LIGHT QUARKS (*u*, *d*, *s*)

OMITTED FROM SUMMARY TABLE

u-QUARK MASS

The *u*-, *d*-, and *s*-quark masses are estimates of so-called "current-quark masses," in a mass- independent subtraction scheme such as $\overline{\rm MS}$. The ratios m_u/m_d and m_s/m_d are extracted from pion and kaon masses using chiral symmetry. The estimates of *d* and *u* masses are not without controversy and remain under active investigation. Within the literature there are even suggestions that the *u* quark could be essentially massless. The *s*-quark mass is estimated from SU(3) splittings in hadron masses.

We have normalized the $\overline{\rm MS}$ masses at a renormalization scale of $\mu = 2$ GeV. Results quoted in the literature at $\mu = 1$ GeV have been rescaled by dividing by 1.35. The values of "Our Evaluation" were determined in part via Figures 1 and 2.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
$\mathbf{2.55^{+0.75}_{-1.05}}$ **(1.5–3.3) OUR EVALUATION**	See the ideogram below.			
2.9 ±0.2	[1] DOMINGUEZ	09	THEO	$\overline{\rm MS}$ scheme
2.9 ±0.8	[2] DEANDREA	08	THEO	$\overline{\rm MS}$ scheme
3.02±0.33	[3] BLUM	07	LATT	$\overline{\rm MS}$ scheme
2.7 ±0.4	[4] JAMIN	06	THEO	$\overline{\rm MS}$ scheme
2.8 ±0.2	[5] NARISON	06	THEO	$\overline{\rm MS}$ scheme
1.7 ±0.3	[6] AUBIN	04A	LATT	$\overline{\rm MS}$ scheme
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.9 ±0.6	[7] JAMIN	02	THEO	$\overline{\rm MS}$ scheme
2.3 ±0.4	[8] NARISON	99	THEO	$\overline{\rm MS}$ scheme
3.9 ±1.1	[9] JAMIN	95	THEO	$\overline{\rm MS}$ scheme
3.0 ±0.7	[10] NARISON	95C	THEO	$\overline{\rm MS}$ scheme

[1] DOMINGUEZ 09 use QCD finite energy sum rules for the two-point function of the divergence of the axial vector current computed to order α_s^4.

[2] DEANDREA 08 determine $m_u - m_d$ from $\eta \rightarrow 3\pi^0$, and combine with the PDG 06 lattice average value of $m_u + m_d = 7.6 \pm 1.6$ to determine m_u and m_d.

[3] BLUM 07 determine quark mass using a QED plus QCD lattice computation with two dynamical flavors of the pseudoscalar meson masses.

[4] JAMIN 06 determine m_u(2 GeV) by combining the value of m_s obtained from the spectral function for the scalar $K\pi$ form factor with other determinations of the quark mass ratios.

[5] NARISON 06 uses sum rules for $e^+ e^- \rightarrow$ hadrons to order α_s^3 to determine m_s combined with other determinations of the quark mass ratios.

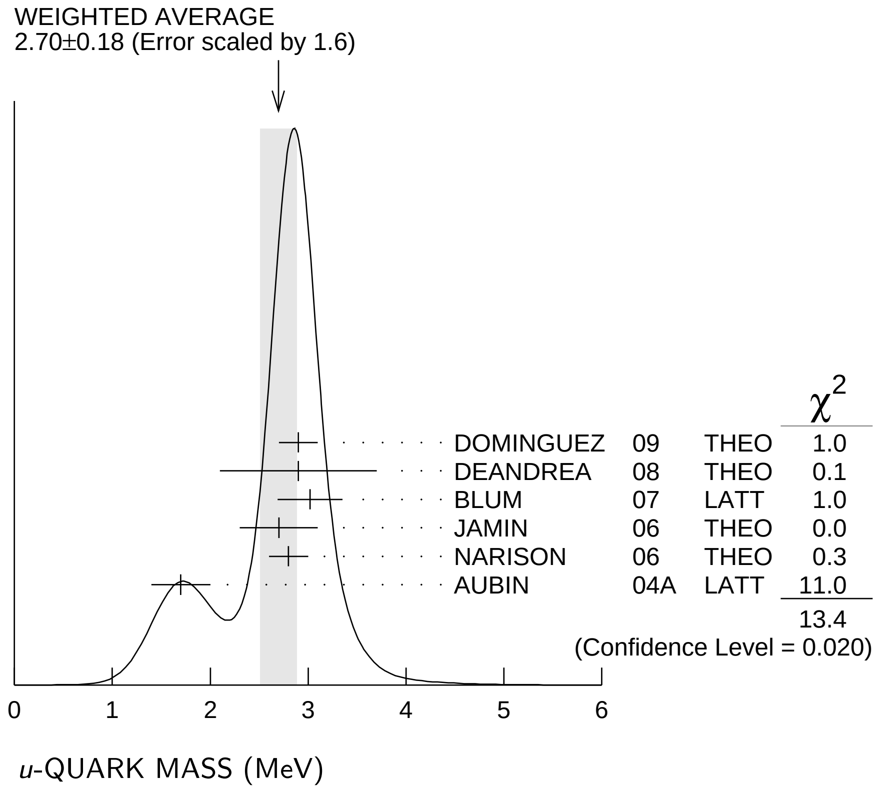
[6] AUBIN 04A employ a partially quenched lattice calculation of the pseudoscalar meson masses.

[7] JAMIN 02 first calculates the strange quark mass from QCD sum rules using the scalar channel, and then combines with the quark mass ratios obtained from chiral perturbation theory to obtain m_u.

[8] NARISON 99 uses sum rules to order α_s^3 for ϕ meson decays to get m_s, and finds m_u by combining with sum rule estimates of $m_u + m_d$ and Dashen's formula.

[9] JAMIN 95 uses QCD sum rules at next-to-leading order. We have rescaled $m_u(1\,\text{GeV}) = 5.3 \pm 1.5$ to $\mu = 2\,\text{GeV}$.

[10] For NARISON 95C, we have rescaled $m_u(1\,\text{GeV}) = 4 \pm 1$ to $\mu = 2\,\text{GeV}$.



d-QUARK MASS

See the comment for the *u* quark above.

We have normalized the $\overline{\text{MS}}$ masses at a renormalization scale of $\mu = 2$ GeV. Results quoted in the literature at $\mu = 1$ GeV have been rescaled by dividing by 1.35. The values of "Our Evaluation" were determined in part via Figures 1 and 2.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
$5.04^{+0.96}_{-1.54}$ (3.5–6.0) OUR EVALUATION See the ideogram below.				
5.3 ±0.4	[11] DOMINGUEZ	09	THEO	$\overline{\text{MS}}$ scheme
4.7 ±0.8	[12] DEANDREA	08	THEO	$\overline{\text{MS}}$ scheme
5.49±0.39	[13] BLUM	07	LATT	$\overline{\text{MS}}$ scheme
4.8 ±0.5	[14] JAMIN	06	THEO	$\overline{\text{MS}}$ scheme
5.1 ±0.4	[15] NARISON	06	THEO	$\overline{\text{MS}}$ scheme
3.9 ±0.5	[16] AUBIN	04A	LATT	$\overline{\text{MS}}$ scheme
• • • We do not use the following data for averages, fits, limits, etc. • • •				
5.2 ±0.9	[17] JAMIN	02	THEO	$\overline{\text{MS}}$ scheme
6.4 ±1.1	[18] NARISON	99	THEO	$\overline{\text{MS}}$ scheme
7.0 ±1.1	[19] JAMIN	95	THEO	$\overline{\text{MS}}$ scheme
7.4 ±0.7	[20] NARISON	95C	THEO	$\overline{\text{MS}}$ scheme

[11] DOMINGUEZ 09 use QCD finite energy sum rules for the two-point function of the divergence of the axial vector current computed to order α_s^4.

[12] DEANDREA 08 determine $m_u - m_d$ from $\eta \to 3\pi^0$, and combine with the PDG 06 lattice average value of $m_u + m_d = 7.6 \pm 1.6$ to determine m_u and m_d.

[13] BLUM 07 determine quark mass using a QED plus QCD lattice computation with two dynamical flavors of the pseudoscalar meson masses.

[14] JAMIN 06 determine m_d(2 GeV) by combining the value of m_s obtained from the spectral function for the scalar $K\pi$ form factor with other determinations of the quark mass ratios.

[15] NARISON 06 uses sum rules for $e^+e^- \to$ hadrons to order α_s^3 to determine m_s combined with other determinations of the quark mass ratios.

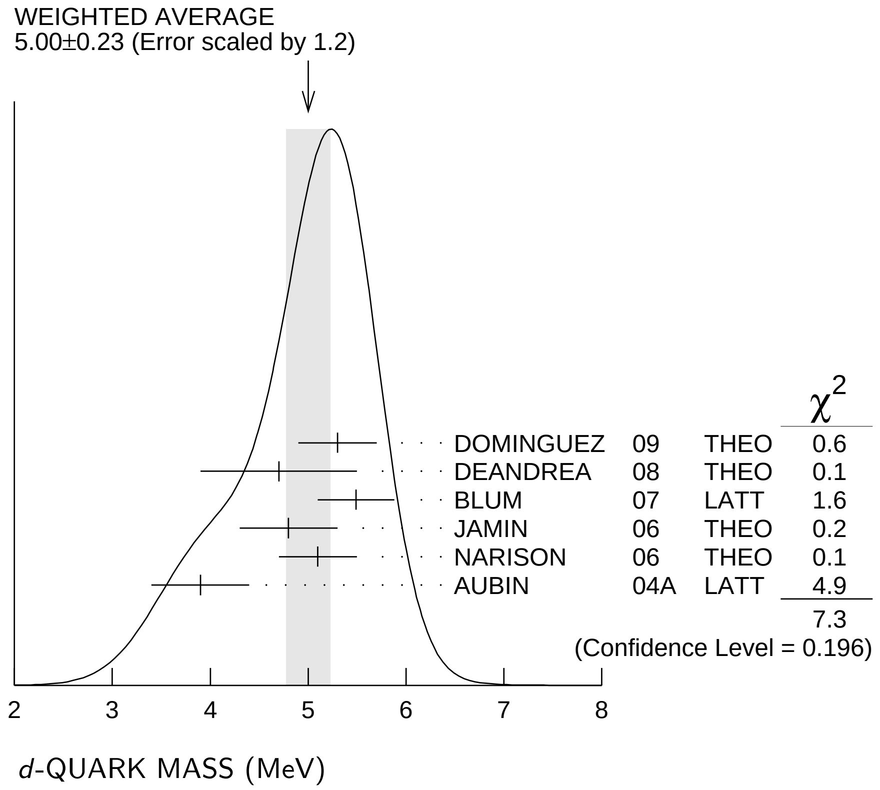
[16] AUBIN 04A perform three flavor dynamical lattice calculation of pseudoscalar meson masses, with continuum estimate of electromagnetic effects in the kaon masses, and one-loop perturbative renormalization constant.

[17] JAMIN 02 first calculates the strange quark mass from QCD sum rules using the scalar channel, and then combines with the quark mass ratios obtained from chiral perturbation theory to obtain m_d.

[18] NARISON 99 uses sum rules to order α_s^3 for ϕ meson decays to get m_s, and finds m_d by combining with sum rule estimates of $m_u + m_d$ and Dashen's formula.

[19] JAMIN 95 uses QCD sum rules at next-to-leading order. We have rescaled m_d(1 GeV) $= 9.4 \pm 1.5$ to $\mu = 2$ GeV.

[20] For NARISON 95C, we have rescaled m_d(1 GeV) $= 10 \pm 1$ to $\mu = 2$ GeV.



$\overline{m} = (m_u + m_d)/2$

See the comments for the *u* quark above.

We have normalized the $\overline{\text{MS}}$ masses at a renormalization scale of $\mu = 2$ GeV. Results quoted in the literature at $\mu = 1$ GeV have been rescaled by dividing by 1.35. The values of “Our Evaluation” were determined in part via Figures 1 and 2.

VALUE (MeV)	*DOCUMENT ID*	*TECN*	*COMMENT*
$3.79^{+1.21}_{-1.29}$ (2.5–5.0) OUR EVALUATION See the ideogram below.			
4.1 ± 0.2	[21] DOMINGUEZ 09	THEO	$\overline{\text{MS}}$ scheme
3.72 ± 0.41	[22] ALLTON 08	LATT	$\overline{\text{MS}}$ scheme
$3.85 \pm 0.12 \pm 0.4$	[23] BLOSSIER 08	LATT	$\overline{\text{MS}}$ scheme
$3.55^{+0.65}_{-0.28}$	[24] ISHIKAWA 08	LATT	$\overline{\text{MS}}$ scheme
4.026 ± 0.048	[25] NAKAMURA 08	LATT	$\overline{\text{MS}}$ scheme
4.25 ± 0.35	[26] BLUM 07	LATT	$\overline{\text{MS}}$ scheme
$4.08 \pm 0.25 \pm 0.42$	[27] GOCKELER 06	LATT	$\overline{\text{MS}}$ scheme
$4.7 \pm 0.2 \pm 0.3$	[28] GOCKELER 06A	LATT	$\overline{\text{MS}}$ scheme
3.95 ± 0.3	[29] NARISON 06	THEO	$\overline{\text{MS}}$ scheme
2.8 ± 0.3	[30] AUBIN 04	LATT	$\overline{\text{MS}}$ scheme
$4.29 \pm 0.14 \pm 0.65$	[31] AOKI 03	LATT	$\overline{\text{MS}}$ scheme
3.223 ± 0.3	[32] AOKI 03B	LATT	$\overline{\text{MS}}$ scheme
$4.4 \pm 0.1 \pm 0.4$	[33] BECIREVIC 03	LATT	$\overline{\text{MS}}$ scheme
$4.1 \pm 0.3 \pm 1.0$	[34] CHIU 03	LATT	$\overline{\text{MS}}$ scheme
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$\geq 4.85 \pm 0.20$	[35] DOMINGUEZ...08B	THEO	$\overline{\text{MS}}$ scheme
$3.45^{+0.14}_{-0.20}$	[36] ALIKHAN 02	LATT	$\overline{\text{MS}}$ scheme
5.3 ± 0.3	[37] CHIU 02	LATT	$\overline{\text{MS}}$ scheme
3.9 ± 0.6	[38] MALTMAN 02	THEO	$\overline{\text{MS}}$ scheme
3.9 ± 0.6	[39] MALTMAN 01	THEO	$\overline{\text{MS}}$ scheme
4.57 ± 0.18	[40] AOKI 00	LATT	$\overline{\text{MS}}$ scheme
4.4 ± 2	[41] GOCKELER 00	LATT	$\overline{\text{MS}}$ scheme
4.23 ± 0.29	[42] AOKI 99	LATT	$\overline{\text{MS}}$ scheme
≥ 2.1	[43] STEELE 99	THEO	$\overline{\text{MS}}$ scheme
4.5 ± 0.4	[44] BECIREVIC 98	LATT	$\overline{\text{MS}}$ scheme
4.6 ± 1.2	[45] DOSCH 98	THEO	$\overline{\text{MS}}$ scheme
4.7 ± 0.9	[46] PRADES 98	THEO	$\overline{\text{MS}}$ scheme
2.7 ± 0.2	[47] EICKER 97	LATT	$\overline{\text{MS}}$ scheme
3.6 ± 0.6	[48] GOUGH 97	LATT	$\overline{\text{MS}}$ scheme
$3.4 \pm 0.4 \pm 0.3$	[49] GUPTA 97	LATT	$\overline{\text{MS}}$ scheme
>3.8	[50] LELLOUCH 97	THEO	$\overline{\text{MS}}$ scheme
4.5 ± 1.0	[51] BIJNENS 95	THEO	$\overline{\text{MS}}$ scheme

[21] DOMINGUEZ 09 use QCD finite energy sum rules for the two-point function of the divergence of the axial vector current computed to order α_s^4.

[22] ALLTON 08 use a lattice computation of the π, K, and Ω masses with 2+1 dynamical flavors of domain wall quarks, and non-perturbative renormalization.

[23] BLOSSIER 08 use a lattice computation of pseudoscalar meson masses and decay constants with 2 dynamical flavors and non-perturbative renormalization.

[24] ISHIKAWA 08 use a lattice computation of the light meson spectrum with 2+1 dynamical flavors of $\mathcal{O}(a)$ improved Wilson quarks, and one-loop perturbative renormalization.

[25] NAKAMURA 08 do a lattice computation using quenched domain wall fermions and non-perturbative renormalization.

[26] BLUM 07 determine quark mass using a QED plus QCD lattice computation with two dynamical flavors of the pseudoscalar meson masses.

[27] GOCKELER 06 use an unquenched lattice computation of the axial Ward Identity with $N_f = 2$ dynamical light quark flavors, and non-perturbative renormalization, to obtain $\overline{m}(2\ \text{GeV}) = 4.08 \pm 0.25 \pm 0.19 \pm 0.23$ MeV, where the first error is statistical, the second and third are systematic due to the fit range and force scale uncertainties, respectively. We have combined the systematic errors linearly.

[28] GOCKELER 06A use an unquenched lattice computation of the pseudoscalar meson masses with $N_f = 2$ dynamical light quark flavors, and non-perturbative renormalization.

[29] NARISON 06 uses sum rules for $e^+e^- \rightarrow$ hadrons to order α_s^3 to determine m_s combined with other determinations of the quark mass ratios.

[30] AUBIN 04 perform three flavor dynamical lattice calculation of pseudoscalar meson masses, with one-loop perturbative renormalization constant.

[31] AOKI 03 uses quenched lattice simulation of the meson and baryon masses with degenerate light quarks. The extrapolations are done using quenched chiral perturbation theory.

[32] The errors given in AOKI 03B were $^{+0.046}_{-0.069}$. We changed them to ± 0.3 for calculating the overall best values. AOKI 03B uses lattice simulation of the meson and baryon masses with two dynamical light quarks. Simulations are performed using the $\mathcal{O}(a)$ improved Wilson action.

[33] BECIREVIC 03 perform quenched lattice computation using the vector and axial Ward identities. Uses $\mathcal{O}(a)$ improved Wilson action and nonperturbative renormalization.

[34] CHIU 03 determines quark masses from the pion and kaon masses using a lattice simulation with a chiral fermion action in quenched approximation.

[35] DOMINGUEZ-CLARIMON 08B obtain an inequality from sum rules for the scalar two-point correlator.

[36] ALIKHAN 02 uses lattice simulation of the meson and baryon masses with two dynamical flavors and degenerate light quarks.

[37] CHIU 02 extracts the average light quark mass from quenched lattice simulations using quenched chiral perturbation theory.

[38] MALTMAN 02 uses finite energy sum rules in the $u d$ and $u s$ pseudoscalar channels. Other mass values are also obtained by similar methods.

[39] MALTMAN 01 uses Borel transformed and finite energy sum rules.

[40] AOKI 00 obtain the light quark masses from a quenched lattice simulation of the meson and baryon spectrum with the Wilson quark action.

[41] GOCKELER 00 obtained from a quenched lattice computation of the pseudoscalar meson masses using $\mathcal{O}(a)$ improved Wilson fermions and nonperturbative renormalization.

[42] AOKI 99 obtain the light quark masses from a quenched lattice simulation of the meson spectrum with the staggered quark action employing the regularization independent scheme.

[43] STEELE 99 obtain a bound on the light quark masses by applying the Holder inequality to a sum rule. We have converted their bound of $(m_u+m_d)/2 \geq 3$ MeV at μ=1 GeV to μ=2 GeV.

[44] BECIREVIC 98 compute the quark mass using the Alpha action in the quenched approximation. The conversion from the regularization independent scheme to the $\overline{\text{MS}}$ scheme is at NNLO.

[45] DOSCH 98 use sum rule determinations of the quark condensate and chiral perturbation theory to obtain $9.4 \leq (m_u+m_d)(1\ \text{GeV}) \leq 15.7$ MeV. We have converted to result to μ=2 GeV.

[46] PRADES 98 uses finite energy sum rules for the axial current correlator.

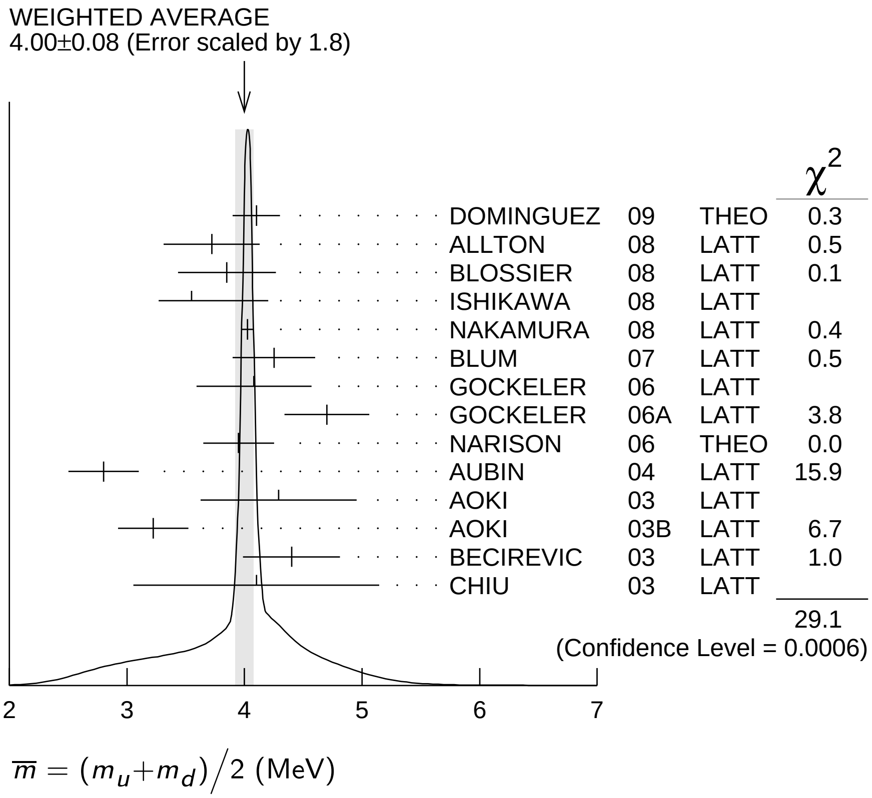
[47] EICKER 97 use lattice gauge computations with two dynamical light flavors.

[48] GOUGH 97 use lattice gauge computations in the quenched approximation. Correcting for quenching gives $2.1 < \overline{m} < 3.5$ MeV at μ=2 GeV.

[49] GUPTA 97 use Lattice Monte Carlo computations in the quenched approximation. The value for two light dynamic flavors at $\mu = 2$ GeV is 2.7 ± 0.3 ± 0.3 MeV.

[50] LELLOUCH 97 obtain lower bounds on quark masses using hadronic spectral functions.

[51] BIJNENS 95 determines $m_u + m_d$ (1 GeV) = 12 ± 2.5 MeV using finite energy sum rules. We have rescaled this to 2 GeV.



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m_u/m_d MASS RATIO

VALUE	*DOCUMENT ID*	*TECN*	*COMMENT*
$\mathbf{0.506^{+0.094}_{-0.156}}$ **(0.35–0.60) OUR EVALUATION**	See the ideogram below.		
0.550±0.031	[52] BLUM 07	LATT	$\overline{\rm MS}$ scheme
0.43 ±0.08	[53] AUBIN 04A	LATT	$\overline{\rm MS}$ scheme
0.410±0.036	[54] NELSON 03	LATT	$\overline{\rm MS}$ scheme
0.553±0.043	[55] LEUTWYLER 96	THEO	Compilation
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.44	[56] GAO 97	THEO	$\overline{\rm MS}$ scheme
<0.3	[57] CHOI 92	THEO	
0.26	[58] DONOGHUE 92	THEO	
0.30 ±0.07	[59] DONOGHUE 92B	THEO	
0.66	[60] GERARD 90	THEO	
0.4 to 0.65	[61] LEUTWYLER 90B	THEO	
0.05 to 0.78	[62] MALTMAN 90	THEO	

[52] BLUM 07 determine quark mass using a QED plus QCD lattice computation with two dynamical flavors of the pseudoscalar meson masses.

[53] AUBIN 04A perform three flavor dynamical lattice calculation of pseudoscalar meson masses, with continuum estimate of electromagnetic effects in the kaon masses.

[54] NELSON 03 computes coefficients in the order p^4 chiral Lagrangian using a lattice calculation with three dynamical flavors. The ratio m_u/m_d is obtained by combining this with the chiral perturbation theory computation of the meson masses to order p^4.

[55] LEUTWYLER 96 uses a combined fit to $\eta \to 3\pi$ and $\psi' \to J/\psi\ (\pi,\eta)$ decay rates, and the electromagnetic mass differences of the π and K.

[56] GAO 97 uses electromagnetic mass splittings of light mesons.

[57] CHOI 92 result obtained from the decays $\psi(2S) \to J/\psi(1S)\pi$ and $\psi(2S) \to J/\psi(1S)\eta$, and a dilute instanton gas estimate of some unknown matrix elements.

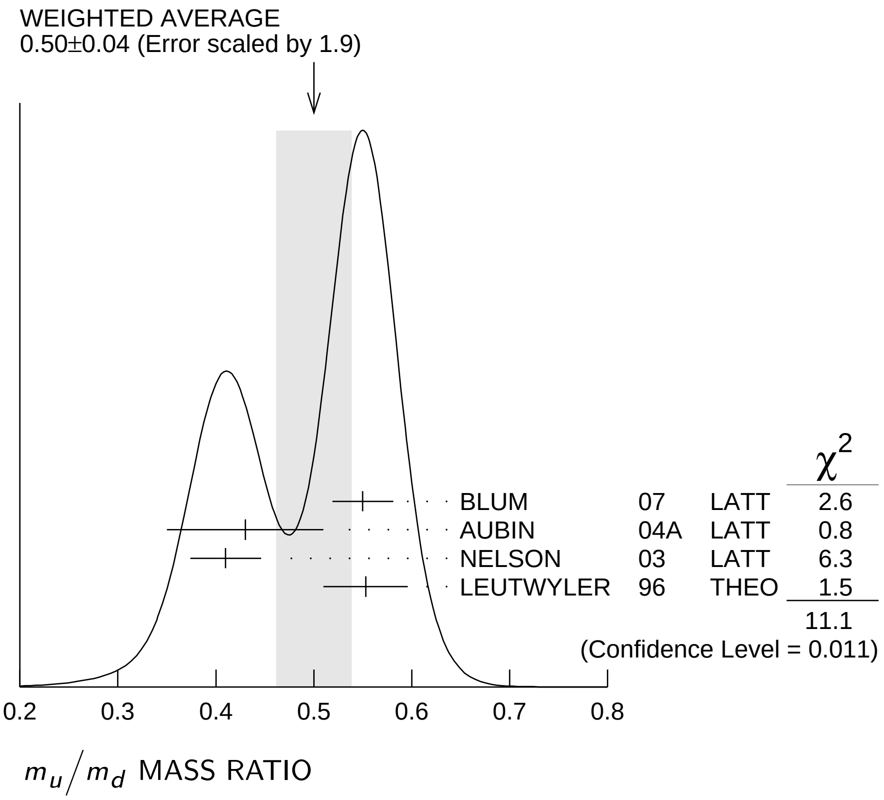
[58] DONOGHUE 92 result is from a combined analysis of meson masses, $\eta \to 3\pi$ using second-order chiral perturbation theory including nonanalytic terms, and $(\psi(2S) \to J/\psi(1S)\pi)/(\psi(2S) \to J/\psi(1S)\eta)$.

[59] DONOGHUE 92B computes quark mass ratios using $(\psi(2S) \to J/\psi(1S)\pi)/(\psi(2S) \to J/\psi(1S)\eta)$, and an estimate of L_{14} using Weinberg sum rules.

[60] GERARD 90 uses large N and η-η' mixing.

[61] LEUTWYLER 90B determines quark mass ratios using second-order chiral perturbation theory for the meson and baryon masses, including nonanalytic corrections. Also uses Weinberg sum rules to determine L_7.

[62] MALTMAN 90 uses second-order chiral perturbation theory including nonanalytic terms for the meson masses. Uses a criterion of "maximum reasonableness" that certain coefficients which are expected to be of order one are ≤ 3.



s-QUARK MASS

See the comment for the *u* quark above.

We have normalized the $\overline{\rm MS}$ masses at a renormalization scale of $\mu = 2$ GeV. Results quoted in the literature at $\mu = 1$ GeV have been rescaled by dividing by 1.35.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
105^{+25}_{-35} (70–130) OUR EVALUATION See the ideogram below.				
107.3 ± 11.7	[63] ALLTON	08	LATT	$\overline{\rm MS}$ scheme
$105 \pm 3 \pm 9$	[64] BLOSSIER	08	LATT	$\overline{\rm MS}$ scheme
102 ± 8	[65] DOMINGUEZ	08A	THEO	$\overline{\rm MS}$ scheme
$90.1^{+17.2}_{-6.1}$	[66] ISHIKAWA	08	LATT	$\overline{\rm MS}$ scheme
105.6 ± 1.2	[67] NAKAMURA	08	LATT	$\overline{\rm MS}$ scheme
119.5 ± 9.3	[68] BLUM	07	LATT	$\overline{\rm MS}$ scheme
$105 \pm 6 \pm 7$	[69] CHETYRKIN	06	THEO	$\overline{\rm MS}$ scheme
$111 \pm 6 \pm 10$	[70] GOCKELER	06	LATT	$\overline{\rm MS}$ scheme
$119 \pm 5 \pm 8$	[71] GOCKELER	06A	LATT	$\overline{\rm MS}$ scheme
92 ± 9	[72] JAMIN	06	THEO	$\overline{\rm MS}$ scheme
104 ± 15	[73] NARISON	06	THEO	$\overline{\rm MS}$ scheme
$\geq 71 \pm 4,\ \leq 151 \pm 14$	[74] NARISON	06	THEO	$\overline{\rm MS}$ scheme
$96\ ^{+5}_{-3}\ ^{+16}_{-18}$	[75] BAIKOV	05	THEO	$\overline{\rm MS}$ scheme
81 ± 22	[76] GAMIZ	05	THEO	$\overline{\rm MS}$ scheme
125 ± 28	[77] GORBUNOV	05	THEO	$\overline{\rm MS}$ scheme
93 ± 32	[78] NARISON	05	THEO	$\overline{\rm MS}$ scheme
76 ± 8	[79] AUBIN	04	LATT	$\overline{\rm MS}$ scheme
$116 \pm 6 \pm 0.65$	[80] AOKI	03	LATT	$\overline{\rm MS}$ scheme
$84.5^{+12}_{-1.7}$	[81] AOKI	03B	LATT	$\overline{\rm MS}$ scheme
$106 \pm 2 \pm 8$	[82] BECIREVIC	03	LATT	$\overline{\rm MS}$ scheme
$92 \pm 9 \pm 16$	[83] CHIU	03	LATT	$\overline{\rm MS}$ scheme
117 ± 17	[84] GAMIZ	03	THEO	$\overline{\rm MS}$ scheme
103 ± 17	[85] GAMIZ	03	THEO	$\overline{\rm MS}$ scheme
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$88\ ^{+3}_{-6}$	[86] ALIKHAN	02	LATT	$\overline{\rm MS}$ scheme
115 ± 8	[87] CHIU	02	LATT	$\overline{\rm MS}$ scheme
99 ± 16	[88] JAMIN	02	THEO	$\overline{\rm MS}$ scheme
100 ± 12	[89] MALTMAN	02	THEO	$\overline{\rm MS}$ scheme
$116\ ^{+20}_{-25}$	[90] CHEN	01B	THEO	$\overline{\rm MS}$ scheme
125 ± 27	[91] KOERNER	01	THEO	$\overline{\rm MS}$ scheme
130 ± 15	[92] AOKI	00	LATT	$\overline{\rm MS}$ scheme
97 ± 4	[93] GARDEN	00	LATT	$\overline{\rm MS}$ scheme
105 ± 4	[94] GOCKELER	00	LATT	$\overline{\rm MS}$ scheme
118 ± 14	[95] AOKI	99	LATT	$\overline{\rm MS}$ scheme
$170\ ^{+44}_{-55}$	[96] BARATE	99R	ALEP	$\overline{\rm MS}$ scheme
115 ± 8	[97] MALTMAN	99	THEO	$\overline{\rm MS}$ scheme
129 ± 24	[98] NARISON	99	THEO	$\overline{\rm MS}$ scheme

114 ±23	[99] PICH	99	THEO	$\overline{\rm MS}$ scheme
111 ±12	[100] BECIREVIC	98	LATT	$\overline{\rm MS}$ scheme
148 ±48	[101] CHETYRKIN	98	THEO	$\overline{\rm MS}$ scheme
103 ±10	[102] CUCCHIERI	98	LATT	$\overline{\rm MS}$ scheme
115 ±19	[103] DOMINGUEZ	98	THEO	$\overline{\rm MS}$ scheme
152.4±14.1	[104] CHETYRKIN	97	THEO	$\overline{\rm MS}$ scheme
$\geq$ 89	[105] COLANGELO	97	THEO	$\overline{\rm MS}$ scheme
140 ±20	[106] EICKER	97	LATT	$\overline{\rm MS}$ scheme
95 ±16	[107] GOUGH	97	LATT	$\overline{\rm MS}$ scheme
100 ±21 ±10	[108] GUPTA	97	LATT	$\overline{\rm MS}$ scheme
>100	[109] LELLOUCH	97	THEO	$\overline{\rm MS}$ scheme
140 ±24	[110] JAMIN	95	THEO	$\overline{\rm MS}$ scheme

[63] ALLTON 08 use a lattice computation of the π, K, and Ω masses with 2+1 dynamical flavors of domain wall quarks, and non-perturbative renormalization.

[64] BLOSSIER 08 use a lattice computation of pseudoscalar meson masses and decay constants with 2 dynamical flavors and non-perturbative renormalization.

[65] DOMINGUEZ 08A make determination from QCD finite energy sum rules for the pseudoscalar two-point function computed to order α_s^4.

[66] ISHIKAWA 08 use a lattice computation of the light meson spectrum with 2+1 dynamical flavors of $\mathcal{O}(a)$ improved Wilson quarks, and one-loop perturbative renormalization.

[67] NAKAMURA 08 do a lattice computation using quenched domain wall fermions and non-perturbative renormalization.

[68] BLUM 07 determine quark mass using a QED plus QCD lattice computation with two dynamical flavors of the pseudoscalar meson masses.

[69] CHETYRKIN 06 use QCD sum rules in the pseudoscalar channel to order α_s^4.

[70] GOCKELER 06 use an unquenched lattice computation of the axial Ward Identity with $N_f = 2$ dynamical light quark flavors, and non-perturbative renormalization, to obtain $\overline{m}_s(2\text{ GeV}) = 111 \pm 6 \pm 4 \pm 6$ MeV, where the first error is statistical, the second and third are systematic due to the fit range and force scale uncertainties, respectively. We have combined the systematic errors linearly.

[71] GOCKELER 06A use an unquenched lattice computation of the pseudoscalar meson masses with $N_f = 2$ dynamical light quark flavors, and non-perturbative renormalization.

[72] JAMIN 06 determine $\overline{m}_s(2\text{ GeV})$ from the spectral function for the scalar $K\pi$ form factor.

[73] NARISON 06 uses sum rules for $e^+e^- \to$ hadrons to order α_s^3.

[74] NARISON 06 obtains the quoted range from positivity of the spectral functions.

[75] BAIKOV 05 determines $\overline{m}_s(M_\tau) = 100^{+5}_{-3}{}^{+17}_{-19}$ from sum rules using the strange spectral function in τ decay. The computations were done to order α_s^3, with an estimate of the α_s^4 terms. We have converted the result to $\mu = 2$ GeV.

[76] GAMIZ 05 determines $\overline{m}_s(2\text{ GeV})$ from sum rules using the strange spectral function in τ decay. The computations were done to order α_s^2, with an estimate of the α_s^3 terms.

[77] GORBUNOV 05 use hadronic tau decays to N^{3}LO, including power corrections.

[78] NARISON 05 determines $\overline{m}_s(2\text{ GeV})$ from sum rules using the strange spectral function in τ decay. The computations were done to order α_s^3.

[79] AUBIN 04 perform three flavor dynamical lattice calculation of pseudoscalar meson masses, with one-loop perturbative renormalization constant.

[80] AOKI 03 uses quenched lattice simulation of the meson and baryon masses with degenerate light quarks. The extrapolations are done using quenched chiral perturbation theory. Determines $m_s = 113.8 \pm 2.3^{+5.8}_{-2.9}$ using K mass as input and $m_s = 142.3 \pm 5.8^{+22}_{-0}$ using ϕ mass as input. We have performed a weighted average of these values.

[81] AOKI 03B uses lattice simulation of the meson and baryon masses with two dynamical light quarks. Simulations are performed using the $\mathcal{O}(a)$ improved Wilson action.

[82] BECIREVIC 03 perform quenched lattice computation using the vector and axial Ward identities. Uses $\mathcal{O}(a)$ improved Wilson action and nonperturbative renormalization. They also quote $\overline{m}/m_s$=24.3 ± 0.2 ± 0.6.

[83] CHIU 03 determines quark masses from the pion and kaon masses using a lattice simulation with a chiral fermion action in quenched approximation.

[84] GAMIZ 03 determines m_s from SU(3) breaking in the τ hadronic width. The value of V_{us} is chosen to satisfy CKM unitarity.

[85] GAMIZ 03 determines m_s from SU(3) breaking in the τ hadronic width. The value of V_{us} is taken from the PDG.

[86] ALIKHAN 02 uses lattice simulation of the meson and baryon masses with two dynamical flavors and degenerate light quarks. The above value uses the K-meson mass to determine m_s. If the ϕ meson is used, the number changes to $90^{+\ 5}_{-10}$.

[87] CHIU 02 extracts the strange quark mass from quenched lattice simulations using quenched chiral perturbation theory.

[88] JAMIN 02 calculates the strange quark mass from QCD sum rules using the scalar channel.

[89] MALTMAN 02 uses finite energy sum rules in the ud and us pseudoscalar channels. Other mass values are also obtained by similar methods.

[90] CHEN 01B uses an analysis of the hadronic spectral function in τ decay.

[91] KOERNER 01 obtain the s quark mass of $m_s(m_\tau) = 130 \pm 27(\mathrm{exp}) \pm 9(\mathrm{thy})$ MeV from an analysis of Cabibbo suppressed τ decays. We have converted this to $\mu = 2$ GeV.

[92] AOKI 00 obtain the light quark masses from a quenched lattice simulation of the meson and baryon spectrum with the Wilson quark action. We have averaged their results of m_s= 115.6 ± 2.3 and m_s= 143.7 ± 5.8 obtained using m_K and m_ϕ, respectively, to normalize the spectrum.

[93] GARDEN 00 use a quenched lattice computation of the hadron spectrum.

[94] GOCKELER 00 obtained from a quenched lattice computation of the pseudoscalar meson masses using $\mathcal{O}(a)$ improved Wilson fermions and nonperturbative renormalization.

[95] AOKI 99 obtain the light quark masses from a quenched lattice simulation of the meson spectrum with the Staggered quark action employing the regularization independent scheme. We have averaged their results of m_s=106.0 ± 7.1 and m_s=129 ± 12 obtained using m_K and m_ϕ, respectively, to normalize the spectrum.

[96] BARATE 99R obtain the strange quark mass from an analysis of the observed mass spectra in τ decay. We have converted their value of $m_s(m_\tau)= 176^{+46}_{-57}$ MeV to μ=2 GeV.

[97] MALTMAN 99 determines the strange quark mass using finite energy sum rules.

[98] NARISON 99 uses sum rules to order α_s^3 for ϕ meson decays.

[99] PICH 99 obtain the s-quark mass from an analysis of the moments of the invariant mass distribution in τ decays.

[100] BECIREVIC 98 compute the quark mass using the Alpha action in the quenched approximation. The conversion from the regularization independent scheme to the $\overline{\mathrm{MS}}$ scheme is at NNLO.

[101] CHETYRKIN 98 uses spectral moments of hadronic τ decays to determine m_s(1 GeV)=200 ± 70 MeV. We have rescaled the result to μ=2 GeV.

[102] CUCCHIERI 98 obtains the quark mass using a quenched lattice computation of the hadronic spectrum.

[103] DOMINGUEZ 98 uses hadronic spectral function sum rules (to four loops, and including dimension six operators) to determine m_s(1 GeV)< 155 ± 25 MeV. We have rescaled the result to μ=2 GeV.

[104] CHETYRKIN 97 obtains 205.5 ± 19.1 MeV at μ=1 GeV from QCD sum rules including fourth-order QCD corrections. We have rescaled the result to 2 GeV.

[105] COLANGELO 97 is QCD sum rule computation. We have rescaled m_s(1 GeV) > 120 to $\mu = 2$ GeV.

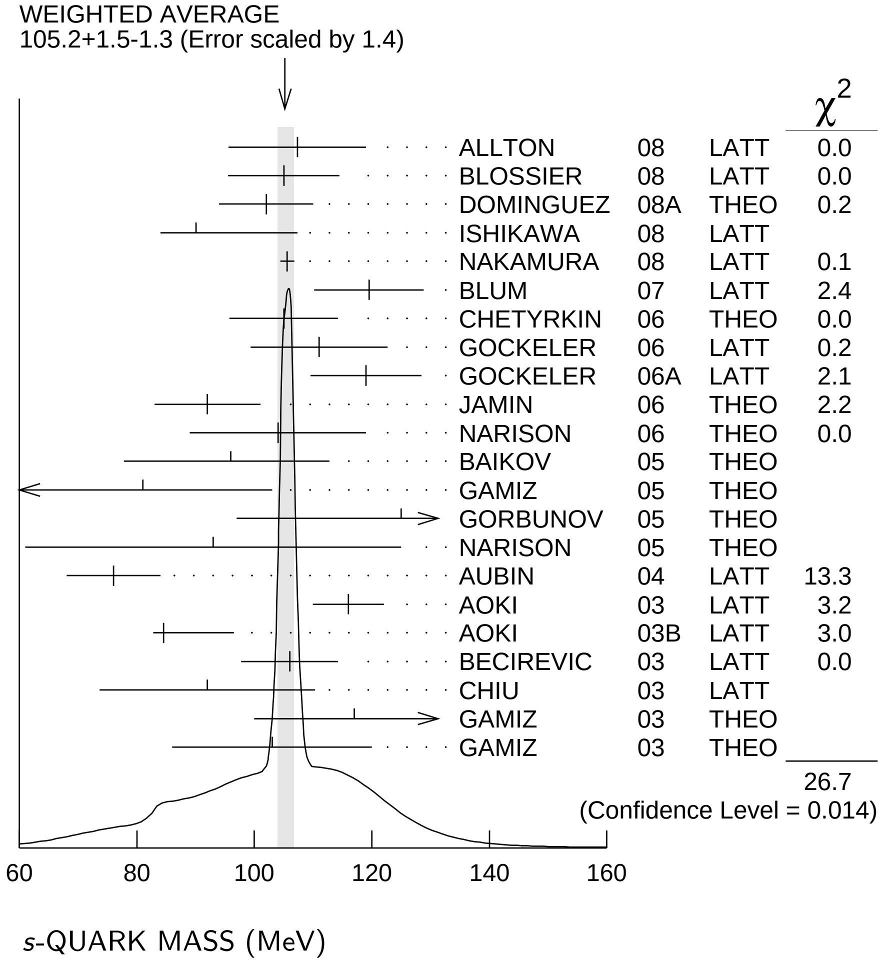
[106] EICKER 97 use lattice gauge computations with two dynamical light flavors.

[107] GOUGH 97 use lattice gauge computations in the quenched approximation. Correcting for quenching gives 54 $< m_s <$ 92 MeV at μ=2 GeV.

[108] GUPTA 97 use Lattice Monte Carlo computations in the quenched approximation. The value for two light dynamical flavors at $\mu = 2$ GeV is 68 ± 12 ± 7 MeV.

[109] LELLOUCH 97 obtain lower bounds on quark masses using hadronic spectral functions.

[110] JAMIN 95 uses QCD sum rules at next-to-leading order. We have rescaled m_s(1 GeV) = 189 ± 32 to $\mu = 2$ GeV.



OTHER LIGHT QUARK MASS RATIOS

m_s/m_d MASS RATIO

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
17 to 22 OUR EVALUATION				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
20.0	[111] GAO	97	THEO	$\overline{\text{MS}}$ scheme
18.9±0.8	[112] LEUTWYLER	96	THEO	Compilation
21	[113] DONOGHUE	92	THEO	
18	[114] GERARD	90	THEO	
18 to 23	[115] LEUTWYLER	90B	THEO	

[111] GAO 97 uses electromagnetic mass splittings of light mesons.

[112] LEUTWYLER 96 uses a combined fit to $\eta \rightarrow 3\pi$ and $\psi' \rightarrow J/\psi\ (\pi,\eta)$ decay rates, and the electromagnetic mass differences of the π and K.

[113] DONOGHUE 92 result is from a combined analysis of meson masses, $\eta \rightarrow 3\pi$ using second-order chiral perturbation theory including nonanalytic terms, and $(\psi(2S) \rightarrow J/\psi(1S)\pi)/(\psi(2S) \rightarrow J/\psi(1S)\eta)$.

[114] GERARD 90 uses large N and η-η' mixing.

[115] LEUTWYLER 90B determines quark mass ratios using second-order chiral perturbation theory for the meson and baryon masses, including nonanalytic corrections. Also uses Weinberg sum rules to determine L_7.

$m_s/\overline{m}$ MASS RATIO

$\overline{m} \equiv (m_u + m_d)/2$

VALUE	*DOCUMENT ID*	*TECN*	*COMMENT*
25 to 30 OUR EVALUATION			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
28.8±1.65	[116] ALLTON 08	LATT	$\overline{\rm MS}$ scheme
27.3±0.3 ±1.2	[117] BLOSSIER 08	LATT	$\overline{\rm MS}$ scheme
23.5±1.5	[118] OLLER 07A	THEO	
27.4±0.4	[119] AUBIN 04	LATT	

[116] ALLTON 08 use a lattice computation of the π, K, and Ω masses with 2+1 dynamical flavors of domain wall quarks, and non-perturbative renormalization.

[117] BLOSSIER 08 use a lattice computation of pseudoscalar meson masses and decay constants with 2 dynamical flavors and non-perturbative renormalization.

[118] OLLER 07A use unitarized chiral perturbation theory to order p^4.

[119] Three flavor dynamical lattice calculation of pseudoscalar meson masses.

Q MASS RATIO

$Q \equiv \sqrt{(m^2{}_s - \overline{m}^2)/(m^2{}_d - m^2{}_u)}$; $\quad \overline{m} \equiv (m_u + m_d)/2$

VALUE	*DOCUMENT ID*	*TECN*
• • • We do not use the following data for averages, fits, limits, etc. • • •		
22.8±0.4	[120] MARTEMYA... 05	THEO
22.7±0.8	[121] ANISOVICH 96	THEO

[120] MARTEMYANOV 05 determine Q from $\eta \rightarrow 3\pi$ decay.

[121] ANISOVICH 96 find Q from $\eta \rightarrow \pi^+\pi^-\pi^0$ decay using dispersion relations and chiral perturbation theory.

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DEANDREA	08	PR D78 034032	A. Deandrea, A. Nehme, P. Talavera	
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DOMINGUEZ...	08B	PL B660 49	A. Dominguez-Clarimon, E. de Rafael, J. Taron	
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OLLER	07A	EPJ A34 371	J.A. Oller, L. Roca	
CHETYRKIN	06	EPJ C46 721	K.G. Chetyrkin, A. Khodjamirian	
GOCKELER	06	PR D73 054508	M. Gockeler *et al.*	(QCDSF, UKQCD Collabs)
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JAMIN	06	PR D74 074009	M. Jamin, J.A. Oller, A. Pich	
NARISON	06	PR D74 034013	S. Narison	
PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)
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GAMIZ	05	PRL 94 011803	E. Gamiz *et al.*	
GORBUNOV	05	PR D71 013002	D.S. Gorbunov, A.A. Pivovarov	
MARTEMYA...	05	PR D71 017501	B.V. Martemyanov, V.S. Sopov	
NARISON	05	PL B626 101	S. Narison	
AUBIN	04	PR D70 031504R	C. Aubin *et al.*	(HPQCD, MILC, UKQCD Collabs.)
AUBIN	04A	PR D70 114501	C. Aubin *et al.*	(MILC Collab.)
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AOKI	03B	PR D68 054502	S. Aoki *et al.*	(CP-PACS Collab.)
BECIREVIC	03	PL B558 69	D. Becirevic, V. Lubicz, C. Tarantino	
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NELSON	03	PRL 90 021601	D. Nelson, G.T. Fleming, G.W. Kilcup	
ALIKHAN	02	PR D65 054505	A. Ali Khan *et al.*	(CP-PACS Collab.)
Also		PR D67 059901 (erratum)	A. Ali Khan *et al.*	(CP-PACS Collab.)
CHIU	02	PL B538 298	T.-W. Chiu, T.-H. Hsieh	
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MALTMAN	02	PR D65 074013	K. Maltman, J. Kambor	
CHEN	01B	EPJ C22 31	S. Chen *et al.*	
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GARDEN	00	NP B571 237	J. Garden *et al.*	(ALPHA, UKQCD Collabs)
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NARISON	95C	PL B358 113	S. Narison	(MONP)
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DONOGHUE	92	PRL 69 3444	J.F. Donoghue, B.R. Holstein, D. Wyler	(MASA+)
DONOGHUE	92B	PR D45 892	J.F. Donoghue, D. Wyler	(MASA, ZURI, UCSBT)
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LEUTWYLER	90B	NP B337 108	H. Leutwyler	(BERN)
MALTMAN	90	PL B234 158	K. Maltman, T. Goldman, Stephenson Jr.	(YORKC+)