MINKOVSKIY FAZOSIDA KO‘P O‘ZGARUVCHILI FUNKSIYANING DIFFERENSIALLANUVCHI BO‘LISHINING ZARURIYLIK SHARTI

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ANNOTATSIYA

Maqolada Minkovskiy fazosida ko‘p o‘zgaruvchili funksiyaning differensiali hamda funksiya differensiallanuvchi bo‘lishining zaruriy sharti keltirilgan. Minkovkiy fazosida funksiya differensiallanuvchi bo‘lishidan hosil qilinadigan natijalar isbotlangan.

Kalit so‘zlar: *Minkovskiy fazosi, ko‘p o‘zgaruvchili funksiya, xususiy hosila, differensial, limit.*

NECESSARY CONDITION FOR MULTIVARIABLE FUNCTION TO BE DIFFERENTIABLE IN MINKOWSKI SPACE

ABSTRACT

The article presents the necessary condition for the differential of a multivariable function and the function to be differentiable in the Minkowski space. The results obtained from the fact that the function is differentiable in the Minkovki space are proved.

Keywords: *Minkowski space, multivariable function, particular derivative, differential, limit.*

KIRISH

Minkovskiy fazosida ham funksiya differensiali Yevklid fazosidagi kabi ta'riflanadi.

Faraz qilaylik, $f(x) = f(x_1, x_2, x_3, \dots, x_n)$ funksiya $E \subset R^n$ to'plamda aniqlangan va $x^0(x_1^0,\ x_2^0,\ x_3^0, \dots, x_n^0)$ va $(x_1^0 + \Delta x_1,\ x_2^0 + \Delta x_2,\ x_3^0 + \Delta x_3, \dots, x_n^0 + \Delta x_n)$ nuqtalar shu to'plamga tegishli bo'lsin. U holda $f(x)$ funksiyaning to'la orttirmasi

$$\Delta f(x^0) = f(x_1^0 + \Delta x_1, x_2^0 + \Delta x_2, x_3^0 + \Delta x_3, \dots, x_n^0 + \Delta x_n) - f(x_1^0, x_2^0, x_3^0, \dots, x_n^0)$$

$\Delta x_1, \Delta x_2, \Delta x_3, \dots, \Delta x_n$ larga bog'liq bo'ladi. Agar $\Delta x_1, \Delta x_2, \Delta x_3, \dots, \Delta x_n$ larga bog'liq bo'lmagan $B_1, B_2, B_3, \dots, B_n$ sonlar mavjud bo'lib, funksiyaning x^0 nuqtadagi to'liq orttirmasi

$$\Delta f(x^0) = B_1 \Delta x_1 + B_2 \Delta x_2 + B_3 \Delta x_3 + \dots + B_n \Delta x_n + \beta_1\, \Delta x_1 + \beta_2\, \Delta x_2 +$$
$$+ \beta_3\, \Delta x_3 + \dots + \beta_n\, \Delta x_n \quad (1)$$

ko'rinishida ifodalansa, $f(x)$ *funksiya* x^0 *nuqtada differensiallanuvchi* deyiladi, bunda $\beta_1, \beta_2, \beta_3, \dots, \beta_n$ lar $\Delta x_1, \Delta x_2, \Delta x_3, \dots, \Delta x_n$ argument orttirmalariga bog'liq bo'lgan va bu orttirmalar bir vaqtda nolga intilganda nolga intiladigan cheksiz kichik miqdorlardir.

Agar $x^0(x_1^0,\ x_2^0,\ x_3^0, \dots, x_n^0)$ va $(x_1^0 + \Delta x_1,\ x_2^0 + \Delta x_2,\ x_3^0 + \Delta x_3, \dots, x_n^0 + \Delta x_n)$

nuqtalar orasidagi masofa

$$\rho = \sqrt{\Delta x_1^2 + \Delta x_2^2 + \Delta x_3^2 + \dots + \Delta x_{n-1}^2 - \Delta x_n^2}$$

uchun $\Delta x_1 \to 0, \Delta x_2 \to 0, \Delta x_3 \to 0, \dots, \Delta x_n \to 0$ da

$$\beta_1\, \Delta x_1 + \beta_2\, \Delta x_2 + \beta_3\, \Delta x_3 + \dots + \beta_n\, \Delta x_n = o(\rho)$$

ekanligidan,

$$\Delta f(x^0) = B_1 \Delta x_1 + B_2 \Delta x_2 + B_3 \Delta x_3 + \dots + B_n \Delta x_n + o(\rho)$$

ni hosil qilamiz. Ushbu munosabat $f(x)$ *funksiyaning* x^0 *nuqtada differensiallanuvchanlik sharti* deyiladi.

NATIJALAR

1-teorema. Agar $f(x)$ funksiya $x^0 \in E \subset R^n$ nuqtada differensiallanuvchi bo‘lsa, u holda funksiya x^0 nuqtada uzluksiz bo‘ladi.

2-teorema. Agar $f(x)$ funksiya $x^0 \in E \subset R^n$ nuqtada differensiallanuvchi bo‘lsa, u holda funksiya x^0 nuqtada barcha xususiy hosilalarga ega bo‘lib,

$$f'_{x_1}(x^0) = B_1, f'_{x_2}(x^0) = B_2, f'_{x_3}(x^0) = B_3, \dots, f'_{x_n}(x^0) = B_n$$

bo‘ladi.

MUHOKAMA

1-teoremaning isboti.

Teorema shartiga ko‘ra $f(x)$ funksiya $x^0 \in E \subset R^n$ nuqtada differensiallanuvchi, bundan uning to‘liq orttirmasi

$$\Delta f(x^0) = B_1\Delta x_1 + B_2\Delta x_2 + B_3\Delta x_3 + \dots + B_n\Delta x_n + \beta_1\,\Delta x_1 + \beta_2\,\Delta x_2 + \\ +\beta_3\,\Delta x_3 + \dots + \beta_n\,\Delta x_n$$

ko‘rinishida ifodalanadi. Bu tenglikdan barcha argument orttirmalari nolga intilganda limitga o‘tib,

$$\lim_{\substack{\Delta x_1 \to 0 \\ \Delta x_2 \to 0 \\ \Delta x_3 \to 0 \\ \dots \\ \Delta x_n \to 0}} \Delta f(x^0) = 0$$

ekanligini topamiz. Demak, $f(x)$ funksiya $x^0 \in E \subset R^n$ nuqtada uzluksiz ham bo‘ladi.

2-teorema isboti.

Teorema shartiga ko‘ra $f(x)$ funksiya $x^0 \in E \subset R^n$ nuqtada differensiallanuvchi, bundan uning to‘liq orttirmasi (1) ko‘rinishida ifodalanishi ma’lum.

Agar (1) tenglikda $\Delta x_1 \neq 0,\ \Delta x_2 = \Delta x_3 = \dots = \Delta x_n = 0$ deb olinsa,

$$\Delta f_{x_1}(x^0) = B_1\Delta x_1 + \beta_1\,\Delta x_1$$

tenglik hosil bo‘ladi. Ushbu tenglikdan funksiyaning xususiy hosilasini

$$\lim_{\Delta x_1 \to 0} \frac{\Delta_{x_1} f(x^0)}{x_1} = \lim_{\Delta x_1 \to 0} (A_1 + \alpha_1) = A_1$$

Demak,

$$f'_{x_1}(x^0) = A_1$$

Shu kabi $f(x)$ funksiyaning x^0 nuqtada barcha xususiy hosilalari

$$f'_{x_2}(x^0) = A_2, f'_{x_3}(x^0) = A_3, \dots, f'_{x_n}(x^0) = A_n$$

bo'lishi ko'rsatiladi.

XULOSA

$f(x)$ funksiyaning x^0 nuqtada barcha xususiy hosilalari

$$f'_{x_1}(x^0),\ f'_{x_2}(x^0),\ f'_{x_3}(x^0), \dots,\ f'_{x_n}(x^0)$$

ning mavjud bo'lishidan uning shu nuqtada differensiallanuvchi bo'lishi kelib chiqavermaydi. Demak, $f(x)$ funksiyaning x^0 nuqtada barcha xususiy hosilalarga ega bo'lishi uning differensiallanuvchi bo'lishining zaruriylik sharti hisoblanadi.

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