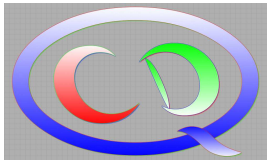

Low-*t* reactions: Thoughts on the Kaon Primakoff Program

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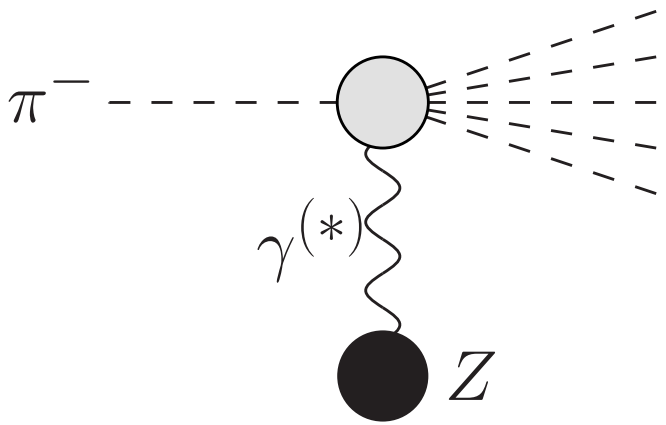
COMPASS++ / AMBER kickoff, Dec. 11 2019

+ input from Norbert Kaiser

Primakoff reactions at COMPASS: $\gamma\pi^- \longrightarrow \ldots$

- pion beam at small momentum transfer:

  photon exchange $\propto 1/t \gg$ hadronic reactions



- $\gamma\pi^- \to \gamma\pi^-$: Compton scatt.
  $\longrightarrow$ pion polarisabilities
  $\longrightarrow$ fundamental information on pion structure

  COMPASS 2015

- $\gamma\pi^- \to (3\pi)^-$:
  $\longrightarrow$ low-energy pion dynamics

  COMPASS 2012

- $\gamma\pi^- \to \pi^-\pi^0$: testing the Wess–Zumino–Witten chiral anomaly
- $\gamma\pi^- \to \pi^-\eta$: — " —

$\longrightarrow$ what is the physics case for a kaon Primakoff program?

Kaon polarisabilities

Charged-pion polarisabilities

- Compton: difference of electric and magnetic polarisabilities

$$\alpha_E^{\pi^+} - \beta_M^{\pi^+} = \frac{8\alpha_{\text{em}}}{F_\pi^2 M_\pi}\left(L_9^r + L_{10}^r\right) + \mathcal{O}(M_\pi)$$

- low-energy theorem: $L_9^r + L_{10}^r \propto$ form factor ratio in $\pi^+ \to e^+\nu_e\gamma$
- two-loop: $\alpha_E^{\pi^+} - \beta_M^{\pi^+} = 5.7(1.0) \times 10^{-4}\,\text{fm}^3$ Gasser et al. 2006

  vs. $\alpha_E^{\pi^+} - \beta_M^{\pi^+} = 4.0(1.2)(1.4) \times 10^{-4}\,\text{fm}^3$ COMPASS 2015
- cross-checked by $\gamma\gamma \to \pi\pi$ sum rules e.g. Hoferichter, Stoffer 2019

Charged-kaon polarisabilities

- one loop $\longrightarrow$ analogous to pion case:

$$\alpha_E^{K^+} - \beta_M^{K^+} = \frac{8\alpha_{\text{em}}}{F_K^2 M_K}\left(L_9^r + L_{10}^r\right) + \mathcal{O}(M_K) \approx 1.2 \times 10^{-4}\,\text{fm}^3$$

Guerrero, Prades 1997

- precision, corrections? two-loop calculation not available
- dispersive cross check? e.g. García-Martín, Moussallam 2010

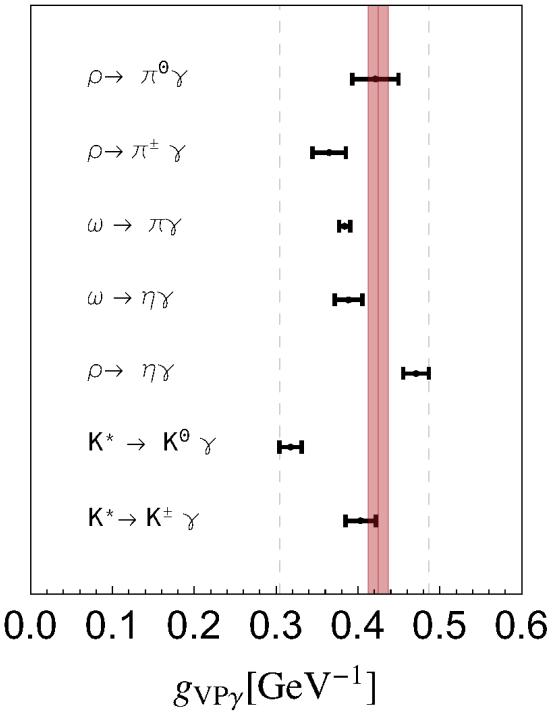
Pion production $\gamma K^- \to (\pi \bar{K})^-$

Upshot $\gamma\pi^- \to \pi^-\pi^0$: Hoferichter, BK, Sakkas, Zanke 2012, 2017

- energy dep. controlled by dispersion theory + $\pi\pi$ phase shifts
  $\longrightarrow$ extract chiral anomaly using complete $\rho(770)$ spectrum
- radiative coupling $\rho \to \pi\gamma$ extracted in model-independent way

Perspectives for $\gamma K^- \to \pi^0 K^-$, $\pi^- \bar{K}^0$:

- similar information on πK phase shifts
  Büttiker et al. 2004; Peláez, Rodas 2016–2018;
  Colangelo et al. (in progress)
- larger quark-mass effects /
  SU(3) breaking in chiral anomaly
  $\longrightarrow$ extract information from ChPT
  Ebertshäuser PhD 2001, Hacker PhD 2008
- $K^*(892) \to K\gamma$: SU(3) symmetry broken
  important input to $\gamma\gamma \to M_1 M_2$



Danilkin et al. 2017