

**$a_0(980)$**

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

See our minireview on scalar mesons under  $f_0(500)$ . (See the index for the page number.)

**$a_0(980)$  MASS**

VALUE (MeV) DOCUMENT ID  
**980 ± 20 OUR ESTIMATE** Mass determination very model dependent

**$\eta\pi$  FINAL STATE ONLY**

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
982.5 ± 1.6 ± 1.1	16.9k	<sup>1</sup> AMBROSINO	09F	KLOE	1.02 $e^+e^- \rightarrow \eta\pi^0\gamma$
986 ± 4		ANISOVICH	09	RVUE	0.0 $\bar{p}p, \pi N$
982.3 <sup>+0.6</sup> <sub>-0.7</sub> <sup>+3.1</sup> <sub>-4.7</sub>		<sup>2</sup> UEHARA	09A	BELL	$\gamma\gamma \rightarrow \pi^0\eta$
987.4 ± 1.0 ± 3.0		<sup>3,4</sup> BUGG	08A	RVUE 0	$\bar{p}p \rightarrow \pi^0\pi^0\eta$
989.1 ± 1.0 ± 3.0		<sup>4,5</sup> BUGG	08A	RVUE 0	$\bar{p}p \rightarrow \pi^0\pi^0\eta$
985 ± 4 ± 6	318	ACHARD	02B	L3	183–209 $e^+e^- \rightarrow e^+e^-\eta\pi^+\pi^-$
995 <sup>+52</sup> <sub>-10</sub>	36	<sup>6</sup> ACHASOV	00F	SND	$e^+e^- \rightarrow \eta\pi^0\gamma$
994 <sup>+33</sup> <sub>-8</sub>	36	<sup>7</sup> ACHASOV	00F	SND	$e^+e^- \rightarrow \eta\pi^0\gamma$
975 ± 7		BARBERIS	00H		450 $pp \rightarrow p_f\eta\pi^0 p_s$
988 ± 8		BARBERIS	00H		450 $pp \rightarrow \Delta_f^{++}\eta\pi^- p_s$
~ 1055		<sup>8</sup> OLLER	99	RVUE	$\eta\pi, K\bar{K}$
~ 1009.2		<sup>8</sup> OLLER	99B	RVUE	$\pi\pi \rightarrow \pi\pi, K\bar{K}$
993.1 ± 2.1		<sup>9</sup> TEIGE	99	B852	18.3 $\pi^- p \rightarrow \eta\pi^+\pi^- n$
988 ± 6		<sup>8</sup> ANISOVICH	98B	RVUE	Compilation
987		TORNQVIST	96	RVUE	$\pi\pi \rightarrow \pi\pi, K\bar{K}, K\pi, \eta\pi$
991		JANSSEN	95	RVUE	$\eta\pi \rightarrow \eta\pi, K\bar{K}, K\pi, \eta\pi$
984.45 ± 1.23 ± 0.34		AMSLER	94C	CBAR	0.0 $\bar{p}p \rightarrow \omega\eta\pi^0$
982 ± 2		<sup>10</sup> AMSLER	92	CBAR	0.0 $\bar{p}p \rightarrow \eta\eta\pi^0$
984 ± 4	1040	<sup>10</sup> ARMSTRONG	91B	OMEG ±	300 $pp \rightarrow p p \eta \pi^+ \pi^-$
976 ± 6		ATKINSON	84E	OMEG ±	25–55 $\gamma p \rightarrow \eta\pi n$
986 ± 3	500	<sup>11</sup> EVANGELIS...	81	OMEG ±	12 $\pi^- p \rightarrow \eta\pi^+\pi^-\pi^- p$
990 ± 7	145	<sup>11</sup> GURTU	79	HBC ±	4.2 $K^- p \rightarrow \Lambda\eta 2\pi$
980 ± 11	47	CONFORTO	78	OSPK –	4.5 $\pi^- p \rightarrow p X^-$
978 ± 16	50	CORDEN	78	OMEG ±	12–15 $\pi^- p \rightarrow n\eta 2\pi$
977 ± 7		GRASSLER	77	HBC –	16 $\pi^\mp p \rightarrow p\eta 3\pi$
989 ± 4	70	WELLS	75	HBC –	3.1–6 $K^- p \rightarrow \Lambda\eta 2\pi$

972	$\pm 10$	150	DEFOIX	72	HBC	$\pm$	$0.7 \bar{p} p \rightarrow 7\pi$
970	$\pm 15$	20	BARNES	69C	HBC	$-$	$4-5 K^- p \rightarrow \Lambda \eta 2\pi$
980	$\pm 10$		CAMPBELL	69	DBC	$\pm$	$2.7 \pi^+ d$
980	$\pm 10$	15	MILLER	69B	HBC	$-$	$4.5 K^- N \rightarrow \eta \pi \Lambda$
980	$\pm 10$	30	AMMAR	68	HBC	$\pm$	$5.5 K^- p \rightarrow \Lambda \eta 2\pi$

<sup>1</sup> Using the model of ACHASOV 89 and ACHASOV 03B.

<sup>2</sup> From a fit with the S-wave amplitude including two interfering Breit-Wigners plus a background term.

<sup>3</sup> Parameterizes couplings to  $\bar{K}K$ ,  $\pi\eta$ , and  $\pi\eta'$ .

<sup>4</sup> Using AMSLER 94D and ABELE 98.

<sup>5</sup> From the T-matrix pole on sheet II.

<sup>6</sup> Using the model of ACHASOV 89. Supersedes ACHASOV 98B.

<sup>7</sup> Using the model of JAFFE 77. Supersedes ACHASOV 98B.

<sup>8</sup> T-matrix pole.

<sup>9</sup> Breit-Wigner fit, average between  $a_0^\pm$  and  $a_0^0$ . The fit favors a slightly heavier  $a_0^\pm$ .

<sup>10</sup> From a single Breit-Wigner fit.

<sup>11</sup> From  $f_1(1285)$  decay.

### $K\bar{K}$ ONLY

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
$\sim 1053$		<sup>12</sup> OLLER	99C	RVUE	$\pi\pi \rightarrow \pi\pi, K\bar{K}$
$982 \pm 3$		<sup>13</sup> ABELE	98	CBAR	$0.0 \bar{p} p \rightarrow K_L^0 K^\pm \pi^\mp$
$975 \pm 15$		BERTIN	98B	OBLX	$\pm$ $0.0 \bar{p} p \rightarrow K^\pm K_S \pi^\mp$
$976 \pm 6$	316	DEBILLY	80	HBC	$\pm$ $1.2-2 \bar{p} p \rightarrow f_1(1285)\omega$
$1016 \pm 10$	100	<sup>14</sup> ASTIER	67	HBC	$\pm$ $0.0 \bar{p} p$
$1003.3 \pm 7.0$	143	<sup>15</sup> ROSENFELD	65	RVUE	$\pm$

<sup>12</sup> T-matrix pole.

<sup>13</sup> T-matrix pole on sheet II, the pole on sheet III is at 1006-i49 MeV.

<sup>14</sup> ASTIER 67 includes data of BARLOW 67, CONFORTO 67, ARMENTEROS 65.

<sup>15</sup> Plus systematic errors.

### $a_0(980)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
<b>50 to 100 OUR ESTIMATE</b> Width determination very model dependent. Peak width in $\eta\pi$ is about 60 MeV, but decay width can be much larger.					
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
$75.6 \pm 1.6$	$^{+17.4}_{-10.0}$	<sup>16</sup> UEHARA	09A	BELL	$\gamma\gamma \rightarrow \pi^0\eta$
$80.2 \pm 3.8$	$\pm 5.4$	<sup>17</sup> BUGG	08A	RVUE 0	$\bar{p} p \rightarrow \pi^0\pi^0\eta$
$50 \pm 13$	$\pm 4$	318 ACHARD	02B	L3	$183-209 e^+e^- \rightarrow e^+e^-\eta\pi^+\pi^-$
$72 \pm 16$		BARBERIS	00H		$450 p p \rightarrow p_f \eta \pi^0 p_S$
$61 \pm 19$		BARBERIS	00H		$450 p p \rightarrow \Delta_f^{++} \eta \pi^- p_S$
$\sim 42$		<sup>18</sup> OLLER	99	RVUE	$\eta\pi, K\bar{K}$
$\sim 112$		<sup>18</sup> OLLER	99B	RVUE	$\pi\pi \rightarrow \eta\pi, K\bar{K}$
$71 \pm 7$		TEIGE	99	B852	$18.3 \pi^- p \rightarrow \eta\pi^+\pi^- n$

92 ± 20		18 ANISOVICH	98B	RVUE	Compilation
65 ± 10		19 BERTIN	98B	OBLX ±	0.0 $\bar{p}p \rightarrow K^\pm K_S^0 \pi^\mp$
~ 100		TORNQVIST	96	RVUE	$\pi\pi \rightarrow \pi\pi, K\bar{K}, K\pi,$ $\eta\pi$
202		JANSSEN	95	RVUE	$\eta\pi \rightarrow \eta\pi, K\bar{K}, K\pi,$ $\eta\pi$
54.12 ± 0.34 ± 0.12		AMSLER	94C	CBAR	0.0 $\bar{p}p \rightarrow \omega\eta\pi^0$
54 ± 10		20 AMSLER	92	CBAR	0.0 $\bar{p}p \rightarrow \eta\eta\pi^0$
95 ± 14	1040	20 ARMSTRONG	91B	OMEG ±	300 $pp \rightarrow$ $pp\eta\pi^+\pi^-$
62 ± 15	500	21 EVANGELIS...	81	OMEG ±	12 $\pi^- p \rightarrow$ $\eta\pi^+\pi^-\pi^- p$
60 ± 20	145	21 GURTU	79	HBC ±	4.2 $K^- p \rightarrow \Lambda\eta 2\pi$
60 <sup>+50</sup> <sub>-30</sub>	47	CONFORTO	78	OSPK -	4.5 $\pi^- p \rightarrow pX^-$
86.0 <sup>+60.0</sup> <sub>-50.0</sub>	50	CORDEN	78	OMEG ±	12-15 $\pi^- p \rightarrow n\eta 2\pi$
44 ± 22		GRASSLER	77	HBC -	16 $\pi^\mp p \rightarrow p\eta 3\pi$
80 to 300		22 FLATTE	76	RVUE -	4.2 $K^- p \rightarrow \Lambda\eta 2\pi$
16.0 <sup>+25.0</sup> <sub>-16.0</sub>	70	WELLS	75	HBC -	3.1-6 $K^- p \rightarrow \Lambda\eta 2\pi$
30 ± 5	150	DEFOIX	72	HBC ±	0.7 $\bar{p}p \rightarrow 7\pi$
40 ± 15		CAMPBELL	69	DBC ±	2.7 $\pi^+ d$
60 ± 30	15	MILLER	69B	HBC -	4.5 $K^- N \rightarrow \eta\pi\Lambda$
80 ± 30	30	AMMAR	68	HBC ±	5.5 $K^- p \rightarrow \Lambda\eta 2\pi$

<sup>16</sup> From a fit with the S-wave amplitude including two interfering Breit-Wigners plus a background term.

<sup>17</sup> From the T-matrix pole on sheet II, using AMSLER 94D and ABELE 98.

<sup>18</sup> T-matrix pole.

<sup>19</sup> The  $\eta\pi$  width.

<sup>20</sup> From a single Breit-Wigner fit.

<sup>21</sup> From  $f_1(1285)$  decay.

<sup>22</sup> Using a two-channel resonance parametrization of GAY 76B data.

### **$K\bar{K}$ ONLY**

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
<b>92 ± 8</b>		<sup>23</sup> ABELE	98	CBAR	0.0 $\bar{p}p \rightarrow K_L^0 K^\pm \pi^\mp$

• • • We do not use the following data for averages, fits, limits, etc. • • •

~ 24                      <sup>24</sup> OLLER            99C    RVUE             $\pi\pi \rightarrow \pi\pi, K\bar{K}$

~ 25                      100    <sup>25</sup> ASTIER           67    HBC    ±

57 ± 13                143    <sup>26</sup> ROSENFELD    65    RVUE    ±

<sup>23</sup> T-matrix pole on sheet II, the pole on sheet III is at 1006-i49 MeV.

<sup>24</sup> T-matrix pole.

<sup>25</sup> ASTIER 67 includes data of BARLOW 67, CONFORTO 67, ARMENTEROS 65.

<sup>26</sup> Plus systematic errors.

## $a_0(980)$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $\eta\pi$	dominant
$\Gamma_2$ $K\bar{K}$	seen
$\Gamma_3$ $\rho\pi$	
$\Gamma_4$ $\gamma\gamma$	seen
$\Gamma_5$ $e^+e^-$	

## $a_0(980)$ PARTIAL WIDTHS

### $\Gamma(\gamma\gamma)$ $\Gamma_4$

VALUE (keV)                      DOCUMENT ID      TECN

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.30 ± 0.10                      <sup>27</sup> AMSLER      98      RVUE

<sup>27</sup> Using  $\Gamma_{\gamma\gamma} B(a_0(980) \rightarrow \eta\pi) = 0.24 \pm 0.08$  keV.

## $a_0(980)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

### $\Gamma(\eta\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ $\Gamma_1\Gamma_4/\Gamma$

VALUE (keV)      EVTS      DOCUMENT ID      TECN      COMMENT

**0.21  $\begin{smallmatrix} +0.08 \\ -0.04 \end{smallmatrix}$  OUR AVERAGE**

0.128  $\begin{smallmatrix} +0.003 +0.502 \\ -0.002 -0.043 \end{smallmatrix}$       <sup>28</sup> UEHARA      09A      BELL       $\gamma\gamma \rightarrow \pi^0\eta$

0.28 ± 0.04 ± 0.10      44      OEST      90      JADE       $e^+e^- \rightarrow e^+e^-\pi^0\eta$

0.19 ± 0.07  $\begin{smallmatrix} +0.10 \\ -0.07 \end{smallmatrix}$       ANTREASYAN 86      CBAL       $e^+e^- \rightarrow e^+e^-\pi^0\eta$

<sup>28</sup> From a fit with the S-wave amplitude including two interfering Breit-Wigners plus a background term.

### $\Gamma(\eta\pi) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_1\Gamma_5/\Gamma$

VALUE (eV)      CL%      DOCUMENT ID      TECN      COMMENT

**<1.5**      90      VOROBYEV      88      ND       $e^+e^- \rightarrow \pi^0\eta$

## $a_0(980)$ BRANCHING RATIOS

### $\Gamma(K\bar{K})/\Gamma(\eta\pi)$ $\Gamma_2/\Gamma_1$

VALUE                      DOCUMENT ID      TECN      CHG      COMMENT

**0.183 ± 0.024 OUR AVERAGE**      Error includes scale factor of 1.2.

0.57 ± 0.16      <sup>29</sup> BARGIOTTI      03      OBLX       $\bar{p}p$

0.23 ± 0.05      <sup>30</sup> ABELE      98      CBAR       $0.0 \bar{p}p \rightarrow K_L^0 K^\pm \pi^\mp$

0.166 ± 0.01 ± 0.02      <sup>31</sup> BARBERIS      98C      OMEG       $450 p p \rightarrow p_f f_1(1285) p_s$

• • • We do not use the following data for averages, fits, limits, etc. • • •

1.20 ± 0.15      <sup>32</sup> ANISOVICH      09      RVUE       $0.0 \bar{p}p, \pi N$

1.05 ± 0.07 ± 0.05      <sup>33</sup> BUGG      08A      RVUE      0       $\bar{p}p \rightarrow \pi^0\pi^0\eta$

~ 0.60      OLLER      99B      RVUE       $\pi\pi \rightarrow \eta\pi, K\bar{K}$

0.7 ± 0.3      <sup>31</sup> CORDEN      78      OMEG       $12-15 \pi^- p \rightarrow n\eta 2\pi$

0.25 ± 0.08      <sup>31</sup> DEFOIX      72      HBC      ±       $0.7 \bar{p} \rightarrow 7\pi$

$\Gamma(\rho\pi)/\Gamma(\eta\pi)$   
 $\rho\pi$  forbidden.
 $\Gamma_3/\Gamma_1$ 

VALUE	CL%	DOCUMENT ID	TECN	CHG	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<0.25	70	AMMAR	70	HBC	$\pm$ 4.1,5.5 $K^- p \rightarrow \Lambda \eta 2\pi$
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<sup>29</sup> Coupled channel analysis of  $\pi^+ \pi^- \pi^0$ ,  $K^+ K^- \pi^0$ , and  $K^\pm K_S^0 \pi^\mp$ .

<sup>30</sup> Using  $\pi^0 \pi^0 \eta$  from AMSLER 94D.

<sup>31</sup> From the decay of  $f_1(1285)$ .

<sup>32</sup> This is a ratio of couplings.

<sup>33</sup> A ratio of couplings, using AMSLER 94D and ABELE 98. Supersedes BUGG 94.

## $a_0(980)$ REFERENCES

AMBROSINO	09F	PL B681 5	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
ANISOVICH	09	IJMP A24 2481	V.V. Anisovich, A.V. Sarantsev	
UEHARA	09A	PR D80 032001	S. Uehara <i>et al.</i>	(BELLE Collab.)
BUGG	08A	PR D78 074023	D.V. Bugg	(LOQM)
ACHASOV	03B	PR D68 014006	N.N. Achasov, A.V. Kiselev	
BARGIOTTI	03	EPJ C26 371	M. Bargiotti <i>et al.</i>	(OBELIX Collab.)
ACHARD	02B	PL B526 269	P. Achard <i>et al.</i>	(L3 Collab.)
ACHASOV	00F	PL B479 53	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
BARBERIS	00H	PL B488 225	D. Barberis <i>et al.</i>	(WA 102 Collab.)
OLLER	99	PR D60 099906 (erratum)	J.A. Oller <i>et al.</i>	
OLLER	99B	NP A652 407 (erratum)	J.A. Oller, E. Oset	
OLLER	99C	PR D60 074023	J.A. Oller, E. Oset	
TEIGE	99	PR D59 012001	S. Teige <i>et al.</i>	(BNL E852 Collab.)
ABELE	98	PR D57 3860	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ACHASOV	98B	PL B438 441	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AMSLER	98	RMP 70 1293	C. Amsler	
ANISOVICH	98B	SPU 41 419	V.V. Anisovich <i>et al.</i>	
		Translated from UFN 168 481		
BARBERIS	98C	PL B440 225	D. Barberis <i>et al.</i>	(WA 102 Collab.)
BERTIN	98B	PL B434 180	A. Bertin <i>et al.</i>	(OBELIX Collab.)
TORNQVIST	96	PRL 76 1575	N.A. Tornqvist, M. Roos	(HELS)
JANSEN	95	PR D52 2690	G. Janssen <i>et al.</i>	(STON, ADLD, JULI)
AMSLER	94C	PL B327 425	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
AMSLER	94D	PL B333 277	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
BUGG	94	PR D50 4412	D.V. Bugg <i>et al.</i>	(LOQM)
AMSLER	92	PL B291 347	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
ARMSTRONG	91B	ZPHY C52 389	T.A. Armstrong <i>et al.</i>	(ATHU, BARI, BIRM+)
OEST	90	ZPHY C47 343	T. Oest <i>et al.</i>	(JADE Collab.)
ACHASOV	89	NP B315 465	N.N. Achasov, V.N. Ivanchenko	
VOROBYEV	88	SJNP 48 273	P.V. Vorobiev <i>et al.</i>	(NOVO)
		Translated from YAF 48 436.		
ANTREASYAN	86	PR D33 1847	D. Antreasyan <i>et al.</i>	(Crystal Ball Collab.)
ATKINSON	84E	PL 138B 459	M. Atkinson <i>et al.</i>	(BONN, CERN, GLAS+)
EVANGELIS...	81	NP B178 197	C. Evangelista <i>et al.</i>	(BARI, BONN, CERN+)
DEBILLY	80	NP B176 1	L. de Billy <i>et al.</i>	(CURIN, LAUS, NEUC+)
GURTU	79	NP B151 181	A. Gurtu <i>et al.</i>	(CERN, ZEEM, NIJM, OXF)
CONFORTO	78	LNC 23 419	B. Conforto <i>et al.</i>	(RHEL, TNTO, CHIC+)
CORDEN	78	NP B144 253	M.J. Corden <i>et al.</i>	(BIRM, RHEL, TELA+)
GRASSLER	77	NP B121 189	H. Grassler <i>et al.</i>	(AACH3, BERL, BONN+)
JAFFE	77	PR D15 267,281	R. Jaffe	(MIT)
FLATTE	76	PL 63B 224	S.M. Flatte	(CERN)
GAY	76B	PL 63B 220	J.B. Gay <i>et al.</i>	(CERN, AMST, NIJM) JP
WELLS	75	NP B101 333	J. Wells <i>et al.</i>	(OXF)
DEFOIX	72	NP B44 125	C. Defoix <i>et al.</i>	(CDEF, CERN)
AMMAR	70	PR D2 430	R. Ammar <i>et al.</i>	(KANS, NWES, ANL, WISC)
BARNES	69C	PRL 23 610	V.E. Barnes <i>et al.</i>	(BNL, SYRA)
CAMPBELL	69	PRL 22 1204	J.H. Campbell <i>et al.</i>	(PURD)
MILLER	69B	PL 29B 255	D.H. Miller <i>et al.</i>	(PURD)
Also		PR 188 2011	W.L. Yen <i>et al.</i>	(PURD)

AMMAR	68	PRL 21 1832	R. Ammar <i>et al.</i>	(NWES, ANL)
ASTIER	67	PL 25B 294	A. Astier <i>et al.</i>	(CDEF, CERN, IRAD)
Includes data of BARLOW 67, CONFORTO 67, and ARMENTEROS 65.				
BARLOW	67	NC 50A 701	J. Barlow <i>et al.</i>	(CERN, CDEF, IRAD, LIPV)
CONFORTO	67	NP B3 469	G. Conforto <i>et al.</i>	(CERN, CDEF, IPNP+)
ARMENTEROS	65	PL 17 344	R. Armenteros <i>et al.</i>	(CERN, CDEF)
ROSENFELD	65	Oxford Conf. 58	A.H. Rosenfeld	(LRL)

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