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Search for the rare $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ decay at the NA62 experiment at CERN

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The rare $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ decay is an ideal probe for exploring physics beyond the Standard Model (BSM) at very high energy scales. This loop-dominated weak decay is heavily suppressed in the SM with a predicted branching ratio (BR) of $(8.4 \pm 1.0) \times 10^{-11}$.

The NA62 experiment at the CERN SPS is designed to study precisely the $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ BR using a new decay-in-flight technique. Kaons present in a 75 GeV mixed hadron beam are tagged and their momentum measured before they enter a 60 metres-long evacuated decay volume. The properties of the decay particles are then recorded by a redundant set of detectors, allowing for the reconstruction of the event kinematics and rejection of copious backgrounds. Photon and muon detectors cover the full signal geometrical acceptance.

During the 2016–2018 period, 20 $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ candidates were observed compared with 7 expected background events. This is the first evidence of this process with a statistical significance of more than three sigma. The corresponding BR is $(11.0_{-3.5}^{+4.0} \text{stat.} \pm 0.3_{\text{sys.}}) \times 10^{-11}$. This is compatible with the SM prediction within one standard deviation and allows sensitive limits to be placed on a range of hypothetical BSM physics. Plans for the 2021 run will also be presented.

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