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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 $\overline{\text{MS}}$. 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 $\overline{\text{MS}}$ 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*
1 to 5 OUR EVALUATION				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.3 ± 0.4	[1] NARISON	99	THEO	$\overline{\text{MS}}$ scheme
3.9 ± 1.1	[2] JAMIN	95	THEO	$\overline{\text{MS}}$ scheme
3.0 ± 0.7	[3] NARISON	95C	THEO	$\overline{\text{MS}}$ scheme
	[4] CHOI	92B	THEO	
4.3	[5] BARDUCCI	88	THEO	
3.8 ± 1.1	[6] GASSER	82	THEO	

[1] 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.

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

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

[4] CHOI 92B argues that $m_u = 0$ is okay based on instanton contributions to the chiral coefficients. Disagrees with DONOGHUE 92 and DONOGHUE 92B.

[5] BARDUCCI 88 uses a calculation of the effective potential for $\overline{\psi}\psi$ in QCD, and estimates for $\Sigma(p^2)$. We have rescaled m_u(1 GeV) $= 5.8$ to $\mu = 2$ GeV.

[6] GASSER 82 uses chiral perturbation theory for the mass ratios, and uses QCD sum rules to extract the absolute values. We have rescaled m_u(1 GeV) $= 5.1 \pm 1.5$ to $\mu = 2$ 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*
3 to 9 OUR EVALUATION			
• • • We do not use the following data for averages, fits, limits, etc. • • •			

6.4±1.1	[7] NARISON 99	THEO	$\overline{\mathrm{MS}}$ scheme
7.0±1.1	[8] JAMIN 95	THEO	$\overline{\mathrm{MS}}$ scheme
7.4±0.7	[9] NARISON 95C	THEO	$\overline{\mathrm{MS}}$ scheme
	[10] ADAMI 93	THEO	
	[11] NEFKENS 92	THEO	
6.2	[12] BARDUCCI 88	THEO	
	[13] DOMINGUEZ 87	THEO	
	[14] KREMER 84	THEO	
6.6±1.9	[15] GASSER 82	THEO	

[7] 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.

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

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

[10] ADAMI 93 obtain $m_d - m_u = 3 \pm 1$ MeV at $\mu = 0.5$ GeV using isospin-violating effects in QCD sum rules.

[11] NEFKENS 92 results for $m_d - m_u$ are 3.1 ± 0.4 MeV from meson masses and 3.6 ± 0.4 MeV from baryon masses.

[12] BARDUCCI 88 uses a calculation of the effective potential for $\overline{\psi}\psi$ in QCD, and estimates for $\Sigma(p^2)$. We have rescaled $m_d(1\ \mathrm{GeV}) = 8.4$ to $\mu = 2$ GeV.

[13] DOMINGUEZ 87 uses QCD sum rules to obtain $m_u+m_d = 15.5 \pm 2.0$ MeV and $m_d - m_u = 6 \pm 1.5$ MeV.

[14] KREMER 84 obtain $m_u+m_d = 21 \pm 2$ MeV at $Q^2 = 1\ \mathrm{GeV}^2$ using SVZ values for quark condensates; they obtain $m_u+m_d = 35 \pm 3$ MeV at $Q^2 = 1\ \mathrm{GeV}^2$ using factorization values for quark condensates.

[15] GASSER 82 uses chiral perturbation theory for the mass ratios, and uses QCD sum rules to extract the absolute values. We have rescaled $m_d(1\ \mathrm{GeV}) = 8.9 \pm 2.6$ to $\mu = 2$ GeV.

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

See the comments for the *u* quark above.

We have normalized the $\overline{\mathrm{MS}}$ 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*
2.5 to 6 OUR EVALUATION			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
4.57±0.18	[16] AOKI 00	LATT	
4.4 ±2	[17] GOECKELER 00	LATT	$\overline{\mathrm{MS}}$ scheme
4.23±0.29	[18] AOKI 99	LATT	$\overline{\mathrm{MS}}$ scheme
≥ 2.1	[19] STEELE 99	THEO	$\overline{\mathrm{MS}}$ scheme
4.5 ±0.4	[20] BECIREVIC 98	LATT	$\overline{\mathrm{MS}}$ scheme
4.6 ±1.2	[21] DOSCH 98	THEO	$\overline{\mathrm{MS}}$ scheme
2.7 ±0.2	[22] EICKER 97	LATT	$\overline{\mathrm{MS}}$ scheme
3.6 ±0.6	[23] GOUGH 97	LATT	$\overline{\mathrm{MS}}$ scheme
3.4 ±0.4 ±0.3	[24] GUPTA 97	LATT	$\overline{\mathrm{MS}}$ scheme
>3.8	[25] LELLOUCH 97	THEO	$\overline{\mathrm{MS}}$ scheme
4.5 ±1.0	[26] BIJNENS 95		

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

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

[18] 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.

[19] 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.

[20] 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.

[21] 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.

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

[23] 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.

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

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

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

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s-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.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
75 to 170 OUR EVALUATION				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
130 ±15	[27] AOKI	00	LATT	
105 ± 4	[28] GOECKELER	00	LATT	$\overline{\text{MS}}$ scheme
118 ±14	[29] AOKI	99	LATT	$\overline{\text{MS}}$ scheme
170^{+44}_{-55}	[30] BARATE	99R		$\overline{\text{MS}}$ scheme
115 ± 8	[31] MALTMAN	99	THEO	$\overline{\text{MS}}$ scheme
129 ±24	[32] NARISON	99	THEO	$\overline{\text{MS}}$ scheme
114 ±23	[33] PICH	99	THEO	$\overline{\text{MS}}$ scheme
111 ±12	[34] BECIREVIC	98		$\overline{\text{MS}}$ scheme
148 ±48	[35] CHETYRKIN	98	THEO	$\overline{\text{MS}}$ scheme
103 ±10	[36] CUCCHIERI	98	LATT	$\overline{\text{MS}}$ scheme
115 ±19	[37] DOMINGUEZ	98	THEO	$\overline{\text{MS}}$ scheme
> 90 ± 9	[38] DOSCH	98	THEO	$\overline{\text{MS}}$ scheme
> 30	[39] LEBED	98	THEO	$\overline{\text{MS}}$ scheme
84 ±80	[40] MALTMAN	98	THEO	$\overline{\text{MS}}$ scheme
<163 ±81	[41] MALTMAN	98B	THEO	$\overline{\text{MS}}$ scheme

152.4±14.1	[42] CHETYRKIN	97	THEO	$\overline{\text{MS}}$ scheme
≥ 89	[43] COLANGELO	97	THEO	$\overline{\text{MS}}$ scheme
140 ±20	[44] EICKER	97	LATT	$\overline{\text{MS}}$ scheme
95 ±16	[45] GOUGH	97	LATT	$\overline{\text{MS}}$ scheme
100 ±21 ±10	[46] GUPTA	97	LATT	$\overline{\text{MS}}$ scheme
>100	[47] LELLOUCH	97	THEO	$\overline{\text{MS}}$ scheme
127 ±11	[48] CHETYRKIN	95	THEO	$\overline{\text{MS}}$ scheme
140 ±24	[49] JAMIN	95	THEO	$\overline{\text{MS}}$ scheme
146 ±22	[50] NARISON	95C	THEO	$\overline{\text{MS}}$ scheme
	[51] NEFKENS	92	THEO	
144 ± 3	[52] DOMINGUEZ	91	THEO	
88	[53] BARDUCCI	88	THEO	
	[54] KREMER	84	THEO	
130 ±41	[55] GASSER	82	THEO	

[27] 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 $m_s = 115.6 \pm 2.3$ and $m_s = 143.7 \pm 5.8$ obtained using m_K and m_ϕ, respectively, to normalize the spectrum.

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

[29] 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 $m_s = 106.0 \pm 7.1$ and $m_s = 129 \pm 12$ obtained using m_K and m_ϕ, respectively, to normalize the spectrum.

[30] 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.

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

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

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

[34] 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.

[35] CHETYRKIN 98 uses spectral moments of hadronic τ decays to determine $m_s(1\,\text{GeV}) = 200 \pm 70$ MeV. We have rescaled the result to μ=2 GeV.

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

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

[38] DOSCH 98 use sum rule determinations of the quark condensate and chiral perturbation theory to obtain $m_s(1\,\text{GeV}) > 121 \pm 12$ MeV. We have converted the result to μ=2 GeV.

[39] LEBED 98 obtain lower bounds of 41, 90, and 139 MeV for $m_s(1\,\text{GeV})$ using dispersion relations and chiral perturbation theory. The numbers assume the chiral perturbation theory form factor is accurate to 5%, 1%, and 0.05%, respectively. We have used the first number converted to μ=2.

[40] MALTMAN 98 uses τ-decay-like sum rules involving electromagnetic spectral data to determine $m_s(1\,\text{GeV}) = 113 \pm 107$ MeV. We have rescaled the result to μ=2 GeV.

[41] MALTMAN 98B uses spectral moments of hadronic τ decays to determine $m_s(1\,\text{GeV}) < 220 \pm 110$ MeV. We have rescaled the result to μ=2 GeV.

[42] 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.

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

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

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

[46] 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.

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

[48] CHETYRKIN 95 uses QCD sum rules at next-to-leading order. We have rescaled m_s(1 GeV) = 171 ± 15 to $\mu = 2$ GeV.

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

[50] For NARISON 95C, we have rescaled m_s(1 GeV) = 197 ± 29 to $\mu = 2$ GeV.

[51] NEFKENS 92 results for $m_s-(m_u+m_d)/2$ are 111 ± 10 MeV from meson masses and 163 ± 15 MeV from baryon masses.

[52] DOMINGUEZ 91 uses QCD sum rules with Λ_{QCD} = 100–200 MeV and the SVZ value for the gluon condensate. We have rescaled m_s(1 GeV) = 194 ± 9 to $\mu = 2$ GeV.

[53] BARDUCCI 88 uses a calculation of the effective potential for $\overline{\psi}\psi$ in QCD, and estimates for $\Sigma(p^2)$. We have rescaled m_s(1 GeV) = 118 to $\mu = 2$ GeV.

[54] KREMER 84 obtain m_u+m_s=245 ± 10 MeV at $Q^2 = 1$ GeV^2 using SVZ values for quark condensates; they obtain m_u+m_s=270 ± 10 MeV at $Q^2 = 1$ GeV^2 using factorization values for quark condensates.

[55] GASSER 82 uses chiral perturbation theory for the mass ratios, and uses QCD sum rules to extract the absolute values. We have rescaled m_s(1 GeV) = 175 ± 55 to $\mu = 2$ GeV.

LIGHT QUARK MASS RATIOS

u/*d* MASS RATIO

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.2 to 0.8 OUR EVALUATION				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.44	[56] GAO	97	THEO	$\overline{\text{MS}}$ scheme
0.553±0.043	[57] LEUTWYLER	96	THEO	Compilation
<0.3	[58] CHOI	92	THEO	
0.26	[59] DONOGHUE	92	THEO	
0.30 ±0.07	[60] DONOGHUE	92B	THEO	
0.66	[61] GERARD	90	THEO	
0.4 to 0.65	[62] LEUTWYLER	90B	THEO	
0.05 to 0.78	[63] MALTMAN	90	THEO	
0.0 to 0.56	[64] CHOI	89B	THEO	
0.0 to 0.8	[65] KAPLAN	86	THEO	
0.57 ±0.04	[66] GASSER	82	THEO	
0.38 ±0.13	[67] LANGACKER	79	THEO	
0.47 ±0.11	[68] LANGACKER	79B	THEO	
0.56	[69] WEINBERG	77	THEO	

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

[57] 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.

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

[59] 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 $(\psi(2S) \rightarrow J/\psi(1S)\pi)/(\psi(2S) \rightarrow J/\psi(1S)\eta)$.

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

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

[62] 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.

[63] 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.

[64] CHOI 89 uses second-order chiral perturbation theory and a dilute instanton gas estimate of second-order coefficients in the chiral lagrangian.

[65] KAPLAN 86 uses second-order chiral perturbation theory including nonanalytic terms for the meson masses. Assumes that less than 30% of the mass squared of the pion is due to second-order corrections.

[66] GASSER 82 uses chiral perturbation theory for the meson and baryon masses.

[67] LANGACKER 79 result is from a fit to the meson and baryon mass spectrum, and the decay $\eta \rightarrow 3\pi$. The electromagnetic contribution is taken from Socolow rather than from Dashen's formula.

[68] LANGACKER 79B result uses LANGACKER 79 and also ρ-ω mixing.

[69] WEINBERG 77 uses lowest-order chiral perturbation theory for the meson and baryon masses and Dashen's formula for the electromagnetic mass differences.

s/*d* MASS RATIO

VALUE	*DOCUMENT ID*	*TECN*	*COMMENT*
17 to 25 OUR EVALUATION			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
20.0	[70] GAO 97	THEO	$\overline{\text{MS}}$ scheme
18.9±0.8	[71] LEUTWYLER 96	THEO	Compilation
21	[72] DONOGHUE 92	THEO	
18	[73] GERARD 90	THEO	
18 to 23	[74] LEUTWYLER 90B	THEO	
15 to 26	[75] KAPLAN 86	THEO	
19.6±1.5	[76] GASSER 82	THEO	
22 ±5	[77] LANGACKER 79	THEO	
24 ±4	[78] LANGACKER 79B	THEO	
20	[79] WEINBERG 77	THEO	

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

[71] 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.

[72] 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 $(\psi(2S) \rightarrow J/\psi(1S)\pi)/(\psi(2S) \rightarrow J/\psi(1S)\eta)$.

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

[74] 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.

[75] KAPLAN 86 uses second-order chiral perturbation theory including nonanalytic terms for the meson masses. Assumes that less than 30% of the mass squared of the pion is due to second-order corrections.

[76] GASSER 82 uses chiral perturbation theory for the meson and baryon masses.

[77] LANGACKER 79 result is from a fit to the meson and baryon mass spectrum, and the decay $\eta \rightarrow 3\pi$. The electromagnetic contribution is taken from Socolow rather than from Dashen's formula.

[78] LANGACKER 79B result uses LANGACKER 79 and also ρ-ω mixing.

[79] WEINBERG 77 uses lowest-order chiral perturbation theory for the meson and baryon masses and Dashen's formula for the electromagnetic mass differences.

$(m_s - \overline{m})/(m_d - m_u)$ MASS RATIO

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

VALUE	DOCUMENT ID		TECN
34 to 51 OUR EVALUATION			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
	[80] ANISOVICH	96	THEO
36 ±5	[81] NEFKENS	92	THEO
45 ±3	[82] NEFKENS	92	THEO
38 ±9	[83] AMETLLER	84	THEO
43.5±2.2	GASSER	82	THEO
34 to 51	GASSER	81	THEO
48 ±7	MINKOWSKI	80	THEO

[80] ANISOVICH 96 find Q=22.7 ± 0.8 with $Q^2 \equiv (m_s^2 - \overline{m}^2)/(m_d^2 - m_s^2)$ from $\eta \rightarrow \pi^+\pi^-\pi^0$ decay using dispersion relations and chiral perturbation theory.

[81] NEFKENS 92 result is from an analysis of meson masses, mixing, and decay.

[82] NEFKENS 92 result is from an analysis of of baryon masses.

[83] AMETLLER 84 uses $\eta \rightarrow \pi^+\pi^-\pi^0$ and ρ dominance.

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

AOKI	00	PRL 84 238	S. Aoki *et al.*	(CP-PACS Collab.)
GOECKELER	00	PR D62 054504	M. Goeckeler *et al.*	
AOKI	99	PRL 82 4392	S. Aoki *et al.*	(JLQCD Collab.)
BARATE	99R	EPJ C11 599	R. Barate *et al.*	(ALEPH Collab.)
MALTMAN	99	PL B462 195	K. Maltman	
NARISON	99	PL B466 345	S. Narison	
PICH	99	JHEP 9910 004	A. Pich, J. Prades	
STEELE	99	PL B451 201	T.G. Steele, K. Kostuik, J. Kwan	
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CHETYRKIN	98	NP B533 473	K.G. Chetyrkin, J.H. Kuehn, A.A. Pivovarov	
CUCCHIERI	98	PL B422 212	A. Chucchieri *et al.*	
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LEBED	98	PL B430 341	R.F. Lebed, K. Schilcher	
MALTMAN	98	PL B428 179	K. Maltman	
MALTMAN	98B	PR D58 093015	K. Maltman	
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GUPTA	97	PR D55 7203	R. Gupta, T. Bhattacharya	
LELLOUCH	97	PL B414 195	L. Lellouch, E. de Rafael, J. Taron	
ANISOVICH	96	PL B375 335	A.V. Anisovich, H. Leutwyler	
LEUTWYLER	96	PL B378 313	H. Leutwyler	
BIJNENS	95	PL B348 226	J. Bijnens, J. Prades, E. de Rafael	(NORD, BOHR+)

CHETYRKIN 95 PR D51 5090 K.G. Chetyrkin *et al.* (INRM, CAPE, MANZ)
JAMIN 95 ZPHY C66 633 M. Jamin, M. Munz (HEIDT, MUNT)
NARISON 95C PL B358 113 S. Narison (MONP)
ADAMI 93 PR D48 2304 C. Adami, E.G. Drukarev, B.L. Ioffe (CIT, ITEP+)
CHOI 92 PL B292 159 K.W. Choi (UCSD)
CHOI 92B NP B383 58 K.W. Choi (UCSD)
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NEFKENS 92 CNPP 20 221 B.M.K. Nefkens, G.A. Miller, I. Slaus (UCLA+)
DOMINGUEZ 91 PL B253 241 C.A. Dominguez, C. van Gend, N. Paver (CAPE+)
GERARD 90 MPL A5 391 J.M. Gerard (MPIM)
LEUTWYLER 90B NP B337 108 H. Leutwyler (BERN)
MALTMAN 90 PL B234 158 K. Maltman, T. Goldman, Stephenson Jr. (YORKC+)
CHOI 89 PRL 62 849 K. Choi, K. Kang, J.E. Kim
CHOI 89B PR D40 890 K. Choi, C.W. Kim (CMU, JHU)
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KREMER 84 PL 143B 476 M. Kremer, N.A. Papadopoulos, K. Schilcher (MANZ)
GASSER 82 PRPL 87 77 J. Gasser, H. Leutwyler (BERN)
GASSER 81 ANP 136 62 J. Gasser (BERN)
MINKOWSKI 80 NP B164 25 P. Minkowski, A. Zepeda (BERN)
LANGACKER 79 PR D19 2070 P. Langacker, H. Pagels (DESY, PRIN)
LANGACKER 79B PR D20 2983 P. Langacker (PENN)
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