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Doubly radiative $\eta^{(\prime)}$ decays: interplay of vector, scalar, and tensor contributions

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We present a theoretical analysis of the doubly radiative decays $\eta^{(\prime)} \to \pi^0\gamma\gamma$ and $\eta' \to \eta\gamma\gamma$, including vector, scalar, and tensor meson exchange contributions. Vector meson dominance and the linear sigma model are used for vector and scalar exchanges, while the $a_2(1320)$ tensor meson is incorporated within a chiral framework. Vector meson exchange dominates all three channels.

For the $\eta \to \pi^0\gamma\gamma$ decay, the tensor meson contribution is small, but its destructive interference with the vector amplitude reduces the decay width by about 14%, bringing our prediction into excellent agreement with the recent KLOE-2 measurement. In $\eta' \to \pi^0\gamma\gamma$, the tensor contribution is negligible, as the decay is largely saturated by the on-shell ω resonance.

For $\eta' \to \eta\gamma\gamma$, scalar exchanges, especially the $\sigma(500)$, provide a sizeable contribution, making this channel a potential probe of the properties of this still poorly understood resonance. Our results provide a unified description of these decays and emphasize the phenomenological impact of vector–tensor interference in the $\eta \to \pi^0\gamma\gamma$ channel.

Collaboration

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