NYUTON KO'PYOQLIKLARI VA DARAJALI ALMASHTIRISHLAR

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Annotatsiya: *Nyuton ko'pyoqligi, Nyuton diagrammalari tushunchalari keltirilgan. Qatorning Nyuton ko'pyoqligi, qatorning Nyuton diagrammasi ta'riflari berilgan. Darajali almashtirishlarning ta'riflari va ularning ayrim xossalari keltirib o'tilgan. Shuningdek, Nyuton ko'pyoqliklariga doir misollar ham qaralgan.*

Annotation: *Concepts of Newton's multiplicity, Newton's diagrams are presented. Definitions of Newton's multiplicity of series and Newton's diagram of series are given. Definitions of level substitutions and some of their properties are given. Examples of Newton's polynomials are also considered.*

Kalit so'zlar: *Nyuton ko'pyoqligi, Nyuton diagrammasi, qatorning Nyuton ko'pyoqligi, qatorning Nyuton diagrammasi, darajali almashtirishlar.*

Biz $\mathbb{N}$, $\mathbb{R}_+$, $\mathbb{R}$ bilan mos ravishda natural sonlar to'plamini, musbat haqiqiy sonlar to'plamini va haqiqiy sonlar to'plamini belgilaylik. Faraz qilamiz $K \subset \mathbb{N}^k$ bo'lib, bu yerda

$K = \{n: n = (n_1, n_2, \dots, n_k) \in \mathbb{N}^k\}, N_0 = \{0,1,2,3, \dots n, \dots\},\ n_i \in N_0$

$$i = 1,2, \dots, k.$$

1-tarif. K to'plamning Nyuton ko'pyoqligi deb

$$\bigcup_{n\in K}(n + \mathbb{R}_+^k)$$

to'plamning $\mathbb{R}_+^k$ dagi qavariq qobig'iga aytiladi.

2-tarif. K to'plamning Nyuton diagrammasi deb, K to'plamning Nyuton ko'pyoqligining barcha kompakt yoqlarining birlashmasiga aytiladi.

К to'plamning Nyuton ko'pyoqligi odatda $\Gamma_+(K)$ orqali, К to'plamning Nyuton diagrammasi esa $\Gamma(K)$ orqali belgilanadi.

Ikki o'zgaruvchili $f(x)$ funksiyaning Teylor qatorini qaraymiz:

$$f(x) = \sum_{n\in N_0^2} a_n x^n,$$

bu yerda $a_n = a_{n_1 n_2} \in \mathbb{C}$, $n = (n_1, n_2)$ bo'lib, $n_1, n_2 \in N_0$ daraja ko'rsatkichlari, $x = (x_1, x_2)$ noma'lum. x^n monom $x^n = x_1^{n_1} x_2^{n_2}$ kabi aniqlanadi. Bu qator uchun $suppf$ bilan f funksiyaning tashuvchisini belgilaylik. $suppf$ quyidagicha aniqlaniladi:

$suppf = \{(n_1, n_2) \in N_0^2 \colon a_{n_1 n_2} \neq 0,\ n_1, n_2 \in N_0\}.$

yoki qisqaroq

$$suppf = \{n \in N_0^2 \colon a_n \neq 0\}.$$

kabi aniqlanadi.

3-tarif. f qatorning Nyuton ko'pyoqligi deb $suppf$ to'plamning Nyuton ko'pyoqligiga aytiladi va $\Gamma_+(f)$ kabi belgilanadi.

4-tarif. f qatorning Nyuton diagrammasi deb $suppf$ to'plamning Nyuton diagrammasiga aytiladi va $\Gamma(f)$ yoki $N(f)$ kabi belgilanadi.

5-tarif. f qatorning asosiy qismi deb

$$f(\Gamma)=\sum_{n\in\Gamma(f)} a_n x^n$$

ko'phadga aytiladi.

1-misol. Ushbu ikki o'zgaruvchili funksiyaning Nyuton ko'pyoqligini topamiz:

$$f(x_1,x_2)=x_1{}^3+3x_1{}^2x_2+4x_2{}^2+5x_1{}^2x_2{}^2+0x_1{}^5+0x_2{}^{13}+\cdots.$$

Bu funksiyaning Nyuton ko'pyoqligi

$$suppf=\{n\in N^2: a_n\neq 0\}=\{(3,0),(2,1),(0,2),(2,2)\}.$$

to'plamning Nyuton ko'pyoqligiga teng.

2-misol. Quyida keltirilgan misolning Nyuton diagrammasini toping.

$$f(x_1,x_2)=5x_1{}^2+13x_1{}^3x_2+4x_2{}^4+6x_1{}^3x_2{}^2+x_1{}^{15}+0x_2{}^{100}+\cdots$$

Endi biz tashuvchining ta'rifiga ko'ra

$$suppf=\{n\in N^2: a_n\neq 0\}=\{(2,0),(3,1),(0,4),(3,2),(15,0)\}.$$

to'plamga ega bo'lamiz. Ushbu to'plamning Nyuton diagrammasi $f(x_1,x_2)$ funksiyaning Nyuton diagrammasini beradi.

Quyidagi shakldagi almashtirishga darajali almashtirish deyiladi.

$$\begin{cases} w_1=v_1{}^{a_1}v_2{}^{a_2}\\ w_2=v_1{}^{b_1}v_2{}^{b_2}\end{cases}$$

bu yerda, v_1,v_2,w_1,w_2- musbat haqiqiy qiymatlar qabul qiladi. a_1,a_2,b_1,b_2-daraja ko'rsatkichlari musbat ratsional qiymatlar qabul qiladi.

Ushbu $\begin{cases} w_1=v_1{}^{a_1}v_2{}^{a_2}\\ w_2=v_1{}^{b_1}v_2{}^{b_2}\end{cases}$ sistema $a_1b_2-a_2b_1\neq 0$ bo'lsa, quyidagi ko'rinishdagi yagona yechimga ega bo'ladi.

$$\begin{cases} v_1=w_1{}^{\frac{b_2}{B}}w_2{}^{\frac{-a_2}{B}}\\ v_2=w_1{}^{\frac{-b_1}{B}}w_2{}^{\frac{a_1}{B}}\end{cases}$$

Haqiqatan ham, $\begin{cases} w_1=v_1{}^{a_1}v_2{}^{a_2}\\ w_2=v_1{}^{b_1}v_2{}^{b_2}\end{cases}$ ushbu sistemani o'rniga qo'yish usuli yordamida yechaylik, sistemani birinchi ifodasidan v_1 ni topib ikkinchi ifodaga qo'yamiz, $v_1=w_1{}^{\frac{1}{a_1}}v_2{}^{\frac{-a_2}{a_1}}$

$$w_2=\left(w_1{}^{\frac{1}{a_1}}v_2{}^{\frac{-a_2}{a_1}}\right)^{b_1}\cdot v_2{}^{b_2}=w_1{}^{\frac{b_1}{a_1}}v_2{}^{\frac{-a_2b_1}{a_1}}v_2{}^{b_2}=w_1{}^{\frac{b_1}{a_1}}v_2{}^{\frac{-a_2b_1+a_1b_2}{a_1}}$$

Bu ifodadan v_2 ni topsak,

$$v_2=\left(w_2w_1{}^{\frac{-b_1}{a_1}}\right)^{\frac{a_1}{-a_2b_1+a_1b_2}}=w_2{}^{\frac{a_1}{-a_2b_1+a_1b_2}}w_1{}^{\frac{-b_1}{-a_2b_1+a_1b_2}}=w_1{}^{\frac{-b_1}{B}}w_2{}^{\frac{a_1}{B}}$$

Shu metodni yana bir bor qo'llab v_1 ni ham topamiz, $v_2=w_1{}^{\frac{1}{a_2}}v_1{}^{\frac{-a_1}{a_2}}$

$$w_2=v_1{}^{b_1}\cdot\left(w_1{}^{\frac{1}{a_2}}v_1{}^{\frac{-a_1}{a_2}}\right)^{b_2}=v_1{}^{b_1}w_1{}^{\frac{b_2}{a_2}}v_1{}^{\frac{-a_1b_2}{a_2}}=w_1{}^{\frac{b_2}{a_2}}v_1{}^{\frac{a_2b_1-a_1b_2}{a_2}}$$

Bu ifodadan v_1 ni topsak

$$v_1 = \left(w_2 w_1^{\frac{-b_2}{a_2}}\right)^{\frac{a_2}{a_2b_1-a_1b_2}} = w_2^{\frac{a_2}{a_2b_1-a_1b_2}} w_1^{\frac{-b_2}{a_2b_1-a_1b_2}} = w_1^{\frac{-b_2}{B}} w_2^{\frac{-a_2}{B}}$$

tenglikka ega bo'lamiz.

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