Instability of thermoacoustic shocks in fluid plasmas

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In certain environments including those where the combustion reaction occurs, the thermoacoustic instability can induce oscillations leading to particle accelerations. Recently, the onset of such instability in the linear regime in fluid complex plasmas and strongly coupled systems has been reported [1,2]. It was shown that the positive thermal feedback due to nonreciprocal interactions of charged particles can lead to the amplification of thermoacoustic waves. Here, we advance the theory in the nonlinear regime to reveal the instability of thermoacoustic shocks in unmagnetized, collisional, viscous fluid complex plasmas In the linear regime it is found that when the effective thermoacoustic interaction is lower (or higher) than the particle collision and/or the kinematic viscosity, the thermoacoustic waves get damped (or anti-damped). However, the thermoacoustic waves in the nonlinear regime can propagate as shocks whose evolution is governed by the Burgers-like equation with nonlocal nonlinearity. The influence of the latter is examined on the stability and instability of shocks. Furthermore, the characteristics of different kinds of shocks are analyzed with the effects of the thermal feedback, thermal diffusion, heat capacity, the particle collision and the fluid kinematic viscosity. A good agreement between the analytical and numerical results is also noted. Such shocks may be able to transport particles and can thereby accelerate them in the conducting medium.

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