Title of the thesis

maybe with some subtitle

Danial Hagemann

bachelor thesis
at the Department for Astronomy and Astrophysics
Faculty of Physics
at the Ludwig-Maximilians-University
Munich

submitted by
Danial Hagemann
born in Gifhorn

Munich, the Submission date in the dean's office

First supervisor: Prof. Dr. Jochen Weller
Second supervisor: Dr. Steffen Hagstotz
Day of the defense: Date of final exam

ACKNOWLEDGEMENT

Here, you can write some acknowledgement.

It has been probably a hard and long way – from your school enrollment to middle school, high school with all its ups and downs, through your time at college/university until this point of your life you have reached now.

You can be proud of yourself by all the effort, all the sweat and tears it took to graduate.

Do not forget that it does not only take diligence and discipline to achieve a bachelor's degree, but also luck and decent people in your life, who brought you up to this point.
Maybe, this is a good opportunity to thank all your colleagues, friends, teachers and family members, who were always there for you in hard and rough times. Without people arround us that we can trust, even the most intelligent and gifted people would not have achieve any success in life.
Thank you!

ABSTRACT

Here you can write a summary, what your thesis is about or short introduction to your thesis.

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

NOTATION AND CONVENTIONS

Here you can write which notation and conventions you want to use in your formulas.

For example, there are two different sign conventions for the metric tensor $\eta_{\mu\nu}$ in Minkowski space.

In (general) relativity, it is common to use the sign convention $\eta_{\mu\nu} = \mathrm{diag}(-,+,+,+)$, which is called the "mostly plus", "space dominant" or "east coast" sign convention.
Therefore, to lower the components of a contravariant vector $\boldsymbol{x} = (ct, x, y, z) =: (x^0, x^1, x^2, x^3)$, we get

$$
\begin{aligned}
x_0 &= \eta_{0\nu} x^\nu = -ct \neq x^0, \\
x_1 &= \eta_{1\nu} x^\nu = +x = x^1, \\
x_2 &= \eta_{2\nu} x^\nu = +y = x^2, \\
x_3 &= \eta_{3\nu} x^\nu = +z = x^3.
\end{aligned}
$$

On the other hand, in particle physics and quantum field theory, it is common to use the sign convention $\eta_{\mu\nu} = \mathrm{diag}(+,-,-,-)$, which is called the "mostly minus", "time dominant" or "west coast" sign convention.
Therefore, to lower the components of a contravariant vector $\boldsymbol{x} = (ct, x, y, z) =: (x^0, x^1, x^2, x^3)$, we get

$$
\begin{aligned}
x_0 &= \eta_{0\nu} x^\nu = +ct = x^0, \\
x_1 &= \eta_{1\nu} x^\nu = -x \neq x^1, \\
x_2 &= \eta_{2\nu} x^\nu = -y \neq x^2, \\
x_3 &= \eta_{3\nu} x^\nu = -z \neq x^3.
\end{aligned}
$$

Personally, I prefer the "mostly plus" sign convention $\eta_{\mu\nu} = \mathrm{diag}(-,+,+,+)$, since it is only necessary to flip the sign of one component by lowering the index instead of three – but that is of course up to you.

Another convention that is often declared at the beginning of a document are the units that are used.
For example, someone might prefer Planck units instead of SI units. Here, I want to show how to convert from SI units to Planck units.

$$
\begin{aligned}
[c]_{\mathrm{SI}} = 299\,792\,458\,\frac{\mathrm{m}}{\mathrm{s}} &\implies \left[\sqrt{\frac{\hbar G}{c^3}}\right]_{\mathrm{SI}} \approx 1{,}616 \cdot 10^{-35}\,\mathrm{m} =: l_P \\
[\hbar]_{\mathrm{SI}} \approx 1{,}054 \cdot 10^{-34}\,\mathrm{kg}\frac{\mathrm{m}^2}{\mathrm{s}} &\implies \left[\sqrt{\frac{\hbar G}{c^5}}\right]_{\mathrm{SI}} \approx 5{,}391 \cdot 10^{-44}\,\mathrm{s} =: t_p \\
[G]_{\mathrm{SI}} \approx 6{,}674 \cdot 10^{-11}\,\frac{\mathrm{m}^3}{\mathrm{kg}\cdot\mathrm{s}^2} &\implies \left[\sqrt{\frac{\hbar c}{G}}\right]_{\mathrm{SI}} \approx 2{,}176 \cdot 10^{-8}\,\mathrm{kg} =: m_P \\
\left[\frac{1}{4\pi\varepsilon_0}\right]_{\mathrm{SI}} \approx 8{,}987 \cdot 10^{9}\,\mathrm{kg}\frac{\mathrm{m}^3}{\mathrm{s}^2\cdot\mathrm{C}^2} &\implies \left[\sqrt{4\pi\epsilon_0\hbar c}\right]_{\mathrm{SI}} \approx 1{,}875 \cdot 10^{-18}\,\mathrm{C} =: q_P \\
[k_B]_{\mathrm{SI}} \approx 1{,}381 \cdot 10^{-23}\,\mathrm{kg}\frac{\mathrm{m}^2}{\mathrm{s}^2\cdot\mathrm{K}} &\implies \left[\sqrt{\frac{\hbar c^5}{G k_B^2}}\right]_{\mathrm{SI}} \approx 1{,}416 \cdot 10^{32}\,\mathrm{K} =: T_P
\end{aligned}
$$

In Planck units, we have $[c]_{\mathrm{P}} = 1, [\hbar]_{\mathrm{P}} = 1, [G]_{\mathrm{P}} = 1, \left[\frac{1}{4\pi\epsilon_0}\right]_{\mathrm{P}} = 1, [k_B]_{\mathrm{P}} = 1$ and therefore $l_P = 1, t_P = 1, m_P = 1, q_P = 1, T_P = 1$, which is very convienent to express and manipulate equations.

Of course, this “trick” demands to remind ourself, which physical quantity we deal with while manipulating equations.

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APPENDIX A

THE FIRST APPENDIX

Here is the first appendix.

APPENDIX B

THE SECOND APPENDIX

Here comes the second appendix.

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DECLARATION OF AUTHORSHIP

I have done this all on my own – trust me ;)