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New results in rare pion and muon decays[1]

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The PIBETA experiment, a program of precise measurements of rare pion and muon decays at PSI, completed in 2004 an experimental study of the pion and muon radiative decays, $\pi^+ \to e^+\nu\gamma$ and $\mu^+ \to e^+\nu\bar{\nu}\gamma$, respectively. The pion radiative decay data have enabled us to evaluate the branching ratio with better than 2% accuracy, with broad phase space coverage. Consequently, we have evaluated F_A, the axial form factor of the pion, with $\sim 2.5\%$ accuracy, a more than five-fold improvement over previous data, as well as improved six-fold the accuracy of F_V, the pion vector form factor, previously poorly determined. The latter result provides one of the most direct confirmation of the validity of the CVC hypothesis in the pion sector. We've also measured, for the first time ever, the momentum dependence of the pion form factors. All our results are in excellent agreements with chiral perturbation theory. Equally important is a new stringent upper limit on the long-debated tensor form factor for the pion. Our study of the muon radiative decay has resulted in a fourteen-fold improvement over previous data in the accuracy of this decay's branching ratio for a large phase space region ($E_\gamma > 10$ MeV, $\theta_{e-\gamma} > 30^\circ$). Our 2% result is in excellent agreement with theoretical predictions. Focusing on a narrower range of phase space, we were able to improve significantly the upper limit on the Michel paramter $\bar{\eta}$, reducing the world average upper limit by a factor of 2.5. $\bar{\eta}$ is sensitive to non-(V-A) admixtures in the weak lagrangian. The new results, their implications, and prospects for future improvements are discussed in detail.

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