THE $\eta(1440)$

The first observation of a meson with $I^G J^{PC} = 0^+0^{-+}$ in the 1400-MeV mass region was made in $p\overline{p} \to K\overline{K}3\pi$ annihilations at rest (BAILLON 67). The $\eta(1440)$ was reported to decay into $K\overline{K}\pi$, equally through $a_0(980)\pi$ and $K^*(892)\overline{K}$.

The $\eta(1440)$ has since also been seen in a partial-wave analysis of the $K\overline{K}\pi$ system (CHUNG 85, BIRMAN 88), in 6-GeV $p\overline{p}$ annihilations (REEVES 86), and in nonperipherally selected $\pi^- p \to K^0_S K^0_S \pi^0 n$ (RATH 89). RATH 89 favors two η resonances in the 1410-1480 MeV region. This is also observed at LEAR in $\overline{p}p \to K\overline{K}3\pi$ annihilations at rest (BERTIN 95).

In a partial-wave analysis of $\pi^- p \to \eta\pi^+\pi^-$, FUKUI 91C confirms the decay $\eta(1440) \to a_0(980)\pi$. In $\overline{p}p \to \eta\pi\pi$ annihilations at rest, AMSLER 95F finds roughly equal contributions from $a_0(980)\pi$ and $\eta(\pi\pi)_S$.

Neither the $\eta(1440)$ nor the $f_1(1420)$ are observed in the $s\bar{s}$-enriched peripheral reaction $K^- p \to K\overline{K}\pi\Lambda$ at 11 GeV/c (ASTON 87), which speaks against an $s\overline{s}$ interpretation of either state. ARMSTRONG 84, 89, studying $K\overline{K}\pi$ central production in $\pi^+ p \to \pi^+(K\overline{K}\pi)p$ and $pp \to p(K\overline{K}\pi)p$ at 85 and 300 GeV/c, observed the $f_1(1420)$ but not the $\eta(1440)$.

The $\eta(1440)$ is also seen as a broad enhancement in $J/\psi(1S)$ radiative decay. BUGG 95 has reanalyzed the MARK-III data and finds a contribution to 4π in agreement with DM2 (BISELLO 89B). The $\eta\pi^+\pi^-$ channel peaks near 1400 MeV (AUGUSTIN 90, BOLTON 92B), in agreement with observations in $\overline{p}p$ annihilation at rest (AMSLER 95F). It has been shown (TOKI 87, BAI 90C) that two pseudoscalar resonances at ≈ 1420 and ≈ 1490 MeV, together with a 1^{++} around 1440 MeV, give a better description of the $K\overline{K}\pi$ data. These results, together with RATH 89 and BERTIN 95, suggest the existence of two overlapping pseudoscalar states, one around 1400 MeV decaying into both $K\overline{K}\pi$ and $\eta\pi\pi$, the other one around 1480 MeV decaying only to $K\overline{K}\pi$.

We continue to list under the $\eta(1440)$ all the results on the 0^{-+} system in the 1380-1490 MeV region, but there is probably more than one resonance present in the observations. It is thus difficult to give reliable $\overline{K}^* K$ or $a_0\pi$ branching ratios.

The masses and widths are given separately according to the various decay modes. See also our Note on "Non-$q\overline{q}$ Mesons."