

Search for the forbidden decays $D^0 \rightarrow hh' ll'$ and observation of $D^0 \rightarrow K^- \pi^+ e^+ e^-$

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Decay modes with two oppositely charged leptons of different flavor correspond to lepton flavor violating (LFV) decays and are essentially forbidden in the Standard Model (SM) because they can occur only through lepton mixing. Decay modes with two leptons of the same charge are lepton-number violating (LNV) decays and are forbidden in the SM. Hence, decays of the form $D^0 \rightarrow hh' ll'$ provide sensitive tools to investigate new mediators or couplings in physics beyond the SM.

In this talk, we report on a search for decays of the type $D^0 \rightarrow hh' ll'$ (with $h, h' = K/\pi$ and $l, l' = e/\mu$) using data taken by the BABAR experiment at the PEP-II e^+e^- collider at the SLAC National Accelerator Laboratory. Upper limits on the branching fractions are improved by up to two orders of magnitude.

We also report on the observation of the flavor-changing neutral current (FCNC) decay $D^0 \rightarrow K^- \pi^+ e^- e^+$, which is strongly suppressed in the SM

because of the Glashow-Iliopoulos-Maiani (GIM) mechanism.

We measure $\mathcal{B}(D^0 \rightarrow K^- \pi^+ e^- e^+) = (4.0 \pm 0.5) \times 10^{-6}$ in the di-lepton mass range $0.675 < m(e^+ e^-) < 0.875 \text{ GeV}/c^2$, where the production of the intermediate state $\rho \rightarrow e^+ e^-$ dominates, and set upper limits for decays outside this interval where long-distance effects are not expected to be significant.

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