$$P_\sigma = \frac{\sigma^N - \sigma^U}{\sigma^N + \sigma^U}\,.$$

At high energies

$$P_\sigma = 2\rho^1_{1\,-1} - \rho^1_{00}\,. \tag{4}$$

Note that P_σ is invariant under rotations around the normal to the production plane; e.g., it is the same in the three systems described above. We also point out that P_σ is sensitive to possible ρ^0-helicity or spin-flip terms (contributing to ρ^1_{00}) which are not usually measured in counter experiments. Counter experiments of the type of Refs. 40 and 41 measure the asymmetry Σ defined as

$$\Sigma = \frac{\sigma_\parallel - \sigma_\perp}{\sigma_\parallel + \sigma_\perp} = \frac{\rho^1_{11} + \rho^1_{1\,-1}}{\rho^0_{11} + \rho^0_{1\,-1}}\,. \tag{5}$$

Here $\sigma_\parallel$ and $\sigma_\perp$ are the cross sections for the pions from symmetric ρ decay ($\theta = \frac{1}{2}\pi$, $\phi = \frac{1}{2}\pi$) to emerge in the plane of the photon polarization ($\Phi = \frac{1}{2}\pi$) and perpendicular to it ($\Phi = 0$). When the helicity-flip terms, ρ^1_{00}, ρ^1_{11}, ρ^0_{00}, $\rho^0_{1\,-1}$ are zero, Σ is equal to P_σ.

The ρ^0 decay distribution may be simplified if we use the angle $\Psi = \phi - \Phi$ which, in the forward direction, is the angle between the photon polarization and the ρ^0 decay plane. If the ρ^0 production mechanism conserves s-channel helicity, i.e., the ρ is transverse and linearly polarized like the photon, then in the helicity system

$$\rho^1_{1\,-1} = -\mathrm{Im}\rho^2_{1\,-1} = \tfrac{1}{2} \tag{6}$$

and all other ρ^α_{ik} in *Eq. (2)* are 0. In these circumstances Ψ is the azimuthal angle in the helicity system of the decay π^+ with respect to the ρ^0 polarization plane and the decay angular distribution is proportional to $\sin^2\theta\cos^2\Psi$. The distribution of Ψ is also related to P_σ if the helicity-flip terms are zero: For 100% linear polarization the decay is $\sin^2\theta\cos^2\Psi$ for $P_\sigma = +1$ while for $P_\sigma = -1$ the decay distribution is $\sin^2\theta\sin^2\Psi$.

4. *The Moments, Y^m_l, of the Dipion System*

Figure 13 shows the distributions of the polar angle θ and the angle Ψ in the helicity system for events in the ρ^0 mass region (0.60–0.85 GeV) with $|t| < 0.4\ \mathrm{GeV}^2$. This figure shows that the ρ^0 decay has a simple description in terms of θ and Ψ in the helicity system, viz., the ρ^0 is well described by a $\sin^2\theta\cos^2\Psi$ angular distribution for $|t| < 0.4\ \mathrm{GeV}^2$. Consequently, in order to give an over-all description of the characteristics of the decay angular distribution of the $\pi^+\pi^-$ system, we present in Fig. 14 the moment sums, $\sum \mathrm{Re}Y^m_l(\theta,\Psi)$, of the $\pi^+\pi^-$ system in the helicity frame as a function of $\pi^+\pi^-$ mass for $|t| < 0.4\ \mathrm{GeV}^2$. Only those moments are

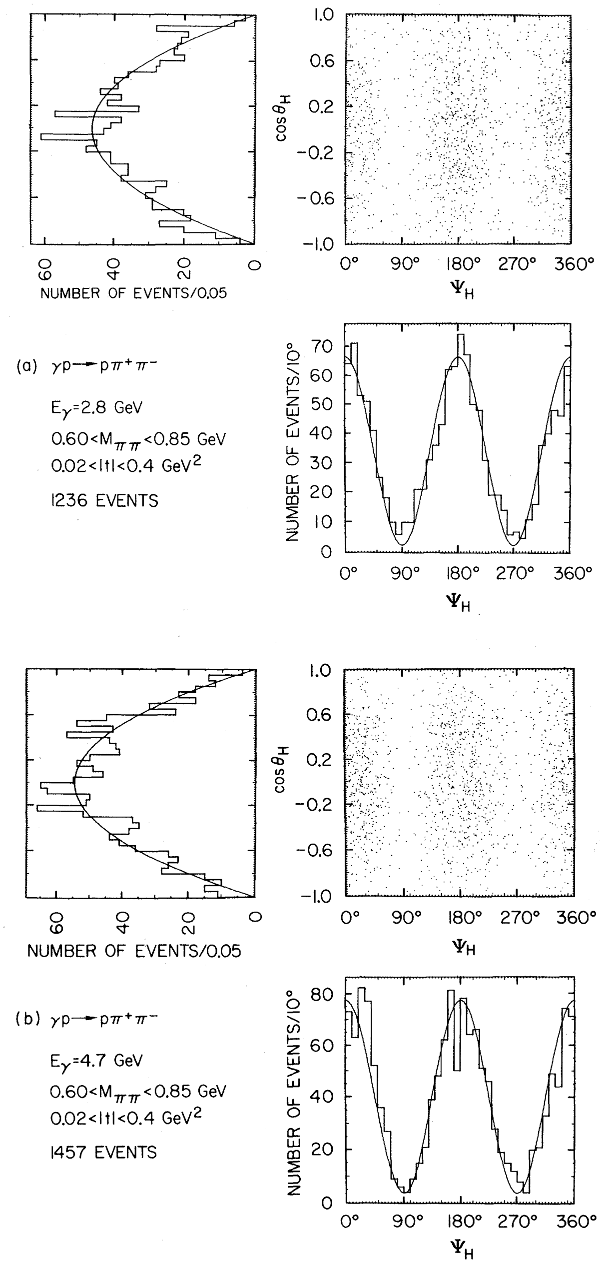

FIG. 13. Reaction $\gamma p \to p\rho^0$ at (a) 2.8 GeV and (b) 4.7 GeV, respectively. ρ-decay angular distributions in the helicity system without background subtraction. The curves are proportional to $\sin^2\theta_H$ and $(1 + P_\gamma\cos 2\Psi_H)$.

shown which have a significant deviation from zero in either the 2.8- or 4.7-GeV data; other moments can be found in Ref. 17. From the moments we conclude that:

(a) Strong Y^0_2 and Y^2_2 moments are present in the ρ^0 region which follow the asymmetric ρ^0 shape. This and the small values of higher even moments demonstrates that *it is the p-wave part of the mass*