ИЯФ

ИНСТИТУТ ЯДЕРНОЙ ФИЗИКИ СО АН СССР

23

V. N. Baier and A. G. Grozin

GLUONIC CONTRIBUTIONS TO THE EXCLUSIVE AMPLITUDES

PREPRINT 85-39

НОВОСИБИРСК

GLUONIC CONTRIBUTIONS TO THE EXCLUSIVE AMPLITUDES

V.N.Baier and A.G.Grozin

Institute of Nuclear Physics, 630090 Novosibirsk, USSR

A b s t r a c t

The contributions from the gluonic wavefunctions to the amplitudes of meson production in e^+e^- annihilation, quarkonium decays and two-photon processes are calculated.

In recent years, the hard exclusive processes in QCD have been actively analysed (see the reviews [1,2] and the literature cited there). In particular, it has been discovered that in case of the processes involving flavor singlet mesons together with the quark-antiquark component the two-gluon component of the wavefunction may be significant as well. The evolution and mixing of the quark and gluonic wavefunctions have been studied in considerable detail (Refs. [3-8]). Besides this, a great deal of calculations for the amplitudes of concrete exclusive processes has been made with the gluonic wavefunctions taken into account. However, a considerable part of the relevant papers either has the errors, or has no indications at which quantum numbers the result is applicable. In the present paper, the gluonic contributions to the amplitudes of a number of exclusive processes are calculated. In the literature available, there are no larger part of the results here obtained, and some of the previously erroneous results are corrected.

We would like to remind that in the processes unsuppressed with respect to $1/Q$, the mesons can be produced with the following quantum numbers (see Ref. 1; spin and parity: S^P; helicity: λ): the type S_+ $(0^+, 2^+, 4^+ ..., \lambda = 0)$, $S_-(1^-, 3^-, 5^-, ..., \lambda = 0)$, P_+ $(0^-, 2^-, 4^-, ..., \lambda = 0)$, P_- $(1^+, 3^+, 5^+, ..., \ = 0)$, $V_+(1^+, 2^+, 3^+, ..., \lambda = \pm 1)$, $V_-(1^-, 2^-, 3^-, ..., \lambda = \pm 1)$ and $T_+(2^+, 3^+, 4^+, ..., \lambda = \pm 2)$. In the case of absolutely neutral mesons, the subscript of the meson's type indicates its C-parity. The flavor singlet mesons of the types S_+ and P_+ have both the quark and gluonic wavefunctions. The T -type mesons must be be flavor singlet and have only a gluonic wavefunction. The remaining mesons have only a quark wavefunction .

The wavefunction $f_M^p(x)$ has a qualitative meaning of the probability amplitude to find, in the meson M, exactly two partons, namely, the parton p carrying the fraction x of the meson's momentum and another parton carrying the fraction $x' \equiv 1 - x$ of the momentum. One of the quantitative definitions is based on the connection of their moments to the matrix elements of the twist 2 operators :

$$\langle 0| O_q^n |M\rangle = \frac{p_\nu}{2}\frac{p_{\mu_1}}{2}\ldots\frac{p_{\mu_n}}{2}\int_{-1}^{+1} f_M^q(X) X^n dX$$

$$\langle 0| O_g^n |M\rangle = \frac{C_F}{2}\frac{p_\nu}{2}\frac{p_{\mu_1}}{2}\ldots\frac{p_{\mu_n}}{2}\int_{-1}^{+1} f_M^g(X)(1-X^2) X^{n-1} dX \qquad (1)$$

where $X \equiv 2x-1$, p is the momentum of the meson, $C_F = \frac{N^2-1}{2N}$, $N = 3$ is the number of the colors, and the operators O^n for various types of wavefunctions are defined as follows:

$$S: O_q^n = \bar{q}\gamma_\nu i\overleftrightarrow{D}_{\mu_1}\ldots i\overleftrightarrow{D}_{\mu_n} q, \quad O_g^n = i G^a_{\alpha\nu} i\overleftrightarrow{D}_{\mu_1}\ldots i\overleftrightarrow{D}_{\mu_{n-1}} G^a_{\mu_n\alpha};$$

$$P: O_q^n = \bar{q}\gamma_\nu\gamma_5 i\overleftrightarrow{D}_{\mu_1}\ldots i\overleftrightarrow{D}_{\mu_n} q, \quad O_g^n = i \tilde{G}^a_{\alpha\nu} i\overleftrightarrow{D}_{\mu_1}\ldots i\overleftrightarrow{D}_{\mu_{n-1}} G^a_{\mu_n\alpha}; \qquad (2)$$

$$V: O_q^n = e^*_\alpha \bar{q}\sigma_{\alpha\nu} i\overleftrightarrow{D}_{\mu_1}\ldots i\overleftrightarrow{D}_{\mu_n} q;$$

$$T: O_g^n = \frac{e^*_\alpha e^*_\beta}{\sqrt{2}} i G^a_{\alpha\nu} i\overleftrightarrow{D}_{\mu_1}\ldots i\overleftrightarrow{D}_{\mu_{n-1}} G^a_{\mu_n\beta}.$$

The formulae (2) imply the symmetrization and subtraction of the traces with respect to the indices $\nu, \mu_1 \ldots \mu_n$; $\overleftrightarrow{D}_\mu = (\overrightarrow{D}_\mu - \overleftarrow{D}_\mu)/2$ and e_α are helicity unit vectors for helicities $\lambda = \pm 1$ (in the V and T types). The wavefunctions of absolutely neutral mesons satisfy the symmetry property (Ref. [1]):

$$f_M^q(x') = -P f_M^q(x), \quad f_M^g(x') = P f_M^g(x) \qquad (3)$$

where P is the parity of the meson M.

The decay of a heavy photon is one of simplest exclusive processes, $\gamma^* \to M_1 M_2$. The mesons can be of the type SS , or PP . The matrix element is possible to write in the form $e(p_1-p_2)_\mu F_{M_1 M_2}(Q^2)$ where $F_{M_1 M_2}$ is the meson-meson form factor. If the mesons are absolutely neutral, they may be assigned to the S_+S_- and P_+P_- types. The quark contribution to the form factor (Fig. 1a) has been known for a long time (see Refs. [1,2]). The gluonic contribution (Fig. 1b,c) has been found in Ref. [8]:

$$F_{P_+P_-}(Q^2) = \frac{C_F}{N}\frac{4\pi\alpha_s}{Q^2}\sum_q I^q_{P_+} I^{\bar{q}}_{P_-},$$

$$F_{S_+S_-}(Q^2) = \frac{C_F}{N}\frac{4\pi\alpha_s}{Q^2}\sum_q (I^q_{S_+} + f^g_{S_+}) I^{\bar{q}}_{S_-} \qquad (4)$$

where Q_q is the charge of the quark q, and for any parton p

$$I_M^p = \int_0^1 \frac{f_M^p(x)dx}{1-x}, \quad f_M^p = \int_0^1 f_M^p(x)dx \qquad (5)$$

It is seen that for P_+P_- the gluonic contribution vanishes.

It is very interesting the situation dealing with the vector-quarkonium decays, $\psi_q \to \gamma M$ (Fig. 2). In these decays the mesons of the S_+, P_+ and T_+ types can be producted. In the Born approximation (Fig. 2a), only the matrix element of S_+ -type meson production does not vanish, while for the P_+ and T_+ type mesons the main asymptotic mechanism of the process is determined by the one-loop diagrams in Fig. 2b,c. This has been revealed in Ref. [7], a year later in Ref. [9] and over again a year later in Ref. [10]. For the S_+ type mesons the contribution of the diagram in Fig. 2a for the matrix element M and branching B is the following (Ref. [8]):

$$M = 4C_F Q_q e g^2 \psi_0 f_M^g \delta_\perp^{\mu\nu}, \quad B = \frac{\alpha}{\alpha_s} Q_q^2 \frac{48\pi^2}{\pi^2-9} \frac{C_F}{N^2-4} \left(\frac{f_M^g}{m}\right)^2,$$

$$B_\gamma \equiv \frac{\Gamma(\psi_q \to \gamma M)}{\Gamma(\psi_q \to \gamma X)} = \frac{4\pi^2}{\pi^2-9} \frac{C_F}{N} \left(\frac{f_M^g}{m}\right)^2 \tag{6}$$

where $\psi_0^2 = \frac{1}{N}\frac{|\psi(0)|^2}{m^3}$, $\delta_\perp^{\mu\nu} = (P_M^\mu P_\gamma^\nu + P_M^\nu P_\gamma^\mu)/P_M P_\gamma - g^{\mu\nu}$, m is the mass of the quarkonium ψ_q, and P_M and P_γ are the momenta of a meson and photon. This result has been rederived in Refs. [9,10].

If the formula (6) is applied to the $\psi \to \gamma f$ decay, we then obtain $f_f^g \sim$ (60÷80) MeV from the experimental value of B_γ. This could evidence a substantial admixture of the two--gluon state in the f-meson. However, one should bear in mind that in the asymptotic mechanism, described by formulae (6), only the f-mesons with helicity $\lambda = 0$ are produced (if A_λ^f is the production amplitude of the f with helicity λ, then only A_0^f is non-vanishing). But, as follows from the experiment (Refs. [11,12]), $x^f \equiv |A_1^f/A_0^f| = 0.96 \pm 0.12$ and $y^f \equiv |A_2^f/A_0^f| = 0.06 \pm 0.13$, so that alongside with the mesons with $\lambda = 0$, with a comparable amplitude the f mesons with $\lambda = \pm 1$ are produced as well. In addition, there are the experimental data on radiative ψ decays with the formation of tensor mesons : $\psi \to \gamma f'(1515)$ and $\psi \to \gamma \vartheta$ (1720) (Ref. [12]). Application of formula (6) to these decays gives

$f_{f'}^g$ = (40-60) MeV, $f_\vartheta^g \sim$ 60 MeV. However, the polarization analysis here gives rise to $x^{f'} = (0.63 \pm 0.10)$, $y^{f'} = (0.17 \pm 0.20)$ and $x^\vartheta = 1.07 \pm 0.20$, $y^\vartheta = 1.09 \pm 0.25$, so that in these decays the mesons also are produced with the helicity $\lambda \neq 0$. Thus it is seen that at 3.1 GeV the asymptotic mechanism is not yet dominant*.

The contribution of the quark wavefunction to the asymptotic matrix element $\psi_q \to \gamma P_+$ (Fig. 2b) is equal to (Ref. [13])

$$M = 4C_F Q_q e \alpha_s^2 \psi_0 i \varepsilon_\perp^{\mu\nu} \int_0^1 \Big\{ \frac{1}{x'}\Big[\ln x + \frac{\pi^2}{4} + F(1-2x) - F(2x-1)\Big] + (x \leftrightarrow x')\Big\} \sum_q f_M^q(x)\, dx \tag{7}$$

where $\varepsilon_\perp^{\mu\nu} = \varepsilon^{\alpha\beta\mu\nu} P_M^\alpha P_\gamma^\beta / P_M P_\gamma$, $F(x) = \int_0^x \frac{\ln(1+y)}{y} dy$ is the Spence function. This result was obtained a year later in Ref. [14]. The gluonic contributions to the asymptotic matrix elements $\psi_q \to \gamma P_+$ and $\psi_q \to \gamma T_+$ (Fig. 2c) are not calculated yet. It is worth noting, however, that the main asymptotic decay mechanism for $\psi_q \to \gamma P_+$ (Eq. (7)) is suppressed as α_s^2, and the power-correction contribution associated with the twist-4 operator $G\tilde{G}$ (Ref. [15]) is enhanced as $1/\alpha_s^2$, so that their ratio, containing the factor $(m_M/m\alpha_s)^4$, is not small even for the family Υ.

The decays of the C- even quarkonium states $\eta_q(^1S_0)$, χ_{q0}, χ_{q1} and χ_{q2} $(^3P_0, {}^3P_1, {}^3P_2)$ into two mesons are described by the diagrams in Fig. 3. The quark contribution has been analysed in a variety of papers (see Refs. [1-2]), and the quark-gluonic contribution (Fig. 3b) has been calculated in Ref. [8]. The purely gluonic contribution (Fig. 3c-i) has been calculated also in Ref. [8], but the result

---

*) Note that this circumstance is the main problem in applying asymptotic exclusive calculations to the decays of charmonium states.

obtained is wrong. This contribution has been considered later in Ref. [10] without the indication of the quantum numbers of the mesons. The result presented in Ref. [10] is not consistent with those derived in the present paper for any quantum numbers of the mesons. Note that there are no diagrams of the type presented in Fig. 3i in the Figure in Ref. [10].

The selection rules (see Ref. [1]) permit the decays $\eta_q, \chi_{q1} \to SP, TT$; $\chi_{q0}, \chi_{q2}(m=0) \to SS, PP, TT$ and $\chi_{q2}(m=\pm 2) \to VV, TS, TP$ (m is the momentum projection onto the decay axis). For the absolutely neutral mesons, the matrix element M and the branching B are written down as follows:

$$M = \frac{C_F}{N} \frac{g^4}{m} a K, \quad B = \pi^2 \frac{C_F}{N^3} \frac{\alpha_s^2}{m^4} b K^2, \quad K = \sum_q K_q + K_{qg} + K_g \tag{8}$$

where $a = \psi_0$ and $b = 2$ for η_q, and $a = 2\sqrt{2}\,\psi_1$ and $b = \frac{3\pi}{n_f \alpha_s L}$ for χ_{q1} (where n_f, the number of the quarks lighter than q, and $L = \ln m/\mu$, μ is the virtuality of the quarks in χ_{q1}, determine the total width of χ_{q1} in logarithmic approximation); $a = \frac{4}{\sqrt{3}}\psi_1$ and $b = \frac{8}{9}$ for χ_{q0}; $a = 4\sqrt{\frac{2}{3}}\,\psi_1$ and $b = \frac{4}{3}$ for χ_{q2} (m = 0), and $a = 4\psi_1$ and $b = 2$ for χ_{q2}(m = $\pm$2). The quantity ψ_0 is defined in formula (6), $\psi_1^2 = \frac{1}{N} \frac{|\vec{\nabla}\psi(0)|^2}{m^5}$

The quark contribution to the matrix element is

$$K_q = \int_0^1\!\!\int_0^1 \frac{c(x_1,x_2) f^q_{M_1}(x_1) f^q_{M_2}(x_2)\, dx_1 dx_2}{x_1 x_1' x_2 x_2' (1 + X_1 X_2)} \tag{9}$$

where (see Refs. [1,2]) for $\eta_q \to SP$: $c = 1 - x_1 - x_2$; for $\chi_{q1} \to SP$: $c = x_1 - x_2$; for $\chi_{q0} \to SS, PP$: $c = 1 + A$; for $\chi_{q2}(m=0) \to SS, PP$: $c = \frac{1}{2} - A$ (here $A = (1-x_1-x_2)^2/(1+X_1X_2)$); and for $\chi_{q2}(m=\pm 2) \to VV$: c = 1.

The quark-gluonic contribution K_{qg} (Ref. [8]) is $K_{qg} = A_1 + A_2$ for $\eta_q, \chi_{q1} \to SP$; $K_{qg} = -\frac{5}{2}(A_1 + A_2)$ for $\chi_{q0} \to SS$;

$K_{qg} = \frac{1}{2}(A_1 + A_2)$ for $\chi_{q2} \to SS$; $K_{qg} = -\frac{1}{2}(A_1 - A_2)$ for $\chi_{q0} \to PP$; $K_{qg} = \frac{1}{2}(A_1 + A_2)$ for $\chi_{q2} \to PP$ and $K_{qg} = \sqrt{3}\,A_1$ for $\chi_{q2} \to TS, TP$ (here $A_{1(2)} = I^g_{M_{1(2)}} \sum_q I^q_{M_{2(1)}}$).

The gluonic contribution to the matrix element can be represented as follows:

$$K_g = N \int_0^1\!\!\int_0^1 \left(g_1 + \frac{g_2}{N^2}\right) f^g_{M_1}(x_1) f^g_{M_2}(x_2)\, dx_1 dx_2 \tag{10}$$

the functions g_1 and g_2 in the above expression are given in the Table. These are expressed via $\xi_{1,2} = X^2_{1,2}$ using the following notations: $\beta_{1,2} = 1/(1-\xi_{1,2})$ and $\beta_{12} = 1/(1-\xi_1\xi_2)$.

Of special interest are the decays into mesons of T type because these decays are determined by the gluonic wavefunctions of mesons. The same zero-helicity mesons are referred to the S type in the case of an even spin and to the P type in the case of an odd spin. For the time being we refer to them as the mesons of T_S, or T_P type. The decays $\eta_q, \chi_{q1} \to T_S T_P$ and $\chi_{q0}, \chi_{q2} \to T_S T_S, T_P T_P$ then differ from the decays $\eta_q, \chi_{q1} \to SP$ and $\chi_{q0}, \chi_{q2} \to SS, PP$ only by the polarization of the final mesons (i.e. for their separation the angular distributions of decay products need to be studied). The decays $\eta_q, \chi_{q1} \to T_S T_S$, $T_P T_P$ and $\chi_{q0}, \chi_{q2} \to T_S T_P$ cannot occur with zero helicity of the mesons being produced and are completely due to their gluonic wavefunctions (for example, $\eta_q, \chi_{q1} \to ff$). The decays $\chi_{q2} \to T_S S$ and $T_P P$ differ from the decays $\chi_{q2} \to SS, PP$ by the polarization of the final mesons and, in the case of an aligned χ_{q2}, by the angular distribution (Ref. [8]). The decays $\chi_{q2} \to T_P S$, $T_S P$ cannot take place with the zero helicity of the T type meson being produced and are completely due to its gluonic wavefunction (for example, $\chi_{q2} \to f\eta'$).

The decays of this type are especially convenient for experimental research of the gluonic wavefunctions.

Let us estimate the branching B of some decays which are due to the gluonic wavefunctions. If one assumes that the gluonic wavefunctions are wide and $x, x' \sim a \ll 1$ dominate in the integral (10), then

$$B(\eta_c \to ff) \sim \frac{(\pi\alpha_s)^2}{72}\left(\frac{f_f^g}{m a_f^g}\right)^4, \quad B(\chi_1 \to ff) \sim \frac{\pi^3 \alpha_s}{64\,4}\left(\frac{f_f^g}{m a_f^g}\right)^4,$$

$$B(\chi_2 \to f\eta') \sim \frac{(4\pi\alpha_s)^2}{3^5}\,\frac{(f_f^g)^2}{m^4}\left[\frac{f_{\eta'}^q}{a_{\eta'}^q} + \frac{3}{8}\,\frac{f_{\eta'}^g}{a_{\eta'}^g(a_{\eta'}^g + a_f^g)}\right] \qquad (11)$$

Putting $f_f^g \sim 100$ MeV, $f_{\eta'}^q \approx \sqrt{3} f_\pi$ and $a \sim 0.1$, we have $B(\eta_c \to ff) \sim 5\cdot 10^{-5}$, $B(\chi_1 \to ff) \sim 5\cdot 10^{-4}$ and $B(\chi_2 \to f\eta') \sim 10^{-5}$.

The $\gamma\gamma \to M_1 M_2$ reaction is described by the diagrams in Fig. 4. For $\gamma\gamma \to SS, PP, VV$, the quark contribution (Fig. 4a-d) has been discussed in Ref. [16] and for $\gamma\gamma \to SP$ in Ref. [1]. For the $\gamma\gamma \to PP$ reaction the gluonic contribution has been considered in Ref. [17]. The comparison of Ref. [17] with the present paper is complicated because in Ref. [17] there is no definition of the used wavefunction; if this definition is the same as in Ref. [10], then the denominator in Ref. [17] has an extra factor $x_1 x_1'$.

Let the total energy be equal to Q in the centre-of-mass frame of $\gamma\gamma$. We put $z = \sin^2\vartheta/2$ and $z' \equiv 1-z$ instead of the scattering angle ϑ (the angle between the lines of photon collision and meson emission). The contribution of the diagrams in Fig. 4 c,d and f,h contains the denominator $-Q^2 c$, or $-Q^2 c'$, where $c = z x_1 x_2 + z' x_1' x_2'$ and $c' = c(z \leftrightarrow z')$. This gives rise to a considerable dependence of the angular distribution on the shape of the wavefunctions. For absolutely neutral mesons, the helicity amplitudes are of the form

$$M = \frac{C_F}{4N}\,\frac{e^2 g^2}{Q^2}\sum_q Q_q^2 \int_0^1\!\!\int_0^1 \Big[\frac{A(x_1,x_2)}{x_1 x_1' x_2 x_2'}\, f_{M_1}^q(x_1) f_{M_2}^q(x_2)$$
$$+ \frac{B_{12}(x_1,x_2)}{x_2 x_2'}\, f_{M_1}^g(x_1) f_{M_2}^q(x_2) + \frac{B_{21}(x_2,x_1)}{x_1 x_1'}\, f_{M_2}^g(x_2) f_{M_1}^q(x_1)\Big]\, dx_1 dx_2 \qquad (12)$$

The non-zero quark contributions are (Refs. [16,1]):

$$A(\gamma^\pm\gamma^\mp \to SS, PP) = -\frac{(x_1 x_2 + x_1' x_2')(x_1 x_1' + x_2 x_2')}{cc'},$$
$$\pm A(\gamma^\pm\gamma^\mp \to SP) = -\frac{(2z-1)(x_1 - x_2)(x_1 x_2 - x_1' x_2')^2}{cc'}, \qquad (13)$$
$$A(\gamma^\pm\gamma^\mp \to V^\pm V^\mp) = A(\gamma^\pm\gamma^\mp \to V^\mp V^\pm, z \leftrightarrow z')$$
$$= -\frac{4zz'(2z-1)(x_1 x_2 - x_1' x_2')^2}{cc'}.$$

The non-zero gluonic contributions are:

$$B_{12}(\gamma^\pm\gamma^\pm \to T^\pm S) = \sqrt{2}\,X_2\left(\frac{1}{c'} + \frac{1}{c}\right),$$
$$\pm B_{12}(\gamma^\pm\gamma^\pm \to T^\pm P) = -\sqrt{2}\left(\frac{1}{c'} + \frac{1}{c}\right),$$
$$B_{12}(\gamma^\pm\gamma^\mp \to SS) = -\frac{z + x_1' - 2x_2}{c'} - \frac{z' + x_1' - 2x_2}{c},$$
$$\pm B_{12}(\gamma^\pm\gamma^\mp \to PS) = \frac{z + x_1' - 2x_2}{c'} - \frac{z' + x_1' - 2x_2}{c}, \qquad (14)$$
$$B_{12}(\gamma^\pm\gamma^\mp \to PP) = \frac{z - x_1'}{c'} + \frac{z' - x_1'}{c},$$
$$\pm B_{12}(\gamma^\pm\gamma^\mp \to SP) = -\frac{z - x_1'}{c'} + \frac{z' - x_1'}{c}.$$

In the presented work, for performing complex calculations the authors have used the computer algebra systems REDUCE (Ref. [18]) and DIRAC (Ref. [19]).

References

1. V.N.Baier, A.G.Grozin. Elem. Chast. i Atom. Yad. 16, 5 (1985).
2. V.L.Chernyak, A.R.Zhitnitsky. Phys. Reports 112, 173 (1984).
3. M.K.Chase. Nucl. Phys. B167, 125, B174, 109 (1980).
4. M.A.Shifman, M.I.Vysotsky. Nucl. Phys. B186, 475 (1981).
5. M.V.Terentyev. Pisma ZhETF 33, 71; Yad. Fiz. 33, 1692 (1981).
6. Th. Ohrndorf. Nucl. Phys. B186, 153 (1981).
7. V.N.Baier, A.G.Grozin. Nucl. Phys. B192, 476 (1981).
8. V.N.Baier, A.G.Grozin. Yad. Fiz. 35, 1021 (1982).
9. S.C.Chao. Preprints OITS-205 (1982); OITS-207 (1983).
10. K.Tsokos. Phys. Lett. 136B, 429 (1984).
11. C.Edwards a.o. Phys. Rev. D25, 3065 (1982).
12. K.Einsweiler. SLAC Report-272 (1984).
13. V.N.Baier, A.G.Grozin. Preprint IYaF 82-92, Novosibirsk (1982).
14. J.H.Kühn. Phys. Lett. 127B, 257 (1983).
15. V.A.Novikov a.o. Nucl. Phys. B165, 55 (1980).
16. S.J.Brodsky, G.P.Lepage. Phys. Rev. D24, 1808 (1981).
17. G.W.Atkinson, J.Sucher, K.Tsokos. Phys. Lett. 137B, 407 (1984).
18. A.C.Hearn. RAND publ. CP-78 (4/83).
19. A.G.Grozin. Proc. of 3 Conf. "Dialogue Man-Computer", Serpukhov, 1984, p. 205; Preprint IYaF 83-117, Novosibirsk (1983).

Table. Functions g_1 and g_2 in Equation (10).

Decay	g_1	g_2	Decay	g_1	g_2
$\eta_q \to SP$	$-X_2\beta_1\beta_2\beta_{12}(1+\zeta_1)(3-\zeta_1-\zeta_2-\zeta_1\zeta_2)$	$X_2\beta_{12}(1+\zeta_1)$	$\chi_{q2}\to PP$	$X_1X_2\beta_{12}^2(2-\zeta_1-\zeta_2)$	$-X_1X_2\beta_{12}^2(1-\zeta_1)(1-\zeta_2)$
$\eta_q \to TT$	$-2\beta_1\beta_2\beta_{12}(3-\zeta_1-\zeta_2-\zeta_1\zeta_2)$	$2\beta_{12}$	$\chi_{q2}\to TT$	0	0
$\chi_{q1}\to SP$	$-X_2\beta_1\beta_2\beta_{12}(1-2\zeta_1-\zeta_2-\zeta_1^2+3\zeta_1^2\zeta_2)$	$X_2\beta_{12}(1+\zeta_1)$	$\chi_{q2}\to TS$	$\sqrt{2}\beta_1\beta_2\beta_{12}(3-\zeta_1-\zeta_2-\zeta_1\zeta_2)$	$-\sqrt{2}\beta_1\beta_{12}(3-\zeta_1-2\zeta_1\zeta_2)$
$\chi_{q1}\to TT$	$\beta_1\beta_2\beta_{12}(2+\zeta_1+\zeta_2-4\zeta_1\zeta_2)$	0	$\chi_{q2}\to TP$	$-\sqrt{2}X_2\beta_1\beta_{12}(1+\zeta_1)$	$\sqrt{2}X_2\beta_{12}$
$\chi_{q0}\to TT$	$3\beta_1\beta_2\beta_{12}(3-\zeta_1-\zeta_2-\zeta_1\zeta_2)$	$-3\beta_{12}$			

Decay	g_1	g_2
$\chi_{q0}\to SS$	$\frac{1}{2}\beta_1\beta_2\beta_{12}^2(18-9(\zeta_1+\zeta_2)+\zeta_1^2+\zeta_2^2-12\zeta_1\zeta_2+2\zeta_1\zeta_2(\zeta_1+\zeta_2)$ $+\zeta_1\zeta_2(\zeta_1^2+\zeta_2^2)+4\zeta_1^2\zeta_2^2-\zeta_1^2\zeta_2^2(\zeta_1+\zeta_2)+2\zeta_1^3\zeta_2^3)$	$-\frac{1}{2}\beta_1\beta_2\beta_{12}^2(24-17(\zeta_1+\zeta_2)+\zeta_1^2+\zeta_2^2-28\zeta_1\zeta_2+20\zeta_1\zeta_2(\zeta_1+\zeta_2)$ $+\zeta_1\zeta_2(\zeta_1^2+\zeta_2^2)+14\zeta_1^2\zeta_2^2-11\zeta_1^2\zeta_2^2(\zeta_1+\zeta_2)+2\zeta_1^3\zeta_2^3)$
$\chi_{q0}\to PP$	$X_1X_2\beta_1\beta_2\beta_{12}^2(11-6(\zeta_1+\zeta_2)+\zeta_1^2+\zeta_2^2-8\zeta_1\zeta_2$ $+2\zeta_1\zeta_2(\zeta_1+\zeta_2)+3\zeta_1^2\zeta_2^2)$	$-X_1X_2\beta_{12}^2(4-\zeta_1-\zeta_2-2\zeta_1\zeta_2)$
$\chi_{q2}\to SS$	$-\frac{1}{2}\beta_1\beta_2\beta_{12}^2(3(\zeta_1+\zeta_2)-\zeta_1^2-\zeta_2^2-12\zeta_1\zeta_2+4\zeta_1\zeta_2(\zeta_1^2+\zeta_2^2)$ $+2\zeta_1^2\zeta_2^2+\zeta_1^2\zeta_2^2(\zeta_1+\zeta_2)-2\zeta_1^3\zeta_2^3)$	$\frac{1}{2}\beta_1\beta_2\beta_{12}^2(6-\zeta_1-\zeta_2-\zeta_1^2-\zeta_2^2-20\zeta_1\zeta_2+10\zeta_1\zeta_2(\zeta_1+\zeta_2)$ $-\zeta_1\zeta_2(\zeta_1^2+\zeta_2^2)+4\zeta_1^2\zeta_2^2-\zeta_1^2\zeta_2^2(\zeta_1+\zeta_2)-2\zeta_1^3\zeta_2^3)$

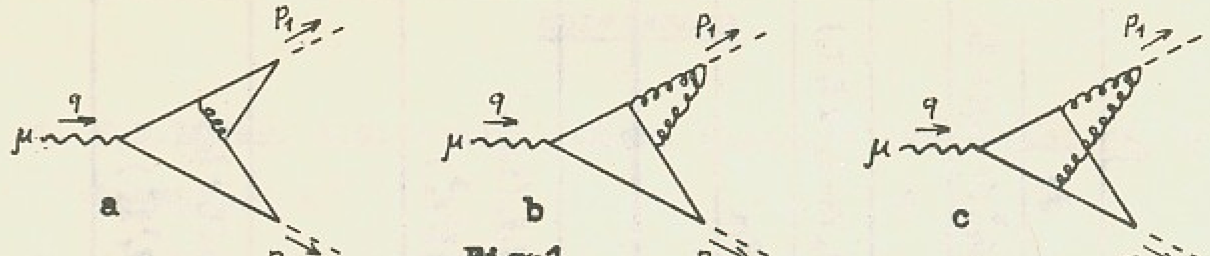

Fig.1

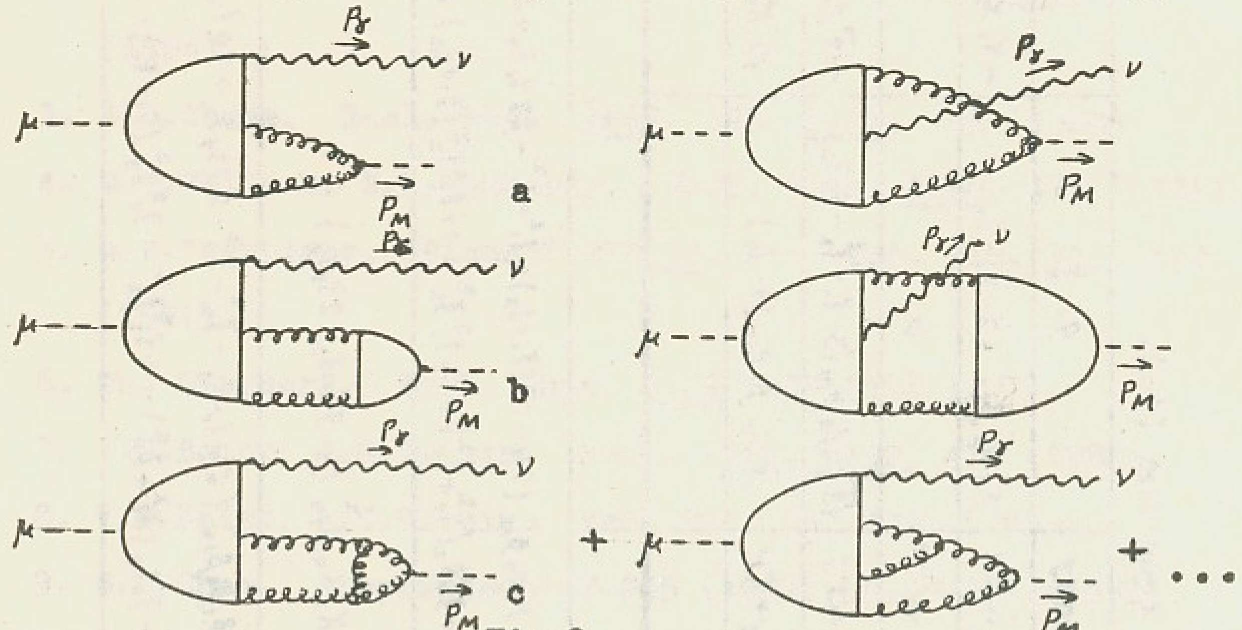

Fig.2

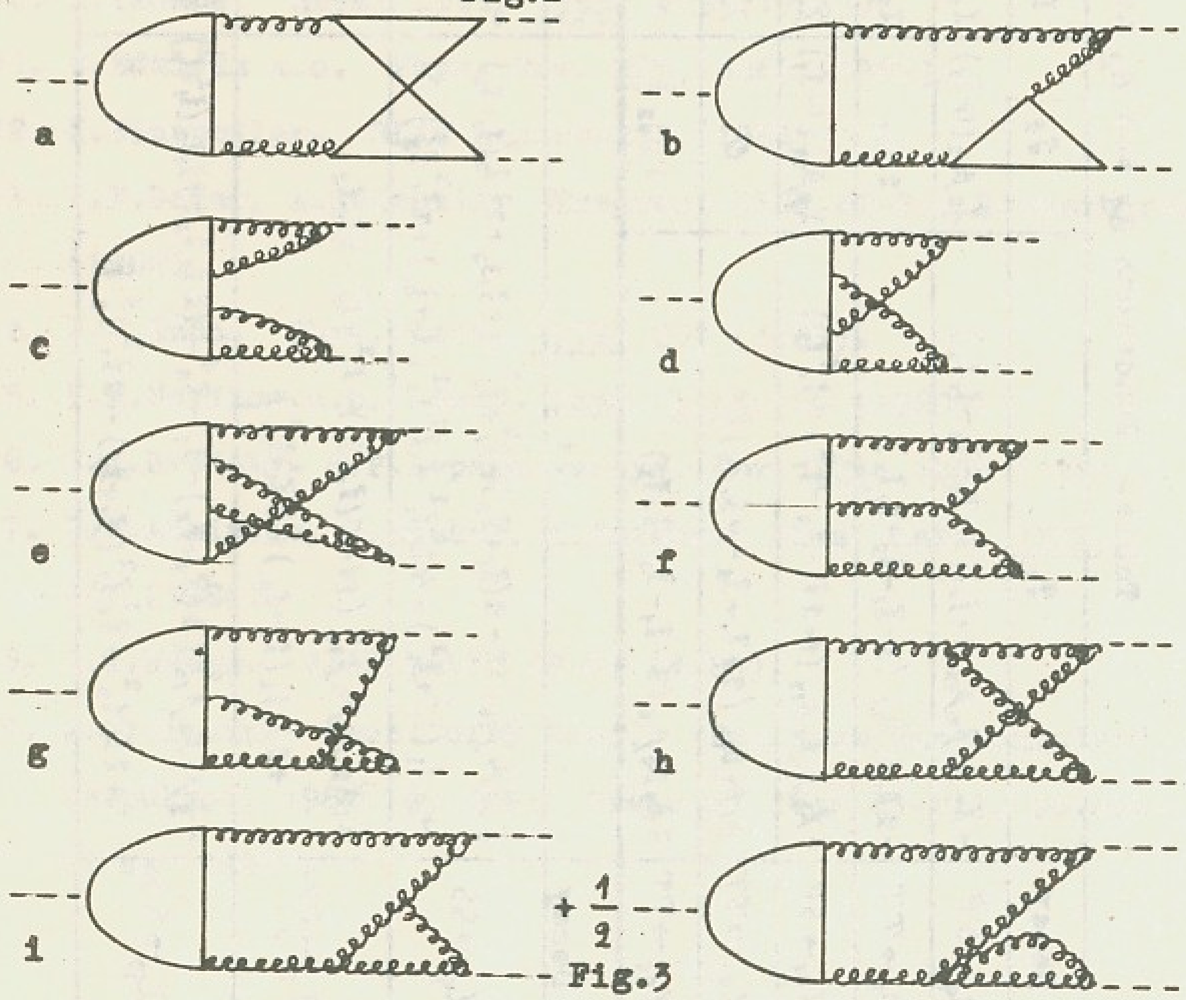

Fig.3

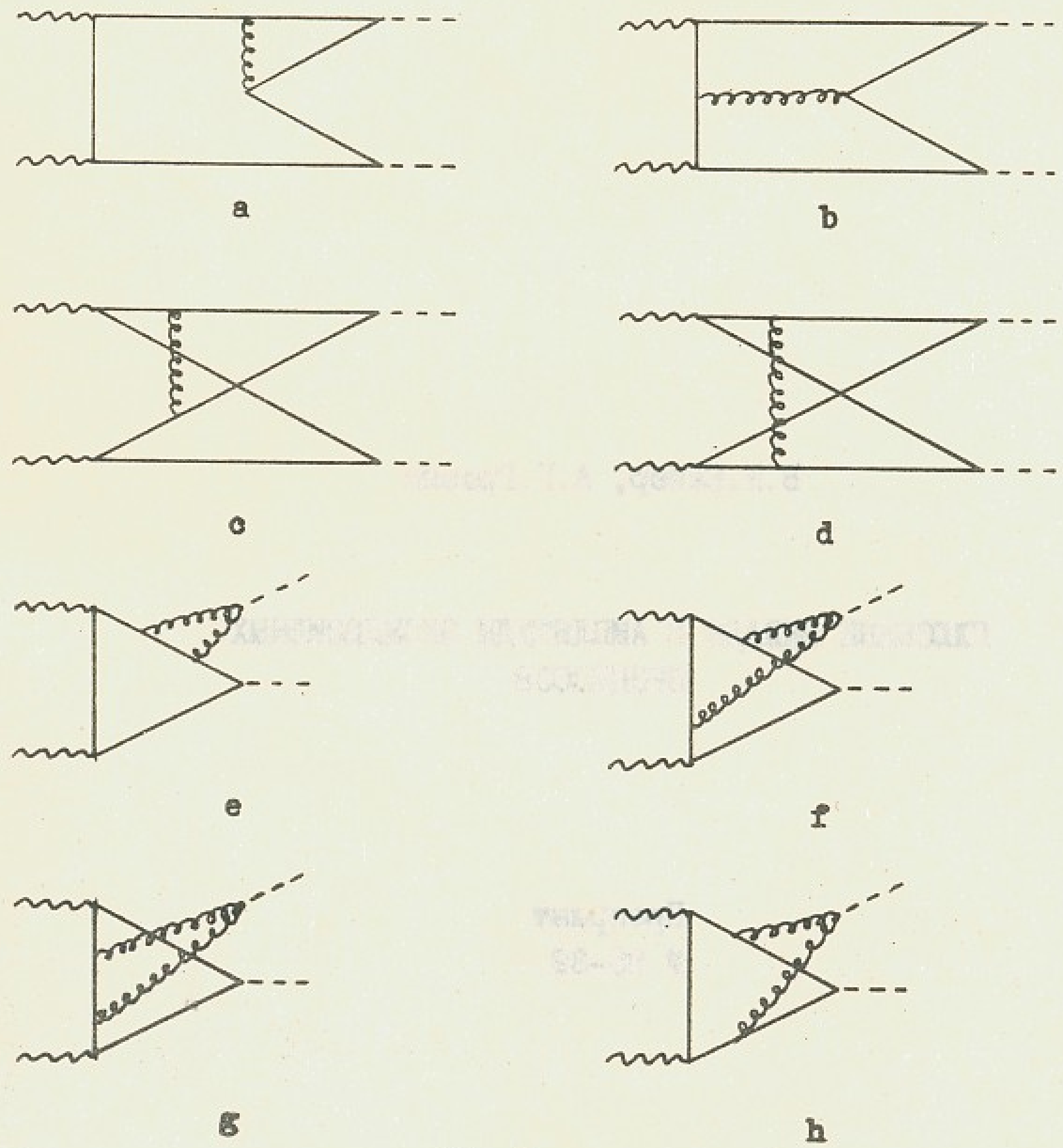

Fig.4

В.Н.Байер, А.Г.Грозин

ГЛЮОННЫЕ ВКЛАДЫ В АМПЛИТУДЫ ЭКСКЛЮЗИВНЫХ ПРОЦЕССОВ

Препринт
№ 85-39

Работа поступила - 4 марта 1985 г.

Ответственный за выпуск - С.Г.Попов
Подписано к печати 19.03-1985 г. МН 06588
Формат бумаги 60х90 1/16 Усл.1,0 печ.л., 0,8 учетно-изд.л.
Тираж 290 экз. Бесплатно. Заказ № 39.

Ротапринт ИЯФ СО АН СССР, г.Новосибирск, 90