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Testing Predictions of the Chiral Anomaly in Primakoff Reactions at COMPASS

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The chiral anomaly is a fundamental property of quantum chromodynamics (QCD). It governs e.g. the decay of the neutral pion $\pi^0 \to \gamma\gamma$. In general, it relates the coupling of an odd number of Goldstone bosons to vector bosons. In case of three pions, the magnitude of the resulting coupling is $F_{3\pi}$ and the value is precisely predicted by chiral perturbation theory. It can experimentally be measured in $\pi^-\gamma \to \pi^-\pi^0$ scattering.

Here, we report on a precision experiment on $F_{3\pi}$ using the COMPASS experiment at CERN where pion-photon scattering is mediated via the Primakoff effect using heavy nuclei as target. We exploit the interference of the production of the $\pi^-\pi^0$ final state via the chiral anomaly with the photo-production of the $\rho(770)$ resonance over a wide mass range ($M_{\pi^-\pi^0} < 1\text{GeV}/c^2$). This is in contrast to previous measurements restricting themselves to the threshold region only. Our analysis allows to simultaneously extract the radiative width of the $\rho(770)$ resonance and gives a stronger handle on $F_{3\pi}$ in a unified approach thereby minimizing systematic effects rarely addressed previously.

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