

Contents

1	Introduction	1
1.1	Introduction	1
	References	9
2	Chiral EW Lagrangian	15
2.1	Equivalence Theorem	16
2.2	The Chiral Lagrangian and Its Parameterizations	18
2.2.1	WBGB Scattering	22
2.2.2	Coupling with $\gamma\gamma$	24
2.2.3	Coupling with $t\bar{t}$	25
	References	27
3	Scattering Amplitudes	31
3.1	Generic form of the WBGB Scattering Amplitude and the Isospin Basis	31
3.1.1	Decomposition of Elastic Scattering $\omega\omega \rightarrow \omega\omega$	34
3.1.2	Higgs–Higgs Cross-Channel: $\omega\omega \rightarrow hh$ and $hh \rightarrow hh$ Amplitudes	37
3.1.3	Other Channels: $\omega^\pm z \rightarrow \omega^\pm z$	38
3.2	LO and NLO Computation of Invariant Scattering Amplitudes	39
3.2.1	$\omega\omega$ Scattering	39
3.2.2	$\gamma\gamma$ Scattering	45
3.2.3	$t\bar{t}$ in the Final State	51
3.2.4	$t\bar{t} \rightarrow t\bar{t}$ Scattering Amplitude	56
3.3	Partial Wave Decomposition	56
3.3.1	$\omega\omega$ Scattering	58
3.3.2	$\gamma\gamma$ Scattering Into and Out of the EWSBS	63
3.3.3	$t\bar{t}$ in the Final State	64
3.3.4	Validity Range of the Approximations	66
	References	68

4 Analytical Properties and Unitarization	71
4.1 Unitarity Condition for Partial Waves	71
4.2 Poles on the Analytical Continuation	76
4.2.1 Spurious Resonances	78
4.2.2 Numerical Search for Poles on the s -plane	78
4.3 Unitarization Procedures for $\omega\omega$ Scattering	82
4.3.1 Dispersion Relations	84
4.3.2 Inverse Amplitude Method	88
4.3.3 N/D Method	92
4.3.4 K-matrix and Improved K-matrix	102
4.3.5 Summary of the Unitarization Methods and Their Range of Applicability	104
4.4 Extensions of the $\omega\omega$ Unitarization	105
4.4.1 $\gamma\gamma$ Scattering Without hh Channel ($a^2 = b$), $J = 0$	106
4.4.2 $\gamma\gamma$ Scattering with hh Channel, $J = 0$	107
4.4.3 $\gamma\gamma$ Scattering Without hh Channel ($a^2 = b$), $J = 2$	110
4.4.4 $\gamma\gamma$ Scattering with hh Channel, $J = 2$	111
4.4.5 $t\bar{t}$ in the Final State Without hh Channel ($a^2 = b$), $J = 0$	112
4.4.6 $t\bar{t}$ in the Final State with hh Channel, $J = 0$	113
References	116
5 Study of the Parameter Space for the $\omega\omega$ Scattering	119
5.1 Numeric Comparison of the Three Methods	119
5.1.1 Scalar-Isoscalar Channel, $I = J = 0$	119
5.1.2 Vector-Isovector Channel, $I = J = 1$	121
5.1.3 Scalar-Isotensor Channel, $J = 0$, $I = 2$	124
5.1.4 Tensor-Isoscalar Channel, $J = 2$, $I = 0$	125
5.1.5 Tensor-Isotensor Channel, $J = 2$, $I = 2$	128
5.2 Systematic Numerical Study of the IAM	130
5.2.1 Purely Elastic Scattering with $b = a^2$	130
5.2.2 Scattering $\omega\omega$ in the presence of $b \neq a^2$	134
References	146
6 Conclusions	147
References	154
Appendix A: Mandelstam Variables	155
Appendix B: Spinor Computation	157
Appendix C: Dimensional Regularization and Passarino–Veltman Functions	163
Appendix D: Several Proofs and Explanations	171

Appendix E: Feynman Diagrams for the Effective Lagrangian 179

Appendix F: One-Loop Feynman Diagrams 187

Curriculum Vitae and Publication List 195

Study of the Electroweak Symmetry Breaking Sector for
the LHC

Delgado López, R.

2017, XV, 197 p. 55 illus., 16 illus. in color., Hardcover

ISBN: 978-3-319-60497-8