The Forbidden and Unexpected Decay of Kaon
($K \to \pi\mu e$)

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Particle physics is the study of the properties of subatomic particles and of the interactions that occur among them. It is the branch of science that deals with the ultimate constituents of matter and the fundamental interactions that occur among them. The subject is known as high-energy physics or elementary particle physics. My project is part of an experiment to search for the rare, possibly forbidden (a process which hasn't been seen) decay of the particle Kaon ($K \to \pi\mu e$). The Kaon has several modes of decay, many of which are easily confused with the decay sought, which implies a need for sophisticated methods of identifying the decays. The most common decay is $K^+ \to \mu^+\nu$, which occurs 63% of the time. This could act as a background decay known as an "accidental" if the muon traveled close in time and space to a separate decay vertex, which would confuse the interpretations of other decays. Two more common decays are $K^+ \to \pi^+\pi^+\pi^-$ (Tau) and $K^+ \to \pi^+\pi^0, \pi^0 \to e^+e^-\gamma$ (Kdal, so called because of the Dalitz decay, $pi^0 \to e + e\gamma$, of the pion). One must know all possible outcomes to minimize mistakes in identifying the found events c orrectly. The decay of $K_{\pi\mu e}$ also sheds light on one of the most perplexing problems with the Standard Model (SM: a model of six Quarks and six Leptons as fundamental entities), the origin of mass. The mass offermions (quarks) is not determined in the SM. The SM particle Physics forbids the decay; through the postulate of Lepton Flavor Number Conservation.

Understanding the postulate of LFN Conservation requires an understanding of at least some of the following topics: the existence of three generations of fermions (Figure 4), because it is only with multiple generations that mixing can occur at all; the origin of mass, which is problematic in the SM and is related to the assumed mass-less ness and degeneracy of the neutrinos required for LFN Conservation; and the difference between the Quark and Lepton Sectors, because the mixing generations is observed in the Quark Sector while it has not, to much lower levels, been observed in the Lepton Sector. My part in this experiment is to use the data collected to study possible backgrounds to this unexpected decay and perhaps even to find a possible candidate for the $K_{\pi\mu e}$ decay.