Improved perturbation theory for solving the equation of anharmonic oscillations.

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The equations of natural processes are nonlinear and in many cases do not have an exact analytical solution. The perturbation theory is useful for solving equations with small nonlinearity. The appearance of resonance terms leads to an increase in error at large times. These resonance terms can be eliminated using improved perturbation theory.

Angarmonik tebranishlar tenglamasini yechishda takomillashgan g'alayonlar nazariyasi.

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Tabiatdagi jarayonlar tenglamalari nochiziqli bo'lib ko'p hollarda aniq analitik yechimi mavjud emas. G'alayonlar nazariyasi nochiziqliligi kichik tenglamalarni yechishda qo'l keladi. Rezonans hadlar paydo bo'lishi katta vaqtlarda xatolikni ko'payishiga olib keladi. Takomillashgan g'alayonlar nazariyasi yordamida bu rezonans hadlarni bartaraf qilish mumkin.

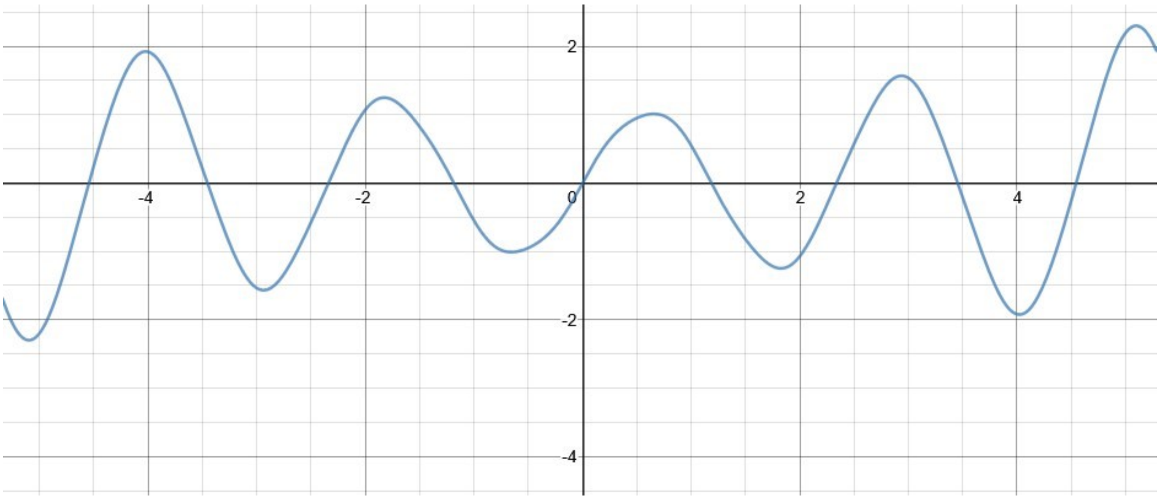
Bu ishda tenglamada x^5 nochiziqlik uchun tashqi rezonans kuch yo'q hol uchun taqribiy yechimlar topilgan. Tenglama

$$\ddot{x}+\omega_0^2 x=\varepsilon(ax^3+x^5) \qquad (1)$$

ko'rinishga ega bo'lsin. Nochiziqlilikning ax^3 qismi uchun ychim [1] adabiyotda keltirilgan. Biz x^5 nochiziqlik uchun taqribiy yechimlarni topamiz. Buning uchun tebranishlar funksiyasini quyidagicha qatorga yoyamiz:

$$x=x_0+\varepsilon x_1+\varepsilon^2 x_2+\ldots,$$

Bu ma'lum bo'lgan natijaga ya'ni tebranishlar amplitudasi oshishiga olib keladi.



1-rasm.

1-rasmda bu natija keltirilgan. Paydo bo’lgan asriy hadlar tufayli amplituda oshyapti. Amplitudani o’sishini bartaraf etish uchun tebranishlar chastotasini va funksiyasini quyidagicha qatorga yoyamiz:

$$\omega^2 = \omega_0^2 + \varepsilon f_1 + \varepsilon^2 f_2 + \cdots; \qquad x = x_0 + \varepsilon x_1 + \varepsilon^2 x_2 + \ldots,$$

va (1) tenglamaga olib borib qo’yamiz.

$$\ddot{x}_0 + \varepsilon \ddot{x}_1 + (\omega^2 - \varepsilon f_1)(x_0 + \varepsilon x_1) = \varepsilon a x^3 + \varepsilon(x_0 + \varepsilon x_1 + \cdots)^5$$

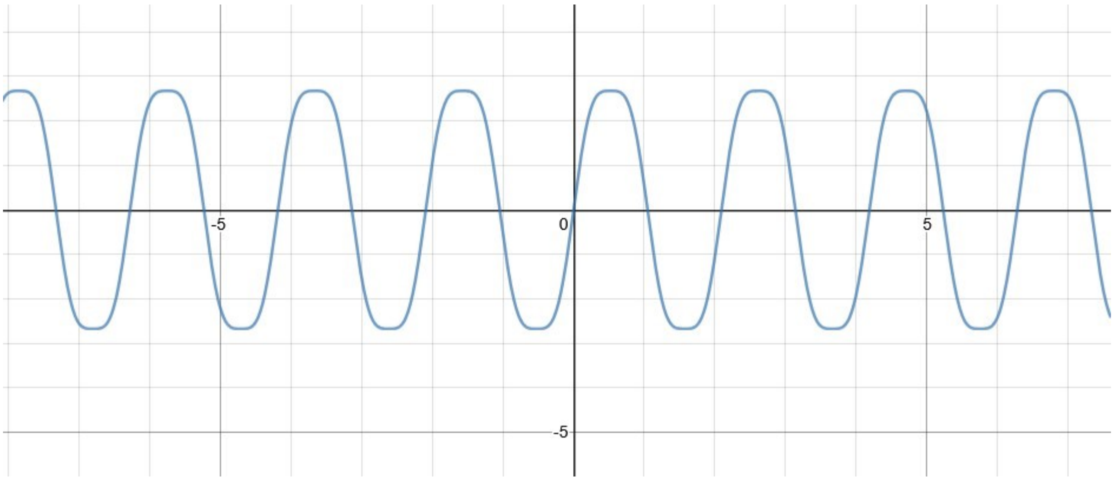
$$\ddot{x}_0 + \varepsilon \ddot{x}_1 + (\omega^2 - \varepsilon f_1)(x_0 + \varepsilon x_1) = \varepsilon a x^3 + \varepsilon\left(x_0^5 + \ldots\right) \qquad (2)$$

X^5 nochiqlik qismi uchun tenglamalarni yozamiz. ε ning darajalari bo’yicha tenglamalarga ajratamiz. Bunda sistemani rezonansga keltiradigan hadlar paydo bo’ladi. Takomillashgan g’alayonlar nazariyasida rezonans hadlarni yo’qotish uchun chastotaning qator koeffisientlari ishlatiladi. Davriy hadlarni qisqartirilgandan so’ng tenglama yechimi quyidagi ko’rinishda topiladi.

$$f_1 = -\frac{5A^4}{8} \; ; \quad \omega^2 = \omega_0^2 - \varepsilon \frac{5A^4}{8}$$

$$x_1 = A^5 \frac{5}{128\omega^2} sin3\,(\omega t + \varphi) - A^5 \frac{1}{384\omega^2} sin5\,(\omega t + \varphi) \quad (3)$$

2-rasmda tebranishlar grafigi keltirilgan.



2-Rasm

[1] A.A.Abdumalikov, Nochiziqli to’lqin tenglamalar, 2010