$f_0(980)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$\pi\pi$	(78.1 ± 2.4) %	
Γ_2	$K\overline{K}$	(21.9 ± 2.4) %	
Γ_3	$\gamma\gamma$	$(1.19 \pm 0.33) \times 10^{-5}$	
Γ_4	e^+e^-	$< 3 \times 10^{-7}$	90%

CONSTRAINED FIT INFORMATION

An overall fit to a branching ratio uses 3 measurements and one constraint to determine 2 parameters. The overall fit has a $\chi^2 = 2.0$ for 2 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\langle \delta x_i \delta x_j \rangle / (\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\rm total}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_2	-100
	x_1

$f_0(980)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ — Γ_3

VALUE (keV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.56±0.11 OUR AVERAGE					
0.63±0.14		[15] MORGAN	90	RVUE	$\gamma\gamma \to \pi^+\pi^-, \pi^0\pi^0$
0.42±0.06±0.18	60 ± 8	[16] OEST	90	JADE	$e^+e^- \to e^+e^-\pi^0\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.29±0.07±0.12		[17,18] BOYER	90	MRK2	$e^+e^- \to e^+e^-\pi^+\pi^-$
0.31±0.14±0.09		[17,18] MARSISKE	90	CBAL	$e^+e^- \to e^+e^-\pi^0\pi^0$

[15] From amplitude analysis of BOYER 90 and MARSISKE 90, data corresponds to resonance parameters $m = 989$ MeV, $\Gamma = 61$ MeV.
[16] OEST 90 quote systematic errors $^{+0.08}_{-0.18}$. We use ±0.18.
[17] From analysis allowing arbitrary background unconstrained by unitarity.
[18] Data included in MORGAN 90 analysis.

$\Gamma(e^+e^-)$ — Γ_4

VALUE (eV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<8.4	90	VOROBYEV	88	ND	$e^+e^- \to \pi^0\pi^0$

$f_0(980)$ BRANCHING RATIOS

$\Gamma(\pi\pi)/[\Gamma(\pi\pi)+\Gamma(K\overline{K})]$ — $\Gamma_1/(\Gamma_1+\Gamma_2)$

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.781±0.024 OUR FIT				
$0.781^{+0.027}_{-0.023}$ OUR AVERAGE				
0.67 ± 0.09	[19] LOVERRE	80	HBC	$4\ \pi^- p \to n 2K^0_S$
$0.81\ ^{+0.09}_{-0.04}$	[19] CASON	78	STRC	$7\ \pi^- p \to n 2K^0_S$
0.78 ± 0.03	[19] WETZEL	76	OSPK	$8.9\ \pi^- p \to n 2K^0_S$

[19] Measure $\pi\pi$ elasticity assuming two resonances coupled to the $\pi\pi$ and $K\overline{K}$ channels only.

$f_0(980)$ REFERENCES

MORGAN	93	PR D48 1185	+Pennington	(RAL, DURH)
ZOU	93	PR D48 R3948	+Bugg	(LOQM)
AGUILAR-...	91	ZPHY C50 405	Aguilar-Benitez, Allison, Batalor+	(LEBC-EHS Collab.)
ARMSTRONG	91	ZPHY C51 351	+Benayoun+	(ATHU, BARI, BIRM, CERN, CDEF)
BOYER	90	PR D42 1350	+Butler+	(Mark II Collab.)
BREAKSTONE	90	ZPHY C48 569	+	(ISU, BGNA, CERN, DORT, HEIDH, WARS)
MARSISKE	90	PR D41 3324	+Antreasyan+	(Crystal Ball Collab.)
MORGAN	90	ZPHY C48 623	+Pennington	(RAL, DURH)
OEST	90	ZHPY C47 343	+Olsson+	(JADE Collab.)
AUGUSTIN	89	NP B320 1	+Cosme	(DM2 Collab.)
VOROBYEV	88	SJNP 48 273	+Golubev, Dolinsky, Druzhinin+	(NOVO)
		Translated from YAF 48 436.		
ABACHI	86B	PRL 57 1990	+Derrick, Blockus+	(PURD, ANL, IND, MICH, LBL)
ETKIN	82B	PR D25 1786	+Foley, Lai+	(BNL, CUNY, TUFTS, VAND)
TORNQVIST	82	PRL 49 624		(HELS)
GIDAL	81	PL 107B 153	+Goldhaber, Guy, Millikan, Abrams+	(SLAC, LBL)
ACHASOV	80	SJNP 32 566	+Devyanin, Shestakov	(NOVO)
		Translated from YAF 32 1098.		
LOVERRE	80	ZPHY C6 187	+Armenteros, Dionisi+	(CERN, CDEF, MADR, STOH) IJP
AGUILAR-...	78	NP B140 73	Aguilar-Benitez, Cerrada+	(MADR, BOMB, CERN+)
CASON	78	PRL 41 271	+Baumbaugh, Bishop, Biswas+	(NDAM, ANL)
LEEPER	77	PR D16 2054	+Buttram, Crawley, Duke, Lamb, Peterson	(ISU)
WETZEL	76	NP B115 208	+Freudenreich, Beusch+	(ETH, CERN, LOIC)
BINNIE	73	PRL 31 1534	+Carr, Debenham, Duane, Garbutt+	(LOIC, SHMP)
GRAYER	73	Tallahassee	+Hyams, Jones, Blum, Dietl, Koch+	(CERN, MPIM)
HYAMS	73	NP B64 134	+Jones, Weilhammer, Blum, Dietl+	(CERN, MPIM)
PROTOPOP...	73	PR D7 1279	Protopopescu, Alston-Garnjost, Galtieri, Flatte+	(LBL)

OTHER RELATED PAPERS

AU	87	PR D35 1633	+Morgan, Pennington	(DURH, RAL)
AKESSON	86	NP B264 154	+Albrow, Almehed+	(Axial Field Spec. Collab.)
MENNESSIER	83	ZPHY C16 241		(MONP)
BARBER	82	ZPHY C12 1	+Dainton, Brodbeck, Brookes+	(DARE, LANC, SHEF)
ETKIN	82C	PR D25 2446	+Foley, Lai+	(BNL, CUNY, TUFTS, VAND)
BIGI	62	CERN Conf. 247	+Brandt, Carrara+	(CERN)
BINGHAM	62	CERN Conf. 240	+Bloch+	(EPOL, CERN)
ERWIN	62	PRL 9 34	+Hoyer, March, Walker, Wangler	(WISC, BNL)
WANG	61	JETP 13 323	+Veksler, Vrana+	(JINR)
		Translated from ZETF 40 464.		

$a_0(980)$
was $\delta(980)$

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

NOTE ON THE $a_0(980)$

The proper $q\overline{q}$ assignment of the $a_0(980)$ scalar meson remains a problem. The observed mass and width seem to be inconsistent with those expected for a member of an $L = 1$ $q\overline{q}$ nonet. However, since the mass and width are distorted by the proximity of the $K\overline{K}$ threshold, the nature of the $a_0(980)$ can be better investigated using different experimental observations.

TORNQVIST 82 has shown that it is possible to understand the unusual experimental features of the $a_0(980)$ in a unitarized quark model. As with the $f_0(980)$, the $a_0(980)$ can be interpreted as a normal $q\overline{q}$ resonance with a large admixture of $K\overline{K}$, $\eta\pi$, and $\eta'\pi$ continuum states.

Assuming dominance of the decay $\eta'(958) \to \eta\pi\pi$ by a virtual $a_0(980)\pi$ intermediate state, BRAMON 80 concludes that the experimental value $\Gamma(\eta'(958) \to \eta\pi\pi) \approx 200$ keV is fully consistent with a $q\overline{q}$ interpretation. The same analysis also finds additional evidence in favor of this interpretation: If the $a_0(980)$ is a $q\overline{q}$ state, one expects that the decay chain $f_1 \to a_0(980)\pi \to \eta\pi\pi$ will be more important for the $f_1(1285)$ than for the $f_1(1420)$; the reverse is true if the $a_0(980)$ is a $q\overline{q}q\overline{q}$ state with a strange quark component. In fact, $f_1(1285) \to a_0(980)\pi \to \eta\pi\pi$ is observed, while $f_1(1420) \to a_0(980)\pi \to \eta\pi\pi$ is (practically) absent.

The main argument in favor of the $q\overline{q}q\overline{q}$ interpretation of the $a_0(980)$ is its degeneracy in mass with the isoscalar $f_0(980)$. A Crystal Ball measurement of $a_0(980) \to \gamma\gamma$ suppression in the reaction $\gamma\gamma \to a_0(980) \to \eta\pi$ (ANTREASYAN 86) has reinforced this four-quark interpretation. ACHASOV 88B points out that none of the calculations performed in the framework of a $q\overline{q}$ scheme can predict such a narrow $a_0(980) \to \gamma\gamma$ width as that found by the Crystal Ball. He then argues that the $a_0(980)$ is unusual and shows that a four-quark model is able to give the correct order of magnitude of suppression of 2γ production for both the scalar $a_0(980)$ and $f_0(980)$ mesons.

Another interesting non-$q\overline{q}$ interpretation is given by WEINSTEIN 83B, 89: The $q\overline{q}q\overline{q}$ system is investigated using the nonrelativistic quark model; assuming a large hyperfine interaction, the $a_0(980)$ and $f_0(980)$ are both interpreted as $K\overline{K}$ bound states, and then the P-wave $q\overline{q}$ states are all in the 1300-MeV region. With this S-wave $K\overline{K}$ mesonium assignment, many of the peculiar properties of the $a_0(980)$ and $f_0(980)$—masses, widths, branching fractions, and two-photon widths—make sense.