



$I(J^P) = 1(\frac{1}{2}^+)$ 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 $\Sigma^0 \rightarrow \Lambda \gamma \rightarrow (p \pi^-)(e^+ e^-)$

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 $\Sigma^0 \rightarrow \Lambda \gamma \rightarrow (p \pi^-)(e^+ e^-)$
● ● ● 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 $(\mu_{\Sigma\Lambda}/\mu_N)^2 \tau = 1.92951 \times 10^{-19} \text{ s}$ (see DEVLIN 86).

VALUE (10^{-20} s)	DOCUMENT ID	TECN	COMMENT
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
$7.6 \pm 0.5 \pm 0.7$	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.

VALUE (μ_N)	DOCUMENT ID	TECN	COMMENT
1.61±0.08 OUR AVERAGE			
$1.72^{+0.17}_{-0.19}$	⁴ DEVLIN	86	SPEC Primakoff effect
$1.59 \pm 0.05 \pm 0.07$	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 %	90%
$\Gamma_2 \quad \Lambda\gamma\gamma$	< 3 %	
$\Gamma_3 \quad \Lambda e^+ e^-$	[a] 5×10^{-3}	

[a] A theoretical value using QED.

Σ^0 BRANCHING RATIOS

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

$\Gamma(\Lambda e^+ e^-)/\Gamma_{\text{total}}$

Γ_3/Γ

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

VALUE	DOCUMENT ID	TECN	COMMENT
0.00545	FEINBERG 58		Theoretical QED calculation

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	$J/\psi/\psi(2S) \rightarrow \Sigma \bar{\Sigma} \rightarrow \Lambda \bar{\Lambda} \gamma \gamma$

α_+ 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	$J/\psi/\psi(2S) \rightarrow \Sigma \bar{\Sigma} \rightarrow \Lambda \bar{\Lambda} \gamma \gamma$

A_{CP}^Σ in $\Sigma \rightarrow \Lambda \gamma$ and $\bar{\Sigma} \rightarrow \bar{\Lambda} \gamma$

$A_{CP}^\Sigma = (\alpha + \bar{\alpha})/(\alpha - \bar{\alpha})$

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)