NODE=B037

$\Lambda(1405)\ 1/2^-$

$I(J^P) = 0(\frac{1}{2}^-)$ Status: ****

The nature of the $\Lambda(1405)$ has been a puzzle for decades: three-quark state or hybrid; two poles or one. We cannot here survey the rather extensive literature. See, for example, CIEPLY 10, KISSLINGER 11, SEKIHARA 11, and SHEVCHENKO 12A for discussions and earlier references. NODE=B037

It seems to be the universal opinion of the chiral-unitary community that there are two poles in the 1400-MeV region. ZYCHOR 08 presents experimental evidence against the two-pole model, but this is disputed by GENG 07A. See also REVAI 09, which finds little basis for choosing between one- and two-pole models; and IKEDA 12, which favors the two-pole model.

A single, ordinary three-quark $\Lambda(1405)$ fits nicely into a $J^P = 1/2^-$ SU(4) $\overline{4}$ multiplet, whose other members are the $\Lambda_c(2595)^+$, $\Xi_c(2790)^+$, and $\Xi_c(2790)^0$; see Fig. 1 of our note on "Charmed Baryons."

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$\Lambda(1405)$ MASS

NODE=B037205

PRODUCTION EXPERIMENTS

NODE=B037M1
NODE=B037M1

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
$1405.1^{+1.3}_{-1.0}$ OUR AVERAGE					
1405^{+11}_{-9}		HASSANVAND	13	SPEC	$pp \to p\Lambda(1405)K^+$
$1405^{+1.4}_{-1.0}$		ESMAILI	10	RVUE	^{4}He $K^- \to \Sigma^\pm\pi^\mp X$ at rest
1406.5 ± 4.0		[1] DALITZ	91		M-matrix fit
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1391 ± 1	700	[1] HEMINGWAY	85	HBC	$K^- p$ 4.2 GeV/c
~ 1405	400	[2] THOMAS	73	HBC	$\pi^- p$ 1.69 GeV/c
1405	120	BARBARO-...	68B	DBC	$K^- d$ 2.1–2.7 GeV/c
1400 ± 5	67	BIRMINGHAM	66	HBC	$K^- p$ 3.5 GeV/c
1382 ± 8		ENGLER	65	HDBC	$\pi^- p$, $\pi^+ d$ 1.68 GeV/c
1400 ± 24		MUSGRAVE	65	HBC	$\overline{p}p$ 3–4 GeV/c
1410		ALEXANDER	62	HBC	$\pi^- p$ 2.1 GeV/c
1405		ALSTON	62	HBC	$K^- p$ 1.2–0.5 GeV/c
1405		ALSTON	61B	HBC	$K^- p$ 1.15 GeV/c

EXTRAPOLATIONS BELOW $N\overline{K}$ THRESHOLD

NODE=B037M2
NODE=B037M2

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1407.56 or 1407.50	[3] KIMURA	00		potential model
1411	[4] MARTIN	81		K-matrix fit
1406	[5] CHAO	73	DPWA	0–range fit (sol. B)
1421	MARTIN	70	RVUE	Constant K-matrix
1416 ± 4	MARTIN	69	HBC	Constant K-matrix
1403 ± 3	KIM	67	HBC	K-matrix fit
1407.5 ± 1.2	[6] KITTEL	66	HBC	0–effective-range fit
1410.7 ± 1.0	KIM	65	HBC	0–effective-range fit
1409.6 ± 1.7	[6] SAKITT	65	HBC	0–effective-range fit

OCCUR=2

$\Lambda(1405)$ WIDTH

NODE=B037210

PRODUCTION EXPERIMENTS

NODE=B037W1
NODE=B037W1

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
50.5 ± 2.0 OUR AVERAGE					
62 ± 10		HASSANVAND	13	SPEC	$pp \to p\Lambda(1405)K^+$
50 ± 2		[1] DALITZ	91		M-matrix fit

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

24	$^{+4}_{-3}$		ESMAILI	10	RVUE	^{4}He $K^- \to \Sigma^\pm \pi^\mp X$ at rest
32	± 1	700	[1] HEMINGWAY	85	HBC	$K^- p$ 4.2 GeV/c
45	to 55	400	[2] THOMAS	73	HBC	$\pi^- p$ 1.69 GeV/c
35		120	BARBARO-...	68B	DBC	$K^- d$ 2.1–2.7 GeV/c
50	±10	67	BIRMINGHAM	66	HBC	$K^- p$ 3.5 GeV/c
89	±20		ENGLER	65	HDBC	
60	±20		MUSGRAVE	65	HBC	
35	± 5		ALEXANDER	62	HBC	
50			ALSTON	62	HBC	
20			ALSTON	61B	HBC	

EXTRAPOLATIONS BELOW $N\overline{K}$ THRESHOLD

NODE=B037W2
NODE=B037W2

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
50.24 or 50.26	[3] KIMURA	00		potential model
30	[4] MARTIN	81		K-matrix fit
55	[5,7] CHAO	73	DPWA	0–range fit (sol. B)
20	MARTIN	70	RVUE	Constant K-matrix
29 ±6	MARTIN	69	HBC	Constant K-matrix
50 ±5	KIM	67	HBC	K-matrix fit
34.1±4.1	[6] KITTEL	66	HBC	
37.0±3.2	KIM	65	HBC	
28.2±4.1	[6] SAKITT	65	HBC	

OCCUR=2

$\Lambda(1405)$ DECAY MODES

NODE=B037215;NODE=B037

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$\Sigma\pi$	100 %	DESIG=1;OUR EST
Γ_2	$\Lambda\gamma$		DESIG=3
Γ_3	$\Sigma^0\gamma$		DESIG=4
Γ_4	$N\overline{K}$		DESIG=2

$\Lambda(1405)$ PARTIAL WIDTHS

NODE=B037217

$\Gamma(\Lambda\gamma)$ — Γ_2

NODE=B037G1
NODE=B037G1

VALUE (keV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
27±8	BURKHARDT	91	Isobar model fit

$\Gamma(\Sigma^0\gamma)$ — Γ_3

NODE=B037G2
NODE=B037G2

VALUE (keV)	DOCUMENT ID		COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
10 ± 4 or 23 ± 7	BURKHARDT	91	Isobar model fit

$\Lambda(1405)$ BRANCHING RATIOS

NODE=B037220

$\Gamma(N\overline{K})/\Gamma(\Sigma\pi)$ — Γ_4/Γ_1

NODE=B037R1
NODE=B037R1

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<3	95	HEMINGWAY	85	HBC	$K^- p$ 4.2 GeV/c

$\Lambda(1405)$ FOOTNOTES

NODE=B037

[1] DALITZ 91 fits the HEMINGWAY 85 data. NODE=B037;LINKAGE=C

[2] THOMAS 73 data is fit by CHAO 73 (see next section). NODE=B037;LINKAGE=B

[3] The KIMURA 00 values are from fits A and B from a coupled-channel potential model using low-energy $\overline{K}N$ and $\Sigma\pi$ data, kaonic-hydrogen x-ray measurements, and our $\Lambda(1405)$ mass and width. The results bear mainly on the *nature* of the $\Lambda(1405)$: three-quark state or $\overline{K}N$ bound state. NODE=B037;LINKAGE=KM

[4] The MARTIN 81 fit includes the $K^\pm p$ forward scattering amplitudes and the dispersion relations they must satisfy. NODE=B037;LINKAGE=AA

[5] See also the accompanying paper of THOMAS 73. NODE=B037;LINKAGE=T

[6] Data of SAKITT 65 are used in the fit by KITTEL 66. NODE=B037;LINKAGE=S

[7] An asymmetric shape, with $\Gamma/2 = 41$ MeV below resonance, 14 MeV above. NODE=B037;LINKAGE=X

Λ(1405) REFERENCES

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