

$\Sigma(1670)$ Bumps

$$I(J^P) = 1(?^?)$$

OMITTED FROM SUMMARY TABLE

Formation experiments are listed separately in the preceding entry.

Probably there are two states at the same mass with the same quantum numbers, one decaying to $\Sigma\pi$ and $\Lambda\pi$, the other to $\Lambda(1405)\pi$.

See the note in front of the preceding entry.

 **$\Sigma(1670)$ MASS
(PRODUCTION EXPERIMENTS)**

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
≈ 1670 OUR ESTIMATE					
1670 ± 4		¹ CARROLL	76 DPWA		Isospin-1 total σ
1675 ± 10		² HEPP	76 DBC	-	$K^- N$ 1.6-1.75 GeV/c
1665 ± 1		APSELL	74 HBC		$K^- p$ 2.87 GeV/c
1688 ± 2 or 1683 ± 5	1200	BERTHON	74 HBC	0	Quasi-2-body σ
1670 ± 6		AGUILAR-...	70B HBC		$K^- p \rightarrow \Sigma\pi\pi$ 4 GeV
1668 ± 10		AGUILAR-...	70B HBC		$K^- p \rightarrow \Sigma 3\pi$ 4 GeV
1660 ± 10		ALVAREZ	63 HBC	+	$K^- p$ 1.51 GeV/c
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
1668 ± 10	150	³ FERRERSORIA81	OMEG	-	$\pi^- p$ 9,12 GeV/c
1655 to 1677		TIMMERMANS76	HBC	+	$K^- p$ 4.2 GeV/c
1665 ± 5		BUGG	68 CNTR		$K^- p, d$ total σ
1661 ± 9	70	PRIMER	68 HBC	+	See BARNES 69E
1685		ALEXANDER	62C HBC	-0	$\pi^- p$ 2-2.2 GeV/c

 **$\Sigma(1670)$ WIDTH
(PRODUCTION EXPERIMENTS)**

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
67.0 ± 2.4		APSELL	74 HBC		$K^- p$ 2.87 GeV/c
110 ± 12		AGUILAR-...	70B HBC		$K^- p \rightarrow \Sigma\pi\pi$ 4 GeV
$135 \begin{smallmatrix} +40 \\ -30 \end{smallmatrix}$		AGUILAR-...	70B HBC		$K^- p \rightarrow \Sigma 3\pi$ 4 GeV
40 ± 10		ALVAREZ	63 HBC	+	

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

90 ± 20	150	³ FERRERSORIA81	OMEG	−	$\pi^- p$ 9,12 GeV/c
52		¹ CARROLL	76 DPWA		Isospin-1 total σ
48 to 63		TIMMERMANS76	HBC	+	$K^- p$ 4.2 GeV/c
30 ± 15		BUGG	68 CNTR		
60 ± 20	70	PRIMER	68 HBC	+	See BARNES 69E
45		ALEXANDER	62C HBC	−0	

Σ(1670) DECAY MODES (PRODUCTION EXPERIMENTS)

Mode
Γ ₁ $N\bar{K}$
Γ ₂ $\Lambda\pi$
Γ ₃ $\Sigma\pi$
Γ ₄ $\Lambda\pi\pi$
Γ ₅ $\Sigma\pi\pi$
Γ ₆ $\Sigma(1385)\pi$
Γ ₇ $\Lambda(1405)\pi$

Σ(1670) BRANCHING RATIOS (PRODUCTION EXPERIMENTS)

$\Gamma(N\bar{K})/\Gamma(\Sigma\pi)$							Γ_1/Γ_3
<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>		
<0.03		TIMMERMANS76	HBC	+	$K^- p$ 4.2 GeV/c		
<0.10		BERTHON	74 HBC	0	Quasi-2-body σ		
<0.2		AGUILAR-...	70B HBC				
<0.26		BARNES	69E HBC	+	$K^- p$ 3.9–5 GeV/c		
0.025		BUGG	68 CNTR	0	Assuming $J = 3/2$		
<0.24	0	PRIMER	68 HBC	+	$K^- p$ 4.6–5 GeV/c		
<0.6		LONDON	66 HBC	+	$K^- p$ 2.25 GeV/c		
<0.19	0	ALVAREZ	63 HBC	+	$K^- p$ 1.15 GeV/c		
≥ 0.5 ± 0.25		SMITH	63 HBC	−0			

$\Gamma(\Lambda\pi)/\Gamma(\Sigma\pi)$							Γ_2/Γ_3
<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>		
0.76 ± 0.09		ESTES	74 HBC	0	$K^- p$ 2.1,2.6 GeV/c		
0.45 ± 0.15		BARNES	69E HBC	+	$K^- p$ 3.9–5 GeV/c		
0.15 ± 0.07		HUWE	69 HBC	+			
0.11 ± 0.06	33	BUTTON-...	68 HBC	+	$K^- p$ 1.7 GeV/c		

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$\leq 0.45 \pm 0.07$		TIMMERMANS76	HBC	+	$K^- p$ 4.2 GeV/c
0.55 ± 0.11		BERTHON	74	HBC	0 Quasi-2-body σ
0	0	PRIMER	68	HBC	+ See BARNES 69E
< 0.6		LONDON	66	HBC	+ $K^- p$ 2.25 GeV/c
1.2	130	ALVAREZ	63	HBC	+ $K^- p$ 1.15 GeV/c
1.2		SMITH	63	HBC	-0

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

Γ_4/Γ_3

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
< 0.6		LONDON	66	HBC	+ $K^- p$ 2.25 GeV/c
0.56	90	ALVAREZ	63	HBC	+ $K^- p$ 1.15 GeV/c
0.17		SMITH	63	HBC	-0

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

Γ_5/Γ_3

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
largest at small angles		ESTES	74	HBC	0 $K^- p$ 2.1,2.6 GeV/c

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

< 0.2		² HEPP	76	DBC	- $K^- N$ 1.6-1.75 GeV/c
0.56	180	ALVAREZ	63	HBC	+ $K^- p$ 1.15 GeV/c

$\Gamma(\Lambda(1405)\pi)/\Gamma(\Sigma\pi)$

Γ_7/Γ_3

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
1.8 ± 0.3 to 0.02 ± 0.07		^{3,4} TIMMERMANS76	HBC	+	$K^- p$ 4.2 GeV/c
largest at small angles		ESTES	74	HBC	\pm $K^- p$ 2.1,2.6 GeV/c
3.0 ± 1.6	50	LONDON	66	HBC	+ $K^- p$ 2.25 GeV/c

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

0.58 ± 0.20	17	PRIMER	68	HBC	+ See BARNES 69E
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$\Gamma(\Sigma\pi)/\Gamma(\Sigma\pi\pi)$

Γ_3/Γ_5

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
varies with prod. angle	⁵ APSELL	74	HBC	+ $K^- p$ 2.87 GeV/c
1.39 ± 0.16	BERTHON	74	HBC	0 Quasi-2-body σ
2.5 to 0.24	⁴ EBERHARD	69	HBC	$K^- p$ 2.6 GeV/c
< 0.4	BIRMINGHAM	66	HBC	+ $K^- p$ 3.5 GeV/c
0.30 ± 0.15	LONDON	66	HBC	+ $K^- p$ 2.25 GeV/c

$\Gamma(\Lambda(1405)\pi)/\Gamma(\Sigma\pi\pi)$

Γ_7/Γ_5

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
0.97 ± 0.08	TIMMERMANS76	HBC		$K^- p$ 4.2 GeV/c
1.00 ± 0.02	APSELL	74	HBC	$K^- p$ 2.87 GeV/c
$0.90^{+0.10}_{-0.16}$	EBERHARD	65	HBC	+ $K^- p$ 2.45 GeV/c

$\Gamma(\Lambda(1405)\pi)/\Gamma(\Sigma(1385)\pi)$

Γ_7/Γ_6

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
< 0.8	EBERHARD	65	HBC	+ $K^- p$ 2.45 GeV/c

$\Gamma(\Lambda\pi\pi)/\Gamma(\Sigma\pi\pi)$	Γ_4/Γ_5			
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
0.35 ± 0.2	BIRMINGHAM 66	HBC	+	$K^- p$ 3.5 GeV/c

$\Gamma(\Lambda\pi)/\Gamma(\Sigma\pi\pi)$	Γ_2/Γ_5			
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
< 0.2	BIRMINGHAM 66	HBC	+	$K^- p$ 3.5 GeV/c

$\Gamma(\Lambda\pi)/[\Gamma(\Lambda\pi) + \Gamma(\Sigma\pi)]$	$\Gamma_2/(\Gamma_2 + \Gamma_3)$			
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
< 0.6	AGUILAR-...	70B HBC		

$\Gamma(\Sigma(1385)\pi)/\Gamma(\Sigma\pi)$	Γ_6/Γ_3			
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
$\leq 0.21 \pm 0.05$	TIMMERMANS76	HBC		$K^- p$ 4.2 GeV/c

$\Sigma(1670)$ QUANTUM NUMBERS (PRODUCTION EXPERIMENTS)

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>CHG</u>	<u>COMMENT</u>
$J^P = 3/2^-$	400	BUTTON-...	68 HBC	\pm	$\Sigma^0 \pi$
$J^P = 3/2^-$		EBERHARD	67 HBC	+	$\Lambda(1405)\pi$
$J^P = 3/2^+$		LEVEQUE	65 HBC		$\Lambda(1405)\pi$

$\Sigma(1670)$ FOOTNOTES

- ¹ Total cross-section bump with $(J+1/2) \Gamma_{el} / \Gamma_{total} = 0.23$.
- ² Enhancements in $\Sigma\pi$ and $\Sigma\pi\pi$ cross sections.
- ³ Backward production in the $\Lambda\pi^- K^+$ final state.
- ⁴ Depending on production angle.
- ⁵ APSELL 74, ESTES 74, and TIMMERMANS 76 find strong branching ratio dependence on production angle, as in earlier production experiments.

$\Sigma(1670)$ REFERENCES (PRODUCTION EXPERIMENTS)

FERRERSORIA 81	NP B178 373	A. Ferrer Soria <i>et al.</i>	(CERN, CDEF, EPOL+)
CARROLL 76	PRL 37 806	A.S. Carroll <i>et al.</i>	(BNL) I
HEPP 76	NP B115 82	V. Hepp <i>et al.</i>	(CERN, HEID, MPIM) I
TIMMERMANS 76	NP B112 77	J.J.M. Timmermans <i>et al.</i>	(NIJM, CERN+) JP
APSELL 74	PR D10 1419	S.P. Apsell <i>et al.</i>	(BRAN, UMD, SYRA+) I
BERTHON 74	NC 21A 146	A. Berthon <i>et al.</i>	(CDEF, RHEL, SACL+) I
ESTES 74	Thesis LBL-3827	R.D. Estes	(LBL)
AGUILAR-... 70B	PRL 25 58	M. Aguilar-Benitez <i>et al.</i>	(BNL, SYRA)
BARNES 69E	BNL 13823	V.E. Barnes <i>et al.</i>	(BNL, SYRA)
EBERHARD 69	PRL 22 200	P.H. Eberhard <i>et al.</i>	(LRL)
HUWE 69	PR 180 1824	D.O. Huwe	(LRL)
BUGG 68	PR 168 1466	D.V. Bugg <i>et al.</i>	(RHEL, BIRM, CAVE) I
BUTTON-... 68	PRL 21 1123	J. Button-Shafer	(MASA, LRL) JP
PRIMER 68	PRL 20 610	M. Primer <i>et al.</i>	(SYRA, BNL)
EBERHARD 67	PR 163 1446	P. Eberhard <i>et al.</i>	(LRL, ILL) IJP

BIRMINGHAM	66	PR 152 1148	M. Haque <i>et al.</i>	(BIRM, GLAS, LOIC, OXF+)
LONDON	66	PR 143 1034	G.W. London <i>et al.</i>	(BNL, SYRA) IJ
EBERHARD	65	PRL 14 466	P.H. Eberhard <i>et al.</i>	(LRL, ILL) I
LEVEQUE	65	PL 18 69	A. Leveque <i>et al.</i>	(SACL, EPOL, GLAS+) JP
ALVAREZ	63	PRL 10 184	L.W. Alvarez <i>et al.</i>	(LRL) I
SMITH	63	Athens Conf. 67	G.A. Smith	(LRL)
ALEXANDER	62C	CERN Conf. 320	G. Alexander <i>et al.</i>	(LRL) I
