Title

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12th September 2014
Last update: 20th July 2024

Master's Thesis Mathematics

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INSTITUTE FOR APPLIED MATHEMATICS

MATHEMATISCH-NATURWISSENSCHAFTLICHE FAKULTÄT DER

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Contents

1. Introduction

Here you have your introduction. This template is mainly based on Felix Boes Master thesis you can find it here https://github.com/felixboes/masters_thesis/tree/master

1.1. First section

Congratulations you have created your first section

1.1.1. Subsections

If you need to divide your thesis use subsections.
You can iterate this with subsub-sections if you want. If you want to do this you have to change the depth of the subsub-sections in the main.
If you want to create a subsection, which does not appear in the contents table use "subsection*"

1.2. How to cite

In this section we will discuss how to cite.
Just add your reference in masterthesis_your_name_bibliography.bib
Then use this line [Abh05] or [Dis06]

2. One

In this chapter we will learn some useful tools.

2.1. How to cross reference

In this section we will learn to cross reference.
For this just use command 1.1. You previously need to create a label.
You can also reference equations in this way

$$\langle v, \mathrm{Re} Av \rangle = \langle v, U^* D U v \rangle = \langle Uv, DUv \rangle \geq \lambda_1 \|Uv\|^2 = \lambda_1 \|v\|^2 \tag{2.1}$$

Lemma 2.1.1. *Let $A \in \mathbb{C}^{M \times M}$ be diagonally dominant then A is invertible.*

This equations can be accsessed by 2.1 and 2.1.1

2.2. How to create Index

In this section we will learn to add elements to the index.
Just use the command as in the example.

Definition 2.2.1. A vectorspace is...

2.3. How to create symbol index

In this section we will learn to add elements to the symbol index.
Just use the command as in the example.

3. Product

In this chapter we will talk about the product. We assume all spaces to be Hausdorff.

3.1. K-spaces and the k-ification

Lemma 3.1.1. *Let X be a k-space. Then the topologies of X and X_c coincide.*

Lemma 3.1.2. *Let X be an anti-compact T_1 space. Then X_c has discrete topology.*

Proof. Let $A \subseteq X_c$ be any set. We need to show that it is open. By the definition of the k-ification it is enough to show that $A \cap C$ is open in C for every compact set $C \subseteq X$. Since X is anti-compact C is finite. And by T_1 every finite set has discrete topology. Thus $A \cap C$ is open in C and X_c has discrete topology. □

Corollary 3.1.3. *Let X be a non-discrete anti-compact T_1 space. Then X is not a k-space.*

3.2. The product of CW-complexes

Lemma 3.2.1. *$(X \times Y)_c$ has weak topology, i.e. $A \subseteq (X \times Y)_c$ is closed iff $(Q_i^n \times P_j^m)(D^{n+m}) \cap A$ is closed for all $n, m \in \mathbb{N}$, $i \in I_n$ and $j \in J_m$.*

Proof.

"$\Rightarrow$" Since D^{n+m} is compact, its image is compact and therefore closed. As the intersection of two closed sets $(Q_i^n \times P_j^m)(D^{n+m}) \cap A$ is closed as well.

"$\Leftarrow$" We know by definition of the k-ification that A is closed if for every compact set $C \subseteq X \times Y$ $A \cap C$ is closed in C. Take such a compact set C. The projections $\mathrm{pr}_1(C)$ and $\mathrm{pr}_2(C)$ are compact as images of a compact set. By ? there are finite sets $E \subseteq \{e_i^n \mid n \in \mathbb{N}, i \in I_n\}$ and $F \subseteq \{f_j^m \mid m \in \mathbb{N}, j \in J_m\}$ s.t $\mathrm{pr}_1(C) \subseteq \bigcup_{e \in E} e$ and $\mathrm{pr}_2(C) \subseteq \bigcup_{f \in F} f$. Thus

$$C \subseteq \mathrm{pr}_1(C) \times \mathrm{pr}_2(C) \subseteq \bigcup_{e \in E} e \times \bigcup_{f \in F} f = \bigcup_{e \in E} \bigcup_{f \in F} e \times f.$$

So C is included in a finite union of cells of $(X \times Y)_c$. Therefore

$$A \cap C = A \cap \left(\bigcup_{e \in E} \bigcup_{f \in F} e \times f \right) \cap C = \left(\bigcup_{e \in E} \bigcup_{f \in F} A \cap (e \times f) \right) \cap C$$

is closed since by assumption $A \cap (e \times f)$ is closed for every e and f and the intersection is finite. Thus $A \cap C$ is in particular closed in C. □

Appendix

A. a

B. b

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Bibliography

[Abh05] Jochen Abhau. “Die Homologie von Modulräumen Riemannscher Flächen – Berechnungen für $g \leq 2$”. Diplomarbeit. Rheinische Friedrich-Wilhelms-Universität Bonn, 2005.

[Dis06] Margherita Disertori. “Constructive Renormalization for Interacting Fermions”. In: *Lett Math Phys* 78 (2006), pp. 263–277. DOI: 10.1007/s11005-006-0124-0. URL: https://doi.org/10.1007/s11005-006-0124-0.