Enhanced $b \rightarrow sg$ Decay, Inclusive $\eta'$ Production, 
and the Gluon Anomaly

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Abstract

The experimental hint of large $B \rightarrow \eta' + X_s$ could be linked to the $b \rightarrow s$ penguins via the gluon anomaly. If running $\alpha_s$ is used in the $\eta' - g-g$ coupling, the standard $b \rightarrow sg^*$ penguin alone may not be enough, calling for the need of dipole $b \rightarrow sg$ from new physics. The latter could be at 10% level as suggested by charm counting and $B_{s,l}$ problems. The added new physics contribution not only brings about sufficient rate, it could lead to CP asymmetries at 10% level, which could be observed soon at B Factories.
In this paper we explore the possible connections between several fascinating topics in B physics and QCD: the possibility of enhanced $b \to sg$ decay at 10% level [1–3], the recent experimental hint [4,5] of large inclusive $B \to \eta' + X_s$, and the $\eta' - g - g$ gluon anomaly. A recent proposal claims [6] that the standard QCD penguin could account for inclusive $\eta'$ production through the latter. We find that with running $\alpha_s$ in the anomaly coupling, however, the Standard Model (SM) alone may not be sufficient, suggesting the need for dipole $b \to sg$ transitions from new physics. If so, CP violating rate asymmetries between $B \to \eta' + X_s$ and $\bar{B} \to \eta' + \bar{X}_s$ could be at the 10% level and easily observable at B Factories.

As suggested some time ago, the charm deficit ($n_C$) and low semileptonic branching ratio ($B_{s,l}$) problems could be explained by some hidden B decay mode at the 10-15% level [1–2], such as $b \to sg$ with $g$ on-shell. Two recent detailed analyses [3,7] argue that the persistent $n_C$ and $B_{s,l}$ problems suggest the existence of additional charmless B decays at the 10% level. The two groups differ in their interpretation, however. One [3] advocates $b \to sg \approx 10\%$ which calls for new physics, while the other [4] abhors new physics and argues that a sizable fraction of $b \to c\bar{c}s$ transitions end up as charmless $b \to s$ decays.

At first sight, one might think that $b \to s c\bar{c} \to sq\bar{q}$ is precisely accounted for by the QCD penguin, which is known to be around 1% [8]. To evade this bound, one needs to invoke [7] some intermediate $c\bar{c}$ state, such as a $c\bar{c}g$ “hybrid” meson. However, the “hybrid” state must satisfy the following: 1) very sizable production fraction in $b \to c\bar{c}s$; 2) relatively narrow width to allow more time for $(c\bar{c})_8 \to g^*$ annihilation; 3) though above threshold, decays via $D\bar{D} + X$ or $(c\bar{c})_{onia} + X$ are suppressed to evade easy detection; 4) strong effect in $b \to c\bar{c}s$ decays but inconclusive in traditional $e^+e^-$ or $pp\bar{p}$ annihilation studies. We therefore conclude that, though not impossible in principle, the “hybrid” (or any non-onia $c\bar{c}$ state) scenario is no less exotic than the plain $b \to sg$ picture.

Turning to QCD penguins, several rare B decays have just been reported [1] by CLEO for the first time. The penguin dominant $K\pi$ mode is at $1.5 \times 10^{-5}$ level and is now separated from the tree dominant $\pi\pi$ mode, which has yet to be established. This is in agreement with theory expectations [1] when taking into account the smallness of $V_{ub}$. The $\omega h^\pm$ mode
is observed at $\approx 3 \times 10^{-5}$, which is larger than expected. No $\eta h^\pm$ events are seen, but the $\eta'h^\pm$ mode turns up 13 events and is at the rather sizable $10^{-4}$ level, and again found to be dominantly $\eta'K$ hence of penguin origins. Though very interesting, these handful of modes do not yet seriously challenge models of exclusive decay. Perhaps more intriguing is the hint of very large semi-inclusive production of fast $\eta'$ mesons,

$$B(B \to \eta' + X_s) = (0.75 \pm 0.15 \pm 0.11) \times 10^{-3} \qquad (2.0 < p_{\eta'} < 2.7 \text{ GeV}) \quad (1)$$

where $X_s$ stands for one kaon plus up to 4 pions with at most one $\pi^0$. With tighter cuts than the exclusive analysis, 7 out of 12 $\eta'K$ events are captured, there is a conspicuous absence of the $\eta'K^*$ mode, and most events are at large $m_{X_s}$ \[3\]. Though effective two body $\eta'D(\ast)$, $\eta'D^{\ast\ast}$ backgrounds are yet to be fully ruled out, if large inclusive charmless $\eta'$ production becomes established soon, it would be one of the more exciting pieces of B physics ever.

Because of the SU$_F$(3) singlet nature of the $\eta'$, it is naturally related to gluons. Atwood and Soni \[6\] (AS) makes the interesting connection of inclusive $\eta'$ production to the QCD penguin via the gluon anomaly. Denoting $\eta'$-$g$-$g$ coupling as $H(q^2, k^2, m_{\eta'}^2) \varepsilon_{\mu\nu\alpha\beta} q^\mu k^\nu \varepsilon^\alpha(q) \varepsilon^\beta(k)$, they extract $H(0, 0, m_{\eta'}^2) \simeq 1.8 \text{ GeV}^{-1}$ from $J/\psi \to \eta'\gamma$ decay. Assuming constant $H(q^2, 0, m_{\eta'}^2) \approx H(0, 0, m_{\eta'}^2)$ they find that the standard $b \to s$ penguin could account for the observed large $B \to \eta' + X_s$ rate. We note, however, that the gluon anomaly coupling is proportional to $\alpha_s$. If running coupling is used, the above conclusion of AS may not hold.

Let us give a more theoretical basis to the gluon anomaly coupling, which concerns the $\eta^0$-$g$-$g$ effective vertex of the singlet field $\eta_0$. In the chiral limit $m_q \to 0$ with $N_F$ (= 3) chiral quarks, the singlet current has an anomaly, $\partial^\mu J^0_\mu = (2N_F \alpha_s/4\pi) \text{tr}(G^{\mu\nu} \tilde{G}_{\mu\nu})$, which breaks the U$_A$(1) symmetry, and through the topological charge $\langle 0 | (2N_F \alpha_s/4\pi) \text{tr}(G^{\mu\nu} \tilde{G}_{\mu\nu}) | \eta' \rangle$ etc., $\eta$ and $\eta'$ masses are elevated by their “gluon content”. Deriving from QCD the low energy effective theory of $\eta$ and $\eta'$ mesons continues to be an active research field \[10\]. The singlet-$g$-$g$ coupling can be formulated without assuming PCAC, as the U$_A$(1) symmetry is already broken. We find \[10\] the fundamental coupling $(N_F \alpha_s/4\pi) \theta \text{tr}(G^{\mu\nu} \tilde{G}_{\mu\nu})$ which arises from the Wess-Zumino term, where $\theta = \eta_0/\sqrt{N_F f_0}$ is the collective “chiral rotation”. Both $\eta_0$
and the “decay constant” $f_0$ are highly complicated objects. In particular, the connection of the $\eta_0$ field to physical mesons at long distances is highly nontrivial. Nevertheless, from our phenomenological standpoint, we will saturate $\eta_0/f_0$ by $c_P \eta'/f_{\eta'} + s_P \eta/f_\eta$, in the convention of $f_\pi \simeq 131$ MeV, where $s_P \equiv \sin \theta_P$ is the pseudoscalar mixing angle. Theoretical uncertainties are thus swept into $f_{\eta'}$. Phenomenological studies \cite{11} indicate that $f_{\eta'} \simeq f_\pi$.

We thus arrive at the Feynman rule for the $\eta'\cdot g\cdot g$ vertex,

$$-i a_g c_P (\eta'/f_{\eta'}) \varepsilon_{\mu\nu\alpha\beta} \varepsilon^\mu(q) \varepsilon^\nu(k) q^\alpha k^\beta,$$

where $a_g(\mu^2) = \sqrt{N_F} \alpha_s(\mu^2)/\pi$ is the effective gluon anomaly coupling and is nothing but

$H(q^2, k^2, m_{\eta'}^2)$ of AS. Note that although the algebraic part of the anomaly is scale independent, the explicit $\alpha_s$ factor suggests running coupling as commonly seen in QCD, a point which is ignored by AS. With one gluon off-shell ($q^2 \neq 0$), one gluon on-shell ($k^2 = 0$) but keeping $\eta'$ on-shell, it is plausible that $\mu^2 = q^2$ for $q^2 > m_{\eta'}^2$. As a cross check, we find that $a_g(m_{\eta'}^2) \simeq 1.9\,\text{GeV}^{-1}$, which is very close to the phenomenological value of $H(0, 0, m_{\eta'}^2) \simeq 1.8\,\text{GeV}^{-1}$ found by AS. This further confirms the validity of eq. (2).

We can now compute the $b \rightarrow \eta' sg$ rate. Defining $v_i \equiv V_{is}^* V_{ib}$ and ignoring $v_u$ (hence $v_t \simeq V_{ts} \simeq -V_{cb}$), one has the loop induced (see Fig. 1(a)) $b \rightarrow s$ current \cite{3} in SM

$$\frac{G_F G_s}{\sqrt{2} 4\pi^2} v_t \bar{s} t u \{\Delta F_1 (q^2 \gamma_\mu - q_\mu \not{q}) L - F_2 \not{\sigma} \not{q} m_b R \},$$

where $\Delta F_1 \equiv F_1^t - F_1^c$ with $F_1^t \simeq 0.25$ and $F_1^c \simeq -2/3 \log(m_c^2/M_W^2) \simeq 5.3$, and $F_2 \simeq F_2^t \simeq 0.2$. Although very large, the $\Delta F_1$ term couples only to virtual gluons because of the associated $q^2$. On-shell $b \rightarrow sg$ can arise only from the dipole term but $F_2 \ll |\Delta F_1|$. Thus, the higher order (in $\alpha_s$) process $b \rightarrow sg^* \rightarrow sq\bar{q}$ dominates over $b \rightarrow sg$ \cite{3}. Representing the effective $b\cdot s\cdot g$ couplings as a box in Fig. 1(b), applying the anomaly coupling of Fig. 1(c) (i.e. eq. (2)) perturbatively, one arrives at the $b \rightarrow \eta' sg$ transition of interest \cite{3} in Fig. 1(d).

Defining $q^2 = (k + k')^2$ (virtual gluon mass) and $m^2 = (p' + k)^2 \equiv m_{X_s}^2$, we assume that the $sg\bar{q}$ system evolves into $X_s$ (ignoring the minor effect of the spectator $\bar{q}$), hence $m^2$ is just the physical recoil mass against the $\eta'$ meson. Because of the anomaly coupling, a parton
level calculation gives us directly a handle on physical distributions. Scaling the variables as 
\( x \equiv m^2/m_b^2, \ y \equiv q^2/m_b^2 \) and \( x' \equiv m_{q'}^2/m_b^2 \), we find the differential branching ratio 
\[
\frac{d^2\mathcal{B}(b \to \eta' sg)}{dxdy} \simeq 0.2 \left( \frac{g_s(m_b)}{4\pi^2} \right)^2 \frac{a_s^2 m_b^2}{4} \left\{ |\Delta F_1|^2 c_0 + |\Delta F_2|^2 c_1 + |F_2|^2 c_2 \right\},
\]
where 0.2 comes from \( V_{cb}^2 G_F^2 m_b^2/192\pi^3 \simeq 0.2 \Gamma_B \) via the standard trick of relating to \( \mathcal{B}_{s,t} \) (see, e.g. ref. [3]). With \( c_0 = (-2x^2y + (1-y)(y-x')(2x+y-x'))/2, \ c_1 = -(1-y)(y-x')^2 \) and \( c_2 = (2x^2y^2 - (1-y)(y-x')(2xy-y+x'))/2 \), we confirm the formulas of AS, except for some subtle differences in defining \( \Delta F_1 \) and \( F_2 \), to which we now turn.

AS adapts from leading log order results from operator product expansion plus renormalization group running (OPE/RG). Comparing with the LO result of the \( C_8(\mu) \) coefficient of the \( O_8 \) operator, they conform with the convention of Buras [12] and absorb a factor of 1/2 into their definition of \( F_2 \). In our notation, we find \( F_2(\mu) \simeq 0.286 \) as compared to \( F_2(m_t) \simeq 0.2 \). Since \( \mathcal{B}(b \to sg) \simeq 0.4 (\alpha_s/\pi) |F_2(\mu)|^2 \), this makes a factor of two change in rate, increasing from 0.1% to 0.2%. This is agreeable since the dipole \( O_8 \) operator contains explicitly the gluon field. The AS treatment of \( F_1 \) is more troublesome for present purpose. They identify \( 4(c_4 + c_6)/g_s \equiv F_1^{\text{AS}}(\mu) \) (which is our \( (g_s/4\pi^2)\Delta F_1 \)) and find a value of \(-0.168 \) at LO [12]. In effect, they take the \( b \to s \) current from the \((\bar{s}t^a\gamma_{\mu}Lb)(\bar{q}t^a\gamma_{\mu}q)\) part of \( c_4(\mu)O_4 + c_6(\mu)O_6 \), then link it up with an “effective gluon”. We stress that this procedure is not appropriate, since the \( c_4(\mu) \) and \( c_6(\mu) \) coefficients contain resummed leading logs: The final \( \bar{s}t^a\gamma_{\mu}Lb \) current does not simply couple to an effective gluon. Put in another way, to apply the OPE/RG method to the present problem, one needs to redo the operator analysis and include \( \eta' \) insertions in every step, something nontrivial and not yet done.

We will thus use the simple one weak loop results for \( F_1 \) and \( F_2 \) as outlined earlier, with 
\( g_s = g_s(m_b) \) in eq. (3). In fact, the OPE/RG result does imply that the correction is only of \( \mathcal{O}(\alpha_s) \) [3], but our advantage is that we can proceed directly from Fig. 1(b) and (c) to Fig. 1(d). Furthermore, unlike the extra effort needed in the OPE/RG approach, which usually stops at a set of effective operators at scale \( \mu = m_b \), our formalism allows the automatic inclusion of final state perturbative rescattering effects such as \( b \to s\bar{c}c \to sg^* \). This last
aspect would be very useful when we turn to CP violating asymmetries.

Let us first check the results of AS numerically. Using $m_b$, $m_s = 4.8, 0.15$ GeV, $\alpha_s(m_b) \simeq 0.21$ (hence $g_s \simeq 1.62$) and constant $a_g c_P \simeq 1.7$ GeV$^{-1}$, we find the $(g_s/4\pi^2) \Delta F_1(\mu) = -0.168$ term alone gives $\mathcal{B}(b \to \eta'sg) \approx 1.6 \times 10^{-3}$, not far from the AS result of $1.9 \times 10^{-3}$. However, the inclusion of $F_2(\mu) = 0.286$ term leads to only $\sim 23\%$ increase rather than the $\sim 50\%$ claimed by AS. We have used the formulas of AS to confirm our findings. Note that the $F_2$ effect alone is negligible but the interference effect is positive. We find that Fig. 3 of AS seems to be the dashed curve [13] for $d\mathcal{B}/dq$ given in our Fig. 2(b), rather than $d\mathcal{B}/dm$ of Fig. 2(a). For the latter, the efficiency of an $m_{X_s}$ cut at 2.35 GeV (corresponding to $p_{\eta'}$ minimum of 2 GeV) is of order 1/2, and is not sensitive to Fermi motion of the $b$ quark, unlike the case for Fig. 2(b) because of the difference in shape. We also show [13] the $d\mathcal{B}/dm$ distribution for the pure $F_2$ case in Fig. 2 to illustrate the difference between $F_1$ and $F_2$ effects. Taking $F_2 \cong 2$ so $b \to sg$ is of order 10% from new physics, we find that the $b \to \eta'sg$ rate in this case is slightly lower than the SM result. If the “new physics” $F_2$ term interferes with SM effect constructively, the resulting $\mathcal{B}(b \to \eta'sg) \simeq 0.5\%$ is way too large, and would suggest the absence of such “new physics” effects.

However, as argued earlier, the anomaly coupling $a_g \propto \alpha_s$ and could be running. Since $m_{\eta'}^2 \leq q^2 \leq (m_b - m_s)^2$ is always larger than $m_{\eta'}^2$, the obvious scale would be the $q^2$ of the virtual gluon. Using two-loop running $\alpha_s$ in $a_g(q^2)$ of eq. (2), we find that $\mathcal{B}(b \to \eta'sg)$ drops by about a factor of more than 3. This is because the anomaly coupling is of derivative form, hence favors large $q^2$ and $m^2$, as indicated by Fig. 2. We find that the SM effect alone decreases to $\sim 0.65 \times 10^{-3}$. Even without applying the $m_{X_s}$ cut, it is insufficient to account for eq. (1). Thus, Fig. 1(d) with running $\alpha_s$ in the anomaly coupling suggests that new physics is needed from $F_2$ to account for the observed $B \to \eta' + X_s$ rate [14].

As demonstrated by Kagan [4], without changing much the electric-dipole $b$-$s$-$\gamma$ coupling, it is possible to enhance the chromo-dipole $b$-$s$-$g$ coupling by new physics at the TeV scale such as supersymmetry or techniscalar models. The essence is that the chromo-dipole $F_2$ term may be linked to the generation of the quark mass matrix, since both involve chirality
flip. This TeV scale connection and the appearance of the $b_R$ field in $\bar{s}_L \sigma_{\mu\nu} m_b b_R$ provide an
exciting input to the problem, namely CP violation. One is now sensitive to right-handed
rotations which would in principle contain CP violating phases that are different from the
standard CKM matrix. Note that within SM, the small effect of $v_u \neq 0$, leads to less than
1% CP violating asymmetry in $b \to \eta' sg$, much like other inclusive $b \to s$ decays.

Parametrizing the new physics term as $F_2 \simeq 2 e^{i\sigma}$ with $v_t$ taken as real, the required
absorptive part comes from $c\bar{c}$ rescattering in $\Delta F_1$ (see the cut in Fig. 1(a)). This
facilitated by the peaking of $d\mathcal{B}/dq$ at $q^2 \gtrsim (2m_c)^2$. The absorptive part is incorporated by
making the change $\Delta F_1 \to \Delta F_1 + 4\Pi(q^2/m_c^2)$, where $\Pi$ is just the one-loop vacuum
polarization familiar from QED. For $\bar{b} \to \eta' \bar{s}g$ one simply replaces $F_2^* \to F_2$ in eq. (4). We
thus easily arrive at the average branching ratio $\mathcal{B}_{av}$ and asymmetry $a_{CP} = (\mathcal{B} - \bar{\mathcal{B}})/(\mathcal{B} + \bar{\mathcal{B}})$
for the $b \to \eta' sg$ transition. The results are given in Table 1. The asymmetry is generally
larger for $\cos \sigma < 0$ (except vanishing as $\sigma \to \pi$) because of destructive interference, but
$\mathcal{B}_{av}$ often becomes too small in this region. As illustration, we give in Fig. 3 the Dalitz
plot (in $q$ and $m$) and $d\mathcal{B}/dq$ and $d\mathcal{B}/dm$ for both $b \to \eta' sg$ and $\bar{b} \to \eta' \bar{s}g$ for $\sigma = \pi/2$. The
more visible difference in $d\mathcal{B}/dq$ is not observable. However, since the shape for $d\mathcal{B}/dm$ is
largely unchanged, a 10% difference in rate below the $m_{X_s}$ cut of 2.35 GeV should be readily
visible, at CLEO and at proposed B Factories that would start operation in 1999.

We make some remarks before closing. First, $b \to sg$ at 10% order alone leads to $b \to \eta' sg$
only at $\sim 0.1\%$, just comparable to the standard $b \to sg^\ast$ penguin which begins with 1%.
This is because $\Delta F_1$ from SM is still larger than $F_2 \sim 2$ from new physics. We stress
that the anomaly induced $b \to \eta' sg$ of Fig. 1(d) is a new diagram in addition to the usual
$b \to sg^\ast \to sq\bar{q}$, and shows very different $q^2$ and $m^2$ dependence. Second, the inclusive $\eta'$ data
seems to [3] conform better with $\eta' +$ two parton fragmentation with 3-body phase space,
rather than naive meson formation emulating $B \to \eta' K$. In particular, there is conspicuous
absence of $\eta' K^\ast$, and suppression of known heavy $K$ resonances in general. All these features
can be explained by Fig. 1(d). We do have $\eta' +$ two partons ($s + g$). It is easy to see that
the $\eta' - g$ pair is in $L = 0$ state, hence the $sg\bar{q}$ system (where $\bar{q}$ is the spectator) retains the
$J = 0$ nature of the original $B$ meson, and can evolve into only two states below 2 GeV: the $0^- K_0$ and $0^+ K^*_0(1430)$. In our numerical study, we took $m_g \sim 0.5$ MeV in phase space to remove soft gluons [13]. If one assumes the $sg\bar{q}$ system with a soft gluon (see Fig. 2(a)) is swept into the $K$ meson, the removed 4-5% is just sufficient for producing the exclusive $\eta'K$ mode. This also suggests that CP violation in $\eta'K$ would be less pronounced since it comes mostly from $q^2 < (2m_c)^2$. Third, the $\eta-g-g$ coupling is $a_g s_P$, hence is weaker by $\tan^2 \theta_P \sim 0.1$ in rate. This seems to be on the small side to account for a small bump seen in the total inclusive $B \to \eta + X$ spectra [16] in similar $p_\eta$ window. Four, although we entertained the new physics picture, at the rate level, the "hybrid $c\bar{c}g$" mechanism of ref. [7] could also work, since the effective $b \to sc\bar{c} \to sg^*$ penguin is much larger than in perturbative application of SM [14]. However, SM mechanisms alone would never bring about CP asymmetries beyond 1% in these modes [15]. Thus, *the large CP asymmetries discussed here could serve as a unique signature for the presence of new physics from dipole $b \to sg$ transition.* Finally, it is worthwhile to pursue perturbative effects of the gluon anomaly in conventional processes. An example would be $e^+e^- \to \eta' + q\bar{q}g$, the study of which would be reported elsewhere.

In summary, the $\eta'-g-g$ anomaly is applied for the first time with running $\alpha_s$ in a perturbative way. We find that the inclusive $B \to \eta'X_s$ rate at $1 \times 10^{-3}$ level cannot be accounted for by the standard $b \to sg^*$ penguin alone, but calls for new physics from $b \to sg$ at 10% level, which is consistent with low values of $n_C$ and $B_{sL}$. CP violating rate asymmetries could then be as large as 10%, and would be easily observable at B Factories.

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[14] Contributions such as $\eta_c \to \eta' + X$ and $\eta_c-\eta'$ mixing are found in ref. [3] to be subdominant. However, the paper by I. Halperin and A. Zhitnitsky, e-print hep-ph/9705251, claims that invoking the “intrinsic charm” content of $\eta'$ can also account for $b \to \eta' + X_s$ rate. Their prediction of $\mathcal{B}(B \to \eta' K^*) \sim 2\mathcal{B}(B \to \eta' K)$ and a low $m_{X_s}$ spectrum con-
sistent with $b \to \eta' + s$, however, are inconsistent with experimental findings in [4].

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FIGURES

FIG. 1. (a) Sample diagram for loop induced $b \to s$ current, with possible $c \bar{c}$ cut; (b) effective $b$-$s$-$g$ coupling, possibly from new physics; (c) the anomaly $\eta'$-$g$-$g$ vertex; (d) the $b \to \eta' sg$ transition.

FIG. 2. (a) $d\mathcal{B}/dm \equiv d\mathcal{B}/dm_{X_s}$ and (b) $d\mathcal{B}/dq$ for SM (dashed, solid: cut of $m_g = 0, 0.5$ GeV) penguin induced $b \to \eta'/sg$. The purely dipole (dotdash) effect with $F_2 \approx 2$ is also given. The vertical dotted line indicates the $m_{X_s} = 2.35$ GeV cut.

FIG. 3. (a,b) Dalitz plot and (c) $d\mathcal{B}/dm$ (d) $d\mathcal{B}/dq$ for $b \to \eta'/sg$ vs. $\bar{b} \to \eta' sg$ (solid and dashed in (c) and (d)) for $\sigma = \pi/2$. 
### TABLE I. $B_{av.}$ and $a_{CP}$ for $b \rightarrow \eta'/sg$ vs. $\bar{b} \rightarrow \eta'/\bar{s}g$ transitions.

| $\sigma = \cdots$ | 0  | 30$^\circ$ | 60$^\circ$ | 90$^\circ$ | 120$^\circ$ | 150$^\circ$ | 180$^\circ$ |
|-------------------|----|-----------|-----------|-----------|-----------|-----------|-----------|
| $B_{av.}$ $(\times 10^{-3})$ | 2.5 | 2.4 | 2.0 | 1.5 | 0.91 | 0.52 | 0.4 |
| $a_{CP}$ (%) | 0.0 | 2.9 | 6.0 | 9.5 | 13.1 | 13.3 | 0.0 |
Fig. 1
Fig. 2
Fig. 3