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به نام خدا

نظریه ی کالزا - کلاین نوین در گرانش لاولاک

به کوشش

سید شاهرخ آسیایی

پایان نامه

ارایه شده به تحصیلات تکمیلی دانشگاه شیراز به عنوان بخشی
از فعالیت های تحصیلی لازم برای اخذ درجه ی کارشناسی ارشد

در رشته ی:

فیزیک (نظری و اختر فیزیک)

از دانشگاه شیراز

شیراز

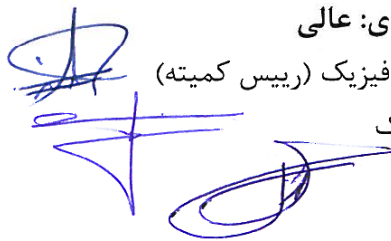
جمهوری اسلامی ایران

ارزیابی کمیته ی پایان نامه، با درجه ی: عالی

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تیر ماه ۱۳۸۸

چکیده

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$$M^4 \times K^{n-4} \quad n$$

$$n-4 \quad K^{n-4}$$

$$M^4$$

r_0 (warp factor)

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* Kaluza – Klein theory

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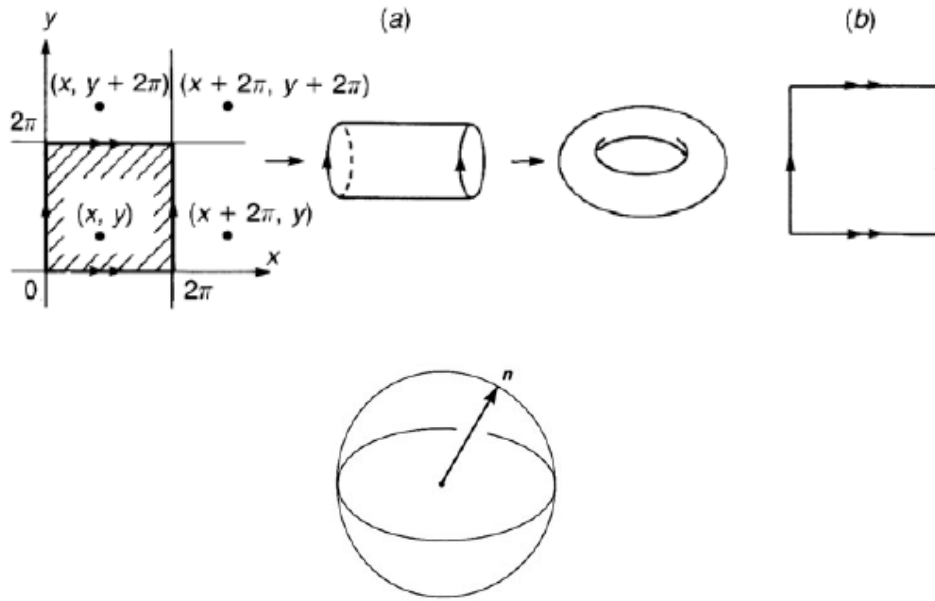
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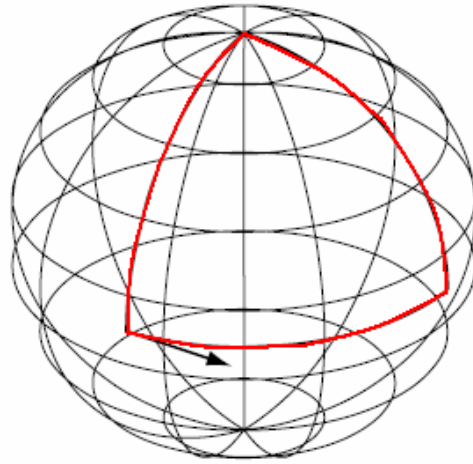


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* curved space geometry

† Intrinsic curvature

‡ Geometry, Topology and Physics M. Nakahara, second edition 2003, P. 72 & 74



* An introduction to general relativity and cosmology, J. Plebanski, A. Krasinski, first edition 2006, P. 11

† manifold

‡ local

^

*

$$\begin{aligned} X'_{ab} &= \frac{\partial x^c}{\partial x'^a} \frac{\partial x^d}{\partial x'^b} X_{cd}, \\ X'^{ab} &= \frac{\partial x'^a}{\partial x^c} \frac{\partial x'^b}{\partial x^d} X^{cd}, \\ X'^a_{bc} &= \frac{\partial x'^a}{\partial x^d} \frac{\partial x^e}{\partial x'^b} \frac{\partial x^f}{\partial x'^c} X^d_{ef}. \end{aligned} \quad (1)$$

* tensor

$$X_{ab} = Y_{ab}.$$

:

$$\frac{\partial x^a}{\partial x'^c} \frac{\partial x^b}{\partial x'^d} X_{ab} = \frac{\partial x^a}{\partial x'^c} \frac{\partial x^b}{\partial x'^d} Y_{ab}.$$

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$$X'_{ab} = Y'_{ab}.$$

u

$$\lim_{\delta u \rightarrow 0} \frac{[X^a]_P - [X^a]_Q}{\delta u} \Big| .$$

Q P

$$\begin{aligned}\partial'_c X'^a &= \frac{\partial}{\partial x'^c} \left(\frac{\partial x'^a}{\partial x^b} X^b \right) \\ &= \frac{\partial x^d}{\partial x'^c} \frac{\partial}{\partial x^d} \left(\frac{\partial x'^a}{\partial x^b} X^b \right) \\ &= \frac{\partial x'^a}{\partial x^b} \frac{\partial x^d}{\partial x'^c} \partial_d X^b + \frac{\partial^2 x'^a}{\partial x^b \partial x^d} \frac{\partial x^d}{\partial x'^c} X^b.\end{aligned}\quad (2)$$

Q

P

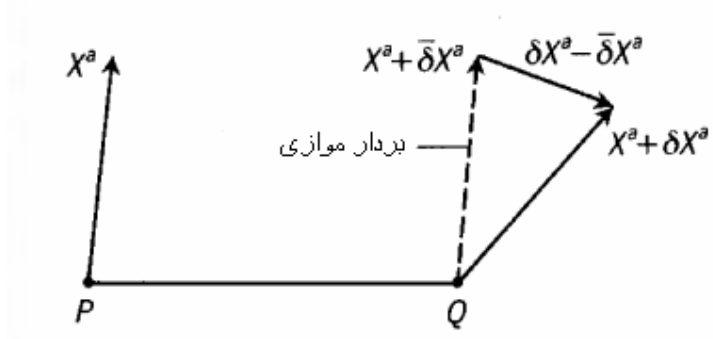
P

$$X^a(x + \delta x) = X^a(x) + \delta X^a(x) = X^a(x) + \delta x^b \partial_b X^a$$

* Lee derivative

† Covariant derivative

‡ Parallel transport



Q

$$\bar{\delta}X^a(x) = -\Gamma_{bc}^a(x)X^b(x)\delta x^c$$

†

$$\Gamma_{bc}^a(x)$$

Q

$$\nabla_c X^a = \lim_{\delta x^c \rightarrow 0} \frac{1}{\delta x^c} \{X^a(x + \delta x) - [X^a(x) + \bar{\delta}X^a(x)]\}.$$

$$\Gamma_{\alpha\beta}^{\gamma} = \frac{\partial x^{\lambda}}{\partial y^{\alpha}} \frac{\partial x^{\mu}}{\partial y^{\beta}} \frac{\partial y^{\gamma}}{\partial x^{\nu}} \Gamma^{\nu}_{\lambda\mu} + \frac{\partial^2 x^{\nu}}{\partial y^{\alpha} \partial y^{\beta}} \frac{\partial y^{\gamma}}{\partial x^{\nu}}. \quad (3)$$

* Introducing Einstein's relativity, R. D'Inverno, 1998

† connection

$$\nabla_c T_{b\dots}^{a\dots} = \partial_c T_{b\dots}^{a\dots} + \Gamma_{dc}^a T_{b\dots}^{d\dots} + \dots - \Gamma_{bc}^d T_{d\dots}^{a\dots} - \dots \quad (4)$$

C

v

 τ

$$\frac{dv^\alpha}{d\tau} = \frac{\partial v^\alpha}{\partial x^\beta} \frac{dx^\beta}{d\tau} = 0,$$

$$\frac{Dv^\alpha}{d\tau} \stackrel{\text{def}}{=} (\nabla_\rho v^\alpha) \frac{dx^\rho}{d\tau} = 0,$$

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* Flat spaces