MOTION OF STATIONARY NON-LINEAR WAVES

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Abstract: This thesis examines the nature and behavior of stationary nonlinear waves. In this environment, the movement of the waves and its sudden changeable nature are described. Expression of these processes through the Kortevega-de Vriza equation is presented.

Key words: Cortevega-de Vriza, approximation, spectral grid, oscillations, stationary waves, quasiharmonic periodic wave, cnoidal wave, soliton.

Chiziqli bo'lmagan to'lqin tenglamalarini o'rganishda birinchi qadam sifatida yechimlar odatda, shaklini o'zgartirmasdan doimiy tezlikda harakatlanadigan, ya’ni statsionar yugiruvchi to'lqinlar shaklida ko'rib chiqiladi.

Matematik jihatdan bu yechimlar x va t kombinatsiyasida $\xi = x - Ut$ ga bog'liq bo'lib, bu yerda U konstanta - to'lqin tezligidir. Bir tomondan, statsionar to‘lqinlarga bo‘lgan qiziqish hususiy hosilali differensial tenglamalarni oddiy differensial tenglamalarga keltirilishi bilan bog‘liq bo‘lib, ba’zi hollarda analitik tarzda yechish mumkin. Boshqa tomondan, solitonlar, statsionar zarba to'lqinlari va boshqalar kabi ba'zi statsionar yechimlar nazariy jihatdan chiziqli bo'lmagan muhitning o'ziga xos rejimlarida juda muhim rol o'ynaydi.

Shunday qilib, biz Kordevega-de Vriza tenglamasining yechimlarini $u = u(\xi)$, $\xi = x - Ut$ shaklida izlaymiz, bu yerda U=const. U holda KdV tenglamasi

$$\beta u''' + \left(\frac{u^2}{2} - Uu\right)' = 0 \qquad (1)$$

shaklini oladi, bu yerda shtrixlar ξ bo`yicha hosilani bildiradi. (1) tenglamani bir marta integrallab, biz konservativ chiziqli bo'lmagan osilator tenglamasiga ega bo`lamiz[2, 10],

$$u'' = -\frac{dW}{du} \qquad (2)$$

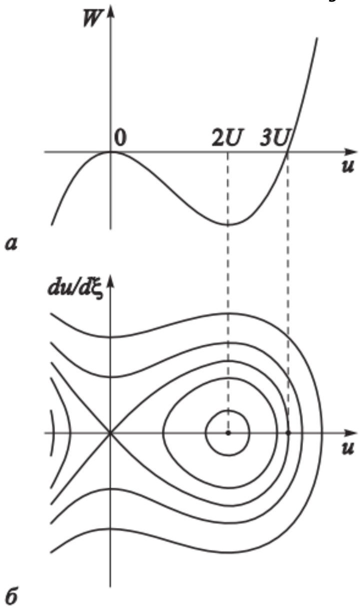
potentsial energiya quyidagiga teng

$$W = -\frac{1}{\beta}\left(C_u + \frac{Uu^2}{2} - \frac{u^3}{6}\right)$$

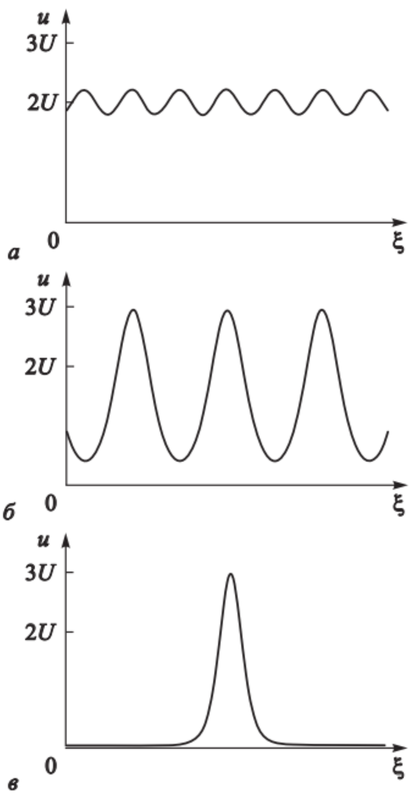
bu yerda C — integral doimiysi. Ushbu funksiya *dW/du=0* tenglama bilan aniqlangan nuqtalarda ikkita ekstremumga ega. Umumiylikni cheklamasdan, biz $C = 0$ ni qo'yishimiz mumkin, u holda quyidagiga ega bo`lamiz

$$W = -\frac{1}{2\beta}\left(Uu^2 - \frac{u^3}{3}\right) \qquad (3)$$

va $u = 0$ hamda $u = 2U$ ekstremal nuqtalar. *W(u)* ning bog'liqligi (1a)-rasmda, (2) osilatorning fazaviy portreti (1b) - rasmda keltirilgan. Shunday qilib, ikkita muvozanat holati mavjud, ulardan biri ($u = 0$) egar, ikkinchisi $u = 2U$ markazdir.



(1-rasm) Kordevega-de Vriza tenglamasining statsionar yechimlari uchun potensial energiya (a) va faza portreti (b)



(2- rasm) Kortevega-de Vriza tenglamasining statsionar yechimlarining har xil turlari: a - kvazigarmonik davriy to'lqin; b-knoidal to'lqin; v-soliton

Faza portretini o'rganish statsionar yechimlarning mumkin bo'lgan turlarini sifat jihatidan tahlil qilishga imkon beradi. Albatta, harakat chegaralangan bo'lgan separatris halqa ichida yotgan traektoriyalargina fizik ma'noga ega. Barqaror muvozanat holatiga yaqin joyda osilatorning tebranishlari kuchsiz chiziqli emas, shuning uchun yechim kvazigarmonik statsionar to'lqindan iborat (2a-rasm). Separatris yaqinida harakat kuchli chiziqli bo'lmagan davriy to'lqinlar xarakteriga ega (2b-rasm), Kortevega va De Vriz knoidal deb nomlanadi. Va nihoyat, separatris bo'ylab harakatlanish yakka to'lqin — soliton shaklida yechimga to'g'ri keladi (2v-rasm). Solitonning amplitudasi aniq $a = 3U$, ya'ni soliton qanchalik tez harakat qilsa, u shunchalik yuqori bo'ladi.

Separatorli halqa gomoklinik yoki ikkilamchi asimptotik traektoriya deb ataladi [2, 10], ikkala tomonda bir xil chegaraga (muvozanat holatiga) olib keladi ($\xi \to \pm\infty$). Egar nuqtasiga cheksiz uzoq yaqinlashish va undan uzoqlashish solitonning cheksiz "dumlari" ga to'g'ri keladi.

Foydalanilgan adabiyotlar

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