η DECAY PARAMETERS

C violation in η decays

A number of experiments have looked for charge asymmetries in $\eta \to \pi^+\pi^-\pi^0$ and $\eta \to \pi^+\pi^-\gamma$ decays. Any difference between the π^+ and π^- spectra in either decay would indicate C violation in electromagnetic interactions. Immediately following this note, we list measurements of the following parameters:

(a) The left-right asymmetry

$$A = (N^+ - N^-)/(N^+ + N^-) ,$$

where N^+ is the number of events in which the π^+ energy in the η rest frame is greater than the π^- energy, *etc.*

(b) For the decay $\eta \to \pi^+\pi^-\pi^0$, the sextant asymmetry

$$A_s = \frac{N_1 + N_3 + N_5 - N_2 - N_4 - N_6}{N_1 + N_2 + N_3 + N_4 + N_5 + N_6} ,$$

where the N_i are the numbers of events in sextants of the Dalitz plot; see, for example, Layter *et al.* [1] A_s is sensitive to an I=0 C-violating final state.

(c) For the decay $\eta \to \pi^+\pi^-\pi^0$, the quadrant asymmetry

$$A_q = \frac{N_1 + N_3 - N_2 - N_4}{N_1 + N_2 + N_3 + N_4} ,$$

where the N_i are numbers of events in quadrants of the Dalitz plot. A_q is sensitive to an I=2 C-violating final state.

(d) For the decay $\eta \to \pi^+\pi^-\gamma$, evidence for a D-wave contribution to the C-violating amplitude. The upper limit for this contribution is measured by the parameter β, defined by

$$dN/d\,|\cos\theta\,| \;\propto\; \sin^2\theta\,(1 + \beta\,\cos^2\theta) ,$$

where θ is the angle between the π^+ and the γ in the dipion center of mass. A term proportional to $\cos^2\theta$ could also come from P- and F-wave interference.

Dalitz plot for $\eta \to \pi^+\pi^-\pi^0$

The Dalitz plot for $\eta \to \pi^+\pi^-\pi^0$ decay may be fit to the distribution

$$|\,M(x,y)|^{\,2} \;\propto\; (1 + ay + by^2 + cx + dx^2 + exy) .$$

Here

$$x = \sqrt{3}\,(T_+ - T_-)/Q \ ,$$

$$y = (3T_0/Q) - 1 \ ,$$

where T_+, T_-, and T_0 are the kinetic energies of the π^+, π^-, and π^0 in the η rest frame, and $Q = T_+ + T_0 + T_-$. The coefficient of the term linear in x is sensitive to C violation due to an I=0 or I=2 final state. Below, we list papers that measured a, b, c, and d, but do not tabulate values of these parameters because the assumptions made by different authors are not compatible and do not allow comparison of the numerical values.

Dalitz plot for $\eta \to \pi^0\pi^0\pi^0$

The Dalitz plot for the decay $\eta \to \pi^0\pi^0\pi^0$ may be fit to

$$|\,M\,|^2 \ \propto\ 1 + 2\alpha z \ ,$$

where

$$z = \frac{2}{3}\sum_{i=1}^{3}\left(\frac{3E_i - m_\eta}{m_\eta - 3m_{\pi^0}}\right)^2 = \frac{\rho^2}{\rho^2_{\rm max}} \ .$$

Here E_i is the energy of the $i^{\rm th}$ pion in the η rest frame, and ρ is the distance from the center of the Dalitz plot. We list measurements of the parameter α below.

Reference

1. J.G. Layter *et al.*, Phys. Rev. Lett. **29**, 316 (1972).