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Pion electronic decay and lepton universality

Involving only light elementary particles, charged pion decays are characterized by simple dynamics, few available decay channels, and extremely well controlled radiative and loop cor rections. The comparative simplicity of pion (and muon) decays allows them to be described with unprecedented precision within the Standard Model, (SM), typically with relative un certainties of ~ 10−4 or lower, reflecting the strong influence of the applicable SM symmetries. Given the highly precise SM theoretical description, pion decays are used as selective and sensitive probes of SM parameters, and of possible SM extensions. In particular, V −A helic ity suppression of the $\pi^+ \longrightarrow e^+\nu e(\gamma)$, or $\pi e2(\gamma)$ decay amplifies the sensitivity to pseudoscalar terms by a factor of ~ 8000, enabling indirect searches for non-SM pseudoscalar terms, as well as scalar and tensor terms, through loop effects, with good sensitivity to interesting regions of the beyond-SM parameter space, such as supersymmetric extensions.

Experimental data on the allowed rare electronic decay of charged pions: $\pi e2(\gamma)$, the muon radiative decay, $\mu^+ \longrightarrow e^+\nu e\bar{\nu}_\mu\gamma$ as well as the semileptonic, $\pi^+ \longrightarrow \pi^0 e^+\nu(\gamma)$, or $\pi e3(\gamma)$ decay, present an internally consistent picture, so far in excellent agreement with SM predictions. However, experimental accuracy is lagging behind that of the theoretical description for all above processes. The PEN experiment at PSI is studying the $\pi e2(\gamma)$ decay with the primary goal to reach a relative precision of 5×10^{-4} in R_{π} e/μ, its branching ratio. We review the current status of the field, the PEN research program, the present status of the PEN data analysis, and the expected uncertainty limits.

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