MEASUREMENT OF THE MUONIC BRANCHING RATIO OF THE τ LEPTON USING THE OPAL DETECTOR AT LEP

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Thesis submitted for the degree of
Doctor of Philosophy

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December 1996

Synopsis

Using the data collected by the OPAL detector at LEP during 1991 - 1994 physics runs, a sample of $e^+e^- \rightarrow Z^0 \rightarrow \tau^+\tau^-$ decays was isolated. Treating each year separately, further selections isolated samples of $\tau \rightarrow \mu\nu\bar{\nu}$ decays. The backgrounds of these selections, estimated initially from Monte Carlo, were checked using control samples formed from the data, and the efficiency of the $\tau \rightarrow \mu\nu\bar{\nu}$ selection was checked with an independent control sample of $\tau \rightarrow \mu\nu\bar{\nu}$ decays, taken from data and Monte Carlo. The overall muonic branching fraction was measured to be:

$$\begin{aligned} B(\tau \rightarrow \mu\nu\bar{\nu}) &= (17.453 \pm 0.121 \pm 0.039)\% \\ &= (17.453 \pm 0.127)\% \end{aligned}$$

where the first error derives from data-variables, and the second part of the error from all other sources. This result is consistent and very competitive with the results obtained by other collaborations, having one of the lowest systematic uncertainties. It is also in good agreement with the current World average value. This work has been released as an OPAL technical note [1] and will shortly be released as an OPAL physics note.

This branching ratio was then used to test lepton universality. The measured ratio for g_μ/g_e, obtained by comparing the muonic and electronic tau branching fractions, was found to be:

$$\left|\frac{g_\mu}{g_e}\right| = 1.0046 \pm 0.0059 \quad ,$$

which is clearly consistent with unity. Assuming lepton universality, a further calculation was made to determine an upper limit on the mass of the τ neutrino, which was found to be:

$$m_{\nu_\tau} < 130\mathrm{MeV/c^2} \quad , \quad \text{at } 95\% \text{ confidence level.}$$

Finally, the relation between the tau lifetime, tau mass, and tau branching ratio was tested by plotting the tau lifetime as a function of branching ratio and mass, and checking for consistency with the branching ratio measured in this analysis. The agreement was found to be very good.

These results serve to confirm Standard Model predictions, and are in agreement with other published results.