The interplay of pGBs, heavy PS, AVs (and gluonium?)

- Chiral limit $\langle VV\partial A\rangle \sim \frac{N_c}{4\pi^2}$ $\Rightarrow$ interplay of L/T;[1] AVs + pGBs
- But away from it chiral (and large-N_c for the singlet)

$$\langle VV\partial A\rangle \sim \frac{N_c}{4\pi^2} + 2m\langle VVP\rangle \ (+G\tilde{G})$$

- For $m \neq 0$ heavy PS and pGB enter $\langle VVP\rangle$ (e.g., for real γ's)

$$\frac{q^2(1+\delta\frac{m_\pi^2}{\Lambda^2})}{4\pi^2(q^2-m_\pi^2)} + \frac{q^2(\delta'\frac{m_\pi^2}{\Lambda^2})}{4\pi^2(q^2-m_P^2)} - \frac{1}{4\pi^2} \sim 2m\langle VVP\rangle \ (+\langle VV\omega\rangle), \quad \omega \sim G\tilde{G}$$

- To resemble $2m\langle VVP\rangle$ or fuflfill high energy $\delta' = -\delta$

$$2m\langle VVP\rangle = \frac{m_\pi^2(1+\delta\frac{m_\pi^2}{\Lambda^2})}{q^2-m_\pi^2} - \frac{m_P^2(\delta\frac{m_\pi^2}{\Lambda^2})}{q^2-m_P^2}; \qquad F_{\pi\gamma\gamma}(0,0) = \frac{1}{4\pi^2 F_\pi}(1+\delta\frac{m_\pi^2}{\Lambda^2})$$

- Resembles RχT • δ from $P\to\gamma\gamma$[2] • high energy from $\langle VVP\rangle$ OPE[3]

[1] M. Knecht JHEP08 (2020); P. Masjuan, P. Roig, P. SP 2005.11761

[2] {Kampf et al PRD84, Escribano et al PRD94, Gérardin et al PRD100, Bickert et al PRD102} $C_7^W = \{0.35(7), 0.5(7), 0.16(18), 0.6(7)\} \times 10^{-3}\ \mathrm{GeV}^{-2}$

[3] M. Knecht, A. Nyffeler, EPJ C21

On-shell Axials

- $a_1(1260)$ missing so far in $\gamma\gamma$ reactions (prospects? th. input? τ decays?)
- So far, f_1's $+U(3)$-symm. **assumptions**; also complicated by $f_1 - f_1'$ mixing...
- **Experimental/lattice?** information on axials ($f_1(1285)$ dominates) welcome

Off-shell Axials (SDCs)

- Axials as "subtracted+contact" term interesting?[4] Note separating AVs into $T + L \Rightarrow$ spurious poles (only meaningful as a whole?)
- Regarding any axial models (incl. holographic), π^0 TFF as a diagnosis tool?

Narrow-resonance estimates and sum rules

- Dispersive narrow-width mesons basis-dependent[5] $\Rightarrow$ explore sum rules? Can we all play this game?
- Anomaly in MV's OPE "basis-independent"? (does it satisfy sum rules?)
- Do holographic models satisfy sum rules?

Short-distances

- SD matching as in Lüdtke et al (EPJ C80 2020) / Colangelo et al[6]?
- Do we need to provide results up to some cut-off?

[4] See A. Rebhan's talk; P. Masjuan, P. Roig, P. SP 2005.11761

[5] Danilkin et al, 2105.01666; Colangelo et al, 2106.13222