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More about sgoldstino interpretation of HyperCP events

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We further discuss possible sgoldstino interpretation of the observation, reported by the HyperCP collaboration, of three $\Sigma^+ \to p\mu^+\mu^-$ decay events with dimuon invariant mass 214.3 MeV within detector resolution. With sgoldstino mass equal to 214.3 MeV, this interpretation can be verified at existing and future B- and ϕ-factories. We find that the most natural values of the branching ratios of two-body B- and D-meson decays to sgoldstino P and vector meson V are about $10^{-6} \div 10^{-7}$. The branching ratios of ϕ-meson decay $\phi \to P\gamma$ are estimated to be in the range $1.8 \cdot 10^{-13} \div 1.6 \cdot 10^{-7}$, depending on the hierarchy of supersymmetry breaking soft terms. Similar branchings for ρ- and ω-mesons are in the range $10^{-14} \div 3.4 \cdot 10^{-7}$.

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Recent publication [1] of anomalous events

$$\Sigma \longrightarrow p\mu^+\mu^- \ , \qquad (1)$$

observed in the HyperCP experiment, renewed interest to models with light particles whose interactions with the Standard Model fermions violate flavor. One of the well-motivated classes of models of this kind, supersymmetric models with light sgoldstino[2)], has been suggested by the HyperCP collaboration [1, 9] to explain the anomalous events. The latter are three events (1) where all dimuon masses fall into a single bin within the detector resolution; notably, no more decays (1) have been observed. This coincidence has been suggested as the first evidence for sgoldstino production in two-body decay with subsequent decay of sgoldstino X into $\mu^+\mu^-$-pair,

$$\Sigma \longrightarrow pX, \quad X \longrightarrow \mu^+\mu^-. \qquad (2)$$

Sgoldstino mass has been fixed from measured dimuon masses as

$$m_X = 214.3 \pm 0.5 \text{ MeV}. \qquad (3)$$

It was pointed out in Refs. [10 – 13] that, generally, X-particle can be either pseudoscalar or pseudovector, but neither scalar nor vector. Thus, only *pseudoscalar* sgoldstino (denoted by P in what follows) in models with *parity conserving* sgoldstino interactions (see Ref. [14] for a description) is viable [12]: light scalar sgoldstino, as well as pseudoscalar sgoldstino in models with parity violating sgoldstino interactions, cannot explain the anomalous events because of the strong upper bounds on the widths of two-body kaon decays, $K \to \pi X (X \to \mu^+\mu^-)$.

From the presented [1] branching ratio of the decay (1) (which is somewhat above the Standard Model predictions [15, 16]), the following product has been estimated [12],

$$|h_{12}^{(D)}| \cdot \text{Br}^{1/2}(P \to \mu^+\mu^-) = 3.8 \cdot 10^{-10}. \qquad (4)$$

Here $h_{12}^{(D)}$ is sgoldstino coupling constant to pseudoscalar current $\bar{d}\gamma_5 s$,

$$\mathcal{L}_{Pds} = -P \cdot (h_{12}^{(D)} \cdot \bar{d} i\gamma^5 s + \text{h.c.}),$$

and $\text{Br}(P \to \mu^+\mu^-)$ denotes sgoldstino branching ratio to muons.

Additional information came from the geometry of the detector and the measured energies of muons, which enables one to put an upper limit on sgoldstino lifetime [12],

$$\tau_X \lesssim 2.5 \cdot 10^{-11} \text{ s}. \qquad (5)$$

Note that a lower limit [12] on sgoldstino lifetime coming from the current limit on supersymmetry breaking scale is about

$$\tau_X \gtrsim 1.7 \cdot 10^{-15} \text{ s} \qquad (6)$$

for sgoldstino mass (3).

The suggested explanation of HyperCP anomalous events awaits a test in other experiments. The processes which can be used to definitely confirm or rule out the sgoldstino explanation have been discussed in Ref. [12]. These are three-body kaon decays [3)] and direct sgoldstino production in e^+e^- collisions. The rates of

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[2)]See, e.g., Refs. [2 – 5] for examples of models and Refs. [6 – 8] for the description of sgoldstino interactions.

[3)]$K \to \pi\pi X$, $K \to \mu^+\mu^-$ and $\Omega^- \to \Xi^- X$ decays have been discussed in Refs. [10 – 13] as signatures to test the hypothesis (2) with some pseudoscalar or axial vector particle X in a model-independent way.

these processes are governed by the same parameters of the sgoldstino Lagrangian, which are constrained by Eqs. (3), (4), (5) and (6).

The parameters are not directly constrained by the HyperCP result. These are other flavor-violating sgoldstino coupling constants, h_{jl} ($h_{jl}^{(U)}$, $j,l = 1,2,3$, and $h_{jl}^{(D)}$, except for $h_{12}^{(D)}$), entering

$$\mathcal{L}_P = -P \cdot (h_{jl} \cdot \bar{f}_j i\gamma^5 f_l + \text{h.c.}), \qquad (7)$$

where f_j are fermions of the Standard Model, and sgoldstino flavor-blind couplings which do not contribute to sgoldstino width because of kinematical constraints imposed by the small sgoldstino mass (3). Nevertheless, these couplings make it possible to extend searches for sgoldstino. Though the rates of corresponding processes cannot be predicted because of lacking knowledge of model parameters, one can estimate the most natural ranges for these rates by making use of the expected patterns of MSSM soft terms. With sgoldstino mass being fixed, these predictions can be tested experimentally, giving an opportunity to find additional evidence for light sgoldstino (but, generally, *not to compromise* the proposed sgoldstino explanation of the HyperCP result). This issue is discussed in this letter.

The dominant[4)] sgoldstino decay modes are [14] $P \to \mu^+\mu^-$ and $P \to \gamma\gamma$. A natural range of values of the ratio of their widths is

$$\frac{\Gamma(P \to \gamma\gamma)}{\Gamma(P \to \mu^+\mu^-)} \simeq 1 \div 10. \qquad (8)$$

However, much larger values for this ratio, such as 10^4 are not excluded (see [12] for discussion). So, we are interested in rare decays with $\mu^+\mu^-$ or $\gamma\gamma$ with invariant mass 214 MeV in final states.

As promising processes, we consider two-body B- and D-meson decays (to probe flavor-violating sector of sgoldstino couplings) and two-body light neutral vector meson decays (to probe flavor-blind sector of sgoldstino couplings). These searches may be performed at B-factories where they would cover the most natural part of the relevant parameter space, while searches at ϕ-factories seem less promising, as one can probe there only a part of the relevant parameter space leaving the rest for future experiments.

We begin with sgoldstino flavor-violating interactions (7) in quark sector. The coupling constants h_{ij} entering these interaction terms are determined by the ratios of the elements of left-right part of squark squared mass matrix $\tilde{m}_{ij}^{(LR)2}$ to vev of auxiliary field in goldstino supermultiplet F, the latter being of the order of the squared scale of supersymmetry breaking in the complete theory, $h_{ij} = \tilde{m}_{ij}^{(LR)2}/\sqrt{2}F$. In particular, nonzero off-diagonal entries of squark squared mass matrix lead to two-body pseudoscalar B- and D-meson decays to a vector meson V and pseudoscalar sgoldstino[5)],

$$P_{B,D} \to VP. \qquad (9)$$

Let p, p_V be momenta of $P_{B,D}$ and V, respectively, $q \equiv p - p_V$, and ϵ_V be the polarization vector of V. With these notations, the hadronic matrix elements

$$O_{P_{B,D},V}(q^2) \equiv \langle V(p_V, \epsilon_V)|\bar{q}_j\gamma^5 q_l|P_{B,D}(p)\rangle$$

entering the decay amplitudes $\mathcal{M}(P_{B,D} \to VP) = h_{jl} \cdot P(q) \cdot O_{P_{B,D},V}(q^2)$ (where $P(q)$ is the wave function of the outgoing sgoldstino) can be expressed via experimentally measured and/or theoretically predicted form-factors $A_0^{(P_{B,D},V)}(q^2)$ as follows (see, e.g., Ref. [17] for notations and other details),

$$O_{P_{B,D},V}(q^2) = A_0^{(P_{B,D},V)}(q^2) \cdot \frac{-2im_V}{m_j + m_l}, \qquad (10)$$

where m_V and m_i are masses of V and quark q_i, respectively; we use $m_b = 4.8$ GeV, $m_c = 1.35$ GeV, $m_s = 0.13$ GeV [17] in our estimates. Making use of the expression (10), one finds the partial width

$$\Gamma(P_{B,D} \to VP) = \frac{|h_{jl}|^2}{16\pi}(A_0^{(P_{B,D},V)}(m_P^2))^2 \times \\ \times \frac{m_{P_{B,D}}^3 \lambda^3(m_{P_{B,D}}, m_V, m_P)}{(m_j + m_l)^2}, \qquad (11)$$

and

$$\lambda(m_1, m_2, m_3) = \sqrt{\left(1 - \frac{(m_2+m_3)^2}{m_1^2}\right)\left(1 - \frac{(m_2-m_3)^2}{m_1^2}\right)}.$$

The values of the form factors $A_0^{(P_{B,D},V)}$ entering Eq. (11) can be found in literature [17–20].

To illustrate the level of precision required to probe the models consistent with HyperCP events, we present estimates of the widths in three different types of supersymmetric models. Two of them are

$$\text{model I}: \quad h_{jl} \sim h_{12}^{(D)}, \quad j \neq l,$$
$$\text{model II}: \quad h_{jl} \sim \frac{A}{F} \cdot \max(m_j, m_l),$$

[4)] The kinematically allowed decay mode $P \to e^+e^-$ is typically suppressed if sgoldstino mass is about 214 MeV.

[5)] Two-body decays of pseudoscalar mesons into pseudoscalar mesons and pseudoscalar sgoldstino are strongly suppressed by parity conservation in sgoldstino interactions.

where A is a flavor-independent constant. The third model is a concrete phenomenologically viable example of left-right supersymmetric model, where parity conservation in sgoldstino interactions is guaranteed [14]. In the first model all off-diagonal entries in squark squared mass matrix are of the same order. In the second model there is a hierarchy in matrix elements h_{jl} reflecting the hierarchy of quark masses. The latter situation is more realistic, as it is typical for minimal supersymmetric models like mSUGRA or models with gauge mediation of supersymmetry breaking, where soft supersymmetry breaking trilinear terms are proportional to the Yukawa matrix. For the model III we take a general left-right SUSY model of the type presented in Ref. [14], with left-right symmetry broken at energy scale $M_R = 3$ TeV. We assume (see notations in Ref. [14]) universality at the SUSY breaking scale $\sqrt{F} = 30$ TeV, i.e. $\mathbf{A}^{(i)} = \mathbf{Y}^{(i)}A^{(i)}$, choose $A^{(1)} = A^{(2)} = M_{1/2}$, $\tan\beta = 3.6$ and neglect mixing between Higgs doublets in doublet-doublet splitting [21]. The left-right entries in the squark squared mass matrices $\tilde{m}^{(LR)\,2}_{D(U)}$ are obtained by making use of one-loop renormalization group equations for gauge, Yukawa, soft trilinear coupling constants and gaugino masses [22]. The value of $A^{(1)}$ at $M_R = 3$ TeV is fixed by (4). Under our assumptions, all relevant parameters in model III are then completely determined.

For these three models it is straightforward to estimate the partial widths of the processes (9) with real sgoldstino decaying into $\mu^+\mu^-$, $P_{B,D} \to VP(P \to \mu^+\mu^-)$. The results are summarized in Table. For the widths of similar processes, but with sgoldstino decaying into photons, $P_{B,D} \to VP(P \to \gamma\gamma)$, one gets the same numbers multiplied by the ratio $\Gamma(P \to \gamma\gamma)/\Gamma(P \to \mu^+\mu^-)$, whose estimates are given in (8).

Comparing the results presented in Table with statistics of B- and D-meson decays collected by B-factories, one concludes that both $\mu^+\mu^-$ and $\gamma\gamma$ decay channels can be probed for the most natural choice of parameters (models II, III). Moreover, a part of expected region for $h^{(D)}_{23}$ is already excluded by the results [23]

$$\begin{aligned} \mathrm{Br}(B^+ \to K^{*+}\mu^+\mu^-) &< 2.2\cdot 10^{-6}, \\ \mathrm{Br}(B^0 \to K^{*0}\mu^+\mu^-) &= (1.3\pm 0.4)\cdot 10^{-6}. \end{aligned} \tag{12}$$

Study of the model I requires, generally, higher statistics. At B-factories model I could be probed if sgoldstino decay mode into photons dominates by one to two orders of magnitude over $\mu^+\mu^-$ mode.

It is worth noting that coupling constants $h^{(D)}_{13}$, $h^{(D)}_{23}$ and $h^{(U)}_{12}$ determine the rates of several decays each. Hence, the ratios of the corresponding rates do not depend on the values of these couplings. This would allow for independent check of sgoldstino interpretation, would any of the anomalous decays listed in Table be observed. In particular, Eq. (12) implies that branching ratios of $B_s \to \phi P(P \to \mu^+\mu^-)$ and $B^+_c \to D^{*+}_s P(P \to \mu^+\mu^-)$ have to be at least three times smaller than the numbers in the two last columns of Table.

Another signature of models with light sgoldstino we would like to discuss is neutral vector meson $\mathcal{V}$ decays to sgoldstino and photon,

$$\mathcal{V} \to P\gamma. \tag{13}$$

The most sensitive are the decays of ϕ-, ω- and ρ-mesons, whose rates are almost saturated by sgoldstino couplings to gluons, as we find below. For J/ψ- and Υ-mesons the corresponding branching ratios do not exceed 10^{-9} (see Table 5 in Ref. [24]).

There are two different contributions, $\mathcal{M}_1$ and $\mathcal{M}_2$, to the amplitude of the decay (13). These are due to sgoldstino couplings to photons and to gluons,

$$\mathcal{L}_1 = \frac{1}{4\sqrt{2}}\epsilon^{\mu\nu\lambda\rho}\left(\frac{M_{\gamma\gamma}}{F}PF_{\mu\nu}F_{\lambda\rho} + \frac{M_3}{F}PG^a_{\mu\nu}G^a_{\lambda\rho}\right) \tag{14}$$

(where $M_{\gamma\gamma} = M_1\cos^2\theta_W + M_2\sin^2\theta_W$ and M_1, M_2 and M_3 are masses of $U(1)_Y$-, $SU(2)_W$- and $SU(3)_c$–gauginos, respectively) and sgoldstino flavor-conserving interactions with quarks (7). The relevant interactions of vector meson $\mathcal{V}$ are $\mathcal{V}-\gamma$ mixing [25],

$$\mathcal{L}_{\mathcal{V},1} = \frac{e}{g}a_{\mathcal{V}}m^2_{\mathcal{V}}A_\mu\mathcal{V}_\mu, \quad g \simeq 8.6 \tag{15}$$

(where $m_{\mathcal{V}}$ is the mass of the corresponding vector meson and $(a_\rho,\ a_\omega,\ a_\phi) = (\sqrt{2},\ \sqrt{2}/3,\ -2/3))$, and coupling to photon and pseudoscalar mesons $\mathcal{P}$ [26],

$$\mathcal{L}_{\mathcal{V},2} = eg_{\mathcal{V}\mathcal{P}\gamma}\epsilon_{\mu\nu\lambda\rho}\partial_\mu A_\nu\partial_\lambda\mathcal{V}_\rho\mathcal{P}, \tag{16}$$

where the values of coupling constants $g_{\mathcal{V}\mathcal{P}\gamma}$ are tuned to saturate the $\mathcal{P}\to\mathcal{V}\gamma$ or $\mathcal{V}\to\mathcal{P}\gamma$ decay rates and are presented in Ref. [26].

Couplings (14) and (15) give rise to the following contribution to the decay amplitude

$$\mathcal{M}_1 = \epsilon_\mu(p)\cdot i\frac{e}{g}a_{\mathcal{V}}\cdot\frac{-i}{m^2_{\mathcal{V}}}\cdot\left(-i\sqrt{2}\frac{M_{\gamma\gamma}}{F}\right)\cdot\epsilon^{\mu\nu\lambda\rho}p_\lambda k_\rho\epsilon^*_\nu(k),$$

where p and k stand for momenta of $\mathcal{V}$-meson and γ, respectively, while $\epsilon(p)$ and $\epsilon(k)$ denote their polarizations. This contribution is illustrated in Figure a.

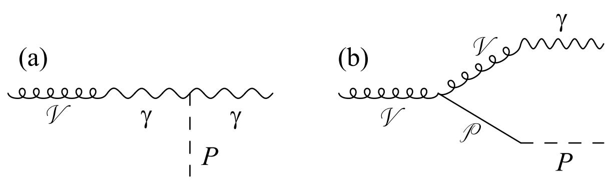
The interactions (14) give rise to $P-\mathcal{P}$ mixing [24],

$$\mathcal{L}_{P\mathcal{P}} = C_{P\mathcal{P}}\cdot P\mathcal{P}, \tag{17}$$

Branching ratios of decays $P_{B,D} \to VP(P \to \mu^+\mu^-)$ in the models I, II and III. Branching ratios of decays $P_{B,D} \to VP(P \to \gamma\gamma)$ are given by the same numbers multiplied by $\Gamma(P \to \gamma\gamma)/\Gamma(P \to \mu^+\mu^-)$

Decay	h_{jl}	$A_0^{(P_{B,D},V)}$	$\mathrm{Br}_{(\text{model I})}$	$\mathrm{Br}_{(\text{model II})}$	$\mathrm{Br}_{(\text{model III})}$
$B_s \to \phi P(P \to \mu^+\mu^-)$	$h_{23}^{(D)}$	0.42 [18]	$6.5 \cdot 10^{-9}$	$8.8 \cdot 10^{-6}$	$8.7 \cdot 10^{-6}$
$B_s \to K^{*0} P(P \to \mu^+\mu^-)$	$h_{13}^{(D)}$	0.37 [18]	$5.3 \cdot 10^{-9}$	$7.2 \cdot 10^{-6}$	$2.3 \cdot 10^{-7}$
$B_c^+ \to D^{*+} P(P \to \mu^+\mu^-)$	$h_{13}^{(D)}$	0.14 [19]	$3.2 \cdot 10^{-10}$	$4.4 \cdot 10^{-7}$	$1.4 \cdot 10^{-8}$
$B_c^+ \to D_s^{*+} P(P \to \mu^+\mu^-)$	$h_{23}^{(D)}$	0.14 [a)]	$3.0 \cdot 10^{-10}$	$4.0 \cdot 10^{-7}$	$4.0 \cdot 10^{-7}$
$B_c^+ \to B^{*+} P(P \to \mu^+\mu^-)$	$h_{12}^{(U)}$	0.23 [20]	$4.1 \cdot 10^{-10}$	$4.4 \cdot 10^{-8}$	$8.2 \cdot 10^{-7}$
$B^+ \to K^{*+} P(P \to \mu^+\mu^-)$	$h_{23}^{(D)}$	0.31 [17]	$3.8 \cdot 10^{-9}$	$5.2 \cdot 10^{-6}$	$5.1 \cdot 10^{-6}$
$B^0 \to K^{*0} P(P \to \mu^+\mu^-)$			$3.5 \cdot 10^{-9}$	$4.8 \cdot 10^{-6}$	$4.7 \cdot 10^{-6}$
$B^0 \to \rho P(P \to \mu^+\mu^-)$	$h_{13}^{(D)}$	0.28 [17]	$3.1 \cdot 10^{-9}$	$4.2 \cdot 10^{-6}$	$1.4 \cdot 10^{-7}$
$B^+ \to \rho^+ P(P \to \mu^+\mu^-)$			$3.3 \cdot 10^{-9}$	$4.6 \cdot 10^{-6}$	$1.3 \cdot 10^{-7}$
$D^0 \to \rho P(P \to \mu^+\mu^-)$	$h_{12}^{(U)}$	0.64 [17]	$1.4 \cdot 10^{-9}$	$1.5 \cdot 10^{-7}$	$2.8 \cdot 10^{-6}$
$D^+ \to \rho^+ P(P \to \mu^+\mu^-)$			$3.5 \cdot 10^{-9}$	$3.7 \cdot 10^{-7}$	$7.0 \cdot 10^{-6}$

[a)] We did not find any estimate of this formfactor in literature and use this value as an order-of-magnitude estimate, which is sufficient for our study.



Diagrams contributing to the decay $\mathcal{V} \to \gamma P$

where

$$C_{P\pi^0} = -\frac{\sqrt{2}\pi m_\pi^2 M_3}{3\alpha_s(M_3)F}\frac{m_u - m_d}{m_u + m_d} f_\pi \,,$$

$$C_{P\eta(\eta')} =$$

$$= \frac{\pi M_3 m_{\eta(\eta')}^2}{\sqrt{3}\alpha_s F} f_{\eta(\eta')} + \frac{B f_\pi A m_s}{\sqrt{6}F}\left(\sqrt{2}\cos\theta \pm \sin\theta\right),$$

$$f_{\eta(\eta')} = f_8 \cos\theta_8 \mp \sqrt{2} f_0 \sin\theta_0,$$

where upper sign stands for η-meson and lower for η'. Here $B_0 \approx m_K^2/m_s \simeq 2$ GeV and we neglect small ($\sim 10^{-2}$) mixing between π^0 and η, η'-mesons, $\eta - \eta'$ mixing angle $\theta = -15.4°$ and we adopt two mixing angle scheme for the parametrization of the gluonic matrix elements [26, 27]

$$\langle\eta|\frac{3\alpha_s(M_3)}{4\pi} G_{\mu\nu}^a \tilde{G}_{\mu\nu}^a|0\rangle = \sqrt{\frac{3}{2}} m_{\eta(\eta')}^2 f_{\eta(\eta')}, \qquad (18)$$

$$\langle\pi^0|\frac{3\alpha_s(M_3)}{4\pi} G_{\mu\nu}^a \tilde{G}_{\mu\nu}^a|0\rangle = -\frac{m_u - m_d}{m_u + m_d} f_\pi m_\pi^2,$$

where we use $f_0 = 1.17 f_\pi$, $f_8 = 1.26 f_\pi$ and $\theta_8 = -21.2°$, $\theta_0 = -9.2°$ [28].

Couplings (16) and (17) give rise to the contribution

$$\mathcal{M}_2 = \sum_{\mathcal{P}} \left(-i g_{\mathcal{V}\mathcal{P}\gamma}\right) \epsilon_\mu(p)\, \epsilon^{\mu\nu\lambda\rho} p_\lambda k_\rho \epsilon_\nu^*(k) \frac{i}{m_P^2 - m_\eta^2} i C_{P\eta}$$

illustrated by the diagram shown in Figure b. Here sum runs over π^0, η and η' mesons.

Finally, the rate of the decay $\mathcal{V} \to P\gamma$ in the case of unpolarized vector meson reads

$$\Gamma(\mathcal{V} \to P\gamma) = \frac{C_{\mathcal{V}}^2}{96\pi}\frac{(m_{\mathcal{V}}^2 - m_P^2)^3}{m_{\mathcal{V}}^3},$$

$$C_{\mathcal{V}} = -\frac{\sqrt{2} a_{\mathcal{V}} e M_{\gamma\gamma}}{gF} + \sum_{\mathcal{P}=\pi^0,\eta,\eta'} \frac{e g_{\mathcal{V}\mathcal{P}\gamma} C_{P\mathcal{P}}}{m_P^2 - m_{\mathcal{P}}^2}. \qquad (19)$$

In most models, the gluino mass is large, so that the dominant contribution comes from sgoldstino couplings to gluons. The corresponding coupling constant is proportional to the ratio M_3/F. It reaches the maximal value in the unitarity limit $M_3 \simeq \sqrt{F}$ at the smallest value of $\sqrt{F}$, which is consistent with current bounds on the scale of supersymmetry breaking, $\sqrt{F} \gtrsim 500$ GeV. So, we have

$$[M_3/F]_{\max} \sim 2 \cdot 10^{-3}\ \mathrm{GeV}^{-1}. \qquad (20)$$

If M_3/F is much smaller than this value, the dominant contribution to C_ϕ comes from either $M_{\gamma\gamma}/F$ or A/F terms, at least one of which is bounded from below by the upper limit on sgoldstino lifetime (5),

$$\left[\frac{M_{\gamma\gamma}}{F}, \frac{|A|}{F}\right]_{\min} \sim 1.5 \cdot 10^{-5}\ \mathrm{GeV}^{-1}. \qquad (21)$$

When considering the case of small M_3, we present the numerical results for the case $|A| \ll M_{\gamma\gamma}$. In the opposite case one obtains about two orders of magnitude smaller numbers for the lower bounds of the intervals.

Thus, the branching ratios of $\mathcal{V} \to P\gamma$ decays are expected to be within the intervals

$$1.8 \cdot 10^{-13} < Br_\phi < 1.6 \cdot 10^{-7}, \quad (22)$$

$$9.1 \cdot 10^{-15} < Br_\rho < 3.3 \cdot 10^{-7}, \quad (23)$$

$$1.8 \cdot 10^{-14} < Br_\omega < 3.4 \cdot 10^{-7}. \quad (24)$$

The produced sgoldstino subsequently decays either into photons or into muons. Comparing the values of the branching ratios in the interval (22) to the collected world statistics of ϕ-mesons (about a few billion) one concludes that the part of the interval (22) with the largest branchings may be tested with existing experimental data at ϕ-factories, while the large part could be tested only with significant increase in statistics. Note that observation of two-body decays of different vector mesons would offer an opportunity to measure all relevant parameters $M_{\gamma\gamma}$, A, M_3, F.

To conclude, by studying two-body decays of B-, D-, ϕ-, ω- and ρ-mesons one can probe the models with light sgoldstino, capable of explaining HyperCP anomalous events. Currently available statistics is sufficient to probe the most natural left-right symmetric models and models with the hierarchy in sgoldstino flavor-violating couplings similar to the hierarchy of quark masses. The rest of models awaits larger statistics. The same conclusion holds for quite similar baryon two-body decay modes like $\Omega^- \to \Xi^- P$ [10–12], $\Omega_c^0 \to \Xi_c^0 P$, etc.: though the rates of (some of) these decays can be predicted from the HyperCP data, the current statistics is too low, so that future experiments are needed to test the sgoldstino explanation by searching for these decays.

If observed, these decays would not only confirm the sgoldstino interpretation of HyperCP results (which have been claimed as the first evidence for supersymmetry [9]) but would give an opportunity to measure sgoldstino life-time and to probe the pattern of sgoldstino flavor violating couplings to quarks. The former would fix the ratios of MSSM soft terms to the squared scale of supersymmetry breaking, while the latter would enable one to estimate the values of off-diagonal entries in squarks squared mass matrix, which can be tested, in turn, by searching for FCNC processes.

The negative results of searches for sgoldstino in two-body B- and D-meson decays at the level of branchings as high as $10^{-7} \div 10^{-8}$ (models II and III) would imply either non-sgoldstino explanation of the HyperCP results or fairly special pattern of off-diagonal squark masses, atypical for simple supersymmetric extensions of the Standard Model. Hence, some mechanism (e.g., additional flavor symmetry) should have to work in that case to provide for this pattern.

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