ELECTRON COMPOSITENESS LIMITS IN e^-e^- COLLISIONS

TIMOTHY L. BARKLOW

Stanford Linear Accelerator Center, Stanford University
Stanford, California 94309, USA

4 fermion contact term :

$$L = \frac{g^2}{2\Lambda^2}\left[\eta_{LL}\overline{\psi_L}\gamma_\mu\psi_L\overline{\psi_L}\gamma^\mu\psi_L + \eta_{RR}\overline{\psi_R}\gamma_\mu\psi_R\overline{\psi_R}\gamma^\mu\psi_R + 2\eta_{LR}\overline{\psi_L}\gamma_\mu\psi_L\overline{\psi_R}\gamma^\mu\psi_R\right]$$

$\frac{g^2}{4\pi} = 1$ largest $|\eta_{xy}| = 1$

$\Lambda =$ compositeness energy scale

Observe interference with SM amplitudes

in $\psi_1 \psi_2 \to \psi_3 \psi_4$

Quark and Lepton Compositeness, Searches for

1998 PDG

Scale Limits Λ for Contact Interactions (the lowest dimensional interactions with four fermions)

If the Lagrangian has the form

$$\pm \frac{g^2}{2\Lambda^2}\, \overline{\psi}_L \gamma_\mu \psi_L \overline{\psi}_L \gamma^\mu \psi_L$$

(with $g^2/4\pi$ set equal to 1), then we define $\Lambda \equiv \Lambda^{\pm}_{LL}$. For the full definitions and for other forms, see the Note in the Listings on Searches for Quark and Lepton Compositeness in the full *Review* and the original literature.

$\Lambda^+_{LL}(eeee)$	> 2.4 TeV, CL = 95%	now 3.5 TeV (ALEPH)
$\Lambda^-_{LL}(eeee)$	> 3.6 TeV, CL = 95%	now 3.8 TeV (OPAL)
$\Lambda^+_{LL}(ee\mu\mu)$	> 2.6 TeV, CL = 95%	
$\Lambda^-_{LL}(ee\mu\mu)$	> 2.9 TeV, CL = 95%	now ~ 4 TeV
$\Lambda^+_{LL}(ee\tau\tau)$	> 1.9 TeV, CL = 95%	
$\Lambda^-_{LL}(ee\tau\tau)$	> 3.0 TeV, CL = 95%	
$\Lambda^+_{LL}(\ell\ell\ell\ell)$	> 3.5 TeV, CL = 95%	
$\Lambda^-_{LL}(\ell\ell\ell\ell)$	> 3.8 TeV, CL = 95%	
$\Lambda^+_{LL}(eeqq)$	> 2.5 TeV, CL = 95%	
$\Lambda^-_{LL}(eeqq)$	> 3.7 TeV, CL = 95%	now 4-6 TeV
$\Lambda^+_{LL}(eebb)$	> 3.1 TeV, CL = 95%	
$\Lambda^-_{LL}(eebb)$	> 2.9 TeV, CL = 95%	
$\Lambda^+_{LL}(\mu\mu qq)$	> 2.9 TeV, CL = 95%	
$\Lambda^-_{LL}(\mu\mu qq)$	> 4.2 TeV, CL = 95%	
$\Lambda^{\pm}_{LR}(\nu_\mu \nu_e \mu e)$	> 3.1 TeV, CL = 90%	
$\Lambda^{\pm}_{LL}(qqqq)$	> 1.6 TeV, CL = 95%	

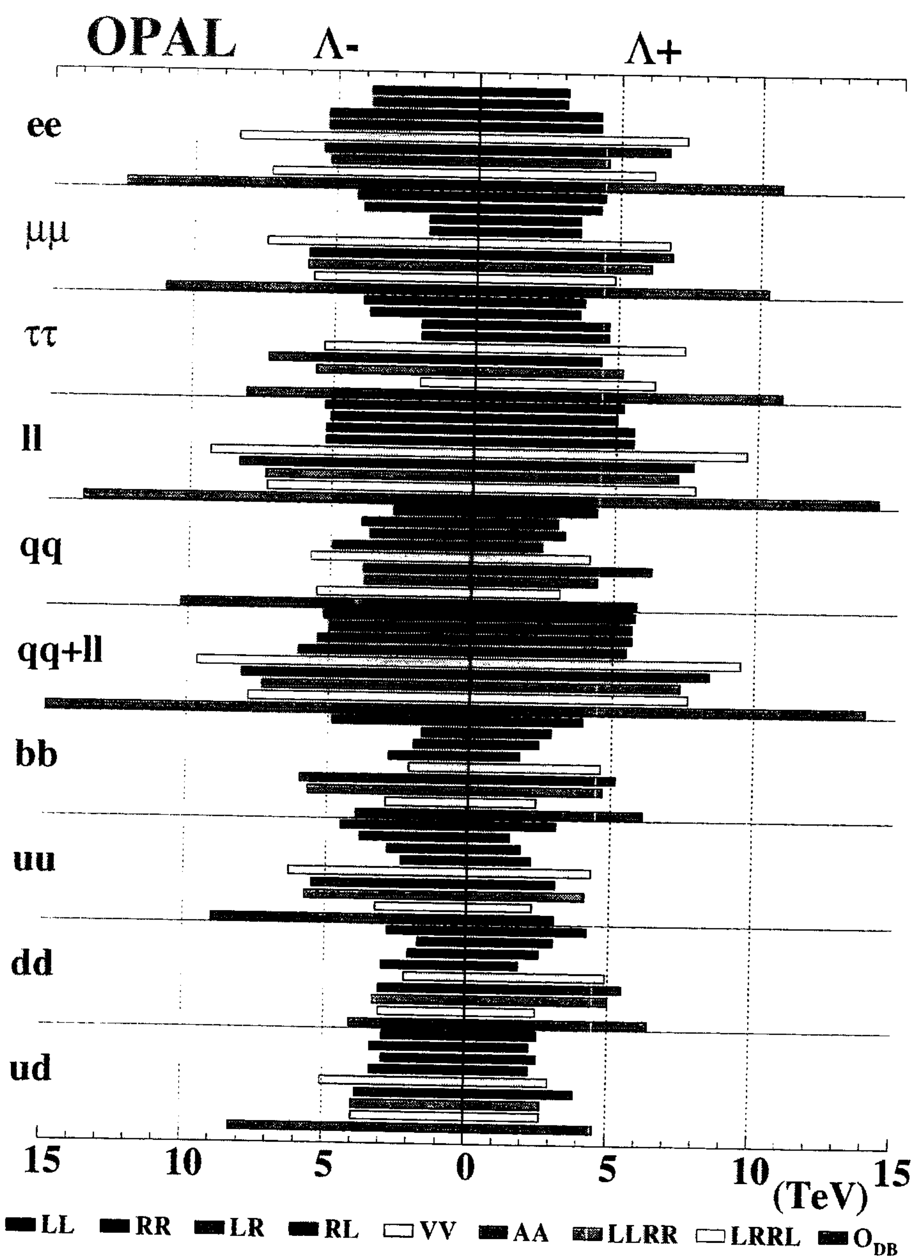


Figure 7: 95% confidence level limits on the energy scale Λ resulting from the contact interaction fits. For each channel, the bars from top to bottom indicate the results for models LL to $\overline{\mathcal{O}}_{\mathrm{DB}}$ in the order given in the key.

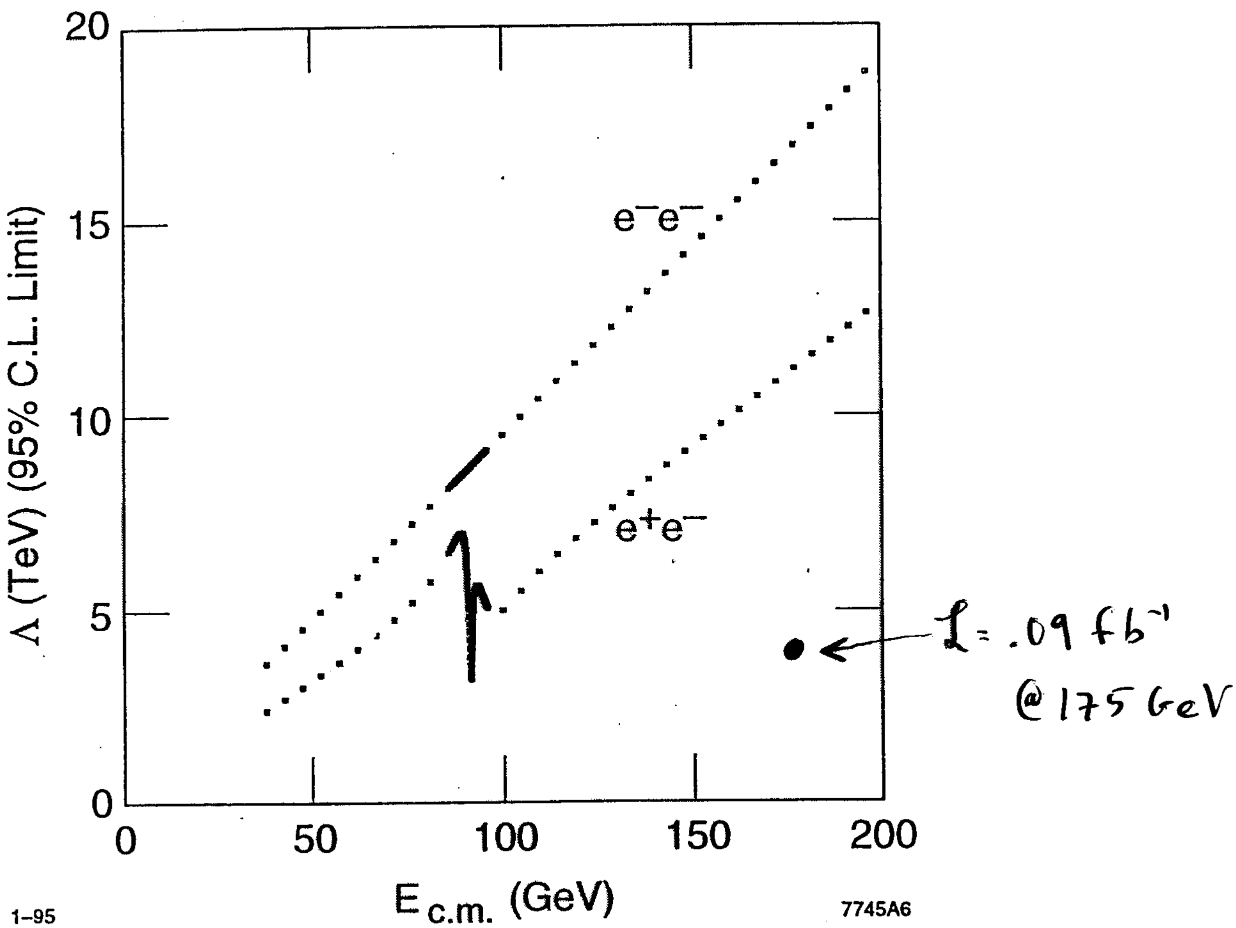
ALEPH

Table 19: Limits on contact interactions coupling to dilepton final states. The 68% confidence level range is given for ϵ whilst the 95% confidence level limits are given for Λ. The results presented for l^+l^- assume lepton universality.

Model	$[\epsilon^-,\epsilon^+]$ (TeV^{-2})	Λ^- (TeV)	Λ^+ (TeV)
$e^+e^- \to e^+e^-$			
LL	$[-0.067, +0.021]$	3.2	3.5
RR	$[-0.067, +0.022]$	3.2	3.4
VV	$[-0.017, +0.003]$	6.4	8.0
AA	$[-0.018, +0.019]$	4.2	5.5
LR	$[-0.042, +0.015]$	4.0	4.2
LL+RR	$[-0.038, +0.009]$	4.2	5.0
LR+RL	$[-0.022, +0.006]$	5.5	6.5
$e^+e^- \to \mu^+\mu^-$			
LL	$[-0.014, +0.040]$	4.7	4.0
RR	$[-0.016, +0.043]$	4.4	3.8
VV	$[-0.005, +0.016]$	7.7	6.3
AA	$[-0.009, +0.015]$	6.8	6.2
LR	$[-0.270, +0.025]$	1.8	3.8
LL+RR	$[-0.007, +0.022]$	6.6	5.4
LR+RL	$[-0.260, +0.019]$	1.9	5.1
$e^+e^- \to \tau^+\tau^-$			
LL	$[-0.039, +0.032]$	3.7	3.9
RR	$[-0.046, +0.034]$	3.4	3.7
VV	$[-0.012, +0.016]$	6.2	5.9
AA	$[-0.022, +0.013]$	5.2	5.6
LR	$[-0.275, +0.033]$	1.8	3.3
LL+RR	$[-0.020, +0.018]$	5.2	5.2
LR+RL	$[-0.265, +0.025]$	1.8	4.3
$e^+e^- \to l^+l^-$			
LL	$[-0.014, +0.020]$	5.5	5.3
RR	$[-0.016, +0.021]$	5.3	5.1
VV	$[-0.005, +0.006]$	9.5	9.3
AA	$[-0.007, +0.010]$	8.0	7.5
LR	$[-0.023, +0.019]$	4.8	5.0
LL+RR	$[-0.008, +0.010]$	7.7	7.3
LR+RL	$[-0.011, +0.009]$	7.1	7.2

Limits at SLC/LEP and LEP II Energies e^- Pol = Ø

Λ^+_{LL}

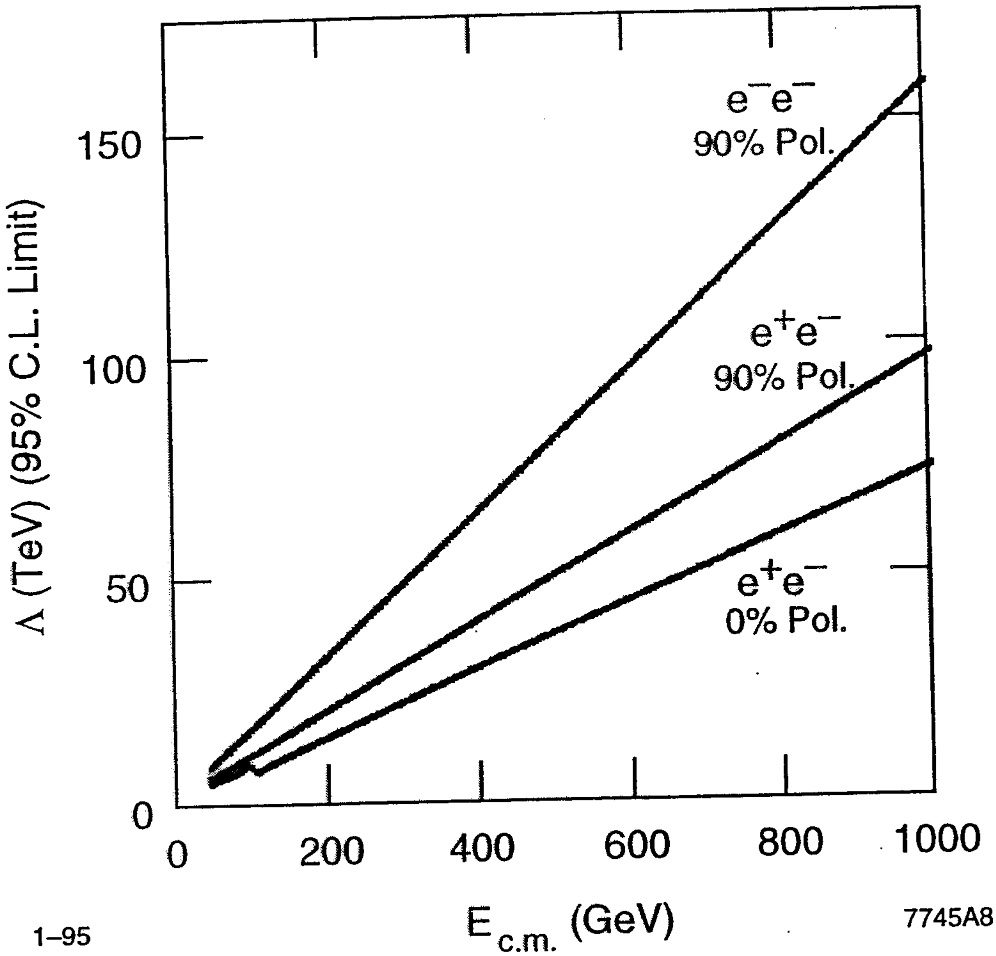


$\sqrt{s}$ (GeV)	$\mathcal{L}$ (fb^{-1})
35	0.1
100	0.8
200	3.2
500	20.0
1000	82.0

$\mathcal{L}$ = .68 fb^{-1} $\frac{s}{M_Z^2}$

Limits at NLC Energies

Λ^{+}_{LL}



$\mathcal{L} = 0.68\ fb^{-1}\ \frac{s}{M_Z^2}$

$\sqrt{s}$ (GeV)	$\mathcal{L}$ (fb^{-1})
35	0.1
100	0.8
200	3.2
500	20.0
1000	82.0

CONCLUSION

- e^-e^- mode extends e^- compositeness studies to energy scales well beyond those probed by e^+e^-

  However to maintain this advantage $\mathcal{L}_{e^-e^-}$ cannot be too much less than $\mathcal{L}_{e^+e^-}$

- Polarization of both beams provides a powerful tool for the study of e^- compositeness if a signal is detected

  This holds true even if $\mathcal{L}_{e^-e^-} \sim \frac{1}{3}\mathcal{L}_{e^+e^-}$