Some new aspects of dust-acoustic structures in space plasmas out of equilibrium

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Some features of linear and nonlinear dust-acoustic (DA) structures is investigated in a space plasma consisting of superthermal electrons, positrons and positive ions in the presence of negatively charged dust grains with finite-temperature by employing a pseudo-potential technique in a hydrodynamic model. For this purpose, it is assumed that the electrons, positrons and ions obey a Kappa-like distribution in the background of adiabatic dust population. In the linear analysis, it is found that the dispersion relation yield two positive dust-acoustic branches, i.e., the slow and fast DA waves. The upper branch (fast DA waves) corresponds to the case in which both (negatively charged) dust particles and (positively charged) ion species oscillate in phase with electrons and positrons. On the other hand, the lower branch (slow DA waves) corresponds to the case in which only dust particles oscillate in phase with electrons and positrons, while ion species are in antiphase with them. On the other hand, the fully nonlinear analysis shows that the existence domain of solitons and their characteristics depend strongly on dust-charge Z_d, ion-charge Z_i, dust-temperature and the spectral index κ . It is found that the minimum/maximum Mach number increases as the spectral index κ increases. Also, it is found that only solitons with negative polarity (rarefactive solitons) can propagate and that their amplitudes increase as the parameter κ increases. Furthermore, the domain of Mach number shifts to the lower values, when the value of dust-charge Z_d increases. Moreover, it is found that the Mach number increases with an increase in dust temperature. Our analysis confirms that in space plasmas with highly charged dusts, the presence of superthermal particles (electrons, positrons and ions) may facilitate the formation of DA solitary waves. Particularly, in two cases of hydrogen ions H^+ ($Z_i = 1$) and two times ionized Helium atom He^{2+} ($Z_i = 2$) the mentioned results are the same. Additionally, the mentioned dusty plasma don't supports DA solitons with positive polarity (compressive solitons). Furthermore, our analysis confirms that DA double layers cannot exist in such a system. Moreover, the positron density has not a considerable effect on the behavior of DA solitons in our model.

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