Matheus Hostert

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Institute for Particle Physics Phenomenology
Department of Physics
Durham University
United Kingdom

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Abstract: This is some abstract about this thesis.

Dedicated to

Bárbara, Humberto and Luciana.

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Declaration

The work in this thesis is based on research carried out in the Department of Physics at Durham University. No part of this thesis has been submitted elsewhere for any degree or qualification.

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I would like to thank...

"It seems very pretty, [...] somehow it seems to fill my head with ideas—only I don't exactly know what they are!

— from *Through the Looking-Glass, and What Alice Found There* by Lewis Carroll

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Phase Space

In this appendix we show explicitly the factorization of N-final state phase space factors into $N-2$ 2-body ones. To study arbitrary observales that depend on the final state momenta, one must also be able to write down the four momenta in terms of the phase space variables. We carry out this exercise for 3 and 4 body phase space below.

A.1 Factorization into 2PS

The final decomposition of the phase space factors then reads:

$$\mathrm{d}PS^2 = \mathrm{d}m^2 \mathrm{d}PS^2(p_1, p_2 3) PS^2(p_2, p_3). \tag{A.1.1}$$

A.2 Three-body phase space

A.3 Four-body phase space

Appendix B

One loop ν masses in Type-I seesaw

B.1 Type-I seesaw neutrino masses in the SM

In this appendix, we compute the one-loop corrections to the light neutrino masses in the SM, following [1–3].

We will also be making use of the On-Shell (OS) renormalization scheme, known . This is ensured by requiring that the off-diagonal elements of the self-energy be diagonal when the external particles are on their mass shell, and that the residue of the renormalized propagator are equal to one.

Assuming Majorana neutrino fields, one can write the self-energy tensor in its most general form:

$$\Sigma_{ij}(\not{q}) = \not{q}\mathrm{P}_L\Sigma^L_{ij}(q^2) + \not{q}\mathrm{P}_R\Sigma^R_{ij}(q^2) + \mathrm{P}_L\Sigma^M_{ij}(q^2) + \mathrm{P}_R\Sigma^{M*}_{ij}(q^2), \tag{B.1.1}$$

where by virtue of the Majorana nature the previous terms obey

$$\Sigma^L_{ij}(q^2) = \Sigma^{R*}_{ij}(q^2), \qquad \Sigma^M_{ij}(q^2) = \Sigma^M_{ji}(q^2).$$

$$\delta m_L = \tag{B.1.2}$$

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