$\hat{\rho}(1405)$

$I^G(J^{PC}) = 1^-(1^{-+})$

OMITTED FROM SUMMARY TABLE

Seen by ALDE 88B in $\pi^- p \to \eta \pi^0 n$ amplitude analysis. Needs confirmation.

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

$\hat{\rho}(1405)$ MASS

VALUE (MeV)	DOCUMENT ID		TECN	CHG	COMMENT
1406 ±20	[1] ALDE	88B	GAM4	0	100 $\pi^- p \to \eta \pi^0 n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1323.1± 4.6	AOYAGI	93	BKEI		$\pi^- p \to \eta \pi^- p$

[1] Seen in the P_0-wave intensity of the $\eta \pi^0$ system.

$\hat{\rho}(1405)$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	CHG	COMMENT
180 ±20	[2] ALDE	88B	GAM4	0	100 $\pi^- p \to \eta \pi^0 n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
143.2±12.5	AOYAGI	93	BKEI		$\pi^- p \to \eta \pi^- p$

[2] Seen in the P_0-wave intensity of the $\eta \pi^0$ system.

$\hat{\rho}(1405)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\eta \pi^0$	seen
Γ_2	$\eta \pi^-$	
Γ_3	$\rho \pi$	not seen
Γ_4	$\eta' \pi$	

$\hat{\rho}(1405)$ BRANCHING RATIOS

$\Gamma(\eta \pi^0)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
seen	[3] ALDE	88B	GAM4	0	100 $\pi^- p \to \eta \pi^0 n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
not seen	[4] APEL	81	NICE	0	40 $\pi^- p \to \eta \pi^0 n$

[3] Seen in the P_0-wave intensity of the $\eta \pi^0$ system.

[4] A general fit allowing S, D, and P waves (including m=0) is not done because of limited statistics.

$\Gamma(\eta \pi^-)/\Gamma_{total}$ — Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
possibly seen	AOYAGI	93	BKEI	$\pi^- p \to \eta \pi^- p$

$\Gamma(\rho \pi)/\Gamma_{total}$ — Γ_3/Γ

VALUE	DOCUMENT ID		COMMENT
not seen	[5] ZIELINSKI	86	200 π^+ Cu,Pb $\to \pi^+ \pi^+ \pi^- X$

[5] A general fit allowing S, D, and P waves (including m=0) is not done because of limited statistics.

$\Gamma(\eta' \pi)/\Gamma(\eta \pi^0)$ — Γ_4/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.80	95	BOUTEMEUR	90	GAM4	100 $\pi^- p \to 4\gamma n$

$\hat{\rho}(1405)$ REFERENCES

AOYAGI	93	PL B314 246	+Fukui, Hasegawa+	(BKEI Collab.)
BOUTEMEUR	90	Hadron 89 Conf. p 119	+Poulet	(SERP, BELG, LANL, LAPP, PISA, KEK)
ALDE	88B	PL B205 397	+Binon, Boutemeur+	(SERP, BELG, LANL, LAPP) IGJPC
ZIELINSKI	86	Berkeley HEP 1 736	+Berg+	(ROCH, MINN, FNAL)
APEL	81	NP B193 269	+Augenstein, Bertolucci, Donskov+	(SERP, CERN)

OTHER RELATED PAPERS

IDDIR	88	PL B205 564	+Le Yaouanc, Ono+	(ORSAY, TOKY)
TUAN	88	PL B213 537	+Ferbel, Dalitz	(HAWA, ROCH, OXFTP)
ZIELINSKI	87	ZPHY C34 255		(ROCH)
ZIELINSKI	86	Berkeley HEP 1 736	+Berg+	(ROCH, MINN, FNAL)

$f_1(1420)$

$I^G(J^{PC}) = 0^+(1^{++})$

See also minireview under non-$q\overline{q}$ candidates.

NOTE ON THE $f_1(1420)$

This particle is the axial-vector component of the old puzzling E/ι, which has caused much trouble.

In hadron-induced reactions, the $f_1(1420)$ is observed in centrally produced $K\overline{K}\pi$ systems obtained with π and p beams (DIONISI 80, ARMSTRONG 84, 89). A Dalitz-plot analysis gives its quantum numbers and the dominant decay mode. For instance, ARMSTRONG 89 finds that the signal is totally consistent with being an 1^{++} state with a dominant quasi-two-body S-wave decay into $K^*(892)\overline{K}$; furthermore, no 0^{-+} or 1^{+-} waves are required to fit the data. A G parity of +1 is suggested by the positive interference between the two overlapping $K^*(892)$ (ARMSTRONG 84). No significant signals in the $\eta\pi\pi$ or 4π decay modes are found in centrally produced 4π systems (ARMSTRONG 89G). All of this is in line with the previous observations made in $\overline{p}p$ annihilations.

In $\gamma\gamma$ fusion from e^+e^- annihilations, a signal at about 1420 MeV is seen only in single-tag events (AIHARA 86C, GIDAL 87B, BEHREND 89, HILL 89), where one of the two photons is off the mass shell; by contrast, it is totally absent in the untagged events where both photons are real and hence they cannot produce a spin-1 meson, because of the Yang-Landau theorem. This clearly implies $J = 1$ and $C = +1$. As for the parity, AIHARA 88B, 88C (same analysis as AIHARA 86C, with 25% more events) and BEHREND 89 all find angular distributions with positive parity preferred, but negative parity not excluded.

Although some uncertainties still remain, the state seen in hadronic interactions and that seen in spacelike virtual photon fusion from e^+e^- annihilations are often identified with one another since there are more similarities than differences. In particular, all experiments agree that this state appears only in $K^*(892)\overline{K}$. The same conclusions are obtained from partial wave analyses of $J/\psi(1S) \to \gamma K\overline{K}\pi$ (BAI 90C, AUGUSTIN 91).

BITYUKOV 88 studied the radiative decay $1^{++} \to \phi\gamma$. Since the ϕ is (almost) a pure $s\overline{s}$ state, the $\phi\gamma$ decay seems to be a good analyser to extract the $s\overline{s}$ component in the wave function of the decaying meson. Finding the $f_1(1285)$ but not the $f_1(1420)$, BITYUKOV 88 concludes that the $f_1(1420)$ cannot be the $s\overline{s}$ isoscalar member of the $q\overline{q}$ nonet containing the $f_1(1285)$. On the other hand, AIHARA 88C argues that, assuming they both belong to the same nonet and using several hypotheses, the octet-singlet mixing angle obtained is compatible with the $f_1(1420)$ being mostly $s\overline{s}$ and the $f_1(1285)$ being mostly $(u\overline{u} + d\overline{d})/\sqrt{2}$, although both require large admixtures of other $q\overline{q}$ components.

Arguments favoring the possibility the $f_1(1420)$ is a hybrid $q\overline{q}g$ meson or a four-quark state are put forward by ISHIDA 89 and by CALDWELL 90, respectively.