$\rho(2150)$

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

OMITTED FROM SUMMARY TABLE

This entry was previously called $T_1(2190)$. See the review on "Spectroscopy of Light Meson Resonances."

$\rho(2150)$ MASS

e^+e^- PRODUCED

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$2044 \pm 31 \pm 4$		[1] ABLIKIM	23BQ	BES3	$e^+e^- \to a_2(1320)^+\pi^- +$ c.c. $\to \eta\pi^+\pi^-$
2095 ± 4		[2] ACHASOV	23A	SND	$e^+e^- \to \omega\pi^0$
$2034 \pm 13 \pm 9$		[3] ABLIKIM	21A	BES3	$e^+e^- \to \omega\pi^0$
$2111 \pm 43 \pm 25$		[4] ABLIKIM	21X	BES3	$e^+e^- \to \eta'\pi^+\pi^-$
$2255 ^{+17}_{-18} {}^{+50}_{-41}$	1.8k	[5] ABLIKIM	20F	BES3	$\psi(2S) \to K^+K^-\eta$
2201 ± 19		[6] LEES	20	BABR	$e^+e^- \to K^+K^-\gamma$
$2227 \pm 9 \pm 9$		[7] LEES	20	RVUE	$e^+e^- \to K^+K^-$
$2039 \pm 8 ^{+36}_{-18}$		[8] ABLIKIM	19AQ	BES	$J/\psi \to K^+K^-\pi^0$
$2239.2 \pm 7.1 \pm 11.3$		[9] ABLIKIM	19L	BES3	$e^+e^- \to K^+K^-$
2254 ± 22		[10] LEES	12G	BABR	$e^+e^- \to \pi^+\pi^-\gamma$
$2150 \pm 40 \pm 50$		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		[11] 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 a Breit-Wigner resonance and a non-resonant contribution. Could be another state.

[2] From a vector dominance fit to the Born cross section between 1.05 and 2.0 GeV with $\rho(770)$, $\rho(1570)$, $\rho(1700)$, $\rho(2150)$. The fit also uses SND data from the VEPP-2M collider below 1.02 GeV and from LEES 17H and ABLIKIM 21A above 1.5 GeV.

[3] 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.

[4] From a Breit-Wigner fit to the Born cross section, including an s-dependent continuum amplitude.

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

[6] 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.

[7] 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.

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

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

[10] 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.
[11] 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 $p\overline{p} \to \omega\pi^0$, $\omega\eta\pi^0$, $\pi^+\pi^-$
$\sim$ 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. • • •					
163 ± 69 ± 24		[1] ABLIKIM	23BQ	BES3	$e^+e^- \to a_2(1320)^+\pi^- +$ c.c. $\to \eta\pi^+\pi^-$
270 ± 3		[2] ACHASOV	23A	SND	$e^+e^- \to \omega\pi^0$
234 ± 30 ± 25		[3] ABLIKIM	21A	BES3	$e^+e^- \to \omega\pi^0$
135 ± 34 ± 30		[4] ABLIKIM	21X	BES3	$e^+e^- \to \eta'\pi^+\pi^-$
460 $^{+54}_{-48}$ $^{+160}_{-90}$	1.8k	[5] ABLIKIM	20F	BES3	$\psi(2S) \to K^+K^-\eta$
70 ± 38		[6] LEES	20	BABR	$e^+e^- \to K^+K^-\gamma$
127 ± 14 ± 4		[7] LEES	20	RVUE	$e^+e^- \to K^+K^-$

$196 \pm 23 \; {}^{+25}_{-27}$	[8] ABLIKIM	19AQ	BES	$J/\psi \to K^+ K^- \pi^0$
$139.8 \pm 12.3 \pm 20.6$	[9] ABLIKIM	19L	BES3	$e^+ e^- \to K^+ K^-$
109 ± 76	[10] LEES	12G	BABR	$e^+ e^- \to \pi^+ \pi^- \gamma$
$350 \pm 40 \pm 50$	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	[11] 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 a Breit-Wigner resonance and a non-resonant contribution. Could be another state.

[2] From a vector dominance fit to the Born cross section between 1.05 and 2.0 GeV with $\rho(770)$, $\rho(1570)$, $\rho(1700)$, $\rho(2150)$. The fit also uses SND data from the VEPP-2M collider below 1.02 GeV and from LEES 17H and ABLIKIM 21A above 1.5 GeV.

[3] 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.

[4] From a Breit-Wigner fit to the Born cross section, including an s-dependent continuum amplitude.

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

[6] 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 $3.5\ \sigma$.

[7] 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.

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

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

[10] 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.

[11] 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}	$a_2(1320) \pi$	
Γ_{11}	$p \overline{p}$	

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

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

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
23.3±5.3±3.3	[1] ABLIKIM	21X	BES3	$e^+ e^- \to \eta' \pi^+ \pi^-$

[1] From a Breit-Wigner fit to the Born cross section interfering constructively with the continuum. For destructive interference the value is 0.64 ± 0.49 ± 0.42 eV.

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

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
34±11±16	ABLIKIM	21A	BES3	$e^+ e^- \to \omega \pi^0$

$\Gamma(a_2(1320)\pi) \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$ $\Gamma_{10}\Gamma_1/\Gamma$

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
34.6±17.1±6.0	[1] ABLIKIM	23BQ	BES3	$e^+ e^- \to a_2(1320)^+ \pi^-$ +c.c. $\to \eta \pi^+ \pi^-$

[1] From a solution of the fit to the cross section between 2.00 and 3.08 GeV using a coherent sum of a single Breit-Wigner resonance and a non-resonant contribution. B($a_2(1320) \to \eta\pi$) $\times$ B($\eta \to \gamma\gamma$) fixed to 0.057. Another solution with equal fit quality gives 137.1 $\pm$ 73.3 $\pm$ 2.1 eV.

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

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

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.

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

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	23BQ	PR D108 L111101	M. Ablikim et al.	(BESIII Collab.)
ACHASOV	23A	PR D108 092012	M.N. Achasov et al.	(SND Collab.)
ABLIKIM	21A	PL B813 136059	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	21X	PR D103 072007	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	17H	PR D96 092009	J.P. Lees et al.	(BABAR 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	