Math Notes

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To my PhD

Contents

Chapter 1

Geometry, Topology and Physics – Nakahara

- inclusion map
- If $f : X \to Y$ preserves these algebraic structures, then f is called a **homomorphism**. If a homomorphism is bijective, then it is called an **isomorphism**.
- equivalence relation, equivalence classes, quotient space $(X/\sim)$, Möbius strip, T^2 (2-d torus), Σ_g (torus with g handles)
- linear map (an homomorphism preserving vector addition and scalar multiplication),
linear function ($V \to K$),
$dimV = dim(kerf) + dim(imf)$.
- dual space (V^*) is a functional space whose axes are given by base functions $e^i(e_j) = \delta_{ij}$. This functional space is also a vector space, and if V is finite dimensional, we have $dimV = dimV^*$. Basically, $f \in V^*$ means f is linear functional defined in V, namely, $f : V \mapsto K$. Given an isomorphism $g : V \mapsto V^*$, define the bilinear form:

$$g(\mathbf{v}, \mathbf{w}) \doteq \langle \mathbf{v}, \mathbf{w} \rangle_g = \langle g\mathbf{v}, \mathbf{w} \rangle = (g(\mathbf{v}))(\mathbf{w})$$

Note, $g(\mathbf{v})$ returns a linear functional.
- discrete/trivial/usual topology, Hausdorff spaces (every metric space is Hausdorff space),
closure $\bar{A}$, interior A°, boundary $b(A)$,
connected, arcwise connected, simply connected.
- homeomorphism is different from homomorphism.
why homeomorphism ? Because it defines a equivalence relation which enables us to deform one topological space continuously to another topological space in the same class.

Chapter 2

Grassmann Algebra – John Browne

- exterior product,
  cobasis $\underline{e_i}$ defined as $e_i \wedge \underline{e_j} = \delta_{ij} e_1 \wedge e_2 \cdots \wedge e_n$
  determinant,

  $$\alpha_1 \wedge \alpha_2 \cdots \wedge \alpha_n = Det \cdot e_1 \wedge e_2 \cdots \wedge e_n$$

  Cofactors

- simplicity (0, 1, $n-1$ and n are simple)

- exterior division:

  $$\frac{\alpha_1 \wedge \alpha_2 \cdots \wedge \alpha_n \wedge \beta}{\beta} = (\alpha_1 + t_1\beta) \wedge (\alpha_2 + t_2\beta) \cdots \wedge (\alpha_n + t_n\beta)$$

Chapter 3

Creation of Cosmos as Objectivation

Chapter 4

More on Cosmic Subjectivation

Chapter 5

More on Multiplicity

Chapter 6

Curvature

chapterAction-Reaction Principle

Chapter 7

Creation of the Physical Universe

Chapter 8

An Example from the Later Stages

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