THE $\eta(1440)$

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

The $\eta(1440)$ has since also been seen in other hadronic reactions: In a partial-wave analysis of the $\eta\pi^+\pi^-$ system, confirming the decay $\eta(1440) \to a_0(980)\pi$ (FUKUI 91C); 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 the interpretation that there are two narrow η resonances in the 1410–1480 MeV region.

Neither the $\eta(1440)$ nor the $f_1(1420)$ are observed in the $s\overline{s}$-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. Moreover, the $\eta(1440)$ is not seen by ARMSTRONG 84, 89 either, who studied $K\overline{K}\pi$ 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 [but the $f_1(1420)$ is seen]. This agrees with earlier results (DIONISI 80, DEFOIX 72, DUBOC 72, LORSTAD 69, *etc.*).

The $\eta(1440)$ is also seen as a broad enhancement in $J/\psi(1S)$ radiative decay. In the $K\overline{K}\pi$ channel, however, its mass is higher than observed in hadronic interactions, and its width is larger. It has been shown (TOKI 87, BAI 90C) that two resonances (with $M \approx 1420$ MeV and $M \approx 1490$ MeV) give a better description of the data. Moreover, the $\eta\pi^+\pi^-$ channel peaks near 1400 MeV (AUGUSTIN 90, BURCHELL 91). All these results suggest the existence of two overlapping states (favored by RATH 89 in hadronic production), one around 1400 MeV decaying into both $K\overline{K}\pi$ and $\eta\pi\pi$, the other one around 1490 MeV seen only in $K\overline{K}\pi$. Other possible decay modes, in $\pi\pi\gamma$ and 4π, are not sufficiently well established to clarify the situation.

There is considerable confusion on the partial decay modes: The $K\overline{K}\pi$ final state is usually dominated by $\overline{K}^*(892)K$ and/or $a_0(980)\pi$ contributions, but it is impossible to quote any reliable

$\overline{K}^* K$ and $a_0\pi$ branching ratios, since the analyses are highly model dependent and the experiments do not agree.

We continue to list under the $\eta(1440)$ all the results on the 0^{-+} system in the 1380–1490 MeV region, but keep in mind that it is likely that there is more than one resonance present in these observations. The masses and widths are given separately according to the various decay modes.