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New results in rare allowed muon and pion decays

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Thanks to the simple underlying dynamics of pion and muon decays, small numbers of the available decay channels, and extremely well controlled radiative and loop corrections, these decays offer a uniquely sensitive means to explore details and limits of the underlying symmetries. For example the anomalously suppressed decay of the charged pion to the electron, $\pi^+ \to e^+\nu$ (labeled π_{e2}), provided an early signal of the V-A Lorentz structure of the weak interaction. Today, the π_{e2} decay still offers the most sensitive test of lepton universality: the equality of the lepton couplings to the weak boson regardless of the lepton family (generation). Hence, π_{e2} decay is highly sensitive to non-(V-A) terms manifested through pseudoscalar contributions. Radiative decays of the muon, $\mu^+ \to e^+\nu\bar{\nu}\gamma$, and pion, $\pi^+ \to e^+\nu\gamma$, or $\pi_{e2\gamma}$, are sensitive in different ways to departures from the basic V-A dynamics of the weak interaction. Currently the experimental precision of all these processes lags significantly, i.e., by an order of magnitude or more, behind the precision of their theoretical description.

We report on new, unpublished results on the radiative decay of the muon (RMD) from a comprehensive program of precise measurements of the pion and muon rare decays at the Paul Scherrer Institute, Switzerland, the PIBETA and PEN experiments. Compared to previous experiments, our recently completed data analysis improves the uncertainty of the RMD branching ratio by a factor of almost 30, and that of the extracted value for the Michel parameter $\bar{\eta}$ by a factor of 4. Both are in good agreement with the SM expectations.

We also update the current status of the data analyses of π_{e2} (implications on limits of lepton universality, as well as non-$V-A$ extensions to the SM) and $\pi_{e2\gamma}$ decays (pion form factors, additions to $V-A$ interaction terms). This work is highly complementary to the Frascati kaon decay measurement program, with both providing key new information.

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