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Development of science ilmiy jurnali 2024 yil 15 aprel kuni №256445 sonli guvohnoma bilan Davlat ro‘yxatidan o‘tgan.

To‘plam elektron ko‘rinishda (pdf formatida) mualliflarga taqdim etiladi. To‘plamga kiritiladigan maqolalarning mazmuni, ulardagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligiga hamda har qanday fikr - mulohazalarga mualliflarning o‘zlari mas’ul hisoblanadilar. Talablarga javob bermaydigan maqolalar to‘plamga kiritilmaydi. Tashkiliy qo‘mita maqola matnini qisqartirish, qisman tuzatish kiritish, seksiyalarga joylashtirish huquqiga ega.

ISSN 3030-3907

UCH O‘LCHAMLI NILPOTENT ALGEBRANING LOKAL VA IKKI LOKAL DIFFERENSIALLASHI

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Annotatsiya. Differensiallash matematikaning fundamental tushunchalaridan biri hisoblanadi. Differensiallashlar algebra fanida ham muhim o‘rin tutadi. Differensiallashlarning turli umumlashmalari mavjud. Bular sarasiga antidifferensiallashlar, δ-differensiallashlar, ternar differensiallashlar va (α,β,γ)-differensiallashlar kiradi. Ushbu ishda uch o‘lchamli nilpotent algebralarning differensiallashi lokal va ikki lokal differensiallashi isboti bilan ko‘rsatilgan.

Kalit so‘zlar: Differensiallash, Algebra, lokal differensiallash va ikki lokal differensiallash, chiziqli akslatirish.

Аннотатция. Дифференциация — одно из фундаментальных понятий математики. Дифференциации также играют важную роль в алгебре. Существуют различные обобщения дифференциаций. К ним относятся антидифференциации, δ-дифференциации, тернарные дифференциации и (α,β,γ)-дифференциации. В данной работе дифференциация трехмерных нильпотентных алгебр демонстрируется путем доказательства локальной дифференциации.

Ключевые слова: Дифференциация, алгебра, локальное дифференцирование, линейное отображение.

Abstract. Differentiation is one of the fundamental concepts of mathematics. Differentiations also play an important role in algebra. There are various generalizations of differentiations. These include antidifferentiations, δ-differentiations, ternary differentiations, and (α,β,γ)-differentiations. In this work, the differentiation of three-dimensional nilpotent algebras is shown by proving local differentiation.

Keywords: Differentiation, Algebra, local differentiation, linear mapping.

I. KIRISH.

1-§. Masalaning qo‘yilishi

Hozirgi kunda jahonda differensiyalashlar nazariyasi bilan bir qatorda, operator algebralarida lokal va 2-lokal differensiyalashlar nazariyasi ham muhim hisoblanadi. So‘ngi 20 yil davomida fon Neyman algebralari C^*- algebralari va JB^*- uchliklarda lokal va 2- lokal differensiallashlar nazariyasini o‘rganish bo‘yicha samarali natijalarga erishildi. Lokal differensiallashlarni o‘rganish 1990-yilda R.B.Kadison va D.R.Larson hamda A.S.Sururlar tomonidan boshlangan.

ISSN 3030-3907

Ixtiyoriy uch o‘lchamli nilpotent algebra bazislari $\{e_1, e_2, e_3\}$ bo‘lgan quyidagi o‘zaro izomorf bo‘lmagan algebralarning biriga izomorf bo‘ladi:

N_1: $e_1^2=e_2$,$e_2^2 = e_3$ N_2: $e_1^2 = e_2$, $e_2e_1 = e_3$, $e_2^2 = e_3$

N_3: $e_1^2 = e_2$, $e_2e_1 = e_3$ $N_4(\alpha)$: $e_1^2 = e_2$, $e_1e_2 = e_3$, $e_2e_1 = \alpha e_3$

N_5: $e_1^2 = e_2$ N_6: $e_1^2 = e_3$, $e_2^2 = e_3$

N_7: $e_1e_2 = e_3$, $e_2e_1 = -e_3$ $N_8(\alpha)$: $e_1^2 = \alpha e_3$, $e_2e_1 = e_3$, $e_2^2 = e_3$

II.ADABIYOTLAR TAHLILI.

Differensiallashning ko‘plab umumlashmalari mavjud. Eng asosiy umumlashmasi bu lokal va 2-lokal umumlashmalari hisoblanadi. So‘ngi yillarda ko‘plab olimlar lokal va 2- lokal differensiallashlarga oid ko‘plab maqolalar chop etishdi[1- 3]

Quyida biz to‘rt o‘lchamli nilpotent algebralarning lokal va ikki lokal differensiallashini keltiramiz.

1-Ta’rif. Agar d: L → L chiziqli akslantirish F maydonda berilgan L algebaradan olingan ixtiyoriy x,y elementlar uchun quyidagi shartni qanoatlantirsa

$$d(xy) = d(x)y + xd(y)$$

U holda, akslantirish L algebrada differensiallash deb ataladi.

$$d(x) = Ax$$

chiziqli akslantirishni qaraylik, buyerda $A - n\times n$ o‘lchamli kvadrat matritsa. Ravshanki, agar L algebradan olingan ixtiyoriy x, y elemenlar uchun

$$A(xy) = (Ax)y + x(Ay) \qquad (1)$$

tenglik bajarilsa $d(x) = Ax$ akslantirish qaralayotgan L algebrada differensiallashdan iborat bo‘ladi.

Endi esa lokal differensiallash tushunchasini keltiramiz.

2-Ta’rif. *L algebra bo‘lib undagi xar bir $x \in L$ element uchun $\Delta(x) = D_x(x)$ shartni qanoatlantiruvchi $D_x: L \to L$ differesiallash mavjud bo‘lsa, u holda $\Delta: L \to L$ chiziqli akslantirish lokal differensiallash deb ataladi.*

3-Ta’rif. *L algebra bo‘lib undagi har bir $x \in L$ element uchun $\Delta(x) = D_x(x)$ shartni qanoatlantiruvchi $D_x: L \to L$ differesiallash mavjud bo‘lsa, u holda $\Delta: L \to L$ chiziqli akslantirish lokal differensiallash deb ataladi.*

N_2 algebraning differensiallashini biz yuqorida 2.2-§ ishda ko‘rib o‘tganmiz

$$\mathrm{A} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ a_{3,1} & 0 & 0 \end{pmatrix}$$

bu yerda quyidagi belgilashni kiritamiz

$a_{3,1} = \alpha$, u holda A matritsa bunday ko‘rinishga o‘tadi.

ISSN 3030-3907

$$A = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \alpha & 0 & 0 \end{pmatrix}$$

Quyidagi teoremada N_2 algebra uchun $\Delta: N_2 \to N_2$ akslantirishni qaraylik.

1-Teorema. N_2 algebraning har qanday chiziqli lokal differensiallashi differensiallashdan iborat.

Isbot. Δ ixtiyoriy lokal differensiallashi bo‘lsin. Barcha $x \in N_2$ uchun ta’rif bo‘yicha $\Delta(x) = D_x(x)$ differensiallashi mavjud.

1- teoremaga ko‘ra, D_x differensiallashi quyidagi matritsa ko‘rinishiga ega:

$$A_x = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \alpha_x & 0 & 0 \end{pmatrix}.$$

Xususan $\Delta(e_1) = D_{e_1}e_1, \Delta(e_2) = D_{e_2}e_2,\ \Delta(e_3) = D_{e_3}e_3$ tengliklarni qanoatlantiruvchi $D_{e_1}, D_{e_2}, D_{e_3}$ matritsalar mavjud. A matritsani quyidagicha quraylik:

$$A = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \alpha_{e_1} & 0 & 0 \end{pmatrix}$$

Δ chiziqli bo`lgani uchun

$$\Delta(\mathrm{x} + \mathrm{y}) = \Delta(\mathrm{x}) + \Delta(\mathrm{y}), \quad \forall x, y \in N_1 \qquad (1)$$

tenglik o`rinli.

Bu tenglikka ko`ra

$$\Delta(\mathrm{e}_1 + \mathrm{e}_2) = \alpha_{\mathrm{e}_1+e_2} e_1$$
$$\Delta(\mathrm{e}_1) + \Delta(\mathrm{e}_2) = \alpha_{\mathrm{e}_1} e_1$$

tengliklarga ega bo`lamiz. Bunda bazis elementlarining koeffitsientlarini taqqoslab,

biz quyidagilarga erishamiz:

$$\alpha_{\mathrm{e}_1+e_2} = \alpha_{\mathrm{e}_1},$$

Bundan esa

$$\alpha_{\mathrm{e}_1+e_2} = \alpha_{\mathrm{e}_1}$$

Shunday qilib, biz Δ lokal differensiallash quyidagi shaklga ega ekanligini bilib olamiz:

$$\Delta = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \alpha_{e_1} & 0 & 0 \end{pmatrix}$$

Teorema isbotlandi.

2-Teorema. N_2 algebraning har bir 2-lokal differensiallashi differensiallashdir.

Isbot. Aytaylik ∇–bu N_2 ning ixtiyoriy 2-lokal differensiallashlari bo‘lsin.

U holda, 1-tarifga ko‘ra har bir $x \in \mathrm{N}_2$ element uchun,

ISSN 3030-3907

$$x = x_1 e_1 + x_2 e_2 + x_3 e_3,$$

α_{x,e_1}, shunday elelemt mavjudki

$$A_{x,e_1} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \alpha_{x,e_1} & 0 & 0 \end{pmatrix},$$

$\nabla(x) = A_{x,e_1}\bar{x}$, bu yerda $\bar{x} = (x_1, x_2, x_3)^T$–$x$ ga mos vektor va

$$\nabla(e_1) = A_{x,e_1}\overline{e_1} = (0,0,\alpha_{x,e_1})^T.$$

Tengliklar $\nabla(e_1) = A_{x,e_1}(e_1) = A_{y,e_1}(e_1)$ o‘rinli bo‘lgani uchun

$$\nabla(e_1) = (0,0,\alpha_{x,e_1})^T =$$
$$= (0,0,\alpha_{y,e_1})^T$$

N_2 dagi elementlarning har bir x, y juftligi uchun.

Shunday qilib,

$$\alpha_{x,e_1} = \alpha_{y,e_1}.$$

Shuning uchun

$$\nabla(x) = A_{y,e_1}\bar{x}$$

Har qanday $x \in N_2$uchun va $\nabla(x)$ matritsasi x ga bog‘liq emas.

Shunday qilib, 2-teoremaga ko‘ra, ∇ differensiallashdir.

Endi N_3 algebrani ko‘ramiz

3-Teorema. N_3 algebraning har bir 2-lokal differensiallashi differensiallashdir.

Isbot. Aytaylik ∇–bu N_3 ning ixtiyoriy 2-lokal differensiallashlari bo‘lsin.

U holda, 1-tarifga ko‘ra har bir $x \in N_3$ element uchun,

$$x = x_1 e_1 + x_2 e_2 + x_3 e_3,$$

$\alpha_{x,e_1}, \beta_{x,e_1}, \gamma_{x,e_1}$ shunday elelemt mavjudki

$$A_{x,e_1} = \begin{pmatrix} \alpha_{x,e_1} & 0 & 0 \\ \beta_{x,e_1} & 2\alpha_{x,e_1} & 0 \\ \gamma_{x,e_1} & \beta_{x,e_1} & 3\alpha_{x,e_1} \end{pmatrix},$$

$\nabla(x) = A_{x,e_1}\bar{x}$, bu yerda $\bar{x} = (x_1, x_2, x_3)^T$–$x$ ga mos vektor va

$$\nabla(e_1) = A_{x,e_1}\overline{e_1} = (\alpha_{x,e_1}, \beta_{x,e_1}, \gamma_{x,e_1})^T.$$

Tengliklar $\nabla(e_1) = A_{x,e_1}(e_1) = A_{y,e_1}(e_1)$ o‘rinli bo‘lgani uchun

65

$$\nabla(e_1) = (\alpha_{x,e_1}, \beta_{x,e_1}, \gamma_{x,e_1})^T = (\alpha_{y,e_1}, \beta_{y,e_1}, \gamma_{y,e_1})^T$$

N_3 dagi elementlarning har bir x, y juftligi uchun.

Shunday qilib,

$$\alpha_{x,e_1} = \alpha_{y,e_1}, \beta_{x,e_1} = \beta_{y,e_1}, \gamma_{x,e_1} = \gamma_{y,e_1}.$$

Shuning uchun

$$\nabla(x) = A_{y,e_1}\bar{x}$$

Har qanday $x \in N_3$uchun va $\nabla(x)$ matritsasi x ga bog‘liq emas.

ISSN 3030-3907

SHunday qilib, 3-teoremaga ko‘ra, ∇ differensiallashdir.

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