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New bound on the vectorial axion-down-strange coupling from $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ data

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We analyze publicly available $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ data collected by NA62 from 2016 to 2022 to constrain the fundamental vectorial coupling of the QCD axion to the down and strange quarks or, equivalently, the Peccei-Quinn scale f_a rescaled by this coupling, obtaining $|(F_V)_{23}| > 1.1 \times 10^{12}$ GeV. Under the complementary assumption that axion production is dominated by weak amplitudes, we derive a model-independent bound on f_a , namely $f_a > 1.0 \times 10^5$ GeV. We also discuss the potential of applying the same approach to $K^+ \rightarrow \pi^+ \pi^0 \nu \bar{\nu}$ data, from which we estimate the bound $|(F_A)_{23}| > 1.0 \times 10^8$ GeV. These constraints represent the strongest existing bounds inferred from controlled experimental setups.

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