

$\Lambda(1520) \ 3/2^-$ $I(J^P) = 0(\frac{3}{2}^-)$ Status: ****

Discovered by FERRO-LUZZI 62; the elaboration in WATSON 63 is the classic paper on the Breit-Wigner analysis of a multichannel resonance.

The measurements of the mass, width, and elasticity published before 1975 are now obsolete and have been omitted. They were last listed in our 1982 edition *Physics Letters* **111B** 1 (1982).

Production and formation experiments agree quite well, so they are listed together here.

$\Lambda(1520)$ POLE POSITION

REAL PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1517 to 1518 (≈ 1517.5) OUR ESTIMATE			
1517.5\pm0.4 OUR AVERAGE			
1517.5 \pm 0.4	SARANTSEV	19	DPWA $\bar{K}N$ multichannel
1517 $\begin{smallmatrix} +4 \\ -4 \end{smallmatrix}$	¹ KAMANO	15	DPWA $\bar{K}N$ multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1518	ZHANG	13A	DPWA $\bar{K}N$ multichannel
1518.8	QIANG	10	SPEC $ep \rightarrow e'K^+X$ (fit to X)
¹ From the preferred solution A in KAMANO 15.			

–2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
14 to 18 (≈ 16) OUR ESTIMATE			
15.3\pm 0.9 OUR AVERAGE			
15.3 \pm 0.9	SARANTSEV	19	DPWA $\bar{K}N$ multichannel
15 $\begin{smallmatrix} +10 \\ -8 \end{smallmatrix}$	¹ KAMANO	15	DPWA $\bar{K}N$ multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
16	ZHANG	13A	DPWA $\bar{K}N$ multichannel
17.2	QIANG	10	SPEC $ep \rightarrow e'K^+X$ (fit to X)
¹ From the preferred solution A in KAMANO 15.			

$\Lambda(1520)$ POLE RESIDUES

The normalized residue is the residue divided by $\Gamma_{pole}/2$.

Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow N\bar{K}$

<u>MODULUS</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.45 \pm0.01	–10 \pm 3	SARANTSEV	19	DPWA $\bar{K}N$ multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.431	–11	¹ KAMANO	15	DPWA $\bar{K}N$ multichannel
¹ From the preferred solution A in KAMANO 15.				

Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Sigma\pi$

<u>MODULUS</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.44 ± 0.01	-15 ± 3	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
• • •				We do not use the following data for averages, fits, limits, etc. • • •
0.435	-10	¹ KAMANO 15	DPWA	$\bar{K}N$ multichannel

¹From the preferred solution A in KAMANO 15.

Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Lambda\eta$

<u>MODULUS</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.013 ± 0.003	116 ± 3	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel

Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Sigma(1385)\pi, S\text{-wave}$

<u>MODULUS</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • •				We do not use the following data for averages, fits, limits, etc. • • •
0.431	-123	¹ KAMANO 15	DPWA	$\bar{K}N$ multichannel

¹From the preferred solution A in KAMANO 15.

Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Sigma(1385)\pi, D\text{-wave}$

<u>MODULUS</u>	<u>PHASE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • •				We do not use the following data for averages, fits, limits, etc. • • •
0.0141	122	¹ KAMANO 15	DPWA	$\bar{K}N$ multichannel

¹From the preferred solution A in KAMANO 15.

$\Lambda(1520)$ MASS

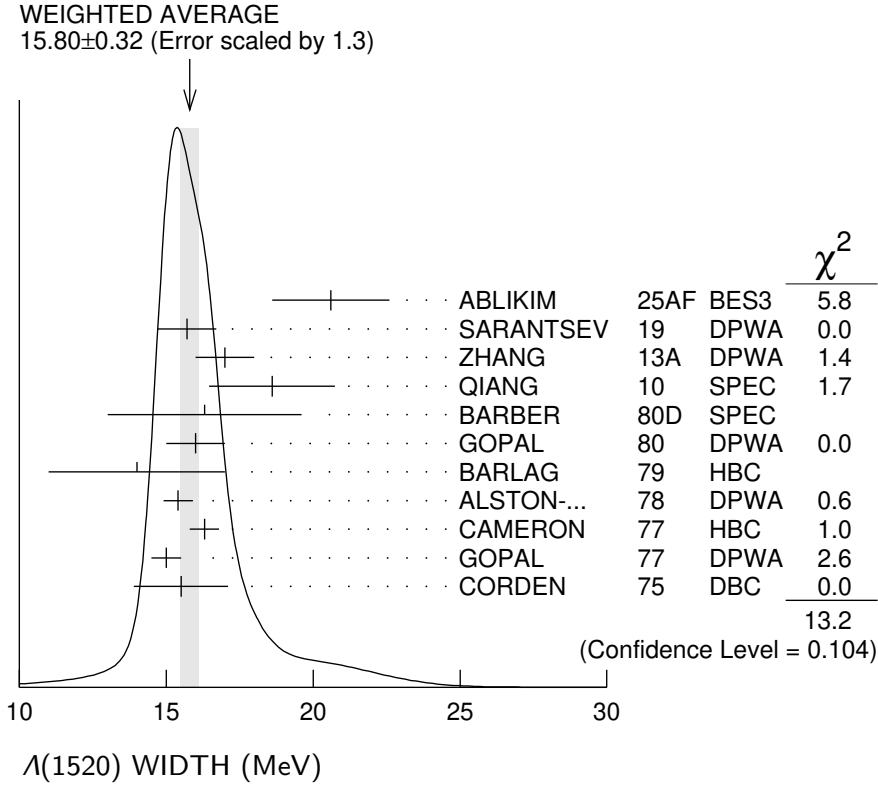
<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1518 to 1520 (\approx 1519) OUR ESTIMATE				
1519.42 ± 0.19 OUR AVERAGE				Error includes scale factor of 1.2.
1519.9 ± 1.6 ± 4.8		ABLIKIM 25AF	BES3	$\psi(3686) \rightarrow \Lambda\bar{\Sigma}^0\pi^0 +$ c.c. (PWA)
1518.5 ± 0.5		SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
1519.6 ± 0.5		ZHANG 13A	DPWA	$\bar{K}N$ multichannel
1520.4 ± 0.6 ± 1.5		QIANG 10	SPEC	$e p \rightarrow e' K^+ X$ (fit to X)
1517.3 ± 1.5	300	BARBER 80D	SPEC	$\gamma p \rightarrow \Lambda(1520) K^+$
1517.8 ± 1.2	5k	BARLAG 79	HBC	$K^- p$ 4.2 GeV/c
1520.0 ± 0.5		ALSTON-... 78	DPWA	$\bar{K}N \rightarrow \bar{K}N$
1519.7 ± 0.3	4k	CAMERON 77	HBC	$K^- p$ 0.96–1.36 GeV/c
1519 ± 1		GOPAL 77	DPWA	$\bar{K}N$ multichannel
1519.4 ± 0.3	2000	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/c

$\Lambda(1520)$ WIDTH

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
15 to 17 (\approx 16) OUR ESTIMATE				
15.80 ± 0.32 OUR AVERAGE				Error includes scale factor of 1.3. See the ideogram below.
20.6 ± 1.9 ± 0.6		ABLIKIM 25AF	BES3	$\psi(3686) \rightarrow \Lambda\bar{\Sigma}^0\pi^0 +$ c.c. (PWA)
15.7 ± 1.0		SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
17 ± 1		ZHANG 13A	DPWA	$\bar{K}N$ multichannel
18.6 ± 1.9 ± 1.0		QIANG 10	SPEC	$e p \rightarrow e' K^+ X$ (fit to X)

16.3 ± 3.3	300	BARBER	80D	SPEC	$\gamma p \rightarrow \Lambda(1520) K^+$
16 ± 1		GOPAL	80	DPWA	$\bar{K} N \rightarrow \bar{K} N$
14 ± 3	677	¹ BARLAG	79	HBC	$K^- p$ 4.2 GeV/c
15.4 ± 0.5		ALSTON-...	78	DPWA	$\bar{K} N \rightarrow \bar{K} N$
16.3 ± 0.5	4k	CAMERON	77	HBC	$K^- p$ 0.96–1.36 GeV/c
15.0 ± 0.5		GOPAL	77	DPWA	$\bar{K} N$ multichannel
15.5 ± 1.6	2000	CORDEN	75	DBC	$K^- d$ 1.4–1.8 GeV/c

¹ From the best-resolution sample of $\Lambda\pi\pi$ events only.



$\Lambda(1520)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\bar{K}$	(45 ± 1) %
Γ_2 $\Sigma\pi$	(42 ± 1) %
Γ_3 $\Lambda\pi\pi$	(10 ± 1) %
Γ_4 $\Sigma(1385)\pi$, S-wave	
Γ_5 $\Sigma(1385)\pi$, D-wave	
Γ_6 $\Sigma(1385)\pi$	(4.1 ± 0.5) %
Γ_7 $\Sigma(1385)\pi (\rightarrow \Lambda\pi\pi)$	
Γ_8 $\Lambda(\pi\pi)$ S-wave	(2.0 ± 0.8) %
Γ_9 $\Sigma\pi\pi$	(0.9 ± 0.1) %
Γ_{10} $\Lambda\gamma$	(0.85 ± 0.15) %
Γ_{11} $\Sigma^0\gamma$	(2.00 ± 0.35) %

$\Lambda(1520)$ BRANCHING RATIOS

See “Sign conventions for resonance couplings” in the Note on Λ and Σ Resonances.

$\Gamma(N\bar{K})/\Gamma_{\text{total}}$				Γ_1/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.45 to 0.47 OUR ESTIMATE				
0.45 \pm 0.01	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel	
0.47 \pm 0.04	ZHANG 13A	DPWA	$\bar{K}N$ multichannel	
0.47 \pm 0.02	GOPAL 80	DPWA	$\bar{K}N \rightarrow \bar{K}N$	
0.45 \pm 0.03	ALSTON-...	78	DPWA $\bar{K}N \rightarrow \bar{K}N$	
0.448 \pm 0.014	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/ <i>c</i>	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.43	¹ KAMANO 15	DPWA	$\bar{K}N$ multichannel	
0.47 \pm 0.01	GOPAL 77	DPWA	See GOPAL 80	
0.42	MAST 76	HBC	$K^- p \rightarrow \bar{K}^0 n$	

¹From the preferred solution A in KAMANO 15.

$\Gamma(\Sigma\pi)/\Gamma_{\text{total}}$				Γ_2/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.42 to 0.46 OUR ESTIMATE				
0.43 \pm 0.01	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel	
0.47 \pm 0.05	ZHANG 13A	DPWA	$\bar{K}N$ multichannel	
0.426 \pm 0.014	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/ <i>c</i>	
0.418 \pm 0.017	BARBARO-... 69B	HBC	$K^- p$ 0.28–0.45 GeV/ <i>c</i>	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.446	¹ KAMANO 15	DPWA	$\bar{K}N$ multichannel	
0.46	KIM 71	DPWA	K-matrix analysis	

¹From the preferred solution A in KAMANO 15.

$\Gamma(\Sigma\pi)/\Gamma(N\bar{K})$				Γ_2/Γ_1
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.9 to 1.0 OUR ESTIMATE				
0.98 \pm 0.03	¹ GOPAL 77	DPWA	$\bar{K}N$ multichannel	
0.82 \pm 0.08	BURKHARDT 69	HBC	$K^- p$ 0.8–1.2 GeV/ <i>c</i>	
1.06 \pm 0.14	SCHEUER 68	DBC	$K^- N$ 3 GeV/ <i>c</i>	
0.96 \pm 0.20	DAHL 67	HBC	$\pi^- p$ 1.6–4 GeV/ <i>c</i>	
0.73 \pm 0.11	DAUBER 67	HBC	$K^- p$ 2 GeV/ <i>c</i>	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
1.06 \pm 0.12	BERTHON 74	HBC	Quasi-2-body σ	
1.72 \pm 0.78	MUSGRAVE 65	HBC		

¹The $\bar{K}N \rightarrow \Sigma\pi$ amplitude at resonance is $+0.46 \pm 0.01$.

$\Gamma(\Lambda\pi\pi)/\Gamma_{\text{total}}$				Γ_3/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.09 to 0.11 OUR ESTIMATE				
0.091 \pm 0.006	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/ <i>c</i>	
0.11 \pm 0.01	¹ MAST 73B	IPWA	$K^- p \rightarrow \Lambda\pi\pi$	

¹Assumes $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46 \pm 0.02$.

$\Gamma(\Lambda\pi\pi)/\Gamma(N\bar{K})$

Γ_3/Γ_1

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.18 to 0.22 OUR ESTIMATE			
0.22±0.03	BURKHARDT 69	HBC	$K^- p$ 0.8–1.2 GeV/ c
0.19±0.04	SCHEUER 68	DBC	$K^- N$ 3 GeV/ c
0.17±0.05	DAHL 67	HBC	$\pi^- p$ 1.6–4 GeV/ c
0.21±0.18	DAUBER 67	HBC	$K^- p$ 2 GeV/ c
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.27±0.13	BERTHON 74	HBC	Quasi-2-body σ
0.2	KIM 71	DPWA	K-matrix analysis

$\Gamma(\Sigma\pi)/\Gamma(\Lambda\pi\pi)$

Γ_2/Γ_3

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
3.4 to 4.4 OUR ESTIMATE			
3.9±1.0	UHLIG 67	HBC	$K^- p$ 0.9–1.0 GeV/ c
3.3±1.1	BIRMINGHAM 66	HBC	$K^- p$ 3.5 GeV/ c
4.5±1.0	ARMENTEROS65C	HBC	

$\Gamma(\Sigma(1385)\pi, S\text{-wave})/\Gamma_{\text{total}}$

Γ_4/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.121	¹ KAMANO 15	DPWA	$\bar{K}N$ multichannel
¹ From the preferred solution A in KAMANO 15.			

$\Gamma(\Sigma(1385)\pi, D\text{-wave})/\Gamma_{\text{total}}$

Γ_5/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.003	¹ KAMANO 15	DPWA	Multichannel
¹ From the preferred solution A in KAMANO 15.			

$\Gamma(\Sigma(1385)\pi)/\Gamma_{\text{total}}$

Γ_6/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.041±0.005	CHAN 72	HBC	$K^- p \rightarrow \Lambda\pi\pi$

$\Gamma(\Sigma(1385)\pi(\rightarrow\Lambda\pi\pi))/\Gamma(\Lambda\pi\pi)$

Γ_7/Γ_3

The $\Lambda\pi\pi$ mode is largely due to $\Sigma(1385)\pi$. Only the values of $(\Sigma(1385)\pi) / (\Lambda\pi\pi)$ given by MAST 73B and CORDEN 75 are based on real 3-body partial-wave analyses. The discrepancy between the two results is essentially due to the different hypotheses made concerning the shape of the $(\pi\pi)_{S\text{-wave}}$ state.

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.58±0.22		CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/ c
0.82±0.10		¹ MAST 73B	IPWA	$K^- p \rightarrow \Lambda\pi\pi$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
<0.44	90	WIELAND 11	SPHR	$\gamma p \rightarrow K^+ \Lambda(1520)$
0.39±0.10		² BURKHARDT 71	HBC	$K^- p \rightarrow (\Lambda\pi\pi)\pi$

¹Both $\Sigma(1385)\pi DS_{03}$ and $\Sigma(\pi\pi) DP_{03}$ contribute.

²The central bin (1514–1524 MeV) gives 0.74 ± 0.10 ; other bins are lower by 2-to-5 standard deviations.

$\Gamma(\Lambda(\pi\pi)_{S\text{-wave}})/\Gamma(\Lambda\pi\pi)$

Γ_8/Γ_3

VALUE	DOCUMENT ID	TECN	COMMENT
0.20±0.08	CORDEN	75	DBC $K^- d$ 1.4–1.8 GeV/c

$\Gamma(\Sigma\pi\pi)/\Gamma_{\text{total}}$

Γ_9/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
0.007 to 0.011 OUR ESTIMATE			
0.007 ±0.002	¹ CORDEN	75	DBC $K^- d$ 1.4–1.8 GeV/c
0.0085±0.0006	² MAST	73	MPWA $K^- p \rightarrow \Sigma\pi\pi$
0.010 ±0.0015	BARBARO-...	69B	HBC $K^- p$ 0.28–0.45 GeV/c

¹ Much of the $\Sigma\pi\pi$ decay proceeds via $\Sigma(1385)\pi$.

² Assumes $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46$.

$\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$

Γ_{10}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
7 to 11 OUR ESTIMATE				
10.7±2.9 ^{+1.5} _{-0.4}	32	TAYLOR	05	CLAS $\gamma p \rightarrow K^+ \Lambda\gamma$
10.2±2.1±1.5	290	ANTIPOV	04A	SPNX $pN(C) \rightarrow \Lambda(1520)K^+N(C)$
8.0±1.4	238	MAST	68B	HBC Using $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.45$

$\Gamma(\Sigma^0\gamma)/\Gamma_{\text{total}}$

Γ_{11}/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
0.02±0.0035	¹ MAST	68B	HBC Not measured; see note

¹ Calculated from $\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$, assuming SU(3). Needed to constrain the sum of all the branching ratios to be unity.

$\Lambda(1520)$ REFERENCES

ABLIKIM	25AF	JHEP 2502 212	M. Ablikim <i>et al.</i>	(BESIII Collab.)
SARANTSEV	19	EPJ A55 180	A.V. Sarantsev <i>et al.</i>	(BONN, PNPI)
KAMANO	15	PR C92 025205	H. Kamano <i>et al.</i>	(ANL, OSAK)
ZHANG	13A	PR C88 035205	H. Zhang <i>et al.</i>	(KSU)
WIELAND	11	EPJ A47 47	F. Wieland <i>et al.</i>	(ELSA SAPHIR Collab.)
QIANG	10	PL B694 123	Y. Qiang <i>et al.</i>	(DUKE, JEFF, PNPI, GWU+)
TAYLOR	05	PR C71 054609	S. Taylor <i>et al.</i>	(JLab CLAS Collab.)
Also		PR C72 039902 (err.)	S. Taylor <i>et al.</i>	(JLab CLAS Collab.)
ANTIPOV	04A	PL B604 22	Yu.M. Antipov <i>et al.</i>	(IHEP SPHINX Collab.)
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)
BARBER	80D	ZPHY C7 17	D.P. Barber <i>et al.</i>	(DARE, LANC, SHEF)
GOPAL	80	Toronto Conf. 159	G.P. Gopal	(RHEL) IJP
BARLAG	79	NP B149 220	S.J.M. Barlag <i>et al.</i>	(AMST, CERN, NIJM+)
ALSTON-...	78	PR D18 182	M. Alston-Garnjost <i>et al.</i>	(LBL, MTHO+) IJP
Also		PRL 38 1007	M. Alston-Garnjost <i>et al.</i>	(LBL, MTHO+) IJP
CAMERON	77	NP B131 399	W. Cameron <i>et al.</i>	(RHEL, LOIC) IJP
GOPAL	77	NP B119 362	G.P. Gopal <i>et al.</i>	(LOIC, RHEL) IJP
MAST	76	PR D14 13	T.S. Mast <i>et al.</i>	(LBL)
CORDEN	75	NP B84 306	M.J. Corden <i>et al.</i>	(BIRM)
BERTHON	74	NC 21A 146	A. Berthon <i>et al.</i>	(CDEF, RHEL, SACL+)
MAST	73	PR D7 3212	T.S. Mast <i>et al.</i>	(LBL) IJP
MAST	73B	PR D7 5	T.S. Mast <i>et al.</i>	(LBL) IJP
CHAN	72	PRL 28 256	S.B. Chan <i>et al.</i>	(MASA, YALE)
BURKHARDT	71	NP B27 64	E. Burkhardt <i>et al.</i>	(HEID, CERN, SACL)
KIM	71	PRL 27 356	J.K. Kim	(HARV) IJP
Also		Duke Conf. 161	J.K. Kim	(HARV) IJP
Hyperon Resonances, 1970				
BARBARO-...	69B	Lund Conf. 352	A. Barbaro-Galtieri <i>et al.</i>	(LRL)
Also		Duke Conf. 95	R.D. Tripp	(LRL)
Hyperon Resonances 1970				

BURKHARDT	69	NP B14 106	E. Burkhardt <i>et al.</i>	(HEID, EFI, CERN+)
MAST	68B	PRL 21 1715	T.S. Mast <i>et al.</i>	(LRL)
SCHEUER	68	NP B8 503	J.C. Scheuer <i>et al.</i>	(SABRE Collab.)
DAHL	67	PR 163 1377	O.I. Dahl <i>et al.</i>	(LRL)
DAUBER	67	PL 24B 525	P.M. Dauber <i>et al.</i>	(UCLA)
UHLIG	67	PR 155 1448	R.P. Uhlig <i>et al.</i>	(UMD, NRL)
BIRMINGHAM	66	PR 152 1148	M. Haque <i>et al.</i>	(BIRM, GLAS, LOIC, OXF+)
ARMENTEROS	65C	PL 19 338	R. Armenteros <i>et al.</i>	(CERN, HEID, SACL)
MUSGRAVE	65	NC 35 735	B. Musgrave <i>et al.</i>	(BIRM, CERN, EPOL+)
WATSON	63	PR 131 2248	M.B. Watson, M. Ferro-Luzzi, R.D. Tripp	(LRL) IJP
FERRO-LUZZI	62	PRL 8 28	M. Ferro-Luzzi, R.D. Tripp, M.B. Watson	(LRL) IJP
