Review of Rare and Forbidden τ Decays

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This is a review of rare and forbidden decays of the τ lepton. For the rare decays, this includes new results on the chiral anomaly decay $\tau^- \to \pi^-\eta\pi^0\nu_\tau$, new upper limits on the second-class-current decay $\tau^- \to \pi^-\eta\nu_\tau$, and the observations of the Cabibbo-suppressed decay $\tau^- \to K^-\eta\nu_\tau$ and the internal conversion decay $\tau^- \to e^-e^+e^-\bar{\nu}_e\nu_\tau$. For the forbidden decays, there are new upper limits on the radiative decays $\tau^- \to e^-\gamma$ and $\tau^- \to \mu^-\gamma$. Some forbidden decays which have not been previously searched for are also suggested.

1. INTRODUCTION

Rare and forbidden decays of the τ lepton are of particular interest. In rare decays, the Standard Model interaction is suppressed and therefore the sensitivity to new physics may be enhanced. In forbidden decays, the observation of a signal would imply physics beyond the Standard Model. The τ lepton is an excellent laboratory for the search for physics beyond the Standard Model. Its large mass allows for searches at high momentum transfer with many decay channels. The sensitivity may be enhanced because the τ is a third generation lepton. In some models, the coupling may have a mass dependence, e.g. $\propto m_\tau^5$, resulting in higher sensitivity than searches using μ decay. In this paper, we first review the rare decays, the chiral anomaly decay $\tau^- \to \pi^-\eta\pi^0\nu_\tau$, the second-class-current decay $\tau^- \to \pi^-\eta\nu_\tau$, the Cabibbo-suppressed decay $\tau^- \to K^-\eta\nu_\tau$, and the internal conversion decay $\tau^- \to e^-e^+e^-\bar{\nu}_e\nu_\tau$. This is followed by the review of forbidden decays, including new upper limits on the radiative decays $\tau^- \to e^-\gamma$ and $\tau^- \to \mu^-\gamma$. Some forbidden decays which have not been previously searched for are also suggested.

2. CHIRAL ANOMALY DECAY $\tau^- \to \pi^-\eta\pi^0\nu_\tau$

The decay $\tau^- \to \pi^-\eta\pi^0\nu_\tau$ proceeds through the vector current since the G-parity of the $\pi\eta\pi^0$ system is positive. However, in the chiral limit, the vector current couples exclusively to even numbers of pseudo-scalars. The decay is thus a chiral anomaly of QCD; the decay proceeds through the Wess-Zumino [1] anomaly term in the effective Lagrangian, changing the parity of three-meson final state and hence permitting the decay without isospin suppression. The calculations of the decay rate have large uncertainties [2–4] as shown in Fig. 1. The rate can be more reliably estimated by using the conserved-vector-current (CVC) [5] hypothesis to relate the coupling strength of the three-meson system to the weak charged vector current and the electromagnetic neutral vector current. The predictions for the rate [6,7] estimated using the measured cross section for $e^+e^- \to \pi^+\pi^-\eta$ are shown in Fig. 1. In 1992, the decay $\tau^- \to h^-\eta\pi^0\nu_\tau$ was observed for the first time by CLEO II [8]. In the measurement, there is no attempt to distinguish the charged particle as π or K; the rate for $\tau^- \to K^-\eta\pi^0\nu_\tau$ is expected to be highly suppressed. The CLEO experiment has updated (preliminary) its measurement using a five times larger data sample [9]. The decay has now been observed by ALEPH [10] as well. The two measurements are consistent with each other as shown in Fig. 1. The measurements are also consistent with the predictions based on an effective Lagrangian. However, they are both somewhat higher than the CVC expectations. This potential discrepancy may be resolved soon with a higher precision measurement of the $\pi^+\pi^-\eta$ cross section expected from Novosibirsk [7].

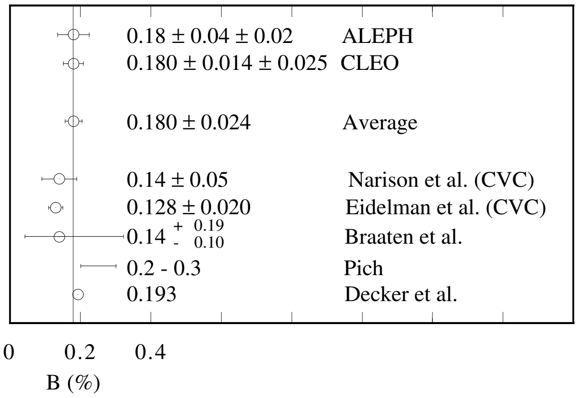

Figure 1. The measured branching ratios for $\tau^- \to h^-\eta\pi^0\nu_\tau$ and the predictions for $\tau^- \to \pi^-\eta\pi^0\nu_\tau$.

3. SECOND-CLASS-CURRENT DECAY $\tau^- \to \pi^-\eta\nu_\tau$

In the Standard Model, the weak hadronic current has a $V-A$ structure and the hadronic decay products have distinctive charge conjugation (C) and isospin (and hence G-parity) signatures, a reflection of the quantum number of the charged hadronic weak current. The weak current is classified according to its G-parity:

$G=-1$	$J^P = 0^-, 1^+$	$\pi, a_1 ...$
$G=+1$	$J^P = 1^-$	$\rho ...$

These are known as the first class currents. Currents with opposite G-parity are called the second class currents [11]. Examples of second class current decays are $\tau^- \to a_0^-(980)\nu_\tau \to \pi^-\eta\nu_\tau$ and $\tau^- \to b_1^-(1235)\nu_\tau \to \pi^-\omega\nu_\tau$.

The classification of the decay $\tau^- \to \pi^-\eta\nu_\tau$ as a second class current can be understood by analyzing the J^P of the $\pi\eta$ system: If system has $J=0$, then

$$P = P(\pi)P(\eta)(-1)^J = (-1)(-1)(-1)^0 = +1$$

and hence $J^P = 0^+$. On the other hand, if $J=1$, then

$$P = P(\pi)P(\eta)(-1)^J = (-1)(-1)(-1)^1 = -1,$$

which gives $J^P = 1^-$. However, the G-parity of the system is

$$G = G(\pi)G(\eta) = (-1)(+1) = -1,$$

which is opposite to that expected for a first class current. The decay $\tau^- \to \pi^-\eta\nu_\tau$ is therefore a second class current regardless of the angular momentum of the $\pi\eta$ system. The decay is strongly suppressed and there are several theoretical predictions on the branching ratio [3,12,13]:

$B \sim 1.6\times10^{-5}$	Tisserant and Truong
$B \sim 1.5\times10^{-5}$	Pich
$B \sim 1.2\times10^{-5}$	Neufeld and Rupertsberger

The CLEO II experiment has obtained a new limit on $\tau^- \to \pi^-\eta\nu_\tau$ in an analysis that also measured the rate for $\tau^- \to K^-\eta\nu_\tau$ [14]. The π/K identification is based on a confidence level ratio which is constructed from the confidence levels for π and K hypotheses, $\mathcal{C}_\pi$ and $\mathcal{C}_K$. The confidence level ratio for π is

$$R_\pi = \frac{\mathcal{C}_\pi}{\mathcal{C}_\pi + \mathcal{C}_K},$$

and similarly for K ($R_K = 1 - R_\pi$). The confidence level is computed from the χ^2 probability for a particle hypothesis using a combination of TOF and dE/dx information. A π candidate is then defined as a particle with $R_\pi > 0.5$, otherwise the particle is considered a kaon. The η meson accompanying the π candidate is detected via the decay channel $\eta \to \gamma\gamma$. There is no evident for the decay in the $\gamma\gamma$ invariant mass spectrum as shown in Fig. 2. The 95% confidence level upper limit on the decay is

$$B(\tau^- \to \pi^-\eta\nu_\tau) < 1.4\times10^{-4}.$$

ALEPH has also searched for the decay and the upper limit [10] is

$$B(\tau^- \to \pi^-\eta\nu_\tau) < 6.2\times10^{-4}.$$

CLEO's upper limit is about one order of magnitude above the theoretical expectations [3,12,13].

In the Standard Model, the decay $\tau^- \to \pi^-\omega\nu_\tau$ proceeds through the vector current with $J^P = 1^-$ for the $\pi\omega$ system. The decay may contain a contribution from the second class current with $J^P = 0^-$ or 1^+. ALEPH has searched for the contribution [10] by analyzing the distribution of the ω decay angle, the angle between the normal to the ω decay plane and the direction of the bachelor pion, in the ω rest frame. The upper limit on the second class current contribution is 8.6% at the 95% confidence level. Using the current world average [15] of $B(\tau^- \to h^-\omega\nu_\tau) = (1.91 \pm 0.09)\%$, this corresponds to $B(\tau^- \to \pi^-\omega\nu_\tau) < 1.7 \times 10^{-3}$ for the second-class-current process.

It is instructive to assess the prospect for observing the second-class-current decay $\tau^- \to \pi^-\eta\nu_\tau$, extrapolated using the CLEO II as a prototype detector for the B-factories. The R_K distribution for the charged track accompanying the η candidate is shown in Fig. 3. Candidates for $\tau^- \to \pi^-\eta\nu_\tau$ populate the low R_K region. In this region, the largest background is $e^+e^- \to q\bar{q}$, followed by $\tau^- \to \pi^-\eta\pi^0\nu_\tau$, and then $\tau^- \to K^-\eta\nu_\tau$. The hadronic background can be greatly suppressed by requiring a lepton tag. Since the CLEO II calorimeter is close to the state-of-the-art, no major gain in suppressing the background from $\tau^- \to \pi^-\eta\pi^0\nu_\tau$ is expected. The $K\eta$ background will be eliminated with the good particle identification capacity expected for the B-factory detectors. The signal to noise ratio is therefore expected to be 1:7, a daunting challenge for the experimenters.

4. CABIBBO-SUPPRESSED DECAY $\tau^- \to K^-\eta\nu_\tau$

There is no G-parity constraint on the Cabibbo-suppressed decay $\tau^- \to K^-\eta\nu_\tau$, unlike the decay $\tau^- \to \pi^-\eta\nu_\tau$, due to SU(3) symmetry breaking. The branching ratio is expected to be larger than $\tau^- \to \pi^-\eta\nu_\tau$ by an order of magnitude [3,16–18] as summarized in Fig. 4.

As stated in the previous section, the CLEO II experiment has searched for $\tau^- \to K^-\eta\nu_\tau$ in the same analysis that searched for $\tau^- \to \pi^-\eta\nu_\tau$

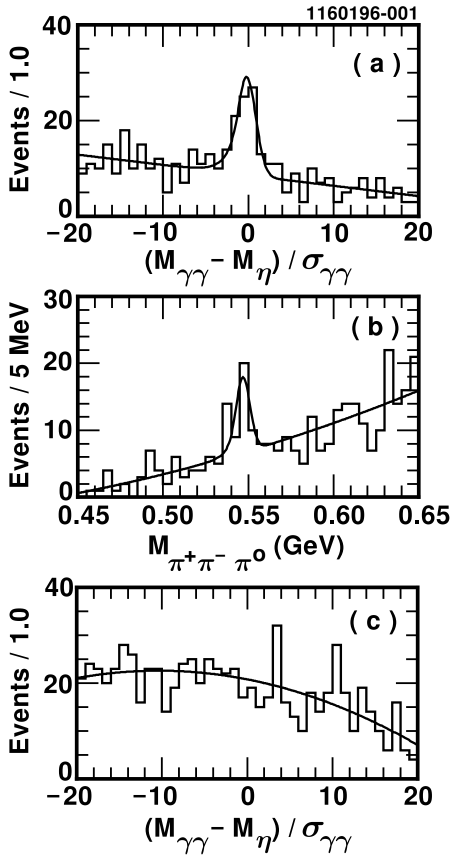

Figure 2. The invariant mass spectrum of the η candidates. Each η candidate is accompanied by a kaon candidate in (a) and (b) and by a pion candidate in (c). Each curve shows a fit to the mass spectrum. The η candidates are selected with an inclusive 1-prong tag (plus any number of photons) in (a) and (b) and with a lepton tag in (c). $\sigma_{\gamma\gamma}$ is the mass resolution.

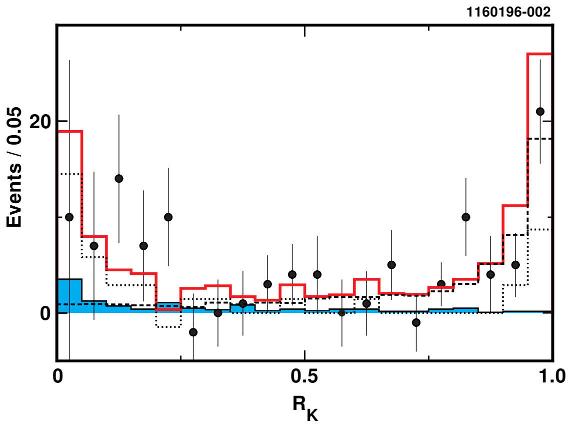

Figure 3. The observed R_K spectrum of the charged particle in the hemisphere containing an η meson after sideband subtraction. The η candidate is selected with an inclusive 1-prong tag (plus any number of photons). The histogram shows the Monte Carlo expectation which is a sum of the predictions for $\tau^- \to K^-\eta\nu_\tau$ (dashed), $\tau^- \to \pi^-\pi^0\eta\nu_\tau$ (shaded), and $e^+e^- \to q\bar{q}$ (dotted).

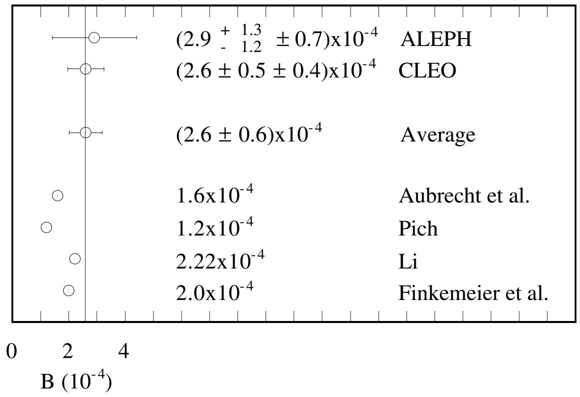

Figure 4. Branching ratios for $\tau^- \to K^-\eta\nu_\tau$.

[14]. The η meson accompanying the K candidate is detected via the decay channels $\eta \to \gamma\gamma$ and $\pi^+\pi^-\pi^0$. A signal is observed in both channels as shown in Fig. 2. This is the first evidence for the decay. CLEO's measurement as well as a recent measurement by ALEPH [10] is shown in Fig. 4. Both results are consistent with each other and the theoretical expectations [3,16–18].

5. INTERNAL CONVERSION DECAY $\tau^- \to l^-l^+l^-\bar{\nu}_l\nu_\tau$

The decay of the τ lepton into three lighter leptons and two neutrinos is allowed in the Standard Model. The decay proceeds via the emission of a virtual photon with subsequent internal conversion into e^+e^- and $\mu^+\mu^-$ as shown in Fig. 5. The contribution from a virtual photon radiated off the W boson is negligible due to the W propagator. The branching ratios for various internal conversion decays have been calculated by Dicus and Vera [19] as shown in Table 1.

The branching ratios have also been calculated by Volobouev of the CLEO Collaboration [20] using the symbolic manipulation program FORM [21]. These predictions are ~7% higher, although they agree on the decay $\mu^- \to e^-e^+e^-\bar{\nu}_e\nu_\mu$. An independent calculation would be useful to resolve the difference. The branching ratios for the decays $\tau^- \to e^-e^+e^-\bar{\nu}_e\nu_\tau$ and $\mu^-e^+e^-\bar{\nu}_\mu\nu_\tau$ are expected to be at the 10^{-5} level and hence within the reach of the CLEO II experiment. The internal conversion into a muon pair is suppressed by two orders of magnitude and hence beyond the reach of the experiment.

The CLEO II experiment has searched for the decays $\tau^- \to e^-e^+e^-\bar{\nu}_e\nu_\tau$ and $\mu^-e^+e^-\bar{\nu}_\mu\nu_\tau$ [20]. Experimentally, this is a very challenging search because of the difficulty in reconstructing the low momentum tracks from the internal conversion and special care has been taken in identifying the soft electron candidates using the specific energy loss measurements (dE/dx). Nevertheless, the experiment has identified five candidates for $\tau^- \to e^-e^+e^-\bar{\nu}_e\nu_\tau$ and one candidate for $\tau^- \to \mu^-e^+e^-\bar{\nu}_\mu\nu_\tau$, over a background of ~0.3 and 0.5 events, respectively. This yields the branching ratios

$$B(\tau^- \to e^-e^+e^-\bar{\nu}_e\nu_\tau) = (2.7^{+1.5}_{-1.1} \pm 0.4^{+0.1}_{-0.3}) \times 10^{-5}$$
$$B(\tau^- \to \mu^-e^+e^-\bar{\nu}_\mu\nu_\tau) < 3.2 \times 10^{-5}$$

at the 95% confidence level, where the first error is statistical, the second is systematic, and the third is due to the uncertainty in the background correction. The result is consistent with both calculations. It is remarkable that we are now measure rare decays at the 10^{-5} level.

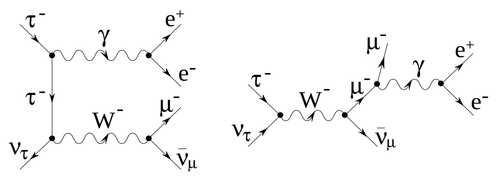

Figure 5. Feynman diagrams for $\tau^- \rightarrow \mu^- e^+ e^- \bar{\nu}_\mu \nu_\tau$.

6. FORBIDDEN DECAYS

In the Standard Model, there is no symmetry associated with lepton flavor and therefore there is no fundamental conservation law for lepton flavor; lepton flavor conservation is an experimentally observed phenomenon. Lepton flavor violation is expected in many extensions of Standard Model such as lepto-quarks [22], SUSY [23–26], superstrings [27], left-right symmetric [28] models and models which include heavy neutral leptons [29–31]. The predictions typically depend on one or two unknown masses of new particles and one or two unknown couplings. Therefore any null result from a search can only constrain the parameter space but cannot rule out a particular model. Nevertheless the search should be pursued vigorously because of its profound implication on the Standard Model should a positive signal be observed.

The number of τ's collected or expected for individual detectors is as follow:

LEP:	4×10^5 τ's
CLEO II:	10^7 τ's
B-factory:	10^9 τ's

So far, all the searches are statistics limited and are not expected to be background limited in the foreseeable future. The CLEO II experiment excels in this kind of search with the world largest τ sample.

The CLEO II experiment has searched for the decays $\tau^- \rightarrow e^-\gamma$ and $\tau^- \rightarrow \mu^-\gamma$ [32]. The experiment searches for the signal by examining the total energy vs. the invariant mass of the lepton and photon in events that survive the select criteria. Figure 6 shows the scatter plots of ΔE vs. $(m_{l\gamma} - m_\tau)$, where $\Delta E = E_{l\gamma} - E_{beam}$ is the difference between the measured total energy and the beam energy, $m_{l\gamma}$ is the invariant mass of the lepton and photon, and m_τ is the mass of the τ lepton. The signal region is defined as the $\pm 3\sigma$ region while the sidebands are defined by the 5 to 8 σ region. In the signal region, there is no $e\gamma$ event while three $\mu\gamma$ events survive the selection criteria. The background is estimated by extrapolating from the sideband regions, assuming that the background is linear in this vicinity. The estimated background is 2.0 events for $e\gamma$ and 5.5 events for $\mu\gamma$. The higher background for the $\mu\gamma$ analysis is due to the looser selection criteria. The observed events are consistent with background expectations. Assuming Poisson statistics, the 90% confidence level upper limits on the branching ratios are:

$$\tau^- \rightarrow e^-\gamma < 2.7 \times 10^{-6}$$
$$\tau^- \rightarrow \mu^-\gamma < 3.0 \times 10^{-6}.$$

These represent considerable improvements over the previous limits [15],

$$\tau^- \rightarrow e^-\gamma < 1.2 \times 10^{-4} \qquad \text{ARGUS}$$
$$\tau^- \rightarrow \mu^-\gamma < 4.2 \times 10^{-6} \qquad \text{CLEO}$$

For comparison, the limit [15] from μ decay is

$$\mu^- \rightarrow e^-\gamma < 4.9 \times 10^{-11}.$$

The new limit on $\tau^- \rightarrow \mu^-\gamma$ can be used to exclude some parameter space such as the mass of certain supersymmetry particles in some models [23,25,26].

Experimenters have searched for neutrino-less decays in 37 modes as shown in Table 2, including the two radiative decays discussed above.

Table 1
Theoretical predictions on the branching ratios for μ and τ decays with internal conversion. The errors are due to the inaccuracies in the numerical integrations.

Channel	Dicus and Vera	CLEO Calculation
$\tau^- \to e^- e^+ e^- \bar{\nu}_e \nu_\tau$	$(4.15 \pm 0.06) \times 10^{-5}$	$(4.457 \pm 0.006) \times 10^{-5}$
$\tau^- \to \mu^- e^+ e^- \bar{\nu}_\mu \nu_\tau$	$(1.97 \pm 0.02) \times 10^{-5}$	$(2.089 \pm 0.003) \times 10^{-5}$
$\tau^- \to e^- \mu^+ \mu^- \bar{\nu}_e \nu_\tau$	$(1.257 \pm 0.003) \times 10^{-7}$	$(1.374 \pm 0.002) \times 10^{-7}$
$\tau^- \to \mu^- \mu^+ \mu^- \bar{\nu}_\mu \nu_\tau$	$(1.190 \pm 0.002) \times 10^{-7}$	$(1.276 \pm 0.004) \times 10^{-7}$
$\mu^- \to e^- e^+ e^- \bar{\nu}_e \nu_\mu$	$(3.60 \pm 0.02) \times 10^{-5}$	$(3.605 \pm 0.005) \times 10^{-5}$

The CLEO II experiment has contributed to 24 modes [33] with limits of a few times 10^{-6}, except $\tau^- \to \mu^-\pi^-K^+$, $\mu^+\pi^-K^-$, and $e^-\bar{K}^{*0}(892)$ where the limits are at the 10^{-5} level. These limits represents the most stringent limits, except $\tau^- \to \mu^-\mu^+\mu^-$ where the ARGUS limit [34] remains the most stringent. The limits on decays which have not been searched for by CLEO II are presently in the range of 10^{-3} to 10^{-5} and the experimenters are urged to search for the decays. There are also decays that have never been searched for:

$$\tau^- \to l^-\eta',\ l^-\omega$$
$$\tau^- \to l^-\pi^0\pi^0,\ l^-\pi^0\eta,\ l^-\eta\eta...$$
$$\tau^- \to l^-K^+K^-,\ l^-\bar{K}^0K^0...$$
$$\tau^- \to l^-\pi^0K^0,\ l^-\eta K^0,\ l^-\eta' K^0...$$

Once again, the experimenters are urged to search for these decays.

Ilakovoc and collaborators [30,31] have calculated the rate for τ decay into three leptons and one lepton plus one or two mesons using a GUT and superstring inspired model with heavy neutral leptons. The rates depend on the masses of the Majorana neutrinos, M_{N_1} and M_{N_2}, and the heavy-light neutrino mixings, $(s_L^{\nu_e})^2$ and $(s_L^{\nu_\tau})^2$. Some of the rates may be as large as 10^{-6}, within the sensitivity of the CLEO II experiment. Figure 7 shows the dependence of the branching ratios on the Majorana mass for the decay into one lepton and two mesons, with $M_N = M_{N_1} = \frac{1}{3}M_{N_2}$, $(s_L^{\nu_e})^2 = 0.01$ and $(s_L^{\nu_\tau})^2 = 0.05$. The rates are largest for $\tau^- \to l^-\pi^+\pi^-$, $l^-K^+K^-$, and $l^-\bar{K}^0K^0$, which are enhanced by vector dominance, and smallest for $\tau^- \to l^+\pi^-\pi^-$, $l^+\pi^-K^-$, and $l^+K^-K^-$, which proceed through tree level diagrams only. There is no experimental limit on $\tau^- \to l^-K^+K^-$.

7. Conclusion

In conclusion, there are several new results on rare and forbidden decays of the τ lepton. The chiral anomaly decay $\tau^- \to \pi^-\eta\pi^0\nu_\tau$ has been measured with good precision and the result is somewhat higher than the prediction of CVC. The second class current has been searched for in the decays $\tau^- \to \pi^-\eta\nu_\tau$ and $\tau^- \to \pi^-\omega\nu_\tau$ and new upper limits have been set. The Cabibbo-suppressed decay $\tau^- \to K^-\eta\nu_\tau$ has been observed and the measured branching ratio is consistent with the Standard Model expectation. The internal conversion decay $\tau^- \to e^-e^+e^-\bar{\nu}_e\nu_\tau$ has also been observed, at a rate expected from the Standard Model. There are also new upper limits on the radiative decays $\tau^- \to e^-\gamma$ and $\tau^- \to \mu^-\gamma$. In summary, we have reached a new level of sensitivity in τ physics. We are now sensitive to branching ratios at the level of 10^{-6}. Unfortunately, there is no hint of physics beyond the Standard Model.

Acknowledgments

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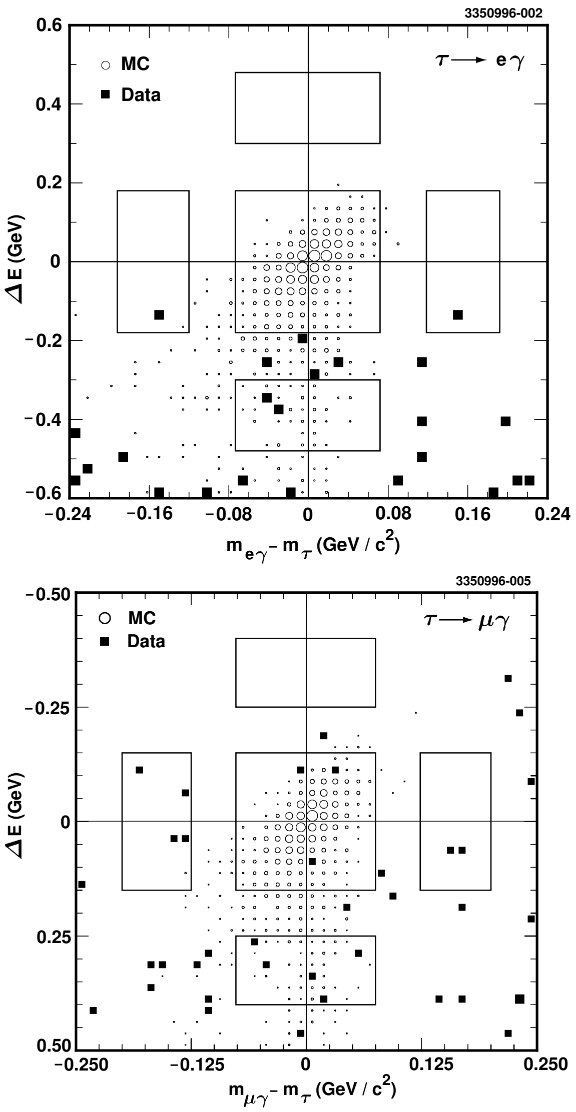

Figure 6. The total energy difference vs. the invariant mass difference for (a) $\tau^- \rightarrow e^-\gamma$ and (b) $\tau^- \rightarrow \mu^-\gamma$.

Table 2
Upper limits on the branching ratios for neutrinoless decays. All limits are at the 90% confidence level, except the last two limits which are at 95% confidence level. The decays $\tau^- \rightarrow \pi^-\gamma$ and $\pi^-\pi^0$ violate angular momentum conservation.

Decay	B	Experiment
$e^-\gamma$	$< 2.7 \times 10^{-6}$	CLEO
$\mu^-\gamma$	$< 3.0 \times 10^{-6}$	CLEO
$e^-\pi^0$	$< 1.4 \times 10^{-4}$	X'Ball
$\mu^-\pi^0$	$< 4.4 \times 10^{-5}$	ARGUS
e^-K^0	$< 1.3 \times 10^{-3}$	Mark II
μ^-K^0	$< 1.0 \times 10^{-3}$	Mark II
$e^-\eta$	$< 6.3 \times 10^{-5}$	ARGUS
$\mu^-\eta$	$< 7.3 \times 10^{-5}$	ARGUS
$e^-\rho^0$	$< 4.2 \times 10^{-6}$	CLEO
$\mu^-\rho^0$	$< 5.7 \times 10^{-6}$	CLEO
$e^-K^{*0}(892)$	$< 6.3 \times 10^{-6}$	CLEO
$\mu^-K^{*0}(892)$	$< 9.4 \times 10^{-6}$	CLEO
$\pi^-\gamma$	$< 2.8 \times 10^{-4}$	ARGUS
$\pi^-\pi^0$	$< 3.7 \times 10^{-4}$	ARGUS
$e^-e^+e^-$	$< 3.3 \times 10^{-6}$	CLEO
$e^-\mu^+\mu^-$	$< 3.6 \times 10^{-6}$	CLEO
$e^+\mu^-\mu^-$	$< 3.5 \times 10^{-6}$	CLEO
$\mu^-e^+e^-$	$< 3.4 \times 10^{-6}$	CLEO
$\mu^+e^-e^-$	$< 3.4 \times 10^{-6}$	CLEO
$\mu^-\mu^+\mu^-$	$< 1.9 \times 10^{-6}$	ARGUS
$e^-\pi^+\pi^-$	$< 4.4 \times 10^{-6}$	CLEO
$e^+\pi^-\pi^-$	$< 4.4 \times 10^{-6}$	CLEO
$\mu^-\pi^+\pi^-$	$< 7.4 \times 10^{-6}$	CLEO
$\mu^+\pi^-\pi^-$	$< 6.9 \times 10^{-6}$	CLEO
$e^-\pi^+K^-$	$< 7.7 \times 10^{-6}$	CLEO
$e^-\pi^-K^+$	$< 4.6 \times 10^{-6}$	CLEO
$e^+\pi^-K^-$	$< 4.5 \times 10^{-6}$	CLEO
$\mu^-\pi^+K^-$	$< 8.7 \times 10^{-6}$	CLEO
$\mu^-\pi^-K^+$	$< 1.5 \times 10^{-5}$	CLEO
$\mu^+\pi^-K^-$	$< 2.0 \times 10^{-5}$	CLEO
$\bar{p}\gamma$	$< 2.9 \times 10^{-4}$	ARGUS
$\bar{p}\pi^0$	$< 6.6 \times 10^{-4}$	ARGUS
$\bar{p}\eta$	$< 1.30 \times 10^{-3}$	ARGUS
$e^-\bar{K}^{*0}(892)$	$< 1.1 \times 10^{-5}$	CLEO
$\mu^-\bar{K}^{*0}(892)$	$< 8.7 \times 10^{-6}$	CLEO
e^-light boson	$< 2.7 \times 10^{-3}$	ARGUS
μ^-light boson	$< 5 \times 10^{-3}$	ARGUS

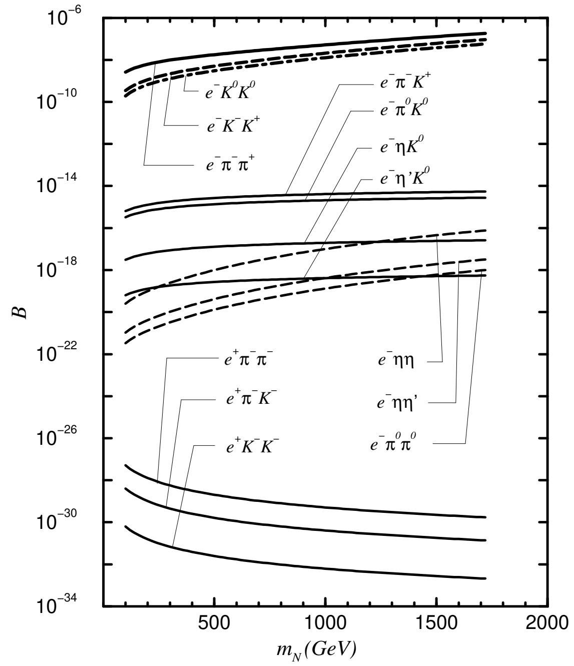

Figure 7. The predictions [31] for the decay branching ratios of τ^- into one lepton and two mesons as a function of the Majorana mass.

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