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A Test of $\mathcal{CP}$-Invariance in $Z^0 \longrightarrow \tau^+\tau^-$ Using Optimal Observables

The OPAL Collaboration

Abstract

Using 27 490 $Z^0 \to \tau^+\tau^-$ decays, accumulated in 1991, 1992 and 1993 with the OPAL detector at LEP, a direct test of $\mathcal{CP}$-invariance in the neutral current reaction $e^+e^- \longrightarrow \tau^+\tau^-$ is performed by measuring $\mathcal{CP}$-odd observables which are proportional to the weak dipole moment of the τ-lepton. A new method based on optimal $\mathcal{CP}$-odd observables constructed from the τ flight and spin directions is employed. More sensitive measurements of the real and, for the first time, the imaginary part of the weak dipole moment with highest possible signal to noise ratio are obtained. No evidence for a non-zero expectation value of the considered observables and hence for $\mathcal{CP}$-violation is observed. An upper limit on the weak dipole moment of $|\,\mathrm{Re}(d_\tau^w)\,| < 7.8 \times 10^{-18}\ e\cdot\mathrm{cm}$ and $|\,\mathrm{Im}(d_\tau^w)\,| < 4.5 \times 10^{-17}\ e\cdot\mathrm{cm}$ with 95% confidence level is obtained.

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