Comment on "Homoclinic chaos in strongly dissipative strongly coupled complex dusty plasmas"

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In a recent paper [S. Ghosh, Phys. Rev. E **103**, 023205 (2021)], the transport properties of the two-dimensional weakly nonlinear quasilongitudinal dust lattice mode were investigated in a highly viscous, strongly coupled, and weakly ionized plasma. Based on the computational results, the author predicted strong viscosity induced Shilnikov homoclinic chaos. In this Comment, it is shown that the dynamical system presented in the paper is inconsistent and incorrect because of an error in the expression of ϵ. As a result, period-2, period-4, chaotic and homoclinic chaotic phenomena do not exist, which were observed in the paper.

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In a recent article, Ghosh [1] investigated the transport properties of the two-dimensional weakly nonlinear quasi-longitudinal dust lattice mode in a highly viscous, strongly coupled, and weakly ionized plasma. Using a continuum approximation, suitable stretching, and scaling, the author obtained the nonlinear partial differential equation (10) for the weakly nonlinear transport of the quasilongitudinal dust lattice wave in highly dissipative strongly coupled complex dusty plasma. The author obtained a dynamical system from Eq. (10), which is erroneous [2]. As a result, the obtained phenomena (period-2, period-4, chaotic motion, and homoclinic chaos) are not correct. To show this fact, we derive the dynamical system in a correct form and obtain the wave phenomena presented in the paper [1]. We analyze Eq. (10) in the χ frame of [1].

Then, Eq. (10) can be reduced to the correct form of the following dynamical system:

$$\frac{d\phi}{d\chi} = \psi,$$

$$\frac{d\psi}{d\chi} = \varphi$$

$$\frac{d\varphi}{d\chi} = \phi\left(U - \frac{1}{2}\phi\right) - \varepsilon\psi - \delta\varphi, \tag{1}$$

where U and δ are the same as the paper, with different $\varepsilon = 2.1\, V_f\, \nu_0^{2/3}\, k_\xi^{-1/3}$, and $V_f = 1 + 0.5\, k_\xi \tan^2\theta/(1 - 2.1\, k_\xi^{-1/3} \nu_0^{2/3})$. In the paper, $\varepsilon = 2.1\, V_f\, \nu_0^{2/3}\, k_\xi^{-5/3}$. Due to this error in ε, all the computational results presented in the paper [1] are wrong. Considering the same values of parameters and initial condition as in the paper, the correct phase plots of the dynamical system (1) are presented in Figs. 1(a)–1(d) for different values of $k_\xi = 1, 1.33, 1.35$, and 1.5, respectively. In all four cases, the dynamical system (1) shows one-period motion only without a small amplitude, which is supported by the graph of Lyapunov exponents with respect to k_ξ in Fig. 2. Hence, there is no period doubling as well as homoclinic bifurcation for the dynamical system (1) using the same parametric and initial conditions as presented in the paper [1].

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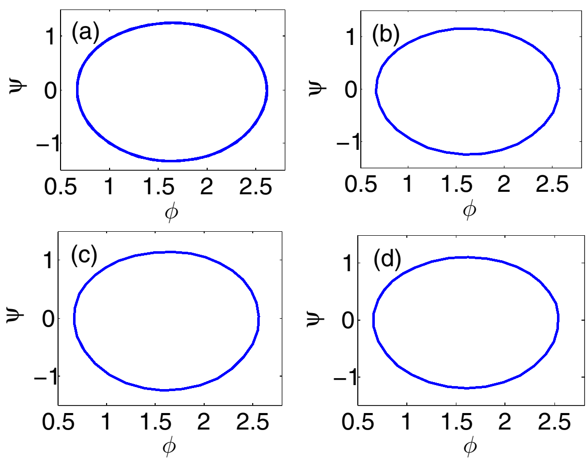

FIG. 1. Phase plots of the system (1) for $v_0 = 0.8$, $\theta = 10^\circ$ with (a) $k_\xi = 1$, (b) $k_\xi = 1.33$, (c) $k_\xi = 1.35$, and (d) $k_\xi = 1.5$, under same initial conditions as in [1].

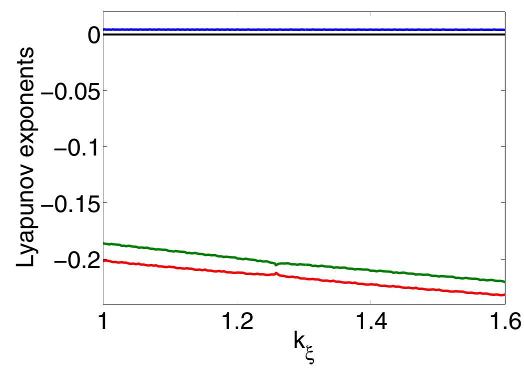

FIG. 2. Lyapunov exponents vs k_ξ for the system (1) with the same parametric and initial condition as Fig. 1.

[1] S. Ghosh, Phys. Rev. E **103**, 023205 (2021).

[2] S. Ghosh, Phys. Rev. E **104**, 019901 (2021).