PREDICTION OF COUPLING CONSTANT RATIO VALUES IN THE OCTET HYPERON EM STRUCTURE *Unitary&Analytic* MODELS

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January 31, 2020

eQCD20, Krynica Zdroj, 2.-8.Feb 2020

Outline

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$1/2^+$ octet baryon EM structure

According to **SU(3) group classification** of hadrons, $1/2^+$ baryon octet consists of
$p, n, \Lambda, \Sigma^+, \Sigma^0, \Sigma^-, \Xi^0, \Xi^-$,
every of which is **compound of 3 quarks** $\Rightarrow$ they naturally have to manifest some **space structure**.

For the first time it was discovered for p in **elastic scattering process** $e^- p \to e^- p$ almost 70 years ago in the last century, **before the quark structure of hadrons has been revealed**.

Because **electrons** are dominantly interacting with p **electromagnetically** $\Rightarrow$ **proton EM structure**, which can be simply extrapolated also to all members of $1/2^+$ **octet baryons**.

$1/2^+$ octet baryon EM structure

The EM structure of every baryon from $1/2^+$-octet is **completely described by two independent functions $F_1^B(t)$ and $F_2^B(t)$**, the Dirac and Pauli FFs, which are **naturally obtained in a decomposition of the baryon matrix element of the EM current $J_\mu^{EM}(0)$ into a maximal number of linearly independent covariants** to be constructed from four-momenta, γ-matrices and Dirac bispinors of baryons.

$$< B|J_\mu^{EM}(0)|B >= e\bar{u}(p')\gamma_\mu F_1^B(t) + \frac{i}{2m_B}\sigma_{\mu\nu}(p' - p)_\mu F_2^B(t)u(p) \quad (1)$$

While **Dirac and Pauli FFs are suitable for a theoretical description of the baryon EM structure**, for an extraction of experimental information on it from the measured quantities, like cross sections and polarizations, the Sachs electric $G_E^B(t)$ and magnetic $G_M^B(t)$ FFs are more suitable.

$1/2^+$ octet baryon EM structure

Further, **in a description of the EM structure of baryons** it is useful to arrange calculations in such a way, that **advantage can be taken of isospin-conservation**.

As EM current has mixed transformation properties under rotation in isospin space:

- **part of it transforms as an isoscalar**
- and **part as a third component of an isovector**.

As a consequence, **every baryon matrix element of the EM current may be expressed in terms of the matrix elements of an isoscalar and of an isovector currents**.

The **sign between them depends on the value of the third component of isospin** of the concrete baryon from the $1/2^+$ baryon octet to be found by $T_3 = Q - \frac{B}{2} - \frac{S}{2}$.

$1/2^+$ octet baryon EM structure

Then the **relations between baryon Sachs FFs and isoscalar and isovector parts of the baryon Dirac and Pauli FFs** are:

for "**nucleons**"

$$\begin{aligned} G_E^p(t) &= [F_{1s}^N(t) + F_{1v}^N(t)] + \frac{t}{4m_p^2}[F_{2s}^N(t) + F_{2v}^N(t)] \\ G_M^p(t) &= [F_{1s}^N(t) + F_{1v}^N(t)] + [F_{2s}^N(t) + F_{2v}^N(t)] \end{aligned} \quad (2)$$

$$\begin{aligned} G_E^n(t) &= [F_{1s}^N(t) - F_{1v}^N(t)] + \frac{t}{4m_n^2}[F_{2s}^N(t) - F_{2v}^N(t)] \\ G_M^n(t) &= [F_{1s}^N(t) - F_{1v}^N(t)] + [F_{2s}^N(t) - F_{2v}^N(t)] \end{aligned} \quad (3)$$

with **normalizations**

$$G_E^p(0) = 1; \quad G_M^p(0) = \mu_p; \quad G_E^n(0) = 0; \quad G_M^n(0) = \mu_n; \quad (4)$$

$$F_{1s}^N(0) = F_{1v}^N(0) = \frac{1}{2}; \quad F_{2s}^N(0) = \frac{1}{2}(\mu_p + \mu_n - 1); \quad F_{2v}^N(0) = \frac{1}{2}(\mu_p - \mu_n - 1); \quad (5)$$

$1/2^+$ octet baryon EM structure

for "Λ-**hyperon**"

$$G_E^\Lambda(t) = F_{1s}^\Lambda(t) + \frac{t}{4m_\Lambda^2} F_{2s}^\Lambda(t) \quad (6)$$

$$G_M^\Lambda(t) = F_{1s}^\Lambda(t) + F_{2s}^\Lambda(t)$$

with **normalizations**

$$G_E^\Lambda(0) = 0; \quad G_M^\Lambda(0) = \mu_\Lambda; \quad (7)$$

$$F_{1s}^\Lambda(0) = 0; \quad F_{2s}^\Lambda(0) = \mu_\Lambda; \quad (8)$$

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for "Σ-**hyperons**"

$$G_E^{\Sigma^+}(t) = [F_{1s}^{\Sigma}(t) + F_{1v}^{\Sigma}(t)] + \frac{t}{4m_{\Sigma^+}^2}[F_{2s}^{\Sigma}(t) + F_{2v}^{\Sigma}(t)] \quad (9)$$

$$G_M^{\Sigma^+}(t) = [F_{1s}^{\Sigma}(t) + F_{1v}^{\Sigma}(t)] + [F_{2s}^{\Sigma}(t) + F_{2v}^{\Sigma}(t)]$$

$$G_E^{\Sigma^0}(t) = F_{1s}^{\Sigma}(t) + \frac{t}{4m_{\Sigma^0}^2}F_{2s}^{\Sigma}(t) \quad (10)$$

$$G_M^{\Sigma^0}(t) = F_{1s}^{\Sigma}(t) + F_{2s}^{\Sigma}(t)$$

$$G_E^{\Sigma^-}(t) = [F_{1s}^{\Sigma}(t) - F_{1v}^{\Sigma}(t)] + \frac{t}{4m_{\Sigma^-}^2}[F_{2s}^{\Sigma}(t) - F_{2v}^{\Sigma}(t)] \quad (11)$$

$$G_M^{\Sigma^-}(t) = [F_{1s}^{\Sigma}(t) - F_{1v}^{\Sigma}(t)] + [F_{2s}^{\Sigma}(t) - F_{2v}^{\Sigma}(t)]$$

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with **normalizations**

$$G_E^{\Sigma^+}(0)=1 \quad G_M^{\Sigma^+}(0)=\mu_{\Sigma^+} \quad G_E^{\Sigma^0}(0)=0 \quad G_M^{\Sigma^0}(0)=\frac{1}{2}(\mu_{\Sigma^+}+\mu_{\Sigma^-}) \quad G_E^{\Sigma^-}(0)=-1 \quad G_M^{\Sigma^-}(0)=\mu_{\Sigma^-} \tag{12}$$

$$F_{1s}^{\Sigma}(0)=0 \quad F_{1v}^{\Sigma}(0)=1 \quad F_{2s}^{\Sigma}(0)=\frac{1}{2}(\mu_{\Sigma^+}+\mu_{\Sigma^-}) \quad F_{2v}^{\Sigma}(0)=\frac{1}{2}(\mu_{\Sigma^+}-\mu_{\Sigma^-})-1 \tag{13}$$

for **"Ξ-hyperons"**

$$\begin{aligned} G_E^{\Xi^0}(t) &= [F_{1s}^{\Xi}(t)+F_{1v}^{\Xi}(t)]+\frac{t}{4m_{\Xi^0}^2}[F_{2s}^{\Xi}(t)+F_{2v}^{\Xi}(t)] \\ G_M^{\Xi^0}(t) &= [F_{1s}^{\Xi}(t)+F_{1v}^{\Xi}(t)]+[F_{2s}^{\Xi}(t)+F_{2v}^{\Xi}(t)] \end{aligned} \tag{14}$$

$$\begin{aligned} G_E^{\Xi^-}(t) &= [F_{1s}^{\Xi}(t)-F_{1v}^{\Xi}(t)]+\frac{t}{4m_{\Xi^-}^2}[F_{2s}^{\Xi}(t)-F_{2v}^{\Xi}(t)] \\ G_M^{\Xi^-}(t) &= [F_{1s}^{\Xi}(t)-F_{1v}^{\Xi}(t)]+[F_{2s}^{\Xi}(t)-F_{2v}^{\Xi}(t)] \end{aligned} \tag{15}$$

$1/2^+$ octet baryon EM structure

with **normalizations**

$$G_E^{\Xi^0}(0) = 0 \quad G_M^{\Xi^0}(0) = \mu_{\Xi^0} \quad G_E^{\Xi^-}(0) = -1 \quad G_M^{\Xi^-}(0) = \mu_{\Xi^-} \tag{16}$$

$$F_{1s}^{\Xi}(0) = -\frac{1}{2} \quad F_{1v}^{\Xi}(0) = \frac{1}{2} \quad F_{2s}^{\Xi}(0) = \frac{1}{2}(\mu_{\Xi^0} + \mu_{\Xi^-} + 1) \quad F_{2v}^{\Xi}(0) = \frac{1}{2}(\mu_{\Xi^0} - \mu_{\Xi^-} - 1) \tag{17}$$

where μ_B are the **magnetic moments of** $1/2^+$ **octet baryons**.

Next we construct **9 resonance** *Unitary&Analytic* **models** of the $1/2^+$ octet baryon EM FFs, which represent an **unification of the following three fundamental features** (besides other known properties) of the baryon EM FFs

U&A models of baryon EM structure

1. The **experimental fact of creation of unstable vector-meson resonances** $\rho, \omega, \phi, \rho', \omega', \phi', \rho'', \omega'', \phi''$, with photon quantum numbers in e^+e^--annihilation processes into hadrons

M.Tanabashi et al. (PDG),
Phys. Rev. D98 (2018) 030001

2. **Similar hypothetical analytic properties** for all baryon EM FFs

3. The **asymptotic behavior of baryon EM FFs** $G_E^B(t) = G_M^B(t) \sim \frac{1}{t^2}$ to be proved also in the framework of QCD.

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The most simple way to take into account **creation of unstable vector-meson resonances in** $e^+e^- \to had$ **processes** is the **naive VMD model** for isoscalar and isovector parts of the Dirac and Pauli baryon FFs

$$F^B_{1s}(t) = \sum_{i=\omega}^{\phi\omega'\phi'\omega''\phi''} \frac{m_i^2}{m_i^2 - t}(f^{(1)}_{iB\bar{B}}/f_i); \quad F^B_{2s}(t) = \sum_{i=\omega}^{\phi\omega'\phi'\omega''\phi''} \frac{m_i^2}{m_i^2 - t}(f^{(2)}_{iB\bar{B}}/f_i) \tag{18}$$

$$F^B_{1v}(t) = \sum_{i=\rho}^{\rho'\rho''} \frac{m_i^2}{m_i^2 - t}(f^{(1)}_{iB\bar{B}}/f_i); \quad F^B_{2v}(t) = \sum_{i=\rho}^{\rho'\rho''} \frac{m_i^2}{m_i^2 - t}(f^{(2)}_{iB\bar{B}}/f_i) \tag{19}$$

However, such **model does not take into account not even, normalizations and the asymptotic behaviors** of FFs

$$F^B_{1s}(t) = F^B_{1v}(t) \sim \frac{1}{t^2}; \quad F^B_{2s}(t) = F^B_{2v}(t) \sim \frac{1}{t^3}; \tag{20}$$

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This problem has been **solved on the price of a reduction of a number of coupling constant ratios as free parameters of the model** in the paper

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Eur. Phys. J. C32 (2004) 381

where for **FF to be saturated by** n **vector-mesons and possess the asymptotic behavior to be determined by the power** m **and** $n > m$ takes the following form

$$F(t) = F_0 \frac{\prod_{j=1}^{m} m_j^2}{\prod_{j=1}^{m}(m_j^2 - t)} + \sum_{k=m+1}^{n} \left\{ \sum_{j=1}^{m} \frac{m_k^2}{(m_k^2 - t)} \frac{\prod_{j\neq i, j=1}^{m} m_j^2}{\prod_{j\neq k, j=1}^{m}(m_j^2 - t)} \frac{\prod_{j\neq i, j=1}^{m}(m_j^2 - m_k^2)}{\prod_{j\neq i, j=1}^{m}(m_j^2 - m_i^2)} - \frac{\prod_{j=1}^{m} m_j^2}{\prod_{j=1}^{m}(m_j^2 - t)} \right\} (f_{kB\bar{B}}/f_k) \quad (21)$$

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and for $n = m$ the form is found

$$F(t) = F_0 \frac{\prod_{j=1}^{m} m_j^2}{\prod_{j=1}^{m}(m_j^2 - t)} \tag{22}$$

for both the **required asymptotical behavior** $F(t)_{t\to\infty} \sim 1/t^m$ **and for** $t = 0$ **the normalization** $F(0) = F_0$ **are fulfilled automatically**.

So, for $m = 2$ and $n = 6$ isoscalar vector-meson resonances for F^B_{1s} one finds

$$F^B_{1s}(t) = F^B_{1s}(0)\frac{m^2_{\omega''}m^2_{\phi''}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)} + \tag{23}$$

$$+\left\{\frac{m^2_{\phi''}m^2_{\omega'}}{(m^2_{\phi''}-t)(m^2_{\omega'}-t)}\frac{(m^2_{\phi''}-m^2_{\omega'})}{(m^2_{\phi''}-m^2_{\omega''})} + \frac{m^2_{\omega''}m^2_{\omega'}}{(m^2_{\omega'}-t)(m^2_{\omega''}-t)}\frac{(m^2_{\omega''}-m^2_{\omega'})}{(m^2_{\omega''}-m^2_{\phi''})} - \right.$$

$$\left. - \frac{m^2_{\omega''}m^2_{\phi''}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)}\right\}(f^{(1)}_{\omega' BB}/f_{\omega'}) +$$

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$$+\left\{\frac{m^2_{\phi'}m^2_{\phi''}}{(m^2_{\phi'}-t)(m^2_{\phi''}-t)}\frac{(m^2_{\phi''}-m^2_{\phi'})}{(m^2_{\phi''}-m^2_{\omega''})}+\frac{m^2_{\omega''}m^2_{\phi'}}{(m^2_{\omega''}-t)(m^2_{\phi'}-t)}\frac{(m^2_{\omega''}-m^2_{\phi'})}{(m^2_{\omega''}-m^2_{\phi''})}-\right.$$
$$\left.-\frac{m^2_{\omega''}m^2_{\phi''}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)}\right\}(f^{(1)}_{\phi' BB}/f_{\phi'})+$$
$$+\left\{\frac{m^2_{\phi''}m^2_{\omega}}{(m^2_{\phi''}-t)(m^2_{\omega}-t)}\frac{(m^2_{\phi''}-m^2_{\omega})}{(m^2_{\phi''}-m^2_{\omega''})}+\frac{m^2_{\omega}m^2_{\omega''}}{(m^2_{\omega}-t)(m^2_{\omega''}-t)}\frac{(m^2_{\omega''}-m^2_{\omega})}{(m^2_{\omega''}-m^2_{\phi''})}-\right.$$
$$\left.-\frac{m^2_{\omega''}m^2_{\phi''}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)}\right\}(f^{(1)}_{\omega BB}/f_{\omega})+$$
$$+\left\{\frac{m^2_{\phi}m^2_{\phi''}}{(m^2_{\phi}-t)(m^2_{\phi''}-t)}\frac{(m^2_{\phi''}-m^2_{\phi})}{(m^2_{\phi''}-m^2_{\omega''})}+\frac{m^2_{\omega''}m^2_{\phi}}{(m^2_{\omega''}-t)(m^2_{\phi}-t)}\frac{(m^2_{\omega''}-m^2_{\phi})}{(m^2_{\omega''}-m^2_{\phi''})}-\right.$$
$$\left.-\frac{m^2_{\omega''}m^2_{\phi''}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)}\right\}(f^{(1)}_{\phi BB}/f_{\phi}).$$

where **instead of 6 coupling constant ratios in VMD model, here only 4 of them appear**.

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The same is valid also for $m = 2$ and $n = 3$ isovector vector-meson resonances in F^B_{1s}

$$F^B_{1v}(t) = F^B_{1v}(0)\frac{m^2_{\rho''}m^2_{\rho'}}{(m^2_{\rho''}-t)(m^2_{\rho'}-t)} + \tag{24}$$

$$+\left\{\frac{m^2_{\rho}m^2_{\rho'}}{(m^2_{\rho}-t)(m^2_{\rho'}-t)}\frac{(m^2_{\rho'}-m^2_{\rho})}{(m^2_{\rho'}-m^2_{\rho''})} + \frac{m^2_{\rho}m^2_{\rho''}}{(m^2_{\rho}-t)(m^2_{\rho''}-t)}\frac{(m^2_{\rho''}-m^2_{\rho})}{(m^2_{\rho''}-m^2_{\rho'})} - \right.$$

$$\left. - \frac{m^2_{\rho''}m^2_{\rho'}}{(m^2_{\rho''}-t)(m^2_{\rho'}-t)}\right\}(f^{(1)}_{\rho BB}/f_{\rho}).$$

where **instead of 3 coupling constant ratios in VMD model, here only 1 of them appears**.

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Similarly, with $m = 3$ and $n = 6$ isoscalar vector-meson resonances one finds for F_{2s}^B

$$F_{2s}^B(t) = F_{2s}^B(0)\frac{m^2_{\omega''}m^2_{\phi''}m^2_{\omega'}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)(m^2_{\omega'}-t)} + \tag{25}$$

$$+\left\{\frac{m^2_{\phi''}m^2_{\phi'}m^2_{\omega'}}{(m^2_{\phi''}-t)(m^2_{\phi'}-t)(m^2_{\omega'}-t)}\frac{(m^2_{\phi''}-m^2_{\phi'})(m^2_{\omega'}-m^2_{\phi'})}{(m^2_{\phi''}-m^2_{\omega''})(m^2_{\omega'}-m^2_{\omega''})} + \right.$$

$$+\frac{m^2_{\omega''}m^2_{\omega'}m^2_{\phi'}}{(m^2_{\omega''}-t)(m^2_{\omega'}-t)(m^2_{\phi'}-t)}\frac{(m^2_{\omega''}-m^2_{\phi'})(m^2_{\omega'}-m^2_{\phi'})}{(m^2_{\omega''}-m^2_{\phi''})(m^2_{\omega'}-m^2_{\phi''})} +$$

$$+\frac{m^2_{\omega''}m^2_{\phi''}m^2_{\phi'}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)(m^2_{\phi'}-t)}\frac{(m^2_{\omega''}-m^2_{\phi'})(m^2_{\phi''}-m^2_{\phi'})}{(m^2_{\omega''}-m^2_{\omega'})(m^2_{\phi''}-m^2_{\omega'})} -$$

$$\left. -\frac{m^2_{\omega''}m^2_{\phi''}m^2_{\omega'}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)(m^2_{\omega'}-t)}\right\}(f^{(2)}_{\phi' BB}/f_{\phi'}) +$$

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$$+\left\{\frac{m^2_{\phi''}m^2_{\omega'}m^2_{\omega}}{(m^2_{\phi''}-t)(m^2_{\omega'}-t)(m^2_{\omega}-t)}\frac{(m^2_{\phi''}-m^2_{\omega})(m^2_{\omega'}-m^2_{\omega})}{(m^2_{\phi''}-m^2_{\omega''})(m^2_{\omega'}-m^2_{\omega''})}+\right.$$

$$+\frac{m^2_{\omega''}m^2_{\omega'}m^2_{\omega}}{(m^2_{\omega''}-t)(m^2_{\omega'}-t)(m^2_{\omega}-t)}\frac{(m^2_{\omega''}-m^2_{\omega})(m^2_{\omega'}-m^2_{\omega})}{(m^2_{\omega''}-m^2_{\phi''})(m^2_{\omega'}-m^2_{\phi''})}+$$

$$+\frac{m^2_{\omega''}m^2_{\phi''}m^2_{\omega}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)(m^2_{\omega}-t)}\frac{(m^2_{\omega''}-m^2_{\omega})(m^2_{\phi''}-m^2_{\omega})}{(m^2_{\omega''}-m^2_{\omega'})(m^2_{\phi''}-m^2_{\omega'})}-$$

$$\left.-\frac{m^2_{\omega''}m^2_{\phi''}m^2_{\omega'}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)(m^2_{\omega'}-t)}\right\}(f^{(2)}_{\omega BB}/f_{\omega})+$$

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$$+\left\{\frac{m^2_{\phi''}m^2_{\omega'}m^2_{\phi}}{(m^2_{\phi''}-t)(m^2_{\omega'}-t)(m^2_{\phi}-t)}\frac{(m^2_{\phi''}-m^2_{\phi})(m^2_{\omega'}-m^2_{\phi})}{(m^2_{\phi''}-m^2_{\omega''})(m^2_{\omega'}-m^2_{\omega''})}+\right.$$
$$+\frac{m^2_{\omega''}m^2_{\omega'}m^2_{\phi}}{(m^2_{\omega''}-t)(m^2_{\omega'}-t)(m^2_{\phi}-t)}\frac{(m^2_{\omega''}-m^2_{\phi})(m^2_{\omega'}-m^2_{\phi})}{(m^2_{\omega''}-m^2_{\phi''})(m^2_{\omega'}-m^2_{\phi''})}+$$
$$+\frac{m^2_{\omega''}m^2_{\phi''}m^2_{\phi}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)(m^2_{\phi}-t)}\frac{(m^2_{\omega''}-m^2_{\phi})(m^2_{\phi''}-m^2_{\phi})}{(m^2_{\omega''}-m^2_{\omega'})(m^2_{\phi''}-m^2_{\omega'})}-$$
$$\left.-\frac{m^2_{\omega''}m^2_{\phi''}m^2_{\omega'}}{(m^2_{\omega''}-t)(m^2_{\phi''}-t)(m^2_{\omega'}-t)}\right\}(f^{(2)}_{\phi BB}/f_{\phi}).$$

where **instead of 6 coupling constant ratios in VMD model, here only 3 of them appear**.

U&A models of baryon EM structure

The same is valid also for $m = 3$ and $n = 3$ isovector vector-meson resonances in F^B_{2v}

$$F^B_{2v}(t) = F^B_{2v}(0)\frac{m^2_{\rho''}m^2_{\rho'}m^2_{\rho}}{(m^2_{\rho''}-t)(m^2_{\rho'}-t)(m^2_{\rho}-t)}. \quad (26)$$

where **instead of 3 coupling constant ratios in VMD model, there is no free coupling constant ratio appearing as a free parameter of the model**.

Nevertheless, the latter model **still suffers from the unpleasant drawback of the naive VMD model** - the $\sigma_{tot}(e^+e^- \rightarrow had)$ at the mass squared values of vector-meson resonances **are acquiring infinite values**.

A removal of this unpleasant drawback is carried out by the **unitarization of** $F^B_{1s}(t), F^B_{1v}(t), F^B_{2s}(t), F^B_{2v}(t)$ **FFs**.

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Unitarization of $F^B_{1s}(t), F^B_{1v}(t), F^B_{2s}(t), F^B_{2v}(t)$ FFs is achieved by **incorporation of the correct baryon EM FF analytic properties** with the non-linear transformations

$$\begin{aligned} t &= t_0^s + \frac{4(t_{in}^{1s} - t_0^s)}{[1/V(t) - V(t)]^2}; \quad t = t_0^v + \frac{4(t_{in}^{1v} - t_0^v)}{[1/W(t) - W(t)]^2}; \\ t &= t_0^s + \frac{4(t_{in}^{2s} - t_0^s)}{[1/U(t) - U(t)]^2}; \quad t = t_0^v + \frac{4(t_{in}^{2v} - t_0^v)}{[1/X(t) - X(t)]^2}, \end{aligned} \tag{27}$$

respectively and then by **subsequent inclusion of the nonzero values of vector-meson widths** into them.

In non-linear transformations (27) $t_0^s = 9m_\pi^2$, $t_0^v = 4m_\pi^2$, $t_{in}^{1s}, t_{in}^{1v}, t_{in}^{2s}, t_{in}^{2v}$ are the square-root branch points, as it is transparent from the inverse transformations

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$$V(t) = i\frac{\sqrt{(\frac{t_{in}^{1s}-t_0^s}{t_0^s})^{1/2}+(\frac{t-t_0^s}{t_0^s})^{1/2}}-\sqrt{(\frac{t_{in}^{1s}-t_0^s}{t_0^s})^{1/2}-(\frac{t-t_0^s}{t_0^s})^{1/2}}}{\sqrt{(\frac{t_{in}^{1s}-t_0^s}{t_0^s})^{1/2}+(\frac{t-t_0^s}{t_0^s})^{1/2}}+\sqrt{(\frac{t_{in}^{1s}-t_0^s}{t_0^s})^{1/2}-(\frac{t-t_0^s}{t_0^s})^{1/2}}} \quad (28)$$

and similarly for $W(t)$, $U(t)$, and $X(t)$, which map the corresponding four-sheeted Riemann surfaces always into one $V-, W-, U-, X-$ plane.

Then for every iso-scalar and iso-vector baryon Dirac and Pauli FF one obtains just **one analytic and smooth function in the domain from** $-\infty$ **to** $+\infty$ in the forms

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$$F^B_{1s}[V(t)] = \left(\frac{1-V^2}{1-V_N^2}\right)^4 \Big\{ F^B_{1s}[V(0)] H_{\omega''}(V) H_{\phi''}(V) + \tag{29}$$

$$+ \left[H_{\phi''}(V) H_{\omega'}(V) \frac{(C^{1s}_{\phi''} - C^{1s}_{\omega'})}{(C^{1s}_{\phi''} - C^{1s}_{\omega''})} + H_{\omega''}(V) H_{\omega'}(V) \frac{(C^{1s}_{\omega''} - C^{1s}_{\omega'})}{(C^{1s}_{\omega''} - C^{1s}_{\phi''})} - H_{\omega''}(V) H_{\phi''}(V) \right] (f^{(1)}_{\omega' BB}/f_{\omega'}) +$$

$$+ \left[H_{\phi''}(V) H_{\phi'}(V) \frac{(C^{1s}_{\phi''} - C^{1s}_{\phi'})}{(C^{1s}_{\phi''} - C^{1s}_{\omega''})} + H_{\omega''}(V) H_{\phi'}(V) \frac{(C^{1s}_{\omega''} - C^{1s}_{\phi'})}{(C^{1s}_{\omega''} - C^{1s}_{\phi''})} - H_{\omega''}(V) H_{\phi''}(V) \right] (f^{(1)}_{\phi' BB}/f_{\phi'}) +$$

$$+ \left[H_{\phi''}(V) L_{\omega}(V) \frac{(C^{1s}_{\phi''} - C^{1s}_{\omega})}{(C^{1s}_{\phi''} - C^{1s}_{\omega''})} + H_{\omega''}(V) L_{\omega}(V) \frac{(C^{1s}_{\omega''} - C^{1s}_{\omega})}{(C^{1s}_{\omega''} - C^{1s}_{\phi''})} - H_{\omega''}(V) H_{\phi''}(V) \right] (f^{(1)}_{\omega BB}/f_{\omega}) +$$

$$+ \left[H_{\phi''}(V) L_{\phi}(V) \frac{(C^{1s}_{\phi''} - C^{1s}_{\phi})}{(C^{1s}_{\phi''} - C^{1s}_{\omega''})} + H_{\omega''}(V) L_{\phi}(V) \frac{(C^{1s}_{\omega''} - C^{1s}_{\phi})}{(C^{1s}_{\omega''} - C^{1s}_{\phi''})} - H_{\omega''}(V) H_{\phi''}(V) \right] (f^{(1)}_{\phi BB}/f_{\phi}) \Big\}$$

to be dependent on **5 free physically interpretable parameters**

$$(f^{(1)}_{\omega' BB}/f_{\omega'}), (f^{(1)}_{\phi' BB}/f_{\phi'}), (f^{(1)}_{\omega BB}/f_{\omega}), (f^{(1)}_{\phi BB}/f_{\phi}), t^{1s}_{in}, \tag{30}$$

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$$F^B_{1v}[W(t)] = \left(\frac{1-W^2}{1-W_N^2}\right)^4 \Big\{ F^B_{1v}[W(0)] L_\rho(W) L_{\rho'}(W) + \quad (31)$$

$$+ \Big[L_{\rho'}(W) L_{\rho''}(W) \frac{(C^{1v}_{\rho'} - C^{1v}_{\rho''})}{(C^{1v}_{\rho'} - C^{1v}_{\rho})} + L_\rho(W) L_{\rho''}(W) \frac{(C^{1v}_{\rho} - C^{1v}_{\rho''})}{(C^{1v}_{\rho} - C^{1v}_{\rho'})} -$$

$$- L_\rho(W) L_{\rho'}(W) \Big] (f^{(1)}_{\rho BB}/f_\rho) \Big\}$$

to be dependent on **2 free physically interpretable parameters**

$$(f^{(1)}_{\rho BB}/f_\rho),\ t^{1v}_{in}, \quad (32)$$

$U\&A$ models of baryon EM structure

$$F^B_{2s}[U(t)] = \left(\frac{1-U^2}{1-U_N^2}\right)^6 \Bigg\{ F^B_{2s}[U(0)]H_{\omega''}(U)H_{\phi''}(U)H_{\omega'}(U) +$$

$$+\Bigg[H_{\phi''}(U)H_{\omega'}(U)H_{\phi'}(U)\frac{(C^{2s}_{\phi''}-C^{2s}_{\phi'})(C^{2s}_{\omega'}-C^{2s}_{\phi'})}{(C^{2s}_{\phi''}-C^{2s}_{\omega''})(C^{2s}_{\omega'}-C^{2s}_{\omega''})} + H_{\omega''}(U)H_{\omega'}(U)H_{\phi'}(U)\frac{(C^{2s}_{\omega''}-C^{2s}_{\phi'})(C^{2s}_{\omega'}-C^{2s}_{\phi'})}{(C^{2s}_{\omega''}-C^{2s}_{\phi''})(C^{2s}_{\omega'}-C^{2s}_{\phi''})} +$$

$$+H_{\omega''}(U)H_{\phi''}(U)H_{\phi'}(U)\frac{(C^{2s}_{\omega''}-C^{2s}_{\phi'})(C^{2s}_{\phi''}-C^{2s}_{\phi'})}{(C^{2s}_{\omega''}-C^{2s}_{\omega'})(C^{2s}_{\phi''}-C^{2s}_{\omega'})} - H_{\omega''}(U)H_{\phi''}(U)H_{\omega'}(U)\Bigg](f^{(2)}_{\phi' BB}/f_{\phi'})$$

$$+\Bigg[H_{\phi''}(U)H_{\omega'}(U)L_{\omega}(U)\frac{(C^{2s}_{\phi''}-C^{2s}_{\omega})(C^{2s}_{\omega'}-C^{2s}_{\omega})}{(C^{2s}_{\phi''}-C^{2s}_{\omega''})(C^{2s}_{\omega'}-C^{2s}_{\omega''})} + H_{\omega''}(U)H_{\omega'}(U)L_{\omega}(U)\frac{(C^{2s}_{\omega''}-C^{2s}_{\omega})(C^{2s}_{\omega'}-C^{2s}_{\omega})}{(C^{2s}_{\omega''}-C^{2s}_{\phi''})(C^{2s}_{\omega'}-C^{2s}_{\phi''})} +$$

$$+H_{\omega''}(U)H_{\phi''}(U)L_{\omega}(U)\frac{(C^{2s}_{\omega''}-C^{2s}_{\omega})(C^{2s}_{\phi'}-C^{2s}_{\omega})}{(C^{2s}_{\omega''}-C^{2s}_{\omega'})(C^{2s}_{\phi''}-C^{2s}_{\omega'})} - H_{\omega''}(U)H_{\phi''}(U)H_{\omega'}(U)\Bigg](f^{(2)}_{\omega BB}/f_{\omega}) +$$

$$+\Bigg[H_{\phi''}(U)H_{\omega'}(U)L_{\phi}(U)\frac{(C^{2s}_{\phi''}-C^{2s}_{\phi})(C^{2s}_{\omega'}-C^{2s}_{\phi})}{(C^{2s}_{\phi''}-C^{2s}_{\omega''})(C^{2s}_{\omega'}-C^{2s}_{\omega''})} + H_{\omega''}(U)H_{\omega'}(U)L_{\phi}(U)\frac{(C^{2s}_{\omega''}-C^{2s}_{\phi})(C^{2s}_{\omega'}-C^{2s}_{\phi})}{(C^{2s}_{\omega''}-C^{2s}_{\phi''})(C^{2s}_{\omega'}-C^{2s}_{\phi''})} +$$

$$+H_{\omega''}(U)H_{\phi''}(U)L_{\phi}(U)\frac{(C^{2s}_{\omega''}-C^{2s}_{\phi})(C^{2s}_{\phi''}-C^{2s}_{\phi})}{(C^{2s}_{\omega''}-C^{2s}_{\omega'})(C^{2s}_{\phi''}-C^{2s}_{\omega'})} - H_{\omega''}(U)H_{\phi''}(U)H_{\omega'}(U)\Bigg](f^{(2)}_{\phi BB}/f_{\phi})\Bigg\}$$

U&A models of baryon EM structure

to be dependent on **4 free physically interpretable parameters**

$$(f^{(2)}_{\phi' BB}/f_{\phi'}), (f^{(2)}_{\omega BB}/f_{\omega}), (f^{(2)}_{\phi BB}/f_{\phi}), t^{2s}_{in}, \tag{34}$$

$$F^B_{2v}[X(t)] = \left(\frac{1-X^2}{1-X_N^2}\right)^6 \left\{ F^B_{2v}[X(0)] L_\rho(U) L_{\rho'}(U) H_{\rho''}(U) \right\} \tag{35}$$

to be dependent on **1 free physically interpretable parameter** t^{2v}_{in},

$U\&A$ models of baryon EM structure

where

$$L_r(V) = \frac{(V_N - V_r)(V_N - V_r^*)(V_N - 1/V_r)(V_N - 1/V_r^*)}{(V - V_r)(V - V_r^*)(V - 1/V_r)(V - 1/V_r^*)}, \quad (36)$$

$$C_r^{1s} = \frac{(V_N - V_r)(V_N - V_r^*)(V_N - 1/V_r)(V_N - 1/V_r^*)}{-(V_r - 1/V_r)(V_r - 1/V_r^*)}, r = \omega, \phi$$

$$H_l(V) = \frac{(V_N - V_l)(V_N - V_l^*)(V_N + V_l)(V_N + V_l^*)}{(V - V_l)(V - V_l^*)(V + V_l)(V + V_l^*)}, \quad (37)$$

$$C_l^{1s} = \frac{(V_N - V_l)(V_N - V_l^*)(V_N + V_l)(V_N + V_l^*)}{-(V_l - 1/V_l)(V_l - 1/V_l^*)}, l = \omega'', \phi'', \omega', \phi'$$

$$L_k(W) = \frac{(W_N - W_k)(W_N - W_k^*)(W_N - 1/W_k)(W_N - 1/W_k^*)}{(W - W_k)(W - W_k^*)(W - 1/W_k)(W - 1/W_k^*)}, \quad (38)$$

$$C_k^{1v} = \frac{(W_N - W_k)(W_N - W_k^*)(W_N - 1/W_k)(W_N - 1/W_k^*)}{-(W_k - 1/W_k)(W_k - 1/W_k^*)}, k = \rho'', \rho', \rho$$

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$$L_r(U) = \frac{(U_N - U_r)(U_N - U_r^*)(U_N - 1/U_r)(U_N - 1/U_r^*)}{(U - U_r)(U - U_r^*)(U - 1/U_r)(U - 1/U_r^*)}, \quad (39)$$

$$C_r^{2s} = \frac{(U_N - U_r)(U_N - U_r^*)(U_N - 1/U_r)(U_N - 1/U_r^*)}{-(U_r - 1/U_r)(U_r - 1/U_r^*)}, r = \omega, \phi$$

$$H_l(U) = \frac{(U_N - U_l)(U_N - U_l^*)(U_N + U_l)(U_N + U_l^*)}{(U - U_l)(U - U_l^*)(U + U_l)(U + U_l^*)}, \quad (40)$$

$$C_l^{2s} = \frac{(U_N - U_l)(U_N - U_l^*)(U_N + U_l)(U_N + U_l^*)}{-(U_l - 1/U_l)(U_l - 1/U_l^*)}, l = \omega'', \phi'', \omega', \phi'$$

$$L_k(X) = \frac{(X_N - X_k)(X_N - X_k^*)(X_N - 1/X_k)(X_N - 1/X_k^*)}{(X - X_k)(X - X_k^*)(X - 1/X_k)(X - 1/X_k^*)}, \quad (41)$$

$$C_k^{2v} = \frac{(X_N - X_k)(X_N - X_k^*)(X_N - 1/X_k)(X_N - 1/X_k^*)}{-(X_k - 1/X_k)(X_k - 1/X_k^*)}, k = \rho', \rho$$

U&A models of baryon EM structure

$$H_{\rho''}(X) = \frac{(X_N - X_{\rho''})(X_N - X^*_{\rho''})(X_N + X_{\rho''})(X_N + X^*_{\rho''})}{(X - X_{\rho''})(X - X^*_{\rho''})(X + X_{\rho''})(X + X^*_{\rho''})}, \tag{42}$$

$$C^{2v}_{\rho''} = \frac{(X_N - X_{\rho''})(X_N - X^*_{\rho''})(X_N + X_{\rho''})(W_X + X^*_{\rho''})}{-(X_{\rho''} - 1/X_{\rho''})(X_{\rho''} - 1/X^*_{\rho''})}.$$

So, if we know **numerical values of free parameters** in $F^B_{1s}[V(t)], F^B_{1v}[W(t)], F^B_{2s}[U(t)], F^B_{2v}[X(t)]$, **one can predict behaviors** of electric $G^B_E(t)$ and magnetic $G^B_M(t)$ FFs of any baryon from the $1/2^+$ octet.

Numerical values of coupling constant ratios

The simplest way of a determination of the coupling constant ratios is in the **nucleon case**, as there is around **530 reliable experimental points on the nucleon EM FFs** - dominant for protons and less experimental information exists on the neutron - **in the spacelike and timelike region**.

It is sufficient to **adjust** $F^B_{1s}[V(t)], F^B_{1v}[W(t)], F^B_{2s}[U(t)], F^B_{2v}[X(t)]$ **by normalizations** corresponding to nucleons and the **by a comparison of obtained expressions for** $G^p_E(t), G^p_M(t), G^n_E(t), G^n_E(t)$ **with existing experimental data** the following values of coupling constant ratios are found.

Numerical values of coupling constant ratios

for nucleons (p and n):

$$
\begin{aligned}
(f^{(1)}_{\rho NN}/f_{\rho}) &= (0.3747 \pm 0.0022)\\
(f^{(1)}_{\omega NN}/f_{\omega}) &= (1.5717 \pm 0.0022)\\
(f^{(1)}_{\phi NN}/f_{\phi}) &= (-1.1247 \pm 0.0011)\\
(f^{(1)}_{\omega' NN}/f_{\omega'}) &= (0.0418 \pm 0.0065)\\
(f^{(1)}_{\phi' NN}/f_{\phi'}) &= (0.1879 \pm 0.0010)\\
(f^{(2)}_{\omega NN}/f_{\omega}) &= (-0.2096 \pm 0.0067)\\
(f^{(2)}_{\phi NN}/f_{\phi}) &= (0.2657 \pm 0.0067)\\
(f^{(2)}_{\phi' NN}/f_{\phi'}) &= (0.1781 \pm 0.0029)
\end{aligned}
\quad (43)
$$

Numerical values of coupling constant ratios

There are **no data on EM FFs of** $1/2^+$ **octet hyperons** $\Lambda, \Sigma^+, \Sigma^0, \Sigma^-, \Xi^0, \Xi^-$, only **some total cross section points** of e^+e^--annihilation into hyperon-antihyperon exist and one **can not repeat a similar to nucleons procedure** in determination of the unknown coupling constant ratios in the Unitary&Analytic hyperon EM structure model.

Despite of this fact, we have **found a method for numerical determination of unknown free hyperon coupling constant ratios** in Unitary&Analytic hyperon EM structure models **utilizing the known nucleon coupling constant ratios** (43) and the SU(3) invariant **Lagrangians of vector-meson interaction with octet baryons**

$$L_{VB\bar{B}} = \frac{i}{\sqrt{2}} f^F [\bar{B}^\alpha_\beta \gamma_\mu B^\beta_\gamma - \bar{B}^\beta_\gamma \gamma_\mu B^\alpha_\beta](V_\mu)^\gamma_\alpha + \frac{i}{\sqrt{2}} f^D [\bar{B}^\beta_\gamma \gamma_\mu B^\alpha_\beta + \bar{B}^\alpha_\gamma \gamma_\mu B^\beta_\gamma](V_\mu)^\gamma_\alpha + \quad (44)$$

$$+ \frac{i}{\sqrt{2}} f^S \bar{B}^\alpha_\beta \gamma_\mu B^\beta_\alpha \omega^0_\mu$$

Numerical values of coupling constant ratios

where baryons are represented here by the **octet matrices**

$$B = \begin{pmatrix} \frac{\Sigma^0}{\sqrt{2}} + \frac{\Lambda^0}{\sqrt{6}} & \Sigma^+ & p \\ \Sigma^- & -\frac{\Sigma^0}{\sqrt{2}} + \frac{\Lambda^0}{\sqrt{6}} & n \\ \Xi^- & \Xi^0 & -\frac{2\Lambda^0}{\sqrt{6}} \end{pmatrix}, \quad (45)$$

$$\bar{B} = \begin{pmatrix} \frac{\bar{\Sigma}^0}{\sqrt{2}} + \frac{\bar{\Lambda}^0}{\sqrt{6}} & \bar{\Sigma}^- & \bar{\Xi}^- \\ \bar{\Sigma}^+ & -\frac{\bar{\Sigma}^0}{\sqrt{2}} + \frac{\bar{\Lambda}^0}{\sqrt{6}} & \bar{\Xi}^0 \\ \bar{p} & \bar{n} & -\frac{2\bar{\Lambda}^0}{\sqrt{6}} \end{pmatrix}, \quad (46)$$

Numerical values of coupling constant ratios

and the 1^{--} vector-meson nonet is classified into an **octet matrix and a singlet** like

$$V = \begin{pmatrix} \omega_8/\sqrt{6} + \rho^0/\sqrt{2} & \rho^+ & K^{*+} \\ \rho^- & \omega_8/\sqrt{6} - \rho^0/\sqrt{2} & K^{*0} \\ K^{*-} & \bar{K}^{*0} & -2\omega_8/\sqrt{6} \end{pmatrix}, \quad \omega_0. \tag{47}$$

Decomposing the Lagrangian (44) into a **sum of products of single matrix elements** one can derive relations between f_{VBB} and the coupling constants f^F, f^D, f^S of SU(3) invariant Lagrangian. However, the ω_8, ω_0 in Lagrangian do not represent experimentally observed particles and therefore one has to use the so-called $\omega - \phi$ mixing form through the real $\omega(782)$ and $\phi(1020)$ vector-mesons. There are generally 8 different mixing forms,

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Numerical values of coupling constant ratios

but only four of them

$$
\begin{aligned}
1.\quad \omega_0 &= \omega\cos\theta + \phi\sin\theta \\
\omega_8 &= \omega\sin\theta - \phi\cos\theta \\
4.\quad \omega_0 &= -\omega\cos\theta - \phi\sin\theta \\
\omega_8 &= -\omega\sin\theta + \phi\cos\theta \\
5.\quad \omega_0 &= \omega\cos\theta - \phi\sin\theta \\
\omega_8 &= \omega\sin\theta + \phi\cos\theta \\
8.\quad \omega_0 &= -\omega\cos\theta + \phi\sin\theta \\
\omega_8 &= -\omega\sin\theta - \phi\cos\theta.
\end{aligned}
\tag{48}
$$

are **physically acceptable**.

Then the relations between f_{VBB} and the coupling constants f^F, f^D, f^S of SU(3) invariant Lagrangian take the forms

Numerical values of coupling constant ratios

for **nucleons**

$$
\begin{aligned}
1. \quad f_{\rho NN} &= +\frac{1}{2}(f^F + f^D) \\
f_{\omega NN} &= +\frac{1}{\sqrt{2}} f^S \cos\theta + \frac{1}{2\sqrt{3}}(3f^F - f^D)\sin\theta \\
f_{\phi NN} &= +\frac{1}{\sqrt{2}} f^S \sin\theta - \frac{1}{2\sqrt{3}}(3f^F - f^D)\cos\theta \\
4. \quad f_{\rho NN} &= +\frac{1}{2}(f^F + f^D) \\
f_{\omega NN} &= -\frac{1}{\sqrt{2}} f^S \cos\theta - \frac{1}{2\sqrt{3}}(3f^F - f^D)\sin\theta \\
f_{\phi NN} &= -\frac{1}{\sqrt{2}} f^S \sin\theta + \frac{1}{2\sqrt{3}}(3f^F - f^D)\cos\theta \\
5. \quad f_{\rho NN} &= +\frac{1}{2}(f^F + f^D) \\
f_{\omega NN} &= +\frac{1}{\sqrt{2}} f^S \cos\theta + \frac{1}{2\sqrt{3}}(3f^F - f^D)\sin\theta \\
f_{\phi NN} &= -\frac{1}{\sqrt{2}} f^S \sin\theta + \frac{1}{2\sqrt{3}}(3f^F - f^D)\cos\theta
\end{aligned}
\tag{49}
$$

Numerical values of coupling constant ratios

$$
\begin{aligned}
8. \quad f_{\rho NN} &= +\frac{1}{2}(f^F + f^D) \\
f_{\omega NN} &= -\frac{1}{\sqrt{2}} f^S \cos\theta - \frac{1}{2\sqrt{3}}(3f^F - f^D)\sin\theta \\
f_{\phi NN} &= +\frac{1}{\sqrt{2}} f^S \sin\theta - \frac{1}{2\sqrt{3}}(3f^F - f^D)\cos\theta .
\end{aligned}
$$

and **similarly for hyperons**.
So, if one knows numerical values of SU(3) f^F, f^D, f^S coupling constants, then one can evaluated coupling constants for all $1/2^+$ octet baryons.

Further we demonstrate, how one can find these f^F, f^D, f^S coupling constants by utilizing previous relations for nucleons, together with numerical values of f_{VNN}/f_V in (43).

Numerical values of coupling constant ratios

The reversed relations to the previous one are

$$
\begin{aligned}
1.\quad f^F &= \frac{\sqrt{3}}{2}(f_{\omega NN}\sin\theta - f_{\phi NN}\cos\theta) + \frac{1}{2}f_{\rho NN} \\
f^D &= -\frac{\sqrt{3}}{2}(f_{\omega NN}\sin\theta - f_{\phi NN}\cos\theta) + \frac{3}{2}f_{\rho NN} \\
f^S &= \sqrt{2}(f_{\omega NN}\cos\theta + f_{\phi NN}\sin\theta) \\
4.\quad f^F &= \frac{\sqrt{3}}{2}(-f_{\omega NN}\sin\theta + f_{\phi NN}\cos\theta) + \frac{1}{2}f_{\rho NN} \\
f^D &= -\frac{\sqrt{3}}{2}(-f_{\omega NN}\sin\theta + f_{\phi NN}\cos\theta) + \frac{3}{2}f_{\rho NN} \\
f^S &= \sqrt{2}(-f_{\omega NN}\cos\theta - f_{\phi NN}\sin\theta) \qquad (50) \\
5.\quad f^F &= \frac{\sqrt{3}}{2}(f_{\omega NN}\sin\theta + f_{\phi NN}\cos\theta) + \frac{1}{2}f_{\rho NN} \\
f^D &= -\frac{\sqrt{3}}{2}(f_{\omega NN}\sin\theta + f_{\phi NN}\cos\theta) + \frac{3}{2}f_{\rho NN} \\
f^S &= \sqrt{2}(f_{\omega NN}\cos\theta - f_{\phi NN}\sin\theta)
\end{aligned}
$$

Numerical values of coupling constant ratios

8.
$$
\begin{aligned}
f^F &= \frac{\sqrt{3}}{2}(-f_{\omega NN}\sin\theta - f_{\phi NN}\cos\theta) + \frac{1}{2}f_{\rho NN} \\
f^D &= -\frac{\sqrt{3}}{2}(-f_{\omega NN}\sin\theta - f_{\phi NN}\cos\theta) + \frac{3}{2}f_{\rho NN} \\
f^S &= \sqrt{2}(-f_{\omega NN}\cos\theta + f_{\phi NN}\sin\theta)
\end{aligned}
$$

However, before the **numerical values of** $f^{(i)}_{VNN}, i = 1, 2$ are determined from the nucleon coupling constant ratios (43) by means of the values of the **universal vector-meson coupling constants** f_V to be extracted from lepton widths $\Gamma(V \to e^+e^-)$ of the vector-mesons under consideration.

But, the latter **can provide only the absolute values of the corresponding** f_V, as this is contained in the expression for lepton width $\Gamma(V \to e^+e^-)$ quadratically.

Numerical values of coupling constant ratios

Signs of f_V

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$$
\begin{aligned}
1.\quad & \frac{1}{f_\rho} : \frac{1}{f_\omega} : \frac{1}{f_\phi} = -\sqrt{3} : -\sin\theta : +\cos\theta \\
4.\quad & \frac{1}{f_\rho} : \frac{1}{f_\omega} : \frac{1}{f_\phi} = -\sqrt{3} : +\sin\theta : -\cos\theta \\
5.\quad & \frac{1}{f_\rho} : \frac{1}{f_\omega} : \frac{1}{f_\phi} = -\sqrt{3} : -\sin\theta : -\cos\theta \\
8.\quad & \frac{1}{f_\rho} : \frac{1}{f_\omega} : \frac{1}{f_\phi} = -\sqrt{3} : +\sin\theta : +\cos\theta
\end{aligned}
\tag{51}
$$

Numerical values of coupling constant ratios

are **strongly dependent on physically acceptable** $\omega - \phi$ **mixing forms** (48) and if we apply $f_\rho = |4.956|$, $f_\omega = |17.058|$, $f_\phi = |13.542|$ with signs given in (51) in coupling constant ratios found in a fitting procedure one gets

$$\begin{array}{llll} 1. & f^{(1)}_{\rho NN} = -1.8570; & f^{(1)}_{\omega NN} = -26.8101; & f^{(1)}_{\phi NN} = -15.2307; \\ 4. & f^{(1)}_{\rho NN} = -1.8570; & f^{(1)}_{\omega NN} = +26.8101; & f^{(1)}_{\phi NN} = +15.2307; \\ 5. & f^{(1)}_{\rho NN} = -1.8570; & f^{(1)}_{\omega NN} = -26.8101; & f^{(1)}_{\phi NN} = +15.2307; \\ 8. & f^{(1)}_{\rho NN} = -1.8570; & f^{(1)}_{\omega NN} = +26.8101; & f^{(1)}_{\phi NN} = -15.2307. \end{array} \quad (52)$$

Substituting them into relation for f^F, f^D, f^S together with $\theta = 38.35^0$, **calculated by Gell-Mann-Okubo quadratic mass formula**, one finds

$$f_1^F = -4.9916; \quad f_1^D = +1.2776; \quad f_1^S = -43.0979; \quad (53)$$

independent on the used $\omega - \phi$ **mixing form.**

Numerical values of coupling constant ratios

Similarly are found also

$$f_2^F = -7.6976; \quad f_2^D = -21.0036; \quad f_2^S = +7.1225; \tag{54}$$

and

$$f_1^{F'} = -5.1607; \quad f_1^{D'} = -16.4400; \quad f_1^{S'} = -9.3767; \tag{55}$$

$$f_2^{F'} = +29.9610; \quad f_2^{D'} = +5.7612; \quad f_2^{S'} = +20.0463; \tag{56}$$

Numerical values of coupling constant ratios

If they are **substituted into the relations for** $f^{(i)}_{VYY}$ **and** $f^{(i)}_{V'YY}$, with $i = 1, 2$ and $Y = \Lambda, \Sigma, \Xi$, respectively, to be derived from the vector-meson-baryon interaction Lagrangian as a functions of these SU(3) coupling constants, and **these are divided** respectively by $f_\rho = |4.9582|$, $f_\omega = |17.0620|$, $f_\phi = |13.4428|$ and $f_{\rho'} = |13.6491|$, $f_{\omega'} = |47.6022|$, $f_{\phi'} = |33.6598|$ with **signs to be dependent on the four different** $\omega - \phi$**-mixing forms**, one gets **unknown coupling constants ratios** of vector-meson with hyperons in the hyperon *Unitary&Analytic* EM structure models as follows:

Numerical values of coupling constant ratios

for Λ-hyperon

$$
\begin{aligned}
(f^{(1)}_{\omega\Lambda\Lambda}/f_{\omega}) &= +1.4389 \\
(f^{(1)}_{\phi\Lambda\Lambda}/f_{\phi}) &= -1.3359 \\
(f^{(1)}_{\omega'\Lambda\Lambda}/f_{\omega'}) &= -0.2253 \\
(f^{(1)}_{\phi'\Lambda\Lambda}/f_{\phi'}) &= -0.3104 \\
(f^{(2)}_{\omega\Lambda\Lambda}/f_{\omega}) &= -0.8554 \\
(f^{(2)}_{\phi\Lambda\Lambda}/f_{\phi}) &= -0.7623 \\
(f^{(2)}_{\phi'\Lambda\Lambda}/f'_{\phi}) &= +0.4437
\end{aligned}
\qquad (57)
$$

Numerical values of coupling constant ratios

for Σ-hyperons

$$
\begin{aligned}
(f^{(1)}_{\rho\Sigma\Sigma}/f_{\rho}) &= +1.0072\\
(f^{(1)}_{\omega\Sigma\Sigma}/f_{\omega}) &= +1.3742\\
(f^{(1)}_{\phi\Sigma\Sigma}/f_{\phi}) &= -1.4391\\
(f^{(1)}_{\omega'\Sigma\Sigma}/f_{\omega'}) &= +0.2327\\
(f^{(1)}_{\phi'\Sigma\Sigma}/f_{\phi'}) &= -0.1004\\
(f^{(2)}_{\omega\Sigma\Sigma}/f_{\omega}) &= +0.2096\\
(f^{(2)}_{\phi\Sigma\Sigma}/f_{\phi}) &= +0.9331\\
(f^{(2)}_{\phi'\Sigma\Sigma}/f_{\phi'}) &= +0.3701
\end{aligned}
\tag{58}
$$

Numerical values of coupling constant ratios

for Ξ-hyperons

$$
\begin{aligned}
(f^{(1)}_{\rho\Xi\Xi}/f_\rho) &= -0.6325 \\
(f^{(1)}_{\omega\Xi\Xi}/f_\omega) &= +1.2571 \\
(f^{(1)}_{\phi\Xi\Xi}/f_\phi) &= -1.6254 \\
(f^{(1)}_{\omega'\Xi\Xi}/f_{\omega'}) &= -0.1412 \\
(f^{(1)}_{\phi'\Xi\Xi}/f_{\phi'}) &= -0.2718 \\
(f^{(2)}_{\omega\Xi\Xi}/f_\omega) &= -0.6941 \\
(f^{(2)}_{\phi\Xi\Xi}/f_\phi) &= -0.5064 \\
(f^{(2)}_{\phi'\Xi\Xi}/f'_\phi) &= +0.6536
\end{aligned}
\tag{59}
$$

Conclusions

The Λ, Σ, Ξ hyperons EM structure - as **generalization of the nucleon** $U\&A$ **EM structure model**.

Based on the fact - **analytic properties of the hyperon EM FFs**, up to the position of effective inelastic thresholds, **equal with analytic properties of the nucleon EM FFs**.

Models **depend on some coupling constant ratios** (f_{VBB}/f_V) **as free parameters**, they have been found from known nucleon coupling constant ratios and SU(3) invariant Lagrangians of vector-meson-baryon interaction.

In their specification a **principal role played the** $\omega - \phi$ **mixing forms with universal vector-meson coupling constants** f_V.

All coupling constant ratios as free parameters of the Λ, Σ, Ξ EM structure models **have been evaluated numerically**.

Thank you for your attention.