Decays of η and η' and the axial $U(1)$ anomaly

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The hadronic decays $\eta \to \pi\pi\pi$, $\eta' \to \pi\pi\pi$ and $\eta' \to \eta\pi\pi$ are investigated within a $U(3)$ chiral unitary approach based on a chiral effective Lagrangian which includes the η' as an explicit degree of freedom and incorporates important features of the underlying QCD Lagrangian such as the axial $U(1)$ anomaly [1]. Final state interactions are included by deriving the effective s wave potentials for meson meson scattering from the chiral effective Lagrangian and iterating them in a Bethe-Salpeter equation. With only a small set of parameters we are able to explain both rates and spectral shapes of these decays.

The decay $\eta \to \pi\pi\pi$ may be used to constrain the double quark mass ratio $Q^2 = \frac{m_s - \hat{m}}{m_d - m_u} \frac{m_s + \hat{m}}{m_d + m_u}$ with $\hat{m} = m_u + m_d$ from which we obtain $Q^2 = 23.4 \pm 0.8$, a value which is in agreement with the requirement by Dashen's theorem and indicates that higher order corrections to this low-energy theorem may be small.

We can furthermore confirm the importance of the a_0(980 resonance for $\eta' \to \eta\pi\pi$ – as has been claimed in the literature – without including it explicitly in the theory.

This approach has recently been extended to the anomalous sector of the chiral effective field theory and applied to both the decays $\pi^0, \eta, \eta' \to \gamma\gamma$ [2] and $\eta, \eta' \to \pi^+\pi^-\gamma$ [3].

[1] N. Beisert and B. Borasoy, Nucl. Phys. A716 (2003) 186

[2] B. Borasoy and R. Nißler, Eur. Phys. J. A19 (2004) 367

[3] B. Borasoy and R. Nißler, submitted to Nucl. Phys. A

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