# $\Sigma(1670)$ 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.

## Σ(1670) MASS (PRODUCTION EXPERIMENTS)

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| **≈ 1670 OUR ESTIMATE** | | | | | | |
| 1670±4 | | [1] CARROLL | 76 | DPWA | | Isospin-1 total $\sigma$ |
| 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 | 1.2k | BERTHON | 74 | HBC | 0 | Quasi-2-body $\sigma$ |
| 1670±6 | | AGUILAR-... | 70B | HBC | | $K^- p \to \Sigma\pi\pi$ 4 GeV |
| 1668±10 | | AGUILAR-... | 70B | HBC | | $K^- p \to \Sigma 3\pi$ 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] FERRERSORIA | 81 | OMEG | − | $\pi^- p$ 9,12 GeV/$c$ |
| 1655 to 1677 | | TIMMERMANS | 76 | HBC | + | $K^- p$ 4.2 GeV/$c$ |
| 1665±5 | | BUGG | 68 | CNTR | | $K^- p$, $d$ total $\sigma$ |
| 1661±9 | 70 | PRIMER | 68 | HBC | + | See BARNES 69E |
| 1685 | | ALEXANDER | 62C | HBC | −0 | $\pi^- p$ 2–2.2 GeV/$c$ |

## Σ(1670) WIDTH (PRODUCTION EXPERIMENTS)

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| 67.0±2.4 | | APSELL | 74 | HBC | | $K^- p$ 2.87 GeV/$c$ |
| 110 ±12 | | AGUILAR-... | 70B | HBC | | $K^- p \to \Sigma\pi\pi$ 4 GeV |
| $135^{+40}_{-30}$ | | AGUILAR-... | 70B | HBC | | $K^- p \to \Sigma 3\pi$ 4 GeV |
| 40 ±10 | | ALVAREZ | 63 | HBC | + | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| 90 ±20 | 150 | [3] FERRERSORIA | 81 | OMEG | − | $\pi^- p$ 9,12 GeV/$c$ |
| 52 | | [1] CARROLL | 76 | DPWA | | Isospin-1 total $\sigma$ |
| 48 to 63 | | TIMMERMANS | 76 | 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 | |

## $\Sigma(1670)$ DECAY MODES (PRODUCTION EXPERIMENTS)

| | Mode |
|---|---|
| $\Gamma_1$ | $N\overline{K}$ |
| $\Gamma_2$ | $\Lambda\pi$ |
| $\Gamma_3$ | $\Sigma\pi$ |
| $\Gamma_4$ | $\Lambda\pi\pi$ |
| $\Gamma_5$ | $\Sigma\pi\pi$ |
| $\Gamma_6$ | $\Sigma(1385)\pi$ |
| $\Gamma_7$ | $\Lambda(1405)\pi$ |

## $\Sigma(1670)$ BRANCHING RATIOS (PRODUCTION EXPERIMENTS)

### $\Gamma(N\overline{K})/\Gamma(\Sigma\pi)$ — $\Gamma_1/\Gamma_3$

| VALUE | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| <0.03 | | TIMMERMANS | 76 | HBC | + | $K^- p$ 4.2 GeV/$c$ |
| <0.10 | | BERTHON | 74 | HBC | 0 | Quasi-2-body $\sigma$ |
| <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/$c$ |
| $\geq$ 0.5 $\pm$0.25 | | SMITH | 63 | HBC | −0 | |

### $\Gamma(\Lambda\pi)/\Gamma(\Sigma\pi)$ — $\Gamma_2/\Gamma_3$

| VALUE | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| 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/$c$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| $\leq$ 0.45±0.07 | | TIMMERMANS | 76 | HBC | + | $K^- p$ 4.2 GeV/$c$ |
| 0.55±0.11 | | BERTHON | 74 | HBC | 0 | Quasi-2-body $\sigma$ |
| 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 | |

### $\Gamma(\Lambda\pi\pi)/\Gamma(\Sigma\pi)$ — $\Gamma_4/\Gamma_3$

| VALUE | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| <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 | |

## $\Gamma(\Sigma\pi\pi)/\Gamma(\Sigma\pi)$ — $\Gamma_5/\Gamma_3$

| VALUE | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| 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/$c$ |

## $\Gamma(\Lambda(1405)\pi)/\Gamma(\Sigma\pi)$ — $\Gamma_7/\Gamma_3$

| VALUE | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| 1.8 ±0.3 to 0.02 ± 0.07 | | [3,4] TIMMERMANS | 76 | HBC | + | $K^- p$ 4.2 GeV/$c$ |
| largest at small angles | | ESTES | 74 | HBC | ± | $K^- p$ 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 |

## $\Gamma(\Sigma\pi)/\Gamma(\Sigma\pi\pi)$ — $\Gamma_3/\Gamma_5$

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| 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 $\sigma$ |
| 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/$c$ |

## $\Gamma(\Lambda(1405)\pi)/\Gamma(\Sigma\pi\pi)$ — $\Gamma_7/\Gamma_5$

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| 0.97±0.08 | TIMMERMANS | 76 | 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/$c$ |

## $\Gamma(\Lambda(1405)\pi)/\Gamma(\Sigma(1385)\pi)$ — $\Gamma_7/\Gamma_6$

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

## $\Gamma(\Lambda\pi\pi)/\Gamma(\Sigma\pi\pi)$ — $\Gamma_4/\Gamma_5$

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| 0.35±0.2 | BIRMINGHAM | 66 | HBC | + | $K^- p$ 3.5 GeV/$c$ |

## $\Gamma(\Lambda\pi)/\Gamma(\Sigma\pi\pi)$ — $\Gamma_2/\Gamma_5$

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| <0.2 | BIRMINGHAM | 66 | HBC | + | $K^- p$ 3.5 GeV/$c$ |

## $\Gamma(\Lambda\pi)/[\Gamma(\Lambda\pi)+\Gamma(\Sigma\pi)]$ — $\Gamma_2/(\Gamma_2+\Gamma_3)$

| VALUE | DOCUMENT ID | | TECN |
|---|---|---|---|
| <0.6 | AGUILAR-... | 70B | HBC |

### $\Gamma(\Sigma(1385)\pi)/\Gamma(\Sigma\pi)$ $\Gamma_6/\Gamma_3$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| $\leq 0.21\pm0.05$ | TIMMERMANS76 | HBC | $K^- p$ 4.2 GeV/$c$ |

## Σ(1670) QUANTUM NUMBERS (PRODUCTION EXPERIMENTS)

| VALUE | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| $J^P = 3/2^-$ | 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 | | $\Lambda(1405)\pi$ |

## Σ(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.

## Σ(1670) REFERENCES (PRODUCTION EXPERIMENTS)


| | | | | | |
|---|---|---|---|---|---|
| FERRERSORIA | 81 | NP B178 373 | A. Ferrer Soria *et al.* | (CERN, CDEF, EPOL+) | |
| CARROLL | 76 | PRL 37 806 | A.S. Carroll *et al.* | (BNL) | I |
| HEPP | 76 | NP B115 82 | V. Hepp *et al.* | (CERN, HEID, MPIM) | I |
| TIMMERMANS | 76 | NP B112 77 | J.J.M. Timmermans *et al.* | (NIJM, CERN+) | JP |
| APSELL | 74 | PR D10 1419 | S.P. Apsell *et al.* | (BRAN, UMD, SYRA+) | I |
| BERTHON | 74 | NC 21A 146 | A. Berthon *et al.* | (CDEF, RHEL, SACL+) | |
| ESTES | 74 | Thesis LBL-3827 | R.D. Estes | (LBL) | |
| AGUILAR-... | 70B | PRL 25 58 | M. Aguilar-Benitez *et al.* | (BNL, SYRA) | |
| BARNES | 69E | BNL 13823 | V.E. Barnes *et al.* | (BNL, SYRA) | |
| EBERHARD | 69 | PRL 22 200 | P.H. Eberhard *et al.* | (LRL) | |
| HUWE | 69 | PR 181 1824 | D.O. Huwe | (LRL) | |
| BUGG | 68 | PR 168 1466 | D.V. Bugg *et al.* | (RHEL, BIRM, CAVE) | I |
| BUTTON-... | 68 | PRL 21 1123 | J. Button-Shafer | (MASA, LRL) | JP |
| PRIMER | 68 | PRL 20 610 | M. Primer *et al.* | (SYRA, BNL) | |
| EBERHARD | 67 | PR 163 1446 | P. Eberhard *et al.* | (LRL, ILL) | IJP |
| BIRMINGHAM | 66 | PR 152 1148 | M. Haque *et al.* | (BIRM, GLAS, LOIC, OXF+) | |
| LONDON | 66 | PR 143 1034 | G.W. London *et al.* | (BNL, SYRA) | IJ |
| EBERHARD | 65 | PRL 14 466 | P.H. Eberhard *et al.* | (LRL, ILL) | I |
| LEVEQUE | 65 | PL 18 69 | A. Leveque *et al.* | (SACL, EPOL, GLAS+) | JP |
| ALVAREZ | 63 | PRL 10 184 | L.W. Alvarez *et al.* | (LRL) | I |
| SMITH | 63 | Athens Conf. 67 | G.A. Smith | (LRL) | |
| ALEXANDER | 62C | CERN Conf. 320 | G. Alexander *et al.* | (LRL) | I |