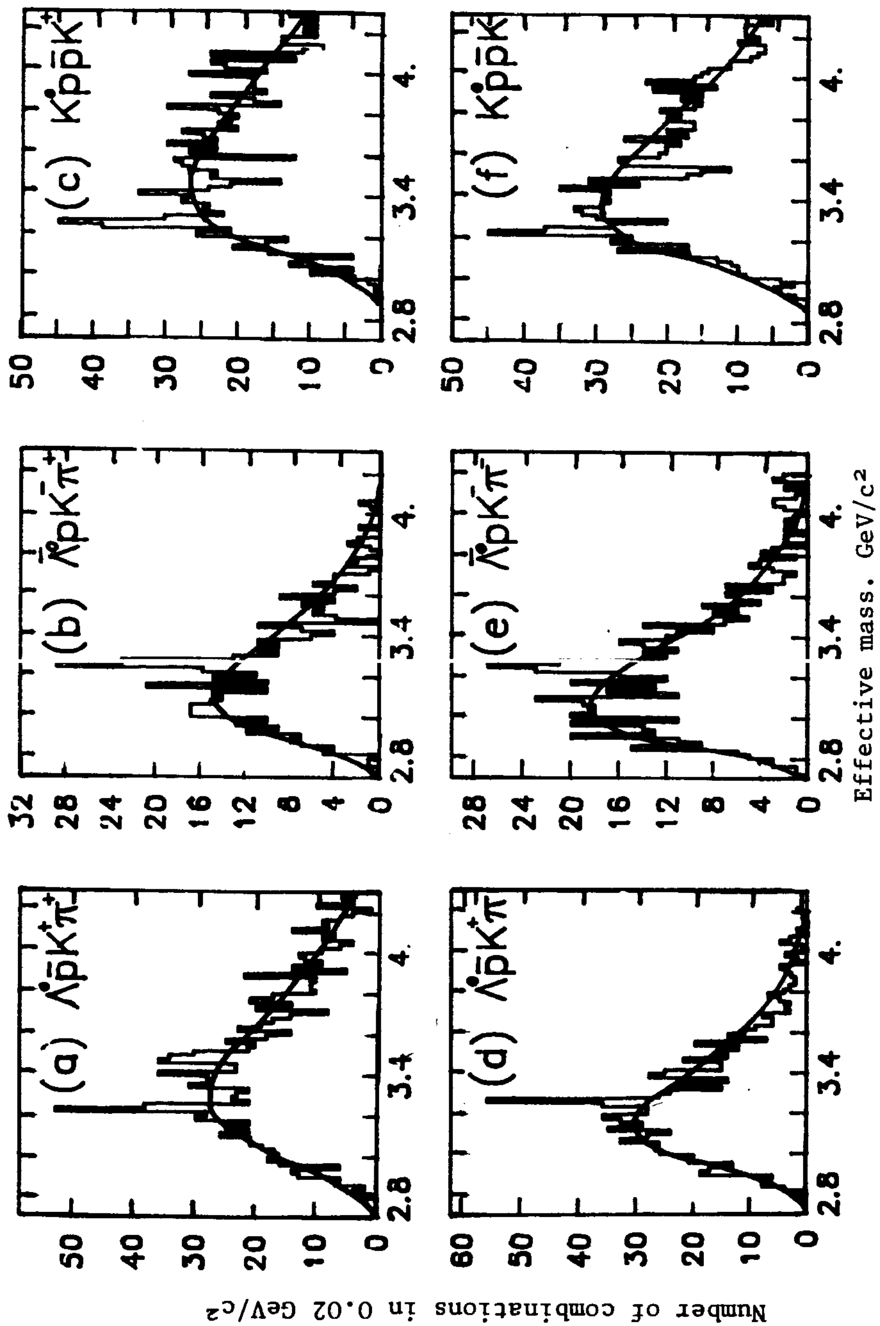

Fig. 2. Invariant mass spectra of the systems: *a)* $\Lambda\bar{p}K^{+}\pi^{+}$, *b)* $\bar{\Lambda}pK^{-}\pi^{+}$, *c)* $K^{\circ}_{s}\bar{p}pK^{+}$, *d)* $\Lambda\bar{p}K^{+}\pi^{-}$, *e)* $\bar{\Lambda}pK^{-}\pi^{-}$, *f)* $K^{\circ}_{s}p\bar{p}K^{-}$.

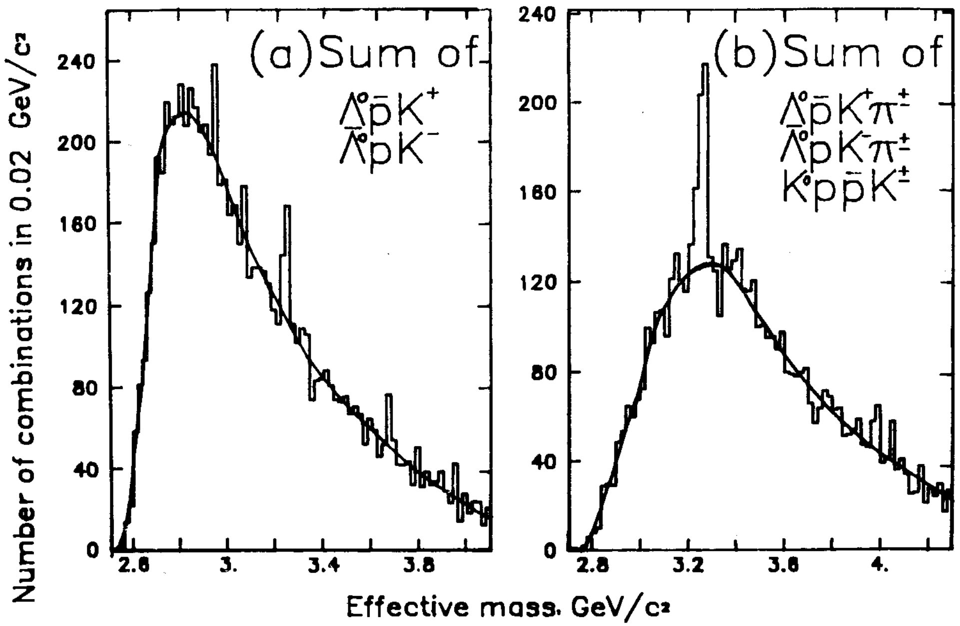

Fig.3. Summary invariant mass spectra of the systems: a) with zero charge, b) with non-zero total charge.

As a result, 5764, 2452, 1249, 460, 1293, 969, 615 and 1222 combinations corresponding to the final states (1a-2f) were selected. Their invariant mass spectra are shown in Figs. 1 and 2. In all the spectra peaks are seen: for the neutral states at the mass value of 3250 MeV/c^2 and for the charged states at the mass value of 3260 MeV/c^2. All eight peaks are statistically significant and, consequently, are physical signals. The characteristics of these peaks are listed in the table.

The results of summing up the invariant mass spectra for neutral (1a) and (1b) and the charged (2a-2f) combinations of the final states are shown on figs. 3(a) and (b). In both spectra the signals are seen. In fig. 3a there are 83±8 combinations and in fig. 3b there exist 197±12 combinations in the signals. In the mass regions of the signals the combinatorial background is about 1·1 combinations per event.

Thus, in all invariant mass spectra of the final states (1a) - (1b) and (2a) - (2f) the signals are seen in the mass interval (3220 - 3290) MeV/c^2. They cannot be the consequence of the kinematic reflection of any resonances, be-

Table

Final State	Mass interval of the signal, MeV/c^2	Number of combinations signal/background
$\Lambda\bar{p}K^+$	3220 - 3260	72/178
$\bar{\Lambda}pK^-$	3240 - 3280	30/50
$\Lambda\bar{p}K^+\pi^+$	3240 - 3280	36/55
$\bar{\Lambda}pK^-\pi^+$	3230 - 3290	30/38
$K^0_s p\bar{p}K^+$	3240 - 3300	36/48
$\Lambda\bar{p}K^+\pi^-$	3240 - 3280	37/55
$\bar{\Lambda}pK^-\pi^-$	3230 - 3290	25/46
$K^0_s p\bar{p}K^-$	3220 - 3260	36/46

cause they are narrow and are presented in eight different final states. Therefore, they indicate the existence of a narrow meson resonance, baryonium, with zero strangeness in three charged states (0, +, -). The mean mass value of the resonance is equal to: 3255±10(stat.)±30(syst.) MeV/c^2. The width of the resonance does not exceed 30 MeV/c^2.

From the detection efficiency estimates obtained by the Monte Carlo method and the values of the observed signals it follows that the decay widths of (1a), (2a) and (2c), are roughly coinciding with (1b), (2b) and (2f), respectively.

The analysis of the inclusive spectra of the longitudinal and transversal momentum components of the resonance shows that the region of its observation in the given experiment is limited by the Feynman variable $x > 0.2$ and by $P_t < 1$ GeV/c. The estimation of the production cross section dependence in this region on the atomic weight of the target nuclei (A) is not in contradiction with the dependence $A^{2/3}$. Taking into consideration this fact, the estimates of the resonance production cross section by neutrons on nucleon were obtained. In the observed region of the kinematic variables the production cross section times the branching ratio is 0.4÷3.0 μb per nucleon for neutral channels and 0.5 to 7 μb per nucleon for charged channels. The production cross section limits are corresponding to the 90% confidence level.

CONCLUSIONS

1. In eight invariant mass spectra of the neutral ($\Lambda\bar{p}K^+$ and $\bar{\Lambda}pK^-$) and charged ($\Lambda\bar{p}K^+\pi^{+/-}$, $\bar{\Lambda}pK^-\pi^{+/-}$ and $K^0_s\bar{p}pK^{+/-}$) final states the narrow peaks are observed at the same mass value. This indicates the existence of the narrow resonance decaying with production of strange particles. The mass of the resonance is $3255 \pm 10(stat.) \pm 30(syst.)$ MeV/c^2. The width of the resonance does not exceed 30 MeV/c^2.

2. This resonance is likely to be a baryonium, because among its decay products there are baryon and antibaryon. Its mass is 200 MeV/c^2 greater than the mass of the strange baryonium U/M_s [4]. Such mass difference is close to the typical splitting of the levels in the SU(3) multiplets of baryons [7], which differ in one unit of the hypercharge. As far as the resonance decays into the strange particles, it can be considered as a candidate into the baryonium with hidden strangeness - the representative of the same SU(3) multiplet of the exotic mesons, as U/M_s. In accordance with this, it is suggested to denote it by M_ϕ, where index ϕ denotes the hidden strangeness.

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Алеев А.Н. и др. Д1-88-369

Наблюдение узких барионием в эксперименте БИС-2.
2. Барионии со скрытой странностью

В эксперименте, выполненном сотрудничеством БИС-2 на Серпуховском ускорителе, проведен поиск бариония со скрытой странностью, продукты распада которого содержат барион-антибарионную пару, а также частицы с противоположными значениями странностей. В восьми различных спектрах инвариантных масс нейтральных и заряженных конечных состояний наблюдаются узкие пики около одного и того же значения массы, что указывает на существование нестранного бариония в зарядовых состояниях: +1, 0 и -1. Масса резонанса равна 3255 ± 10(стат.)± 30(сист.) МэВ/c^2. Ширина резонанса не превышает 30 МэВ/c^2.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1988

Aleev A.N. et al. D1-88-369

Observation of Narrow Baryoniums in the Experiment BIS-2.
2. Baryoniums with Hidden Strangeness

In the experiment carried out by the BIS-2 collaboration at the Serpukhov accelerator the search has been performed for baryoniums with hidden strangeness, decay products of which are containing baryon-antibaryon pair, and also particles with opposite strangenesses. In eight different invariant mass spectra of the neutral and charged final states, the narrow peaks are observed at one and the same mass value. This indicates the existence of the nonstrange baryonium in three charged states: +1, 0 and -1. The mass of the resonance is equal to 3255 ± 10(stat.)± 30(syst.) MeV/c^2. The width of the resonance does not exceed 30 MeV/c^2.

The investigation has been performed at the Laboratory of High Energies, JINR.

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