

$\Sigma(1660) 1/2^+$ $I(J^P) = 1(\frac{1}{2}^+)$ Status: ***

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

 $\Sigma(1660)$ POLE POSITION**REAL PART**

| <u>VALUE (MeV)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|--------------------|--------------------|-------------|----------------|
|--------------------|--------------------|-------------|----------------|

| | | | |
|------------------|--------------|------|-------------------------|
| 1585 ± 20 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |
|------------------|--------------|------|-------------------------|

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

| | | | |
|---------------------|------------------------|------|-------------------------|
| 1547^{+111}_{-59} | ¹ KAMANO 15 | DPWA | $\bar{K}N$ multichannel |
|---------------------|------------------------|------|-------------------------|

¹From the preferred solution A in KAMANO 15. Solution B reports $M = 1457^{+5}_{-1}$ MeV.

−2×IMAGINARY PART

| <u>VALUE (MeV)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
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| 290⁺¹⁴⁰_{−40} | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |
|---|--------------|------|-------------------------|

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

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|-------------------|------------------------|------|-------------------------|
| 183^{+86}_{-78} | ¹ KAMANO 15 | DPWA | $\bar{K}N$ multichannel |
|-------------------|------------------------|------|-------------------------|

¹From the preferred solution A in KAMANO 15. Solution B reports $\Gamma = 78^{+2}_{-8}$ MeV.

 $\Sigma(1660)$ POLE RESIDUES

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

Normalized residue in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow N\bar{K}$

| <u>MODULUS</u> | <u>PHASE (°)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|----------------|------------------|--------------------|-------------|----------------|
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|--------------------|------------------|--------------|------|-------------------------|
| 0.07 ± 0.03 | −165 ± 35 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |
|--------------------|------------------|--------------|------|-------------------------|

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

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|--------|-----|------------------------|------|-------------------------|
| 0.0247 | 168 | ¹ KAMANO 15 | DPWA | $\bar{K}N$ multichannel |
|--------|-----|------------------------|------|-------------------------|

¹From the preferred solution A in KAMANO 15.

Normalized residue in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Sigma\pi$

| <u>MODULUS</u> | <u>PHASE (°)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|----------------|------------------|--------------------|-------------|----------------|
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|--------------------|-----------------|--------------|------|-------------------------|
| 0.17 ± 0.04 | 150 ± 20 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |
|--------------------|-----------------|--------------|------|-------------------------|

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

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|------|----|------------------------|------|-------------------------|
| 0.16 | 78 | ¹ KAMANO 15 | DPWA | $\bar{K}N$ multichannel |
|------|----|------------------------|------|-------------------------|

¹From the preferred solution A in KAMANO 15.

Normalized residue in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Lambda\pi$

| <u>MODULUS</u> | <u>PHASE (°)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|----------------|------------------|--------------------|-------------|----------------|
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|--------------------|---------------|--------------|------|-------------------------|
| 0.16 ± 0.05 | 0 ± 25 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |
|--------------------|---------------|--------------|------|-------------------------|

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

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|--------|-----|------------------------|------|-------------------------|
| 0.0614 | −84 | ¹ KAMANO 15 | DPWA | $\bar{K}N$ multichannel |
|--------|-----|------------------------|------|-------------------------|

¹From the preferred solution A in KAMANO 15.

Normalized residue in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Sigma\sigma$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|------------------|------------------------------------|--------------------|-------------|-------------------------|
| 0.14±0.06 | -150 ± 30 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |

Normalized residue in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Sigma(1385)\pi$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|----------------|------------------------------------|--------------------|-------------|----------------|
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• • • We do not use the following data for averages, fits, limits, etc. • • •

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|--------|-----|---------------------|----|------|--------------|
| 0.0513 | -44 | ¹ KAMANO | 15 | DPWA | Multichannel |
|--------|-----|---------------------|----|------|--------------|

¹From the preferred solution A in KAMANO 15.

Normalized residue in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Lambda(1405)\pi$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|------------------|------------------------------------|--------------------|-------------|-------------------------|
| 0.06±0.03 | -90 ± 25 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |

Normalized residue in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Lambda(1520)\pi$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|------------------|------------------------------------|--------------------|-------------|-------------------------|
| 0.04±0.02 | 5 ± 20 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |

 $\Sigma(1660)$ MASS

| <u>VALUE (MeV)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|--------------------|--------------------|-------------|----------------|
|--------------------|--------------------|-------------|----------------|

1640 to 1680 (≈ 1660) OUR ESTIMATE

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|-------------|--------------------|----|--|
| 1665 ± 20 | SARANTSEV | 19 | DPWA $\bar{K}N$ multichannel |
| 1633 ± 3 | GAO | 12 | DPWA $\bar{K}N \rightarrow \Lambda\pi$ |
| 1665.1±11.2 | ¹ KOISO | 85 | DPWA $K^-p \rightarrow \Sigma\pi$ |
| 1670 ± 10 | GOPAL | 80 | DPWA $\bar{K}N \rightarrow \bar{K}N$ |
| 1679 ± 10 | ALSTON-... | 78 | DPWA $\bar{K}N \rightarrow \bar{K}N$ |
| 1668 ± 25 | VANHORN | 75 | DPWA $K^-p \rightarrow \Lambda\pi^0$ |
| 1670 ± 20 | KANE | 74 | DPWA $K^-p \rightarrow \Sigma\pi$ |

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

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|--------------|----------------------|----|--|
| 1676 ± 15 | GOPAL | 77 | DPWA $\bar{K}N$ multichannel |
| 1565 or 1597 | ² MARTIN | 77 | DPWA $\bar{K}N$ multichannel |
| 1660 ± 30 | ³ BAILLON | 75 | IPWA $\bar{K}N \rightarrow \Lambda\pi$ |
| 1671 ± 2 | ⁴ PONTE | 75 | DPWA $K^-p \rightarrow \Lambda\pi^0$ |

¹The evidence of KOISO 85 is weak.

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

³From solution 1 of BAILLON 75; not present in solution 2.

⁴From solution 2 of PONTE 75; not present in solution 1.

 $\Sigma(1660)$ WIDTH

| <u>VALUE (MeV)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|--------------------|--------------------|-------------|----------------|
|--------------------|--------------------|-------------|----------------|

100 to 300 (≈ 200) OUR ESTIMATE

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|---|--------------------|----|--|
| 300 $\begin{matrix} +140 \\ -40 \end{matrix}$ | SARANTSEV | 19 | DPWA $\bar{K}N$ multichannel |
| 121 $\begin{matrix} +4 \\ -7 \end{matrix}$ | GAO | 12 | DPWA $\bar{K}N \rightarrow \Lambda\pi$ |
| 81.5± 22.2 | ¹ KOISO | 85 | DPWA $K^-p \rightarrow \Sigma\pi$ |
| 152 ± 20 | GOPAL | 80 | DPWA $\bar{K}N \rightarrow \bar{K}N$ |

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|---|----------------------|----|--|
| 38 ± 10 | ALSTON-... | 78 | DPWA $\bar{K}N \rightarrow \bar{K}N$ |
| 230 +165 - 60 | VANHORN | 75 | DPWA $K^- p \rightarrow \Lambda\pi^0$ |
| 250 ±110 | KANE | 74 | DPWA $K^- p \rightarrow \Sigma\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 120 ± 20 | GOPAL | 77 | DPWA $\bar{K}N$ multichannel |
| 202 or 217 | ² MARTIN | 77 | DPWA $\bar{K}N$ multichannel |
| 80 ± 40 | ³ BAILLON | 75 | IPWA $\bar{K}N \rightarrow \Lambda\pi$ |
| 81 ± 10 | ⁴ PONTE | 75 | DPWA $K^- p \rightarrow \Lambda\pi^0$ |

¹The evidence of KOISO 85 is weak.²The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit.³From solution 1 of BAILLON 75; not present in solution 2.⁴From solution 2 of PONTE 75; not present in solution 1.

Σ(1660) DECAY MODES

| Mode | Fraction (Γ_i/Γ) |
|-------------------------------|--------------------------------|
| Γ_1 $N\bar{K}$ | 0.05 to 0.15 (≈ 010) |
| Γ_2 $\Lambda\pi$ | (35 ±12) % |
| Γ_3 $\Sigma\pi$ | (37 ±10) % |
| Γ_4 $\Sigma\sigma$ | (20 ± 8) % |
| Γ_5 $\Sigma(1385)\pi$ | |
| Γ_6 $\Lambda(1405)\pi$ | (4.0 ± 2.0) % |
| Γ_7 $\Lambda(1520)\pi$ | |

Σ(1660) 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 |
|---|---------------------|------|--------------------------------------|-------------------|
| VALUE | DOCUMENT ID | TECN | COMMENT | |
| 0.05 to 0.15 (≈ 010) OUR ESTIMATE | | | | |
| 0.07 ±0.03 | SARANTSEV | 19 | DPWA $\bar{K}N$ multichannel | |
| 0.12 ±0.03 | GOPAL | 80 | DPWA $\bar{K}N \rightarrow \bar{K}N$ | |
| 0.10 ±0.05 | ALSTON-... | 78 | DPWA $\bar{K}N \rightarrow \bar{K}N$ | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.005 | ¹ KAMANO | 15 | DPWA $\bar{K}N$ multichannel | |
| <0.04 | GOPAL | 77 | DPWA See GOPAL 80 | |
| 0.27 or 0.29 | ² MARTIN | 77 | DPWA $\bar{K}N$ 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. | | | | |

| $\Gamma(\Lambda\pi)/\Gamma_{\text{total}}$ | | | | Γ_2/Γ |
|---|---------------------|------|------------------------------|-------------------|
| VALUE | DOCUMENT ID | TECN | COMMENT | |
| 0.35 ±0.12 | | | | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.128 | ¹ KAMANO | 15 | DPWA $\bar{K}N$ multichannel | |
| ¹ From the preferred solution A in KAMANO 15. | | | | |

$\Gamma(\Sigma\pi)/\Gamma_{\text{total}}$ Γ_3/Γ

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|------------------------|------|-------------------------|
| 0.37 ± 0.10 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 0.865 | ¹ KAMANO 15 | DPWA | $\bar{K}N$ multichannel |
| ¹ From the preferred solution A in KAMANO 15. | | | |

 $\Gamma(\Sigma\sigma)/\Gamma_{\text{total}}$ Γ_4/Γ

| VALUE | DOCUMENT ID | TECN | COMMENT |
|--------------------|--------------|------|-------------------------|
| 0.20 ± 0.08 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |

 $\Gamma(\Sigma(1385)\pi)/\Gamma_{\text{total}}$ Γ_5/Γ

| 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. | | | |

 $\Gamma(\Lambda(1405)\pi)/\Gamma_{\text{total}}$ Γ_6/Γ

| VALUE | DOCUMENT ID | TECN | COMMENT |
|--------------------|--------------|------|-------------------------|
| 0.04 ± 0.02 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |

 $\Gamma(\Lambda(1520)\pi)/\Gamma_{\text{total}}$ Γ_7/Γ

| VALUE | DOCUMENT ID | TECN | COMMENT |
|--------|--------------|------|-------------------------|
| < 0.01 | SARANTSEV 19 | DPWA | $\bar{K}N$ multichannel |

 $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Lambda\pi$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|-------------------------|------|-----------------------------------|
| $-0.064^{+0.005}_{-0.003}$ | GAO 12 | DPWA | $\bar{K}N \rightarrow \Lambda\pi$ |
| < 0.04 | GOPAL 77 | DPWA | $\bar{K}N$ multichannel |
| $0.12^{+0.12}_{-0.04}$ | VANHORN 75 | DPWA | $K^-p \rightarrow \Lambda\pi^0$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| -0.10 or -0.11 | ¹ MARTIN 77 | DPWA | $\bar{K}N$ multichannel |
| -0.04 ± 0.02 | ² BAILLON 75 | IPWA | $\bar{K}N \rightarrow \Lambda\pi$ |
| $+0.16 \pm 0.01$ | ³ PONTE 75 | DPWA | $K^-p \rightarrow \Lambda\pi^0$ |
| ¹ The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit. | | | |
| ² From solution 1 of BAILLON 75; not present in solution 2. | | | |
| ³ From solution 2 of PONTE 75; not present in solution 1. | | | |

 $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\bar{K} \rightarrow \Sigma(1660) \rightarrow \Sigma\pi$ $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|------------------------|------|------------------------------|
| -0.13 ± 0.04 | ¹ KOISO 85 | DPWA | $K^-p \rightarrow \Sigma\pi$ |
| -0.16 ± 0.03 | GOPAL 77 | DPWA | $\bar{K}N$ multichannel |
| -0.11 ± 0.01 | KANE 74 | DPWA | $K^-p \rightarrow \Sigma\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| -0.34 or -0.37 | ² MARTIN 77 | DPWA | $\bar{K}N$ multichannel |
| not seen | HEPP 76B | DPWA | $K^-N \rightarrow \Sigma\pi$ |
| ¹ The evidence of KOISO 85 is weak. | | | |
| ² The two MARTIN 77 values are from a T-matrix pole and from a Breit-Wigner fit. | | | |

$\Sigma(1660)$ REFERENCES

| | | | | |
|------------|-----|-------------------|---|-------------------------|
| 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) |
| 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 <i>et al.</i> | (TOKY, MASA) |
| PDG | 82 | PL 111B 1 | M. Roos <i>et al.</i> | (HELS, CIT, CERN) |
| GOPAL | 80 | Toronto Conf. 159 | G.P. Gopal | (RHEL) IJP |
| 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 |
| GOPAL | 77 | NP B119 362 | G.P. Gopal <i>et al.</i> | (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 |
| HEPP | 76B | PL 65B 487 | V. Hepp <i>et al.</i> | (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 <i>et al.</i> | (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 |
| KANE | 74 | LBL-2452 | D.F. Kane | (LBL) IJP |
