Measurement of the CP violation parameter $|\eta_{+-}|$ and the charge asymmetry in $K^{\pm} \rightarrow 3\pi$ decays by NA48 and NA48/2

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The main goal of the NA48 experiment at the CERN SPS has been the search for direct CP violation (CPV) in kaon decays. The observable η_{+-} is related to the parameters of indirect and direct CPV $(\eta_{+-} = \varepsilon + \varepsilon')$ and defined as the CP violating amplitude ratio of the neutral kaon decaying into two charged pions: $\eta_{+-} = A(K_L \to \pi^+\pi^-)/A(K_S \to \pi^+\pi^-)$. NA48 has determined $|\eta_{+-}|$ via the measurement of the ratio of decay rates $\Gamma(K_L \to \pi^+\pi^-)/\Gamma(K_L \to \pi e\nu)$. The data were taken during a dedicated run in 1999 using a pure K_L beam. The analysis is based on 47000 $K_L
ightarrow \pi^+\pi^$ and five million $K_L \rightarrow \pi e \nu$ decays. Complementary with ε'/ε , the observable in the charged kaons sector is the asymmetry $A_q = (g^+ - g^-)/(g^+ + g^-)$ of the linear slope parameter g in the Dalitz plot of $K^{\pm} \rightarrow 3\pi$ decays. Any non-zero value of A_q would reflect evidence for direct CPV. SM predictions for the charge asymmetry give an upper limit of a few 10^{-5} , while theoretical calculations involving processes beyond the SM do not exclude substantial enhancements of $A_g.$ The NA48/2 experiment used simultaneous K^+/K^- beams, and from the data samples taken in 2003 and 2004, $3.11 \times 10^9 K^{\pm} \rightarrow \pi^{\pm} \pi^+ \pi^-$ and $9.13 \times 10^7 K^{\pm} \rightarrow \pi^{\pm} \pi^0 \pi^0$ were selected. The charge asymmetry parameter A_{q} was determined with a total uncertainty of $\sim 2 \times 10^{-4}$ for each mode, ten times more accurate than previous measurements.

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