



$$I(J^P) = 1(\frac{1}{2}^+) \quad \text{Status: } ****$$

COURANT 63 and ALFF 65, using $\Sigma^0 \rightarrow \Lambda e^+ e^-$ decays (Dalitz decays), determined the Σ^0 parity to be positive, given that $J = 1/2$ and that certain very reasonable assumptions about form factors are true. The results of experiments involving the Primakoff effect, from which the Σ^0 mean life and $\Sigma^0 \rightarrow \Lambda$ transition magnetic moment come (see below), strongly support $J = 1/2$.

Σ^0 MASS

The fit uses Σ^+ , Σ^0 , Σ^- , and Λ mass and mass-difference measurements.

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
1192.642 ± 0.024				OUR FIT

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

1192.65 ± 0.020 ± 0.014	3327	¹ WANG	97	SPEC	$\Sigma^0 \rightarrow \Lambda \gamma \rightarrow (p\pi^-)(e^+e^-)$
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¹ This WANG 97 result is redundant with the Σ^0 - Λ mass-difference measurement below.

$m_{\Sigma^-} - m_{\Sigma^0}$

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
4.807 ± 0.035				OUR FIT
Error includes scale factor of 1.1.				

4.86 ± 0.08 **OUR AVERAGE** Error includes scale factor of 1.2.

4.87 ± 0.12	37	DOSCH	65	HBC	
5.01 ± 0.12	12	SCHMIDT	65	HBC	See note with Λ mass
4.75 ± 0.1	18	BURNSTEIN	64	HBC	

$m_{\Sigma^0} - m_{\Lambda}$

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
76.959 ± 0.023				OUR FIT

76.966 ± 0.020 ± 0.013	3327	WANG	97	SPEC	$\Sigma^0 \rightarrow \Lambda \gamma \rightarrow (p\pi^-)(e^+e^-)$
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• • • We do not use the following data for averages, fits, limits, etc. • • •

76.23 ± 0.55	109	COLAS	75	HLBC	$\Sigma^0 \rightarrow \Lambda \gamma$
76.63 ± 0.28	208	SCHMIDT	65	HBC	See note with Λ mass

Σ^0 MEAN LIFE

These lifetimes are deduced from measurements of the cross sections for the Primakoff process $\Lambda \rightarrow \Sigma^0$ in nuclear Coulomb fields. An alternative expression of the same information is the Σ^0 - Λ transition magnetic moment given in the following section. The relation is $(\mu_{\Sigma\Lambda}/\mu_N)^2 \tau = 1.92951 \times 10^{-19}$ s (see DEVLIN 86).

<u>VALUE (10^{-20} s)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
7.4±0.7 OUR EVALUATION	Using $\mu \Sigma \Lambda$ (see the above note).		
6.5 ^{+1.7} _{-1.1}	² DEVLIN	86	SPEC Primakoff effect
7.6±0.5±0.7	³ PETERSEN	86	SPEC Primakoff effect
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
5.8±1.3	² DYDAK	77	SPEC See DEVLIN 86
² DEVLIN 86 is a recalculation of the results of DYDAK 77 removing a numerical approximation made in that work.			
³ An additional uncertainty of the Primakoff formalism is estimated to be < 5%.			

$|\mu(\Sigma^0 \rightarrow \Lambda)|$ TRANSITION MAGNETIC MOMENT

See the note in the Σ^0 mean-life section above. Also, See the “Quark Model” review.

<u>VALUE (μ_N)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.61±0.08 OUR AVERAGE			
1.72 ^{+0.17} _{-0.19}	⁴ DEVLIN	86	SPEC Primakoff effect
1.59±0.05±0.07	⁵ PETERSEN	86	SPEC Primakoff effect
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1.82 ^{+0.25} _{-0.18}	⁴ DYDAK	77	SPEC See DEVLIN 86
⁴ DEVLIN 86 is a recalculation of the results of DYDAK 77 removing a numerical approximation made in that work.			
⁵ An additional uncertainty of the Primakoff formalism is estimated to be < 2.5%.			

Σ^0 DECAY MODES

Mode	Fraction (Γ_i/Γ)	Confidence level
$\Gamma_1 \quad \Lambda\gamma$	100 %	
$\Gamma_2 \quad \Lambda\gamma\gamma$	< 3 %	90%
$\Gamma_3 \quad \Lambda e^+ e^-$	[a] 5×10^{-3}	

[a] A theoretical value using QED.

Σ^0 BRANCHING RATIOS

$\Gamma(\Lambda\gamma\gamma)/\Gamma_{\text{total}}$				Γ_2/Γ
<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	
<0.03	90	COLAS	75	HLBC

$\Gamma(\Lambda e^+ e^-)/\Gamma_{\text{total}}$				Γ_3/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>		
0.00545	FEINBERG	58	Theoretical QED calculation	

See COURANT 63 and ALFF 65 for measurements of the invariant-mass spectrum of the Dalitz pairs.

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>COMMENT</u>
0.00545	FEINBERG	58

Σ^0 DECAY PARAMETERS α for $\Sigma^0 \rightarrow \Lambda\gamma$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
$-1.7 \pm 2.1 \pm 1.8$	1.1M	ABLIKIM	24CE BES3	$J/\psi/\psi(2S) \rightarrow \Sigma \bar{\Sigma} \rightarrow \Lambda \bar{\Lambda} \gamma \gamma$

 $\bar{\alpha}$ for $\bar{\Sigma}^0 \rightarrow \bar{\Lambda}\gamma$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
$2.1 \pm 2.0 \pm 2.2$	1.1M	ABLIKIM	24CE BES3	$J/\psi/\psi(2S) \rightarrow \Sigma \bar{\Sigma} \rightarrow \Lambda \bar{\Lambda} \gamma \gamma$

 $\alpha + \bar{\alpha}$ in $\Sigma \rightarrow \Lambda\gamma$ and $\bar{\Sigma} \rightarrow \bar{\Lambda}\gamma$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
$0.4 \pm 2.9 \pm 1.3$	1.1M	ABLIKIM	24CE BES3	$J/\psi/\psi(2S) \rightarrow \Sigma \bar{\Sigma} \rightarrow \Lambda \bar{\Lambda} \gamma \gamma$

 Σ^0 REFERENCES

ABLIKIM	24CE	PRL 133 101902	M. Ablikim <i>et al.</i>	(BESIII Collab.)
WANG	97	PR D56 2544	M.H.L.S. Wang <i>et al.</i>	(BNL-E766 Collab.)
DEVLIN	86	PR D34 1626	T. Devlin, P.C. Petersen, A. Beretvas	(RUTG)
PETERSEN	86	PRL 57 949	P.C. Petersen <i>et al.</i>	(RUTG, WISC, MICH+)
DYDAK	77	NP B118 1	F. Dydak <i>et al.</i>	(CERN, DORT, HEIDH)
COLAS	75	NP B91 253	J. Colas <i>et al.</i>	(ORSAY)
ALFF	65	PR 137 B1105	C. Alff <i>et al.</i>	(COLU, RUTG, BNL) P
DOSCH	65	PL 14 239	H.C. Dosch <i>et al.</i>	(HEID)
SCHMIDT	65	PR 140 B1328	P. Schmidt	(COLU)
BURNSTEIN	64	PRL 13 66	R.A. Burnstein <i>et al.</i>	(UMD)
COURANT	63	PRL 10 409	H. Courant <i>et al.</i>	(CERN, UMD) P
FEINBERG	58	PR 109 1019	G. Feinberg	(BNL)