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EXPERIMENTS ON HADRON SPECTROSCOPY ON UNK HYPERON BEAM[†]

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The experimental program for the UNK hyperon beam is considered. It is expected, that a focused "pure" Σ^- hyperon beam with $P \simeq 2700$ GeV/c, intensity $> 10^7\ \Sigma^-/s$ and $>$ 85% of Σ^- hyperons may be created in this machine. The magnetized iron shielding will allow one to reduce the muon "halo" by two orders of magnitude. The experiments on the study of strange-charmed and strange-beauty baryons, search for exotic states with strangeness and charm and cryptoexotic strange hadrons with hidden charm and beauty are discussed.

1. INTRODUCTION

A very high primary energy of the UNK proton beam allows one to produce high quality intense hyperon beam, whose characteristics are close to those of usual hadron beams. At the UNK energies the decay length for charged hyperons is about $50 \div 100$ m. In this case it becomes possible to form focused hyperon beam in the channel with magnetic optics, as well as to construct a very reliable shielding, designed for the operation with the ultimate intensity of the proton beam (up to $3 \cdot 10^{14}$ p/cycle). The shielding includes an active guard system of magnetized iron slabs, which greatly reduces the muon background in the setup area. All these measures taken together make it possible to realize the operational modes in the range of $x_F > 0.9$, where $I(\Sigma^-) \gg I(\pi^-)$, which will be done for the first time in experiments. Almost pure Σ^- beam with momentum of $P_\Sigma = 2.7$ TeV/c and intensity $> 10^7\ \Sigma^- \mathrm{s}^{-1}$ may be obtained at the UNK 3 TeV machine. These properties of the UNK hyperon beam are unique.

The collaboration IHEP–ITEP–LINP–INPS MSU proposed to carry out a fundamental research program on the UNK hyperon beam of high luminosity[1]. The leading role in this program seems to belong to the experiments on heavy quark physics, which will enable a decisive check of the Standard Model, and the study of hadron structure and of the properties of ordinary and exotic states with beauty, charmed and strange quarks. Besides we will be able to carry out a search for low energy manifestations of new fundamental interactions.

2. UNK HYPERON BEAM[2]

The scheme of the UNK hyperon beam, which includes a system of particle quadrupole focusing and active muon shielding, is presented in fig. 1. The main parameters of the hyperon beam are: beam line length $L = 100$ m; total deflection angle 9.6 mrad; beam dimensions in the focus $\sigma_x \approx \sigma_y \approx (2 \div 3)$ mm; momentum bite $\sigma_p \approx 5\%$; momentum resolution in the beam spectrometer (M9, 10) $\sigma_p < 1\%$. Almost pure Σ^- beam (with pion admixture $< 15\%$) with momentum $p_\Sigma = 2.7$ TeV/c and intensity $1.5 \cdot 10^7\ \Sigma^- \mathrm{s}^{-1}$ may be produces per $10^{12}\ p \cdot s^{-1}$ (e.g. at $\sim$ 10% of maximum intensity of UNK proton beam). The integral fluxes of hyperons $N(\Sigma^-) \simeq 3 \cdot 10^{13}\ \Sigma^-$; $N(\overline{\Sigma^+}) \simeq 3 \cdot 10^8\ \overline{\Sigma^+}$; $N(\Xi^-) \simeq 3 \cdot 10^{11}\ \Xi^-$; $N(\Omega^-) \simeq 4 \cdot 10^8\ \Omega^-$ may be obtained per 100 days of the UNK machine operation ($3 \cdot 10^6$ s with an account of the 30% duty factor). The decay of π, K mesons from hadronic cascades produced in the target and beam chunnel elements is the main

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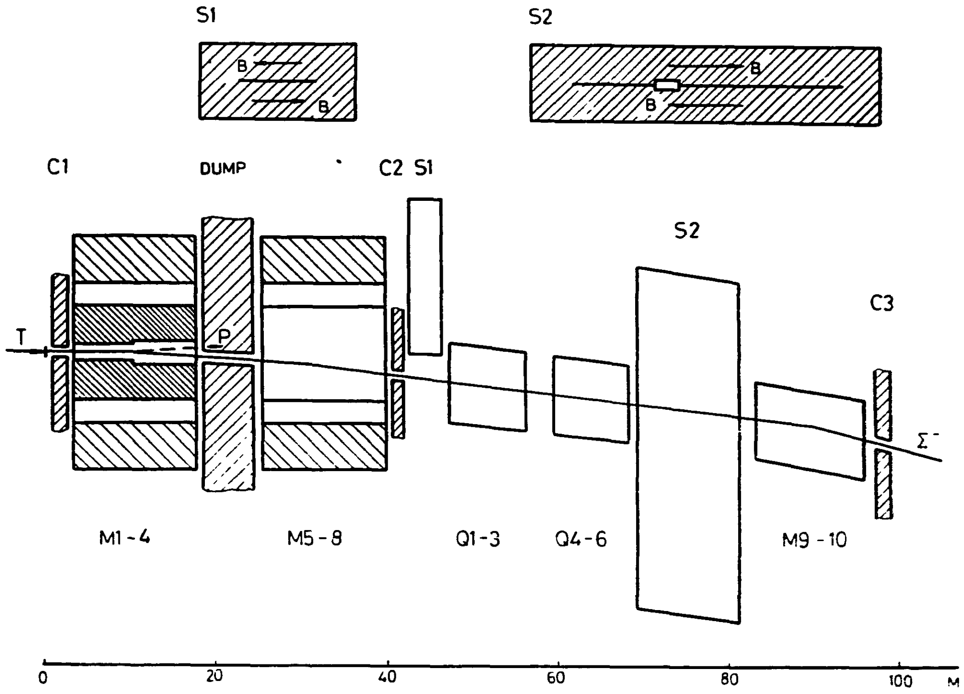

FIGURE 1
Hyperon beam layout: T—target; M1-M4—radiation resistant magnets; M5-M8—magnets; M9-M10—superconducting magnets; Q1-Q6—SC quadrupole lenses; C1-C3—collimators; DUMP—absorber to dump protons not interacting in the target; S1, S2—magnet spoilers.

muon source in the hyperon beam channel. An efficient shielding against muons may be provided if muons are deflected vertically with the help of an optimized system of two magnetic spoilers with oppositely directed currents (fig. 1). This system reduces the muonic flux onto experimental area $\simeq 10^2$ times and thus lowering muon background $N_\mu(\text{halo})/N_\Sigma(\text{beam})$ down to $< 3\%$.

3. EXPERIMENTAL FACILITY FOR HYPERON INVESTIGATIONS

The general layout of the experimental setup for the investigations on the UNK hyperon beam is presented in fig. 2. The setup consists of the following main elements:

1. hyperon beam identification system;
2. active target and vertex detector;
3. vertex magnetic spectrometer M1 to detect secondaries with intermediate momenta (with minidrift chambers and scintillation hodoscopes);
4. magnetic spectrometer M2 to detect fast secondaries (with track detectors and hodoscopes);
5. magnetic spectrometer M3 for the experiments in the region of large x_F ;
6. differential multichannel gas Čerenkov RICH counters of three types for secondary π, K, p identification in the momentum range of $4 \div 240$ GeV/c;
7. transition radiation detectors (TRD) for π and K/p separation at momenta > 200 GeV/c and for e identification;
8. electromagnetic and hadronic calorimeters;
9. muon detector.

The setup should have large acceptance and ultimate resolution which would be necessary for the detection of heavy particle production in the region of $0 < x_F < 1$ and for the identification of

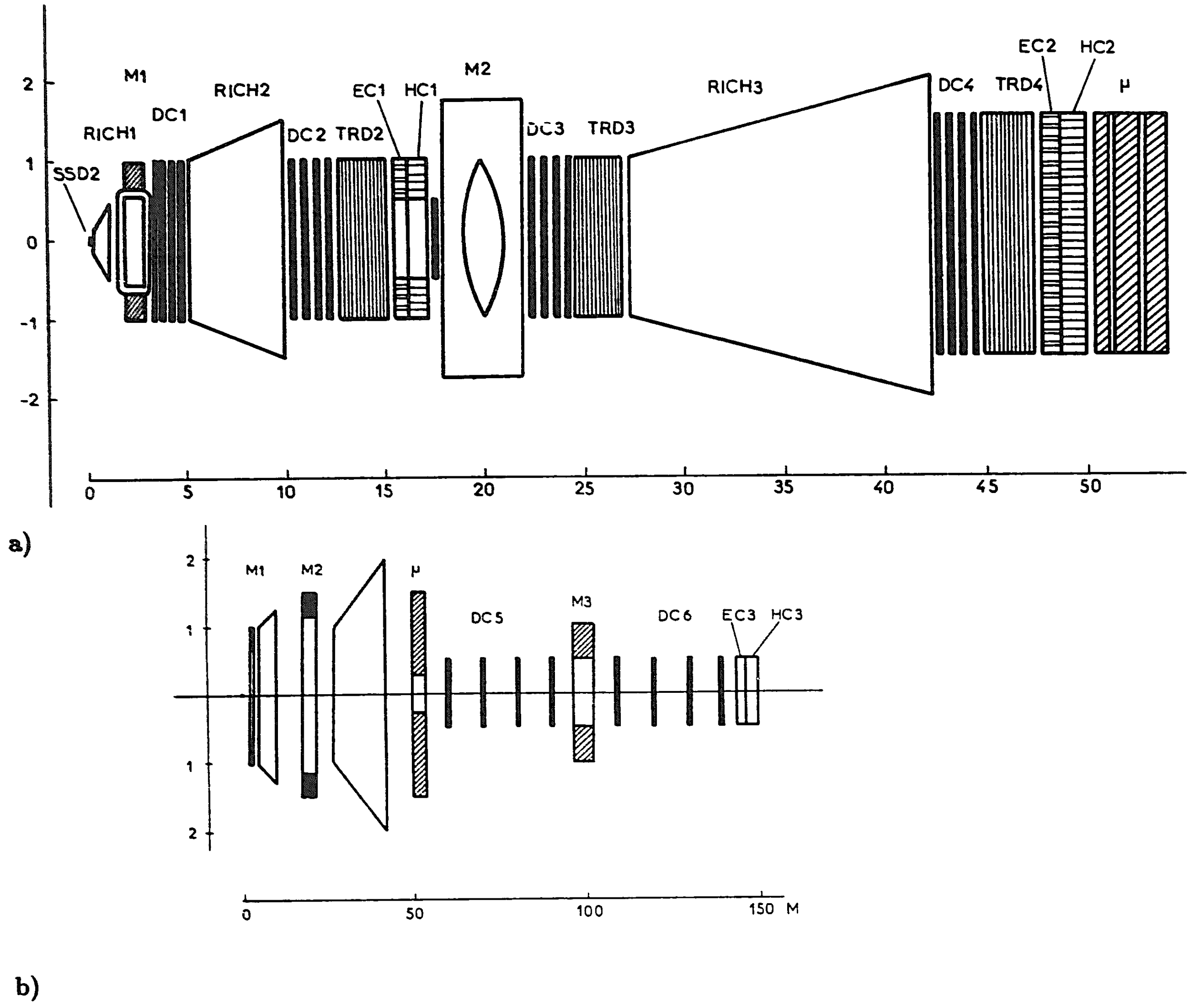

FIGURE 2
Experimental facility for hyperon studies. a) Spectrometer for beauty and charmed hadron detection. b) General layout of the facility. SSD—microstrip detector; RICH1-3—differential Čerenkov spectrometers; DC1-DC6—minidrift chambers; TRD1-TRD4—transition radiation detectors; M1-M3—magnets; EC1-EC3—electromagnetic calorimeters; HC1-HC3—hadron calorimeters; μ—muon detector.

their hadronic and leptonic decays. The facility should also include a sophisticated vertex detector with microstrip Si planes, pixel devices and scintillating fibers to single out the cascade decays of short-lived particles and to investigate the $B^0 \leftrightarrow \bar{B}^0$ and $D^0 \leftrightarrow \bar{D}^0$ oscillations. The vertex detector will be used to produce triggering signals for the selection of the events with beauty and charmed particles.

4. RESEARCH PROGRAM

4.1. Study of Heavy Quark Physics

The UNK hyperon beam opens new possibilities for the experiments with strange-beauty and strange-charmed baryons (Qsq and Qss; $Q = c, b$) which up to now have not practically been investigated.

The results of two experiments with Ξ_c^+ baryons on the hyperon beam (CERN, $P_{\Sigma^-} =$

135 GeV/c)[3] and on the neutron beam with $< E_n >= 600$ GeV (Fermilab)[4] may be a good evidence in favor of the advantages of the hyperon beams as far as the study of baryonic (Qsq) states is concerned.

It was shown that the hyperon production processes of strange-charmed baryons may be characterized by considerably larger cross sections or by a more smooth x_F distribution contrary to the NN collisions. For $x_F > 0.5 \div 0.6$ there are more pure conditions for the search of new baryon states as compared with central production processes. All these make us think that the hyperon experiments open unique possibilities in the search and study of baryon states with heavy and strange quarks. These possibilities are beyond any competition with experiments at other types of accelerators and beams.

Let us enumerate now the main directions in the heavy particle physics to be realized with the UNK hyperon beam.

4.1.1. Spectroscopy of Strange-Beauty and Strange-Charmed Baryons

a) Search and study for (Qsq), (Qss) and (QQs) type baryons with strange and heavy quarks and their excited states $\Xi_c^+ \equiv (usc)^+$; $\Xi_c^0 \equiv (dsc)^0$; $\Omega_c^0 \equiv (ssc)^0$; $\Omega_{cc}^+ \equiv (scc)^+$; $\Xi_b^0 \equiv (usb)^0$; $\Xi_b^- \equiv (dsb)^-$; $\Omega_b^- \equiv (ssb)^-$; $\Omega_{cb}^0 \equiv (scb)^0$.

b) Study of complicated cascade decays of these baryons, acquiring detailed information about concrete exclusive decay channels and their characteristics (decay probabilities, asymmetry parameters, etc.). It is required to reconstruct a number of cascade decay vertices in these experiments.

Table 1 presents the data, which allow one to estimate the capability of the proposed experimental program to observe a number of new strange-charmed and strange-beauty baryons and to study their weak leptonic and nonleptonic decays. As it follows from Table 1 one can obtain an extremely detailed information about many processes. For instance, one can study weak cascade decays

$$\begin{array}{lcl} \Xi_b^- & \rightarrow & \Xi_c^+(2467)\pi^-\pi^- \\ \Xi_c^+(2467) & \rightarrow & \Xi^-\pi^+\pi^+ \end{array} \tag{1}$$

or

$$\begin{array}{lcl} \Xi_b^- & \rightarrow & \Lambda_c^+(2285)K^-\pi^- \\ \Lambda_c^+(2285) & \rightarrow & K^-p\pi^+ \end{array} \tag{2}$$

by detecting $(1 \div 2) \cdot 10^3$ completely identified events of (1) and $(350 - 700)$ events of (2). It will also be possible to detect a number of other nonleptonic decay channels and to obtain data on leptonic decays

$$\begin{array}{lcl} \Xi_b^0 & \rightarrow & \Xi_c^+(2467)e^-\bar{\nu}_e \\ \Xi_c^+ & \rightarrow & \Xi^-\pi^+\pi^+ \end{array} \tag{3}$$

$(BR \sim 1.5 \cdot 10^{-3}$, $N \sim 3 \cdot 10^3$ events) or

$$\begin{array}{lcl} \Omega_b^- & \rightarrow & \Omega_c^0 e\bar{\nu}_e \\ \Omega_c^0 & \rightarrow & \Omega^-\pi^+ \\ \Omega_c^0 & \rightarrow & \Omega^-\pi^+\pi^+\pi^- \\ \Omega_c^0 & \rightarrow & \Omega^-\pi^+\pi^+\pi^+\pi^-\pi^- \end{array} \tag{4}$$

$(BR \sim 3 \cdot 10^{-3}$, $N \sim 5 \cdot 10^2$ events).

It is of interest also to look for excited states of strange-charmed, and, may be, strange-beauty baryons which may decay with further emission of π mesons or photons. To improve the background conditions one should carry out experiments in the region of $x_F > 0.5$. There is also a possibility to observe radiative decays of strange-charmed excited baryons produced in the constrained cascade decays of heavier beauty baryons (for example, $\Xi_b^- \rightarrow S_c(2560)^+\pi^-\pi^-$; $S_c(2560)^+ \rightarrow \Xi_c^+\gamma$).

4.1.2. Study of Mixing Effects in the System of Neutral B-Mesons

Let us consider the search for spatial $B_s^0 \leftrightarrow \bar{B}_s{}^0$ oscillations. B_s^0 mesons are produced in the reactions

$$\Sigma^- + N \rightarrow B_S^0 + \begin{cases} (\text{ b-barion }) + X \\ \bar{B}^0 + X \\ B^- + X \end{cases} \tag{5}$$

The time dependence of the number of B_s^0 meson decays has the form:

$$N_{B_S^0}(t) = \left[N_{B_S^0}(0)/2\right] \exp(-t/\tau)[1 + \cos(\chi_S t/\tau)] \tag{6}$$

TABLE 1
Statistic for the events with charmed and beauty particles.

Process	Cross section $\sigma(X_F > 0)$ (cm^2)	$(\sum BR)_h$	$N_{\text{nonlep.}}$ per 100 days of measurements	$(\sum BR)_{e+\mu}$	$N_{\text{lep.}}$ per 100 days of measurements
$\Sigma^- + N \to c\bar{c} + X$	$(1 \div 2) \cdot 10^{-28}$		$5 \cdot 10^9$		
$\Sigma^- + N \to (scu)^+ + X$ $\to (scd)^0 + X$	$(1 \div 2) \cdot 10^{-29}$	$0.05 \div 0.10$	$3 \cdot 10^7 \div 10^8$	0.10	10^8
$\Sigma^- + N \to (ssc)^0 + X$	$(1 \div 2) \cdot 10^{-30}$	$0.15 \div 0.20$	$(1 \div 2) \cdot 10^7$	0.08	$5 \cdot 10^6 \div 10^7$
$\Sigma^- + N \to (scc)^+ + X$	$10^{-34} \div 10^{-33}$	$\simeq 0.02$	$10^2 \div 10^3$	$\simeq 0.02$	$10^2 \div 10^3$
$\Sigma^- + N \to b\bar{b} + X$	$(3 \div 5) \cdot 10^{-31}$		$(2 \div 4) \cdot 10^7$		
$\Sigma^- + N \to (bsu)^0 + X$ $\to (bsd)^- + X$	$\simeq 3 \cdot 10^{-32}$	$\simeq 0.005$	$\simeq 10^4$	$\simeq 0.015$	$\simeq 3 \cdot 10^4$
$\Sigma^- + N \to (bss)^- + X$	$\simeq 3 \cdot 10^{-33}$	$\simeq 0.01$	$\simeq 2 \cdot 10^3$	$\simeq 0.02$	$\simeq 4 \cdot 10^3$
$\Sigma^- + N \to (bcs)^0 + X$	$\simeq 3 \cdot 10^{-38}$	$\simeq 0.01$	$\simeq 10^{-2}$		
$\Sigma^- + N \to B_S^0 + X$	$\simeq 6 \cdot 10^{-32}$	$\simeq 0.01$	$\simeq 4 \cdot 10^4$	$\simeq 0.015$	$\simeq 6 \cdot 10^4$
$\Sigma^- + N \to D_S^\pm + X$ $\hookrightarrow \tau^\pm \nu_\tau$	$(2.5 \div 5) \cdot 10^{-29}$			$0.02 \div 0.04$	$5 \cdot 10^7 \div 2 \cdot 10^8$

Notes:

1. The data on the production cross sections for heavy particles are rather ambiguous, and the relevant theoretical estimates admit considerable arbitrariness (see[1]).
2. It is assumed, that there will be 10^6 $\Sigma^- N$ interactions/s. The application of the $\sigma(b\bar{b},\ c\bar{c}) \propto A^1$ dependence increases the statistics for the Si target three times.
3. The average efficiency of detecting heavy particle decays is $\epsilon \simeq 0.25$.
4. $(\sum BR)_h$ is the total probability for all nonleptonic decays of a relevant heavy state into charged particles and Λ^0 hyperons only. $(\sum BR)_{\mu+e}$ is the total probability for leptonic decays of heavy particles $R \to [X(h^\pm)e^-\bar{\nu}_e + X(h^\pm)\mu^-\bar{\nu}_\mu]$ with completely identified hadronic states decaying into charged particles only. $(\sum BR)_h$ and $(\sum BR)_{\mu+e}$ have been determined from theoretical estimates[5].
5. $B_S^0 \equiv (s\bar{b})$.

Here τ is the lifetime of B_s^0 (in the rest frame), $\chi_s = \Delta m \cdot \tau$ is the oscillation parameter. In the framework of the Standard Model using the data on $B_d^0 \leftrightarrow \bar{B}_d^0$ – mixing one obtains the prediction

$$\chi_s \simeq \left|V_{ts}/V_{td}\right|^2 \chi_d \simeq 15 \qquad (7)$$

Direct experiments on observing spatial oscillations are required for χ_s measurements. For this purpose one should measure the time-of-flight distributions for B_s^0 and momenta of these particles (to identify B_s^0 and to determine time in B_s^0 rest frame) and tag initial $B_s^0 \equiv (\bar{b}s)$ by their flavor. The tagging can be realized by the associative b–particle decay study. The total statistics for such tagged one reconstructed B_s^0 decays will make up $5 \cdot 10^3$ per 100 days of the accelerator operation, which is quite sufficient for spatial oscillation measurements with an accuracy in χ_s (7) of several percent.

4.1.3. Search for Rare and Forbidden Heavy Particle Decays

The experiments with B and D mesons as well those with τ leptons open new possibilities in the search for rare processes caused by lepton charge nonconservation, contribution from weak neutral currents with flavor changes (FCNC) or by some other new processes ($B^0_{s,d} \to \mu\tau$, μe; $B \to \mu\tau X$; $\tau \to 3\mu$; $\tau \to \mu e^+e^-$; $B^0_{s,d} \to \mu^+\mu^-X$; $D^0 \leftrightarrow \bar{D}^0$ et al.; the τ leptons are produced in the $D_s^\pm \to \tau^\pm\nu_\tau$ decays, see Table 1). Here the search for lepton charge nonconservation in the transition between the third and second, third and first or to all the three generations of fundamental particles are of primary interest. Up to now a sensitive check of lepton charge conservation was realized only for the transitions between members the second and first fundamental generations ($\mu \to e\gamma$; $\mu \to 3e$) or within one generation (double β decay).

The experiments on the search for CP violation effects in the B decays,which require luminosity corresponding to $> 10^8$ $B\bar{B}$ pair production, may be carried out in the underground hall for the hyperon beam where one can perform investigations with high intensity protons using specialized facilities with precise measurement of the effective masses of the final states.

4.2. Search for Heavy Exotic Hadrons

During last years there was quite a noticeable progress in the experiments on search for exotic hadrons: multi-quark mesons ($qq\bar{q}\bar{q}$) and baryons ($qqqq\bar{q}$), glueballs (gg) and mixing states of a hybrid type ($q\bar{q}g$; $qqqg$). The study of the systems of strongly interacting particles consisting of light u, d, s quarks resulted in the observation of several states, whose properties could not be described in the framework of a naive quark model as ($q\bar{q}$) mesons or (qqq) baryons (see, for example, review[6]). The success in the study of exotic hadrons with light quarks was caused, to a great extent, by proper choice of exclusive processes for their production and specific decay channels with bright signatures, which allow one to single out a signal against background.

At the UNK energies the search for exotic hadrons may greatly be extended, since then they will include multiquark states with heavy c and/or b quarks. A larger number of flavors may bring us to new interesting possibilities. In ref.[7] the flavor antisymmetry principle was formulated, according to it the most strongly bounded states are those consisting of quarks and/or antiquarks with different flavors. Then for the mesons of the type $qq\bar{q}\bar{q}$:

a) the lowest states with $q = u, d, s$ do not have exotic quantum numbers, it is possible that $a_0(975)$ and $a_0(980)$ are such cryptoexotic mesons;

b) the lowest strange-charmed (strange-beauty) mesons may have open exotic sets of quantum numbers (since now quarks are characterized by 4 different flavors).

In[7–9] it has been shown that there may exist exotic strange-charmed mesons (for example, $cs\bar{q}\bar{q}$) and exotic baryons ($\bar{c}qqqs$) or ($\bar{c}qqss$) with strange quarks and charmed antiquarks, which with a large probability may be stable w.r.t. strong and electromagnetic interactions. Such a situation may also take place for ($\bar{b}qqqs$) baryons and ($bs\bar{q}\bar{q}$) mesons.

The search for the quasi-stable open exotic strange-charmed states $\widetilde{F_s^0} = (cs\bar{u}\bar{d})$ or $P^0 = (\bar{c}uuds)$ which can decay only weakly, would be done in exposures with vertex detector in parallel with the study of heavy quarks baryonic spectroscopy (see 4.1.1.). If these exotic hadrons have masses big enough and normal strong or electromagnetic decays they can be recognized because of striking signatures of their cascade decays —

for example, $\widetilde{F_s^0} \to D^+K^- \to K^-K^-\pi^+\pi^+$.

There are also many interesting possibilities, connected with the search for other exotic and cryptoexotic states with open and hidden beauty and charm.

At the energies of $1 \div 3$ TeV the cross sections of the most exclusive two-particle reactions, used in the experiments with light mesons at moderate energies (below 100 GeV), become very small. Therefore such processes can no longer be effective for the search of exotic hadrons in a new energy range. However we should mention here some other mechanisms which may successfully be used in the search for heavy exotic hadrons at high energies both in hyperon beam and in proton and π meson beams.

1. Quasiexclusive processes (inclusive over the bottom vertex)

$$h + N \to (\text{Exotic})|_{x_F>0.9} + X_{\substack{\text{bottom}\\ \text{vertex}}} \tag{8}$$

2. Exotic hadron production in the fragmentation region (large x_F)

$$h + N \to (\text{Exotic})|_{x_F>0.5} + X \tag{9}$$

3. Diffractional cryptoexotic hadron production (pomeron exchange)

$$h + N \to (\text{Exotic})|_{\text{diffr.}} + N \tag{10}$$

4. Coherent production of exotic hadrons in the nucleus Coulomb field

$$h + (Z, A) \to (\text{Exotic}) + (Z, A) \tag{11}$$

5. Central production of exotic states (double pomeron exchange)

$$h + N \to h_f + (\text{Exotic})|_{x_F\approx 0} + N_s \tag{12}$$

6. Exotic hadron production in large p_T processes

$$h + N \to (\text{Exotic})|_{\text{large } p_T} + (\text{jet})|_{\text{large } p_T} + X \tag{13}$$

Table 2 presents the estimates of the experimental possibilities for some of the relevant processes (for more details see[1]).

4.3. Other processes

Let us briefly discuss some other possibilities of the experiments on the UNK hyperon beams.

1. The elastic and inelastic hyperon scattering on the atomic electron target and the study of the Σ^-, Ξ^-, Ω^- hyperon formfactors and transition $\Sigma - \Sigma^*$ formfactors.
2. The Coulomb production of the excited hyperon states $\Sigma(1385)^{*-}$, $\overline{\Sigma(1385)}^{*+}$, $\Xi(1530)^*$, $\Lambda(1520)^*$, etc. and the measurements of their radiative decay widths. Some of these radiative processes are $SU(3)$ and $SU(6)$ suppressed.
3. The measurement of the Σ^- hyperon structure function and its comparison with the proton structure function in the reaction $\Sigma^- N \to (\mu^+\mu^-) + X$ and $pN \to (\mu^+\mu^-) + X$ at 3 TeV ($4 < m_{\mu^+\mu^-} < 25$ GeV).
4. Weak decays of Σ^-, Λ^0, Ξ^-, Ω^- hyperons (high precision studies of weak hyperon decays and search for rare processes of this type). The sensitivity of the relevant experiments may be 10^{-13} for Σ^- decays, 10^{-11} for the Ξ^- and Λ^0 decays, and 10^{-8} for Ω decays (the decay $\Xi^- \to \Lambda^0\pi^-$ is the source of the tagged polarized Λ^0 hyperons).
5. A standard program for study of the hyperon strong interactions in a new energy region (total cross sections, elastic scattering, exclusive and inclusive processes, polarization experiments).

5. GENERAL CONCLUSION

The experiments on the UNK hyperon beams have many advantages as compared with all other accelerators both due to higher energy and to an improved beam quality (the latter being of extreme importance). These experiments provide possibilities for the investigation of many principal problems in elementary particle physics. Here we have such fundamental trends as precision tests of the Standard Model, the problem of CP invariance, confinement problem, search for "horizontal interactions", new currents, leptonic charge nonconservation, new generations of

TABLE 2
Search and study of the production of exotic hadronic states.

Process	Experimental sensitivity	Notes
$\Sigma^- + N \to \underbrace{(ddsc\bar{c})^-}_{\hookrightarrow \Psi\Sigma^-} + N$ $\Sigma^- + N \to \underbrace{(ddsb\bar{b})^-}_{\hookrightarrow \Upsilon\Sigma^-} + N$	600 events/nb (for $\sigma_{dif.} \cdot BR[(ddsc\bar{c}) \to \Psi\Sigma^-]$). 200 events/nb (for $\sigma_{dif.} \cdot BR[(ddsb\bar{b}) \to \Upsilon\Sigma^-]$).	Diffractional production of cryptoexotic baryons with heavy quarks. Be target, 15 $\mathrm{g \cdot cm^{-2}}$.
$\Sigma^-(p) + N \to \underbrace{(s\bar{s}c\bar{c})^0}_{\hookrightarrow \phi\psi;\ K^+K^-\psi} + X$ $\Sigma^-(p) + N \to \underbrace{(q\bar{q}b\bar{b})^0}_{\hookrightarrow \Upsilon\pi;\ \Upsilon\rho} + X$	$\left.\begin{array}{l}\text{300 - 600 events/nb}\\ \text{200 events/nb}\end{array}\right\}$ for $\sigma\vert_{x>0.5\div0.9} \times$ $\times BR$	Production of cryptoexotic mesons and baryons with heavy quarks in the reactions (8) and (9). Be target, 15 $\mathrm{g \cdot cm^{-2}}$
$\Sigma^-(p) + N \to \underbrace{(\bar{c}uuds)^0}_{\hookrightarrow p(\phi,\eta)\pi^-;\ \Lambda K^+\pi^-}\vert_{x_F>0.5} + X$ $\Sigma^-(p) + N \to \underbrace{(cs\bar{u}\bar{d})^0}_{\hookrightarrow \pi^+\pi^+K^-K^-}\vert_{x_F>0.5} + X$	It is assumed, that the production cross sections of these open exotic states are ~ 10^{-2} $\sigma(\Xi_c)$ (see Table 1). The best possibilities for the identification of these states are for the hadrons which can decay only weakly (exposure with vertex detector). $10^3 \div 10^4$ events of this type for each process may be detected.	
$\Sigma^- + \mathrm{Pb} \to \Sigma(3170)^-_\phi + \mathrm{Pb}$ $\quad\hookrightarrow \Sigma^- K\bar{K} + k\pi;\ \phi\Sigma^-$ $\Sigma^- + \mathrm{Pb} \to \underbrace{(c\bar{c}dds)^-}_{\hookrightarrow \Psi\Sigma^-} + \mathrm{Pb}$ $\quad\hookrightarrow e^+e^-;\ \mu^+\mu^-$	This studies allow one to solve the problem on the existence of a narrow $\Sigma(3170)^-_\phi \equiv (ddss\bar{s})^-$ baryon, if $BR[\Sigma^-_\phi \to \phi\Sigma^-] > 0.04 \div 0.07$, or $\Sigma(5000)^-_\psi \equiv (c\bar{c}dds)^-$ if $BR[\Sigma(5000)^-_\psi \to \psi\Sigma^-] > 0.07$.	Experiments on exotic hadron production in the nuclear Coulomb field: $h + \mathrm{Pb} \to (\mathrm{Exotic}) + \mathrm{Pb}$. Pb target, 1.4 $\mathrm{g \cdot cm^{-2}}$.

Notes:

1. The measurements are assumed to be carried out during 10 days ($3 \cdot 10^5$ s with an account of the accelerator duty factor) at the intensity of 10^7 particles/s.
2. In estimating the sensitivity the setup efficiency and secondary particles decay branchings (ϕ, ψ, Υ etc.) were taken into account.

fundamental particles.

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