

Contents

1	Introduction	1
1.1	Outline	3
2	Higgs Associated Top-Pair Production at Born Level	5
2.1	The Unpolarized Cross Section	6
2.2	Prospects for Measuring Y_t at the ILC	8
2.3	The Advantages of Beam Polarization	11
2.4	The Polarized Cross Section	12
2.5	The Large Higgs Energy Limit	13
3	The Breakdown of Perturbation Theory near Threshold	19
4	The Effective Theory vNRQCD	23
4.1	Overview	23
4.2	Basic Ingredients	26
5	NLL QCD Corrections to $e^+e^- \rightarrow t\bar{t}H$	33
5.1	The QCD Matching for Unpolarized Beams	34
5.2	QCD Matching for Polarized Beams	37
5.3	Extending the Formula to Small Higgs Energies	41
6	NLL Finite Lifetime Effects	45
6.1	Absorptive Matching Conditions	46
6.2	Current Matching	55
6.3	NLL Mixing Effects	58
6.4	Phase Space Matching	63

7 Numerical Analysis of the NLL Cross Section	69
7.1 The NLL QCD Corrections	71
7.2 Experimental Study with the vNRQCD Cross Section	79
7.3 The NLL EW corrections	82
8 Conclusions and Outlook	89
A The Dirac Equation	93
A.1 The Dirac Equation	93
A.2 Solutions to the Dirac Equation	95
A.3 Helicity Eigenstates	96
A.4 Spin Projector	99
A.5 Spin Singlet and Triplet States	100
A.6 Spin Summation	100
B Some Basic Ideas	103
B.1 Method of Regions	103
B.2 The Optical Theorem	107
B.3 Schrödinger Equation and Threshold Green Function	108
C Renormalization	113
C.1 Renormalization Constants and Counterterms	115
D Tensor Reduction of One-Loop Integrals	121
D.1 Definitions	122
D.2 Reduction of Three- and Four-Point Functions	128
E The Cuts	135
E.1 Cuts of Tensor Loop Integrals	136
E.2 The Two-Particle Cut	138
E.3 The Scalar Bubble	140
E.4 The Scalar Triangle	140
E.5 The Scalar Box	141
E.6 The Dilogarithm	144
E.7 Feynman Parameterization	145
F The Standard Matrix Elements	147
G Current Matching Formulas	151