$\rho(2150)$

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

OMITTED FROM SUMMARY TABLE

This entry was previously called $T_1(2190)$. See our mini-review under the $\rho(1700)$.

$\rho(2150)$ MASS

e^+e^- PRODUCED

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2034 ±13 $\pm$ 9		[1] ABLIKIM	21A	BES3	$e^+e^- \to \omega\pi^0$
2255 $^{+17}_{-18}$ $^{+50}_{-41}$	1.8k	[2] ABLIKIM	20F	BES3	$\psi(2S) \to K^+K^-\eta$
2201 ±19		[3] LEES	20	BABR	$e^+e^- \to K^+K^-\gamma$
2227 $\pm$ 9 $\pm$ 9		[4] LEES	20	RVUE	$e^+e^- \to K^+K^-$
2039 $\pm$ 8 $^{+36}_{-18}$		[5] ABLIKIM	19AQ	BES	$J/\psi \to K^+K^-\pi^0$
2239.2$\pm$ 7.1$\pm$11.3		[6] ABLIKIM	19L	BES3	$e^+e^- \to K^+K^-$
2254 ±22		[7] LEES	12G	BABR	$e^+e^- \to \pi^+\pi^-\gamma$
2150 ±40 ±50		AUBERT	07AU	BABR	10.6 $e^+e^- \to f_1(1285)\pi^+\pi^-\gamma$
1990 ±80		AUBERT	07AU	BABR	10.6 $e^+e^- \to \eta'\pi^+\pi^-\gamma$
2153 ±37		BIAGINI	91	RVUE	$e^+e^- \to \pi^+\pi^-$, K^+K^-
2110 ±50		[8] CLEGG	90	RVUE	$e^+e^- \to 3(\pi^+\pi^-)$, $2(\pi^+\pi^-\pi^0)$

[1] From a fit to the cross section between 2.00 and 3.08 GeV with a coherent sum of Breit-Wigner amplitudes, including contributions from $\rho(770)$, $\rho(1450)$ and $\rho(1700)$. Could be another state.

[2] Seen in $\psi(2S)$ decay with branching ratio $\psi(2S) \to X\eta \to K^+K^-\eta = (21.7 \pm 1.9^{+7.7}_{-8.3}) \times 10^{-6}$.

[3] From the fit to the BABAR data of LEES 13Q assuming a coherent sum of a single Breit-Wigner resonance and a nonresonant contribution. The resonance significance is 3.5 σ.

[4] From the fit to the BABAR data of LEES 13Q and BESIII data of ABLIKIM 19L assuming a coherent sum of a single Breit-Wigner resonance and a nonresonant contribution.

[5] Could also be another state. Seen in J/ψ decay with branching ratio $J/\psi \to X\pi^0 \to K^+K^-\pi^0 = (6.7 \pm 1.1^{+2.2}_{-1.8}) \times 10^{-6}$.

[6] The observed structure can be due to both the $\phi(2170)$ and $\rho(2150)$.

[7] Using the GOUNARIS 68 parametrization of the pion form factor leaving the masses and widths of the $\rho(1450)$, $\rho(1700)$, and $\rho(2150)$ resonances as free parameters of the fit.

[8] Includes ATKINSON 85.

$\overline{p}p \to \pi\pi$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$\sim$ 2191	HASAN	94	RVUE	$\overline{p}p \to \pi\pi$
$\sim$ 2070	[1] OAKDEN	94	RVUE	0.36–1.55 $\overline{p}p \to \pi\pi$
$\sim$ 2170	[2] MARTIN	80B	RVUE	
$\sim$ 2100	[2] MARTIN	80C	RVUE	

[1] See however KLOET 96 who fit $\pi^+\pi^-$ only and find waves only up to $J = 3$ to be important but not significantly resonant.
[2] $I(J^P) = 1(1^-)$ from simultaneous analysis of $p\overline{p} \to \pi^-\pi^+$ and $\pi^0\pi^0$.

S-CHANNEL $\overline{N}N$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2110±35	[1] ANISOVICH	02	SPEC	0.6–1.9 $p\overline{p} \to \omega\pi^0, \omega\eta\pi^0, \pi^+\pi^-$
∼ 2190	[2] CUTTS	78B	CNTR	0.97–3 $\overline{p}p \to \overline{N}N$
2155±15	[2,3] COUPLAND	77	CNTR	0.7–2.4 $\overline{p}p \to \overline{p}p$
2193± 2	[2,4] ALSPECTOR	73	CNTR	$\overline{p}p$ S channel
2190±10	[5] ABRAMS	70	CNTR	S channel $\overline{p}N$

[1] From the combined analysis of ANISOVICH 00J, ANISOVICH 01D, ANISOVICH 01E, and ANISOVICH 02.
[2] Isospins 0 and 1 not separated.
[3] From a fit to the total elastic cross section.
[4] Referred to as T or T region by ALSPECTOR 73.
[5] Seen as bump in $I = 1$ state. See also COOPER 68. PEASLEE 75 confirm $\overline{p}p$ results of ABRAMS 70, no narrow structure.

$\pi^- p \to \omega\pi^0 n$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2140±30	ALDE	95	GAM2	38 $\pi^- p \to \omega\pi^0 n$
2170±30	ALDE	92C	GAM4	100 $\pi^- p \to \omega\pi^0 n$

$\rho(2150)$ WIDTH

e^+e^- PRODUCED

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
234 ± 30 ± 25		[1] ABLIKIM	21A	BES3	$e^+e^- \to \omega\pi^0$
460 $^{+54}_{-48}$ $^{+160}_{-90}$	1.8k	[2] ABLIKIM	20F	BES3	$\psi(2S) \to K^+K^-\eta$
70 ± 38		[3] LEES	20	BABR	$e^+e^- \to K^+K^-\gamma$
127 ± 14 ± 4		[4] LEES	20	RVUE	$e^+e^- \to K^+K^-$
196 ± 23 $^{+25}_{-27}$		[5] ABLIKIM	19AQ	BES	$J/\psi \to K^+K^-\pi^0$
139.8± 12.3± 20.6		[6] ABLIKIM	19L	BES3	$e^+e^- \to K^+K^-$
109 ± 76		[7] LEES	12G	BABR	$e^+e^- \to \pi^+\pi^-\gamma$
350 ± 40 ± 50		AUBERT	07AU	BABR	10.6 $e^+e^- \to f_1(1285)\pi^+\pi^-\gamma$
310 ±140		AUBERT	07AU	BABR	10.6 $e^+e^- \to \eta'\pi^+\pi^-\gamma$
389 ± 79		BIAGINI	91	RVUE	$e^+e^- \to \pi^+\pi^-, K^+K^-$
410 ±100		[8] CLEGG	90	RVUE	$e^+e^- \to 3(\pi^+\pi^-), 2(\pi^+\pi^-\pi^0)$

[1] From a fit to the cross section between 2.00 and 3.08 GeV with a coherent sum of Breit-Wigner amplitudes, including contributions from $\rho(770)$, $\rho(1450)$ and $\rho(1700)$. Could be another state.

[2] Seen in $\psi(2S)$ decay with branching ratio $\psi(2S) \to X\eta \to K^+K^-\eta = (21.7 \pm 1.9^{+7.7}_{-8.3}) \times 10^{-6}$.
[3] From the fit to the BABAR data of LEES 13Q assuming a coherent sum of a single Breit-Wigner resonance and a nonresonant contribution. The resonance significance is 3.5 σ.
[4] From the fit to the BABAR data of LEES 13Q and BESIII data of ABLIKIM 19L assuming a coherent sum of a single Breit-Wigner resonance and a nonresonant contribution.
[5] Could also be another state. Seen in J/ψ decay with branching ratio $J/\psi \to X\pi^0 \to K^+K^-\pi^0 = (6.7 \pm 1.1^{+2.2}_{-1.8}) \times 10^{-6}$.
[6] The observed structure can be due to both the $\phi(2170)$ and $\rho(2150)$.
[7] Using the GOUNARIS 68 parametrization of the pion form factor leaving the masses and widths of the $\rho(1450)$, $\rho(1700)$, and $\rho(2150)$ resonances as free parameters of the fit.
[8] Includes ATKINSON 85.

$\overline{p}p \to \pi\pi$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
~ 296	HASAN	94	RVUE	$\overline{p}p \to \pi\pi$
~ 40	[1] OAKDEN	94	RVUE	0.36–1.55 $\overline{p}p \to \pi\pi$
~ 250	[2] MARTIN	80B	RVUE	
~ 200	[2] MARTIN	80C	RVUE	

[1] See however KLOET 96 who fit $\pi^+\pi^-$ only and find waves only up to $J = 3$ to be important but not significantly resonant.
[2] $I(J^P) = 1(1^-)$ from simultaneous analysis of $p\overline{p} \to \pi^-\pi^+$ and $\pi^0\pi^0$.

S-CHANNEL $\overline{N}N$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
230±50	[1] ANISOVICH	02	SPEC	0.6–1.9 $p\overline{p} \to \omega\pi^0, \omega\eta\pi^0, \pi^+\pi^-$
135±75	[2,3] COUPLAND	77	CNTR	0.7–2.4 $\overline{p}p \to \overline{p}p$
98± 8	[3] ALSPECTOR	73	CNTR	$\overline{p}p$ S channel
~ 85	[4] ABRAMS	70	CNTR	S channel $\overline{p}N$

[1] From the combined analysis of ANISOVICH 00J, ANISOVICH 01D, ANISOVICH 01E, and ANISOVICH 02.
[2] From a fit to the total elastic cross section.
[3] Isospins 0 and 1 not separated.
[4] Seen as bump in $I = 1$ state. See also COOPER 68. PEASLEE 75 confirm $\overline{p}p$ results of ABRAMS 70, no narrow structure.

$\pi^- p \to \omega\pi^0 n$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
320±70	ALDE	95	GAM2	38 $\pi^- p \to \omega\pi^0 n$
~ 300	ALDE	92C	GAM4	100 $\pi^- p \to \omega\pi^0 n$

$\rho(2150)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	e^+e^-	
Γ_2	$\pi^+\pi^-$	seen
Γ_3	K^+K^-	seen
Γ_4	$3(\pi^+\pi^-)$	seen
Γ_5	$2(\pi^+\pi^-\pi^0)$	seen
Γ_6	$\eta'\pi^+\pi^-$	seen
Γ_7	$f_1(1285)\pi^+\pi^-$	seen
Γ_8	$\omega\pi^0$	seen
Γ_9	$\omega\pi^0\eta$	seen
Γ_{10}	$p\overline{p}$	

$\rho(2150)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(\text{total})$

$\Gamma(\omega\pi^0) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_8\Gamma_1/\Gamma$

VALUE (eV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$34\pm11\pm16$	ABLIKIM	21A	BES3	$e^+e^- \to \omega\pi^0$

$\rho(2150)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma^2(\text{total})$

$\Gamma(f_1(1285)\pi^+\pi^-)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_7/\Gamma \times \Gamma_1/\Gamma$

VALUE (units 10^{-7})	*DOCUMENT ID*		*TECN*	*COMMENT*
3.1±0.6±0.5	[1] AUBERT	07AU	BABR	10.6 $e^+e^- \to f_1(1285)\pi^+\pi^-\gamma$

[1] Calculated by us from the reported value of cross section at the peak.

$\Gamma(\eta'\pi^+\pi^-)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_6/\Gamma \times \Gamma_1/\Gamma$

VALUE (units 10^{-8})	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4.9 ± 1.9	[1] AUBERT	07AU	BABR	10.6 $e^+e^- \to \eta'\pi^+\pi^-\gamma$

[1] Calculated by us from the reported value of cross section at the peak.

$\rho(2150)$ REFERENCES

ABLIKIM	21A	PL B813 136059	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	20F	PR D101 032008	M. Ablikim *et al.*	(BESIII Collab.)
LEES	20	PR D101 012011	J.P. Lees *et al.*	(BESIII Collab.)
ABLIKIM	19AQ	PR D100 032004	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	19L	PR D99 032001	M. Ablikim *et al.*	(BESIII Collab.)
LEES	13Q	PR D88 032013	J.P. Lees *et al.*	(BABAR Collab.)
LEES	12G	PR D86 032013	J.P. Lees *et al.*	(BABAR Collab.)
AUBERT	07AU	PR D76 092005	B. Aubert *et al.*	(BABAR Collab.)
ANISOVICH	02	PL B542 8	A.V. Anisovich *et al.*	
ANISOVICH	01D	PL B508 6	A.V. Anisovich *et al.*	
ANISOVICH	01E	PL B513 281	A.V. Anisovich *et al.*	
ANISOVICH	00J	PL B491 47	A.V. Anisovich *et al.*	(RAL, LOQM, PNPI+)
KLOET	96	PR D53 6120	W.M. Kloet, F. Myhrer	(RUTG, NORD)
ALDE	95	ZPHY C66 379	D.M. Alde *et al.*	(GAMS Collab.) JP

HASAN	94	PL B334 215	A. Hasan, D.V. Bugg	(LOQM)
OAKDEN	94	NP A574 731	M.N. Oakden, M.R. Pennington	(DURH)
ALDE	92C	ZPHY C54 553	D.M. Alde *et al.*	(BELG, SERP, KEK, LANL+)
BIAGINI	91	NC 104A 363	M.E. Biagini *et al.*	(FRAS, PRAG)
CLEGG	90	ZPHY C45 677	A.B. Clegg, A. Donnachie	(LANC, MCHS)
ATKINSON	85	ZPHY C29 333	M. Atkinson *et al.*	(BONN, CERN, GLAS+)
MARTIN	80B	NP B176 355	B.R. Martin, D. Morgan	(LOUC, RHEL) JP
MARTIN	80C	NP B169 216	A.D. Martin, M.R. Pennington	(DURH) JP
CUTTS	78B	PR D17 16	D. Cutts *et al.*	(STON, WISC)
COUPLAND	77	PL 71B 460	M. Coupland *et al.*	(LOQM, RHEL)
PEASLEE	75	PL 57B 189	D.C. Peaslee *et al.*	(CANB, BARI, BROW+)
ALSPECTOR	73	PRL 30 511	J. Alspector *et al.*	(RUTG, UPNJ)
ABRAMS	70	PR D1 1917	R.J. Abrams *et al.*	(BNL)
COOPER	68	PRL 20 1059	W.A. Cooper *et al.*	(ANL)
GOUNARIS	68	PRL 21 244	G.J. Gounaris, J.J. Sakurai	