# $\Sigma(1670)$ $3/2^-$

$I(J^P) = 1(\frac{3}{2}^-)$ Status: ∗∗∗∗

For most results published before 1974 (they are now obsolete), see our 1982 edition Physics Letters **111B** 1 (1982).

Results from production experiments are listed separately in the next entry.

## Σ(1670) POLE POSITION

### REAL PART

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **$1669^{+7}_{-7}$** | [1] KAMANO | 15 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1674 | ZHANG | 13A | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### −2×IMAGINARY PART

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **$64^{+10}_{-14}$** | [1] KAMANO | 15 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 54 | ZHANG | 13A | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

## Σ(1670) POLE RESIDUES

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

### Normalized residue in $N\overline{K} \rightarrow \Sigma(1670) \rightarrow N\overline{K}$

| MODULUS | PHASE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.129 | −20 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### Normalized residue in $N\overline{K} \rightarrow \Sigma(1670) \rightarrow \Sigma\pi$

| MODULUS | PHASE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.249 | −21 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### Normalized residue in $N\overline{K} \rightarrow \Sigma(1670) \rightarrow \Lambda\pi$

| MODULUS | PHASE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.0818 | −7 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### Normalized residue in $N\overline{K} \rightarrow \Sigma(1670) \rightarrow \Sigma(1385)\pi$, $S$-wave

| MODULUS | PHASE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.228 | 167 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### Normalized residue in $N\overline{K} \rightarrow \Sigma(1670) \rightarrow \Sigma(1385)\pi$, $D$-wave

| MODULUS | PHASE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.0915 | 141 | KAMANO | 15 | DPWA | Multichannel |

## Σ(1670) MASS

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **1665 to 1685 (≈ 1670) OUR ESTIMATE** | | | | |
| 1678 ± 2 | ZHANG | 13A | DPWA | Multichannel |
| 1673 ± 1 | GAO | 12 | DPWA | $\overline{K}N \rightarrow \Lambda\pi$ |
| 1665.1 ± 4.1 | KOISO | 85 | DPWA | $K^- p \rightarrow \Sigma\pi$ |
| 1682 ± 5 | GOPAL | 80 | DPWA | $\overline{K}N \rightarrow \overline{K}N$ |
| 1679 ± 10 | ALSTON-... | 78 | DPWA | $\overline{K}N \rightarrow \overline{K}N$ |
| 1670 ± 5 | GOPAL | 77 | DPWA | $\overline{K}N$ multichannel |
| 1670 ± 6 | HEPP | 76B | DPWA | $K^- N \rightarrow \Sigma\pi$ |
| 1685 ± 20 | BAILLON | 75 | IPWA | $\overline{K}N \rightarrow \Lambda\pi$ |
| $1659\ ^{+12}_{-5}$ | VANHORN | 75 | DPWA | $K^- p \rightarrow \Lambda\pi^0$ |
| 1670 ± 2 | KANE | 74 | DPWA | $K^- p \rightarrow \Sigma\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1667 or 1668 | [1] MARTIN | 77 | DPWA | $\overline{K}N$ multichannel |
| 1650 | DEBELLEFON | 76 | IPWA | $K^- p \rightarrow \Lambda\pi^0$ |
| 1671 ± 3 | PONTE | 75 | DPWA | $K^- p \rightarrow \Lambda\pi^0$ (sol. 1) |
| 1655 ± 2 | PONTE | 75 | DPWA | $K^- p \rightarrow \Lambda\pi^0$ (sol. 2) |

[1] The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit.

## Σ(1670) WIDTH

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **40 to 80 (≈ 60) OUR ESTIMATE** | | | | |
| 55 ± 4 | ZHANG | 13A | DPWA | Multichannel |
| $52\ ^{+5}_{-2}$ | GAO | 12 | DPWA | $\overline{K}N \rightarrow \Lambda\pi$ |
| 65.0 ± 7.3 | KOISO | 85 | DPWA | $K^- p \rightarrow \Sigma\pi$ |
| 79 ± 10 | GOPAL | 80 | DPWA | $\overline{K}N \rightarrow \overline{K}N$ |
| 56 ± 20 | ALSTON-... | 78 | DPWA | $\overline{K}N \rightarrow \overline{K}N$ |
| 50 ± 5 | GOPAL | 77 | DPWA | $\overline{K}N$ multichannel |
| 56 ± 3 | HEPP | 76B | DPWA | $K^- N \rightarrow \Sigma\pi$ |
| 85 ± 25 | BAILLON | 75 | IPWA | $\overline{K}N \rightarrow \Lambda\pi$ |
| 32 ± 11 | VANHORN | 75 | DPWA | $K^- p \rightarrow \Lambda\pi^0$ |
| 79 ± 6 | KANE | 74 | DPWA | $K^- p \rightarrow \Sigma\pi$ |

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

| | | | | |
|---|---|---|---|---|
| 46 or 46 | [1] MARTIN | 77 | DPWA | $\overline{K}N$ multichannel |
| 80 | DEBELLEFON | 76 | IPWA | $K^- p \to \Lambda\pi^0$ |
| 44 ±11 | PONTE | 75 | DPWA | $K^- p \to \Lambda\pi^0$ (sol. 1) |
| 76 ± 5 | PONTE | 75 | DPWA | $K^- p \to \Lambda\pi^0$ (sol. 2) |

[1] The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit.

## Σ(1670) DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $N\overline{K}$ | 7–13 % |
| $\Gamma_2$ | $\Lambda\pi$ | 5–15 % |
| $\Gamma_3$ | $\Sigma\pi$ | 30–60 % |
| $\Gamma_4$ | $\Lambda\pi\pi$ | |
| $\Gamma_5$ | $\Sigma\pi\pi$ | |
| $\Gamma_6$ | $\Sigma(1385)\pi$ | |
| $\Gamma_7$ | $\Sigma(1385)\pi$, S-wave | |
| $\Gamma_8$ | $\Sigma(1385)\pi$, S-wave | |
| $\Gamma_9$ | $\Sigma(1385)\pi$, D-wave | |
| $\Gamma_{10}$ | $N\overline{K}^*(892)$, S=1/2, D-wave | |
| $\Gamma_{11}$ | $N\overline{K}^*(892)$, S=3/2, S-wave | |
| $\Gamma_{12}$ | $N\overline{K}^*(892)$, S=3/2, D-wave | |
| $\Gamma_{13}$ | $\Lambda(1405)\pi$ | |
| $\Gamma_{14}$ | $\Lambda(1520)\pi$ | |

## Σ(1670) BRANCHING RATIOS

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

### $\Gamma(N\overline{K})/\Gamma_{total}$ $\Gamma_1/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.07 to 0.13 OUR ESTIMATE** | | | | |
| 0.062±0.007 | ZHANG | 13A | DPWA | Multichannel |
| 0.10 ±0.03 | GOPAL | 80 | DPWA | $\overline{K}N \to \overline{K}N$ |
| 0.11 ±0.03 | ALSTON-... | 78 | DPWA | $\overline{K}N \to \overline{K}N$ |

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

| | | | | |
|---|---|---|---|---|
| 0.121 | [1] KAMANO | 15 | DPWA | Multichannel |
| 0.08 ±0.03 | GOPAL | 77 | DPWA | See GOPAL 80 |
| 0.07 or 0.07 | [2] MARTIN | 77 | DPWA | $\overline{K}N$ multichannel |

[1] From the preferred solution A in KAMANO 15.
[2] The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit.

### $\Gamma(\Lambda\pi)/\Gamma_{total}$ — $\Gamma_2/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.058 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### $\Gamma(\Sigma\pi)/\Gamma_{total}$ — $\Gamma_3/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.465 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### $\Gamma(\Lambda\pi\pi)/\Gamma_{total}$ — $\Gamma_4/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| <0.11 | ARMENTEROS | 68E | HBC | $K^- p$ ($\Gamma_1$=0.09) |

### $\Gamma(\Sigma\pi\pi)/\Gamma_{total}$ — $\Gamma_5/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| <0.14 | [1] ARMENTEROS | 68E | HBC | $K^- p$, $K^- d$ ($\Gamma_1$=0.09) |

[1] Ratio only for $\Sigma 2\pi$ system in $I = 1$, which cannot be $\Sigma(1385)$.

### $\Gamma(\Sigma(1385)\pi, S\text{-wave})/\Gamma_{total}$ — $\Gamma_8/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.309 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### $\Gamma(\Sigma(1385)\pi, D\text{-wave})/\Gamma_{total}$ — $\Gamma_9/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.044 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### $\Gamma(N\overline{K}^*(892), S=1/2, D\text{-wave})/\Gamma_{total}$ — $\Gamma_{10}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.001 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### $\Gamma(N\overline{K}^*(892), S=3/2, S\text{-wave})/\Gamma_{total}$ — $\Gamma_{11}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.002 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### $\Gamma(N\overline{K}^*(892), S=3/2, D\text{-wave})/\Gamma_{total}$ $\Gamma_{12}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.001 | [1] KAMANO | 15 | DPWA | Multichannel |

[1] From the preferred solution A in KAMANO 15.

### $\Gamma(\Lambda(1405)\pi)/\Gamma_{total}$ $\Gamma_{13}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $<0.06$ | ARMENTEROS | 68E | HBC | $K^- p$, $K^- d$ ($\Gamma_1$=0.09) |

### $\Gamma(\Lambda(1405)\pi)/\Gamma(\Sigma(1385)\pi)$ $\Gamma_{13}/\Gamma_6$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.23\pm0.08$ | BRUCKER | 70 | DBC | $K^- N \to \Sigma\pi\pi$ |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\overline{K} \to \Sigma(1670) \to \Lambda\pi$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $+0.08\ \pm0.01$ | ZHANG | 13A | DPWA | Multichannel |
| $+0.081^{+0.002}_{-0.004}$ | GAO | 12 | DPWA | $\overline{K}N \to \Lambda\pi$ |
| $+0.17\ \pm0.03$ | [1] MORRIS | 78 | DPWA | $K^- n \to \Lambda\pi^-$ |
| $+0.13\ \pm0.02$ | [1] MORRIS | 78 | DPWA | $K^- n \to \Lambda\pi^-$ |
| $+0.10\ \pm0.02$ | GOPAL | 77 | DPWA | $\overline{K}N$ multichannel |
| $+0.06\ \pm0.02$ | BAILLON | 75 | IPWA | $\overline{K}N \to \Lambda\pi$ |
| $+0.09\ \pm0.02$ | VANHORN | 75 | DPWA | $K^- p \to \Lambda\pi^0$ |
| $+0.018\pm0.060$ | DEVENISH | 74B | | Fixed-$t$ dispersion rel. |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $+0.08$ or $+0.08$ | [2] MARTIN | 77 | DPWA | $\overline{K}N$ multichannel |
| $+0.05$ | DEBELLEFON | 76 | IPWA | $K^- p \to \Lambda\pi^0$ |
| $+0.08\ \pm0.01$ | PONTE | 75 | DPWA | $K^- p \to \Lambda\pi^0$ (sol. 1) |
| $+0.17\ \pm0.01$ | PONTE | 75 | DPWA | $K^- p \to \Lambda\pi^0$ (sol. 2) |

[1] Results are with and without an $S_{11}$ $\Sigma(1620)$ in the fit.

[2] The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit.

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\overline{K} \to \Sigma(1670) \to \Sigma\pi$ $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $+0.20\pm0.01$ | ZHANG | 13A | DPWA | Multichannel |
| $+0.20\pm0.02$ | KOISO | 85 | DPWA | $K^- p \to \Sigma\pi$ |
| $+0.21\pm0.02$ | GOPAL | 77 | DPWA | $\overline{K}N$ multichannel |
| $+0.20\pm0.01$ | HEPP | 76B | DPWA | $K^- N \to \Sigma\pi$ |
| $+0.21\pm0.03$ | KANE | 74 | DPWA | $K^- p \to \Sigma\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $+0.18$ or $+0.17$ | [1] MARTIN | 77 | DPWA | $\overline{K}N$ multichannel |

[1] The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit.

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\overline{K} \to \Sigma(1670) \to \Sigma(1385)\pi$, S-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $+0.11\pm0.03$ | PREVOST | 74 | DPWA | $K^- N \to \Sigma(1385)\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $0.17\pm0.02$ | [1] SIMS | 68 | DBC | $K^- N \to \Lambda\pi\pi$ |

[1] SIMS 68 uses only cross-section data. Result used as upper limit only.

### $\Gamma_i\Gamma_f/\Gamma^2_{total}$ in $N\overline{K} \to \Sigma(1670) \to \Lambda(1405)\pi$ — $\Gamma_1\Gamma_{13}/\Gamma^2$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.007\pm0.002$ | [1] BRUCKER | 70 | DBC | $K^- N \to \Sigma\pi\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $<0.03$ | BERLEY | 69 | HBC | $K^- p$ 0.6–0.82 GeV/$c$ |

[1] Assuming the $\Lambda(1405)\pi$ cross-section bump is due only to $3/2^-$ resonance.

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\overline{K} \to \Sigma(1670) \to \Lambda(1520)\pi$ — $(\Gamma_1\Gamma_{14})^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.081\pm0.016$ | [1] CAMERON | 77 | DPWA | P-wave decay |

[1] The CAMERON 77 upper limit on F-wave decay is 0.03.

## $\Sigma(1670)$ REFERENCES


| | | | | |
|---|---|---|---|---|
| KAMANO | 15 | PR C92 025205 | H. Kamano *et al.* | (ANL, OSAK) |
| ZHANG | 13A | PR C88 035205 | H. Zhang *et al.* | (KSU) |
| GAO | 12 | PR C86 025201 | P. Gao, J. Shi, B.S. Zou | (BHEP, BEIJT) |
| Also | | NP A867 41 | P. Gao, B.S. Zou, A. Sibirtsev | (BHEP, BEIJT+) |
| KOISO | 85 | NP A433 619 | H. Koiso *et al.* | (TOKY, MASA) |
| PDG | 82 | PL 111B 1 | M. Roos *et al.* | (HELS, CIT, CERN) |
| GOPAL | 80 | Toronto Conf. 159 | G.P. Gopal | (RHEL) IJP |
| ALSTON-... | 78 | PR D18 182 | M. Alston-Garnjost *et al.* | (LBL, MTHO+) IJP |
| Also | | PRL 38 1007 | M. Alston-Garnjost *et al.* | (LBL, MTHO+) IJP |
| MORRIS | 78 | PR D17 55 | W.A. Morris *et al.* | (FSU) IJP |
| CAMERON | 77 | NP B131 399 | W. Cameron *et al.* | (RHEL, LOIC) IJP |
| GOPAL | 77 | NP B119 362 | G.P. Gopal *et al.* | (LOIC, RHEL) IJP |
| MARTIN | 77 | NP B127 349 | B.R. Martin, M.K. Pidcock, R.G. Moorhouse | (LOUC+) IJP |
| Also | | NP B126 266 | B.R. Martin, M.K. Pidcock | (LOUC) |
| Also | | NP B126 285 | B.R. Martin, M.K. Pidcock | (LOUC) IJP |
| DEBELLEFON | 76 | NP B109 129 | A. de Bellefon, A. Berthon | (CDEF) IJP |
| HEPP | 76B | PL 65B 487 | V. Hepp *et al.* | (CERN, HEIDH, MPIM) IJP |
| BAILLON | 75 | NP B94 39 | P.H. Baillon, P.J. Litchfield | (CERN, RHEL) IJP |
| PONTE | 75 | PR D12 2597 | R.A. Ponte *et al.* | (MASA, TENN, UCR) IJP |
| VANHORN | 75 | NP B87 145 | A.J. van Horn | (LBL) IJP |
| Also | | NP B87 157 | A.J. van Horn | (LBL) IJP |
| DEVENISH | 74B | NP B81 330 | R.C.E. Devenish, C.D. Froggatt, B.R. Martin | (DESY+) |
| KANE | 74 | LBL-2452 | D.F. Kane | (LBL) IJP |
| PREVOST | 74 | NP B69 246 | J. Prevost *et al.* | (SACL, CERN, HEID) |
| BRUCKER | 70 | Duke Conf. 155 | E.B. Brucker *et al.* | (FSU) I |
| Hyperon Resonances, 1970 | | | | |
| BERLEY | 69 | PL 30B 430 | D. Berley *et al.* | (BNL) |
| ARMENTEROS | 68E | PL 28B 521 | R. Armenteros *et al.* | (CERN, HEID, SACL) I |
| SIMS | 68 | PRL 21 1413 | W.H. Sims *et al.* | (FSU, TUFTS, BRAN) |