$\eta(1440)$
was $\iota(1440)$

$I^G(J^{PC}) = 0^+(0^{-+})$

See also the mini-review under non-$q\overline{q}$ candidates. (See the index for the page number.)

NOTE ON 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.

$\eta(1440)$ MASS

VALUE (MeV)	DOCUMENT ID
1420±20 OUR ESTIMATE	This is only an educated guess; the error given is larger than the error on the average of the published values.

$\eta\pi\pi$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
1399± 4 OUR AVERAGE					
1400± 6		[1] BURCHELL	91	MRK3	$J/\psi \to \gamma\eta\pi^+\pi^-$
1398± 6	261±24	[2] AUGUSTIN	90	DM2	$J/\psi \to \gamma\eta\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1385±15		[1] BEHREND	92	DM2	$J/\psi \to \gamma\eta\pi^+\pi^-$
1388± 4		FUKUI	91C	SPEC	$8.95\ \pi^- p \to \eta\pi^+\pi^- n$
1420± 5		ANDO	86	SPEC	$8\ \pi^- p \to n\eta\pi^+\pi^-$

[1] From fit to the $a_0(980)\pi$ 0^{-+} partial wave.
[2] Best fit with a single Breit Wigner.

$\pi\pi\gamma$ MODE

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1401±18	[3,4] AUGUSTIN	90	DM2	$J/\psi \to \pi^+\pi^-\gamma\gamma$
1440±20	[4] COFFMAN	90	MRK3	$J/\psi \to \pi^+\pi^- 2\gamma$

[3] Best fit with a single Breit Wigner.
[4] This peak in the $\gamma\rho$ channel may not be related to the $\eta(1440)$.

4π MODE

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1489±12	3270	[5] BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$

[5] Estimated by us from various fits.

$K\overline{K}\pi$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
1419.8± 1.0 OUR AVERAGE	Error includes scale factor of 1.2.				
1421 ±14		[6] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
1416 ± 8 $^{+7}_{-5}$	700	[7] BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$
1413 ± 8	500	DUCH	89	ASTE	$\overline{p}p \to \pi^+\pi^- K^\pm\pi^\mp K^0$
1419 ± 1	8800±200	[8,9] BIRMAN	88	MPS	$8\ \pi^- p \to K^+\overline{K}^0\pi^- n$
1424 ± 3	620	[9,10] REEVES	86	SPEC	$6.6\ p\overline{p} \to K\overline{K}\pi X$
1421 ± 2		CHUNG	85	SPEC	$8\ \pi^- p \to K\overline{K}\pi n$
1425 ± 7	800	[9,11] BAILLON	67	HBC	$0.0\ \overline{p}p \to K\overline{K}\pi\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1459 ± 5		[8] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
1445 ± 8	693±30	[9] AUGUSTIN	90	DM2	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$
1433 ± 8	296±20	[9] AUGUSTIN	90	DM2	$J/\psi \to \gamma K^+ K^-\pi^0$
1490 $^{+14}_{-8}$ $^{+3}_{-16}$	1100	[6] BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$
1443 ± 5		[6] TAKAMATSU	90	SPEC	$8\ \pi^- p \to nK^*(892)K$
1424 ± 4		TAKAMATSU	90	SPEC	$8\ \pi^- p \to nK^0_S K^\pm\pi^\mp$
1475 ± 4		[12] RATH	89	MPS	$21.4\ \pi^- p \to nK^0_S K^0_S\pi^0$
1452.8± 6.8	170±15	[9] RATH	89	MPS	$21.4\ \pi^- p \to K^0_S K^0_S\pi^0 n$
1412.8± 5.4		RATH	89	MPS	$21.4\ \pi^- p \to nK^0_S K^0_S\pi^0$
1454 ± 3		WISNIEWSKI	87	MRK3	$J/\psi \to K\overline{K}\pi\gamma$
1440 $^{+20}_{-15}$	174	EDWARDS	82E	CBAL	$J/\psi \to \gamma K^+ K^-\pi^0$
1440 $^{+10}_{-15}$		SCHARRE	80	MRK2	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$

[6] From fit to the $K^*(892)K$ 0^{-+} partial wave.
[7] From fit to the $a_0(980)\pi$ 1^{++} partial wave. cannot rule out a $a_0(980)\pi$ 1^{++} partial wave.
[8] From fit to the $a_0(980)\pi$ 0^{-+} partial wave.
[9] Best fit with a single Breit Wigner.
[10] From fit of the 0^{-+} partial wave , mainly $a_0(980)\pi$.
[11] From best fit of 0^{-+} partial wave , 50% $K^*(892)K$, 50% $a_0(980)\pi$.
[12] From fit to the $a_0(980)\pi$ 0^{-+} partial wave , but $a_0(980)\pi$ 1^{++} cannot be excluded. The fit is also consistent with one resonance at 1453 MeV.